A Study of Brine Treatment

EPRI

Keywords:
- Brine Treatment Methods
- Scaling Prevention
- Corrosion Prevention
- Survey

EPRI ER-476
Project 791
LBL-6371
UC-66d
TID-4500-R65
Final Report
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Prepared by
Lawrence Berkeley Laboratory
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(Operating under
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ELECTRIC POWER RESEARCH INSTITUTE

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ABSTRACT

The objective of this project was to collect the available information pertinent to the treatment of geothermal brines by literature search and then evaluate and summarize this information for use by the electric utility and geothermal industry.

The information used for this study was screened from the geothermal, oil and gas, wastewater disposal, and boiler water treatment industries. This information was evaluated and the current state of knowledge and methodology concerning the treatment of geothermal brines to control scaling and corrosion in geothermal electric power production was assessed. Currently, geothermal scale in pipes and wells is removed by physical or chemical methods. There is a growing effort on developing methods to control scale formation for both fresh and spent brines, including pH adjustment and application of an electrical potential for fresh fluids, and coagulation to treat spent fluids. Current methods of corrosion control center around planned replacement of piping and other plant components, with efforts focused primarily on development of materials with improved corrosion resistance. Recommendations for additional work to improve brine treatment include the following:

1) Chemical and physical characterization of brine and scale compositions

2) Basic data on the mechanism of scale formation and the effects of inhibitors

3) Development of instrumentation to monitor geothermal brine constituents

4) Correlation of laboratory results with field test data

5) Screening of currently available commercial inhibitors for application to geothermal brines

An annotated bibliography of the reference material used in this study is contained in this report.

ACKNOWLEDGMENT

The authors are thankful to Arnold E. Greenberg, State of California Department of Health, Berkeley, CA; Phillip N. La Mori, Electric Power Research Institute, Palo Alto, CA; Daniel A. McLean, East Bay Municipal Utility District, Oakland, CA; Lawrence B. Owen, Lawrence Livermore Laboratory, Livermore, CA, and Donald W. Shannon, Battelle Pacific Northwest Laboratories, Richland, WA, for their comments.

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Section 1

INTRODUCTION

Utilization of geothermal energy for power production requires a fluid (e.g., brine) to extract heat from the earth. Major development of geothermal energy in the next 25 years will be in regions where the fluid occurs naturally and has been in contact with the country rocks for a considerable period of time. The chemical composition of the fluids will therefore reflect the composition of the country rock and in general be in chemical equilibrium with it. Because of the wide variety in rock types, the composition of geothermal fluids is expected to vary widely, ranging from several thousand to several hundred thousand ppm dissolved solids combined with dissolved gases (e.g., CO_2, H_2S) in an aqueous solution. The fresh fluids can react with the total geothermal power generation system to cause scaling and corrosion, and may plug injection wells and formations.

Treatment of the fluids by chemical or physical methods could reduce scaling in the power cycle and plugging in the injection cycle. The problem is compounded by the large volume of fluids required for geothermal power production. As a result many chemical treatment systems which can be devised to control scaling and corrosion could be uneconomic. The treatment techniques devised for geothermal brines will have to be of low cost, e.g., additions of ions, catalysts, electric charge, settling, coagulation.

The purpose of this study is to compile and evaluate the current information on brine treatment technology for use by the utility industry and EPRI. The current published worldwide literature on treatment of geothermal brines to control scaling and corrosion is sparse, with information widely scattered and incomplete. For this reason, we have also included in the compilation and drawn on the relevant data from other industries (e.g., boiler water, wastewater disposal, oilfield brines) to provide additional information which may be useful to geothermal brine treatment methodology.

Scale incrustation is a fairly common occurrence that arises mainly from the deposition of soluble or suspended constituents of geothermal brines in piping and other components of power plants (Ref. 1, 2). The interest in controlling scaling stems from two major concerns: (1) plugging of well casings and pipes transporting geothermal hot water, and (2) decrease in the efficiency of heat exchangers and other components. The other main problem related to geothermal hot water utilization covered here is corrosion of metallic components of power plants which are in contact with the fluid. The corrosion process is complicated and related to a number of parameters, including the following: material of construction, chloride concentration, pH, CO_2 partial pressure, H_2S partial pressure, and temperature of the brine. Current methods of dealing with corrosion center around either scheduled replacement of plant components or the selection and choice of suitable resistant materials (Ref. 3). Table 1-1 lists the principal parameters affecting geothermal scaling and corrosion.

Data on brine chemistry are important because scale and corrosion treatment methods must be designed on the basis of the brine constituent (e.g., sulfide content) that should be changed by the treatment to control scaling and corrosion. The dissolved solids and gases content of selected geothermal brines are listed in Table 1-2 and Table 1-3.

While it is our intent that this report be as comprehensive as possible, it is realized that no literature search can be totally complete. In this context, the reader is urged to communicate important omissions on geothermal brine treatment to the National Geothermal Information Resource, Lawrence Berkeley Laboratory, University of California, Berkeley, CA 94720. This additional information, together with new data, will be stored in our computer file for subsequent critical evaluation and general dissemination.

For additional background information on geothermal scaling and corrosion, the reader is referred to the following: Economic Impact of Corrosion and Scaling Problems in Geothermal Energy Systems (Ref. 2), Silicate Scale Control in Geothermal Brines--Final Report (Ref. 4), Scale Deposition and Control Research for Geothermal Utilization (Ref. 5), Materials Problems Associated with the Development of Geothermal Energy Resources (Ref. 6), Second Workshop on Materials Problems Associated with the Development of Geothermal Energy Systems (Ref. 7), and "Corrosion Encountered in Energy Extraction from Geothermal Brines and Steams" (Ref. 9).

Table 1-1

IMPORTANT PARAMETERS AFFECTING SCALING AND CORROSION IN GEOTHERMAL PLANTS

Scale and Incrustation

- Brine composition
- Temperature and temperature changes
- Pressure changes, including partial pressure change in CO_2, H_2S, NH_3
- Velocity and turbulence
- Residence time in each part of plant
- Surface effects and surface to volume ratio effects
- Fluid phase (steam or water)
- Geometry of power plant components
- Salt carryover in steam phase

Materials Corrosion

- Brine composition
- pH of fluid
- Temperature and temperature changes
- Fluid phase (steam or water)
- Moisture and soluble salts carryover in steam phase
- Partial pressures of CO_2, H_2S, NH_3, H_2
- Atmospheric O_2 leakage into plant system (e.g., piping, condenser, heat exchanger)
- Stress levels in materials and especially cyclic stresses
- Crevices
- Presence of scale deposits
- Passive or active state of metal protective films
- Velocity of fluid
- Suspended solids content
- Ionic strength of water
- Galvanic coupling of dissimilar metals
- Power plant material

Table 1-2

NOMINAL CONCENTRATIONS OF GASES IN GEOTHERMAL BRINES (PPM). DATA ARE FOR STANDARD TEMPERATURE AND PRESSURE. (REF. 10)

	Iceland	New Zealand	Raft River (Idaho, USA)	Boise (Idaho, USA)
CO_2	90	92	16.4	0.20
H_2S	2.6	4.2	--	0.005
H_2	2.0	1.8	0.06	--
CH_4	0.03	0.9	0.01	0.065
N_2	--	--	100.	18.5
Ar	4.43	0.3	2.6	0.62
O_2	0.0	--	0.02	0.003

Table 1-3

APPROXIMATE CONCENTRATION OF DISSOLVED SOLIDS IN SELECTED GEOTHERMAL WATERS COMPARED WITH SEAWATER AND OILFIELD BRINES

	[a]Seawater (mg/l)	[c]Oilfield Brine (mg/l)	[a]East Mesa, Calif. (Holtville) (ppm)	[d]East Mesa (Well 6-1) (mg/l)	[b]Salton Sea, Calif. (Sinclair #3) (ppm)	[b]Salton Sea (Niland #IID-2) (ppm)	[b]Salton Sea (Woolsey #1) (ppm)	[b]Salton Sea (Magmamax #1) (mg/l)	[b]Raft River, Idaho (RRGE #2) (ppm)	[b]Roosevelt Hot Springs, Utah (#3-1) (ppm)	[a]Wairakei, New Zealand (ppm)	[b]Cerro Prieto, Mexico (#M-5) (ppm)
T°C	16-22	--	165-180	138	280*	330*	238*	240	126	> 205	240	100
pH	8.0	--	7.6	5.6-6.0	5.3	4.64	6.2	6.1	6.96	6.3	8.6	7.89
SiO_2	7.0	--	100	286	350	400	112	435	86.8	560	640	1,318
Li	0.1	--	55	54	49	210	65.0	75.6	1.1	20.0	14	22.9
B	--	--	--	--	210	390	--	--	--	25.0	--	17.7
Na	10,561	12,000-150,000	11,000	7,050	36,340	53,000	49,257	47,300	408	2,437	1,320	8,016
K	380	30-4,000	1,430	890	7,820	16,500	2,881	7,960	36	448	225	1,899
Mg	1,272	500-25,000	22	16	780	10	651	110	0.04	0.01	0.03	0.50
Ca	400	1,000-120,000	1,370	770	14,550	27,800	8,550	23,600	27.5	8.0	17	504
Sr	13	--	226	135	360	440	--	102	0.9	--	--	15.4
Ba	0.05	--	58	--	540	250	--	55.3	< 4	--	--	9.4
F	1.4	--	1.5	--	2.4	--	--	12.0	7.4	5.0	8.3	2.0
Cl	18,980	20,000-250,000	18,000	14,000	93,650	155,000	59,015	123,390	678	4,090	8,730	14,828
I	--	1-300	--	--	--	--	--	--	--	--	--	.74
Br	380	50-5,000	35	--	--	--	--	--	--	--	--	23.7
SO_4	2,650	0-3,600	16	173	58	--	--	< 10.0	--	59	36	13.0
HCO_3	140	0-1,200	--	--	60	--	--	61.6	38	180	19	59.0
CO_3	--	--	--	300	--	500	--	--	--	--	--	0.0
NO_3 or Bi	--	--	--	--	--	--	--	Bi = 5.0	--	NO_3 = 0.1	--	--
S	--	--	< 1	< 1	--	30	--	--	--	--	--	--
NH_4	0.05	--	39	--	340	--	--	570	1.2	--	0.2	--
Fe	10^{-9}	--	0.18	1-10	166	2,000	84.0	172	--	--	--	0.51
Mn	0.01	--	0.9	--	410	1,370	121.0	--	0.55	--	--	0.88
Ni	--	--	--	--	--	--	--	1.05	0.66	--	--	< 0.01
BO_4	--	--	--	36	--	--	--	--	--	--	--	--
Cs	--	--	--	--	--	20	--	250	--	--	--	39.5
Rb	--	--	--	--	--	70	--	50.4	--	--	--	11.2
Pb	--	--	--	--	80	80	--	36.2	--	--	--	--
As	--	--	--	--	10.0	--	--	.187	--	--	--	1.5
Ag or Sn	--	--	--	--	--	Ag < 1	--	Sn = 2.2	--	--	--	--
Zn or Cr	--	--	--	--	--	Zn = 500	--	Zn = 283	--	--	--	Cr < 0.5
Sb or Cu	--	--	--	--	Sb = 0.2	Cu = 3	--	Sb = 6.7	--	--	--	--
TOTAL DISSOLVED SOLIDS	--	--	--	24,800	153,300	259,000	120,735	203,410	--	7,067	--	25,429

[a]Ref. 10 [b]Ref. 11 [c]Ref. 12 [d]Ref. 4

*Maximum well temperature; all other temperatures listed are measured at the wellhead.

Section 2

SCOPE OF STUDY

The scope of this study includes the current, proposed, or suggested means for the treatment of geothermal hot water with the purpose of controlling scaling and corrosion prior to (1) utilization of the fluid for electric power production, and (2) disposal of the spent fluid, e.g., to injection wells or holding ponds. Discussion of the treatment of geothermal fluids is based on available worldwide data and is intended to be comprehensive; selected methods are included from other technologies, principally boiler water, wastewater, and oilfield brine treatment.

BRINE TREATMENT FOR SCALE CONTROL

This section centers on the work to date covering mainly the following: (1) the methods of treatment of fresh geothermal brines to prevent scale formation prior to utilization in power production (e.g., pH adjustment); (2) methods that are or might be used to treat geothermal brines after power production utilization and prior to disposal, for example, coagulation.

The brine treatment study centers around the three principal forms of deposits which are commonly found in geothermal scales: silica, carbonate, and sulfide. It is recognized that a geothermal scale is likely to be composed of a mixture of these main deposits and lesser amounts of other substances (e.g., Fe, Pb), so that brine treatment methods specific to calcite, silica, or sulfides may have to be modified for application to mixed scales. Tables 2-1 through 2-8 list the compositions of some geothermal brines and the resulting scales. Since brine treatment methodology for geothermal applications is still in the experimental/development stage and since most scale and incrustants are by and large removed mechanically or chemically, we have also included for completeness a section covering methods which are or might be used for the removal of scale once it has formed (e.g., reaming, acidizing).

Additional information on geothermal scaling may be obtained from the following: <u>Silicate Scale Control in Geothermal Brines--Final Report</u> (Ref. 4), <u>Second Workshop</u>

on Materials Problems Associated with the Development of Geothermal Energy Systems (Ref. 7), and Conference on Scale Management in Geothermal Energy Development (Ref. 8).

BRINE TREATMENT FOR CORROSION CONTROL

This section covers mainly deaeration and materials selection which are the principal methods used or suggested to control the rate of corrosion for geothermal brines.

The reader is referred to the Extended Abstracts of the fall meeting of the Electrochemical Society (Ref. 9) for recent work on geothermal corrosion.

In summary, the literature on geothermal scaling and corrosion is not extensive. In other treatment technologies, we have found the following as useful sources for non-geothermal brine treatment data: Water Quality and Treatment (Ref. 16); Brine Disposal Treatment Practices Relating to the Oil Production Industry (Ref. 12); Subsurface Salt-Water Disposal (Ref. 17); Introduction to Oilfield Water Technology (Ref. 18); Underground Waste Management and Environmental Implications (Ref. 19), and Salt Water Disposal, East Texas Oil Field (Ref. 20).

Table 2-1

DESCRIPTION OF TYPICAL BRINE AS DELIVERED TO TEST UNIT
FROM EAST MESA WELL 6-1 BETWEEN 3/18/74 AND 4/9/74 (REF. 5)

State	Liquid, clear, colorless
Temperature	138°C (280°F)
Pressure	88 psig
Solution saturated pressure	65 psig @ 138°C
Density @ 25°C	1.011
pH	5.6 to 6.0

Total dissolved solids 24800 mg/l

Cl	14000 mg/l	Mg	16 mg/l
Na	7050 mg/l	SiO_2	286 mg/l
K	890 mg/l	CO_3	300 mg/l
Ca	770 mg/l	SO_4	173 mg/l
Fe	1 to 10 mg/l	S	<1 mg/l
Sr	135 mg/l	BO_4	36 mg/l
Li	54 mg/l		

Table 2-2

CHEMICAL COMPOSITION OF SCALES FROM EAST MESA WELL 6-1 BRINE.
ALL COMPONENTS IN WEIGHT PERCENT. (REF. 5)

	RUN	Na	Cl	CO_3	Ca	Fe	SiO_2	Sr	Mg	Mn	SO_4	K	S	SUM[1]	SUM[2]
PROBE	102	0.74	0.81	28.80	14.60	21.00	15.02	0.21	0.31	0.68	-	0.12	0.02	82.31	104.10
PROBE	205	5.55	-	-	20.90	6.20	0.86	0.40	0.30	-	-	-	-	-	-
PYREX PIPE	205	0.43	-	56.81	31.50	6.70	0.10	0.40	0.10	-	-	-	-	96.04	100.18
CONTROL VALVE STEM	205	0.12	-	55.74	34.90	6.40	0.20	0.60	0.10	-	-	-	-	96.06	102.08
PROBE BOTTOM THIRD	207	0.11	0.26	52.40	29.00	7.23	2.00	0.61	0.11	0.52	0.29	0.03	-	92.56	98.16
PROBE TOP THIRD	207	0.13	0.24	54.18	30.30	6.33	1.20	0.62	0.10	0.52	0.32	0.02	-	93.96	98.53
SEPARATOR ENTRY	207	0.11	0.16	54.25	33.10	2.55	0.94	2.44	0.04	0.17	0.21	0.01	-	93.98	96.09
PROBE	300	3.34	3.91	47.57	27.80	3.79	6.40	0.39	0.13	-	-	-	0.02	93.35	99.49
PROBE, UNHEATED PART	301	0.16	0.17	56.33	30.30	8.00	0.24	0.40	0.20	0.55	-	0.01	0.04	96.40	101.41
PROBE, HEATED PART	301	0.09	0.11	57.40	30.70	7.62	0.11	0.44	0.20	0.51	-	0.01	0.02	97.21	101.92
PROBE	302	0.87	-	11.48	6.11	24.50	29.80	-	0.20	-	-	-	-	72.96	105.73
PROBE TOP	303	0.10	0.01	57.42	33.20	6.40	0.38	0.50	0.20	-	-	-	-	98.21	102.34
EXIT LINE	204/5	1.50	0.02	-	0.87	27.20	28.20	0.10	0.30	-	-	-	-	58.19	91.64
MOLECULAR WEIGHT	-	22.99	35.45	60.01	40.08	55.84	60.09	87.62	24.31	54.93	96.06	39.10	32.10	-	-

(1) Of determined components listed in table

(2) Assuming 2.5 moles OH per mole Fe and 2 moles H_2O per mole SiO_2

Table 2-3

CHEMICAL COMPOSITIONS OF GEOTHERMAL WATER OF NO. 1 AND NO. 2 WELLS (PPM), MATSUKAWA, JAPAN (REF. 13)

Thermal water	pH	SiO_2	Fe	Al	Ca	Mg	SO_4	Na	K
No. 1	5.0	1000-1500	400-600	10-15	30-40	10-15	1500-1800	200-300	150-200
No. 2	7.5	2000	5	5-10	10-15	5	400	150-200	40-50

Table 2-4

CHEMICAL COMPOSITIONS OF SCALE IN NO. 1 AND NO. 2 WELLS (%), MATSUKAWA, JAPAN (REF. 13)

Scale	SiO_2	Fe	Al	CaO	MgO	SO_4	S	Na	K
Well No. 1	17.75	12.20	0.83	0.30	0.21	40.84	3.20	9.25	5.05
Well No. 2	90.45	0.35	0.84	0.59	0.30	2.25	Tr	1.50	0.50

Table 2-5

CHEMICAL COMPOSITION OF SCALE (%) IN GEOTHERMAL POWER PLANT, MATSUKAWA, JAPAN (REF. 13)

		SiO_2	Fe	Al	CaO	MgO	SO_4	S	Na	K
A		69.85	4.25	17.34	0.40	0.23	—	3.74	—	—
B	No. 1 well silencer	17.75	12.20	0.83	0.30	0.21	40.84	3.20	9.25	5.05
C		16.20	13.96	0.27	0.40	0.65	41.45	4.25	—	—
D		51.80	13.74	0.36	0.38	0.38	1.12	7.79	—	—
E		14.0	16.5	1.5	1.4	1.1	51.99	0.1	—	—
F	400 kW Generator	59.0	7.0	0.8	1.7	1.2	13.8	0.05	—	—
G		Tr *	46.90	Tr	Tr	Tr	Tr	53.10	Tr	Tr
H		61.55	3.80	0.27	1.50	1.20	10.20	0.05	2.35	0.80
I_1		67.3	11.6	0.45	1.30	0.80	26.50	Tr	6.50	3.80
I_2		90.45	0.35	0.84	0.59	0.30	2.25	Tr	1.50	0.50
J	Separator	58.5	16.3	—	0.6	0.3	16.8	—	--	—
K		70.82	4.46	3.77	8.06	3.07	3.50	0.25	1.00	0.40
L		71.20	0.33	0.08	0.66	0.02	15.24	Tr	5.90	3.00
M	Header	66.60	17.62	0.87	0.96	Tr	0.83	9.55	Tr	Tr
N		50.42	28.14	4.21	0.12	Tr	0.32	14.25	Tr	Tr
O		40.90	27.30	2.80	4.76	1.50	15.89	—	—	—
P	Drain separator	72.50	6.03	3.23	4.20	0.01	10.22	0.50	1.00	0.50
Q		65.40	8.94	2.13	4.36	0.03	8.50	0.80	1.10	1.00
R	Main valve	78.90	5.24	0.25	1.35	0.17	13.50	Tr	2.30	1.00
S_1	Control valve	69.28	1.00	0.05	1.60	0.04	17.56	Tr	6.10	3.80
S_2		44.40	2.01	1.84	1.30	0.55	32.82	Tr	8.5	3.5
S_3		49.10	2.01	1.63	1.28	0.33	30.06	Tr	8.0	4.0
T_1	Rotor	24.00	10.20	0.53	1.14	0.30	50.26	0.38	9.26	2.80
T_2		11.30	50.83	0.20	0.35	0.11	23.50	2.28	2.30	0.60
T_3		4.00	55.49	0.20	0.05	Tr	17.75	4.31	0.56	Tr
U_2	Nozzle	58.60	1.45	0.11	3.44	0.13	24.05	0.20	7.2	4.7
U_3		60.00	4.80	5.82	9.11	0.36	14.50	Tr	2.1	1,3
V	Exhaust pipe	6.00	55.85	Tr	Tr	Tr	2.90	7.70	—	—
W	Ejector	40.60	27.40	2.50	0.49	0.40	15.50	2.10	2.3	0.8
T_{p1}	Trap	31.40	32.50	1.80	0.80	0.41	18.40	3.20	3.25	1.80
T_{p2}		80.52	6.20	0.85	0.49	0.18	8.80	Tr	2.0	0.8

* Tr = traces.

Table 2-6

CHEMICAL COMPOSITION OF THE FLUIDS FLOWING FROM THE CERRO PRIETO WELLS, MEXICO (REF. 14)

Well No.	Sampling Date	Pressure (psig)	Chemical composition in ppm									Ratios	
			Na	K	Li	Ca	Cl	B	CO_3	HCO_3	SiO_2	Na/K	Na/Ca
•M-1A	12/72	3	4175	575	11	212	7470	8	0	62	235	12.3	34
•M-3	8/72	200	5875	1312	15	331	11261	11	13	64	507	7.6	31
M-5	6/73	300	8300	2210	27	521	16431	15	6	44	864	6.4	28
•M-6	10/72	10	4375	475	17	552	8141	6	0	836	162	15.6	14
•M-7	11/72	71	5800	1175	16	316	10258	14	8	197	530	8.4	32
M-8	6/73	232	7999	2125	24	427	15884	18	5	74	1218	6.4	32
M-9	6/73	100	6331	1067	17	447	11459	11	8	65	495	10.1	25
•M-10	12/72	197	5500	1487	17	232	9910	14	13	179	675	6.3	41
M-11	6/73	578	8281	1987	18	494	15965	17	0	59	870	7.1	29
M-13	6/72	148	8775	2200	26	448	16254	11	27	27	880	6.7	34
•M-15	3/69	315	5375	1587	–	260	9604	7	0	19	1231	5.7	36
M-15A	1/75	212	6000	1125	15	321	11500	9	24	19	678	9.1	32.1
M-19A	2/75	415	8540	2124	20	547	16750	–	–	–	967	6.8	26.8
M-20	1/74	120	7100	1620	15	510	12800	13	5	58	800	7.4	25
•M-21	10/72	610	5525	1725	18	304	11437	10	13	106	675	5.4	32
•M-21A	4/74	280	5803	1628	14	318	10301	–	–	–	804	6.0	34
M-25	1/74	105	8650	2000	23	585	16900	–	–	44	900	7.3	28
M-26	1/74	92	9050	2200	20	840	16800	–	–	40	1000	7.0	22
M-29	2/74	90	6450	1200	15	480	12100	13	16	55	500	9.1	23
M-30	1/74	116	8500	1980	22	585	16400	–	–	36	950	7.3	25
M-31	1/74	274	7700	1930	20	500	15400	14	11	48	850	6.7	26
M-34	2/74	86	7100	1200	18	645	13100	11	0	48	600	10.0	19
M-35	3/74	290	9459	2557	20	545	17064	–	–	–	–	6.3	30
M-38	10/72	540	7050	1900	23	360	13984	15	8	58	755	6.3	34
M-39	2/74	90	6100	1080	14	455	11300	15	30	60	650	9.6	23
•M-51	4/74	340	6180	1905	16	302	11184	–	–	–	785	5.5	35
•M-53	11/74	1088	7843	2742	–	341	16483	–	–	–	1441	4.8	39.5

•Samples were obtained by bleeding the well through a small drainage line.

Table 2-7

CHEMICAL ANALYSES OF WELL CASING INCRUSTATIONS,
CERRO PRIETO, MEXICO (% WEIGHT) (REF. 14)

Measurement	As	M-5	M-6	M-7	M-10
Silicon	SiO_2	15.1	T	1.8	19.5
Iron	FeS	83.4	T	1.2	1.6
Calcium	$CaCO_3$	1.5	97.5	93.0	75.5
Magnesium	$MgCO_3$	T	2.5	4.0	2.2
Depth (m)		604	--	200	--

T = trace

Table 2-8

CHEMICAL COMPOSITION OF SCALE IN PRODUCTION PIPE
OF WELL M-9 (750731) AT 147-170 METERS, CERRO PRIETO, MEXICO (REF. 15)

$CaCO_3$	75.56%
SiO_2	12.51%
NaCl	0.82%
FeS	9.46%

Section 3

BRINE TREATMENT FOR SCALE CONTROL

There is an active research and development effort on treating and handling geothermal brines to prevent scale formation. In this section, we describe typical methods either used or proposed for use to prevent silica, sulfide, and carbonate scale formation. We have found it convenient to organize the treatment methods into two broad categories: (1) those used to control scaling caused by fresh geothermal fluid prior to utilization for power production, and (2) methods used to control scaling by the spent fluid following power production and prior to disposal. See Table 3-1 for a listing of treatment methods for scale control.

A. FRESH FLUID TREATMENT

The term fresh fluid as used here refers to the hot water from the producing wells which is used to drive a turbine for power generation.

1. Silica Treatment Methods

The mechanism of silica precipitation from a geothermal fluid to cause deposition can be complex as indicated in the following discussion:

> A simple model is proposed to account for the precipitation of amorphous silica from SSGF [Salton Sea Geothermal Field] brines. Because of the lack of information bearing on the kinetics of scale formation, the model should be viewed as a working hypothesis. As more data become available necessary refinements can be made. The ultimate goal will be to achieve a basic understanding of precipitation mechanisms, at which time it may be possible to devise methods for minimizing or preventing the problem.
>
> As brine is expanded to the surface from a geothermal reservoir, it cools adiabatically. As pressure declines, dissolved gases and steam are evolved, and the residual brine salinity increases. The principal result of the evolution of CO_2, the most abundant noncondensible gas in SSGF brine, and H_2S is an increase in brine pH. As a consequence, sulfides (and probably hydroxides of multivalent elements, such as iron, aluminum, zinc, lead, possibly rare earths, etc.) begin precipitating. A suite of dispersed fine-grained sulfides (and hydroxides) induces the precipitation of dissolved silica either by serving as nucleation centers or by adsorption mechanisms.

Table 3-1

TYPICAL TREATMENT METHODS TO CONTROL SCALE FORMATION

Scale Type	Treatment Method	Comments
Silica	pH adjustment (acid injection)	Tested at Magmamax No. 1 well, Niland, California
Silica	Injection of base (NH_3 or NaOH)	Sinclair wells, California
Silica	Dilution of the unflashed geothermal fluid	Namafjall, Iceland
Mixed	Application of electrical potential	Sinclair Well No. 4, California
Calcite in borehole	Maintain CO_2 pressure	Tested at East Mesa Well 6-1, California
"	Acid addition	Proposed method
"	Alkaline phosphate addition	Proposed method

TREATMENT METHODS FOR SPENT FLUID DISPOSAL

Silica and arsenic	Sedimentation and coagulation (addition of slaked lime, hypochlorite, and flocculant)	Used at Wairakei and Broadlands, New Zealand
Silica	Plain sedimentation; retention tank	Used at Otake, Japan, and Ahuachapan, El Salvador
Calcite	Addition of scale inhibitors and sequestrants (polyphosphates, EDTA)	Proposed method

> The presence of NaCl promotes the polymerization of monomerica silica in basic solutions. Simultaneous increase in pH and decrease in temperature coupled with high concentrations of NaCl, KCl, and $CaCl_2$ probably induce polymerization of silica in SSGF brines when brine pH values exceed 4.5. (Ref. 32)

The solubility of silica in water depends on a number of parameters, including form, temperature, and time. For example, as shown in Fig. 3-1, the solubility for the five forms given increases with temperature over the range 0°C to about 300°C, then falls off markedly for both quartz and chalcedony. Fig. 3-2 shows the effect of pH on silica solubility at 25°C. At other temperatures, the solubility of amorphous silica follows a logarithmic relation.

> The solubility at the vapor pressure (v.p.) of the solution, from 0° to 250°C, is given by the equation:
>
> $$\log C = \frac{-731}{T} + 4.52$$
>
> where C is the silica concentration in ppm and T is the absolute temperature. The maximum solubility at the v.p. of solution is 1660 ppm at 340° and the extrapolated solubility at the critical point is 890 ppm.
>
> At a constant pressure of 1034 bars, the solubility from 0° to 380°C is given by the equation:
>
> $$\log C = \frac{-810}{T} + 4.82$$
>
> Solubilities intermediate between 1034 bars and the v.p. of the solution can be calculated using a plot of solubility vs. density of water. When the data are plotted in this way, solubilities at constant temperature and variable pressure lie along straight lines. (Ref. 33)

Silica is less soluble in NaCl solutions than in pure water. An increase in salinity decreases the activity of water ($\underline{a}_{H_2O}$) which in turn lowers silica solubility (Ref. 34).

a. pH Adjustment. This section includes a discussion of methods used to control silica scale formation by addition of acid or base to the hot water, thereby adjusting the pH to higher or lower values than that of the untreated fluid.

(1) Addition of Acid. In an experiment at Niland, California, Lawrence Livermore Laboratory found HCl injection beneficial in controlling scale formation:

> A mobile field test unit has been established at the ERDA-SDG&E test site in the southwestern part of the SSGF. Brine from the Magmamax No. 1 well was flowed through a steam separator that isolated vapor

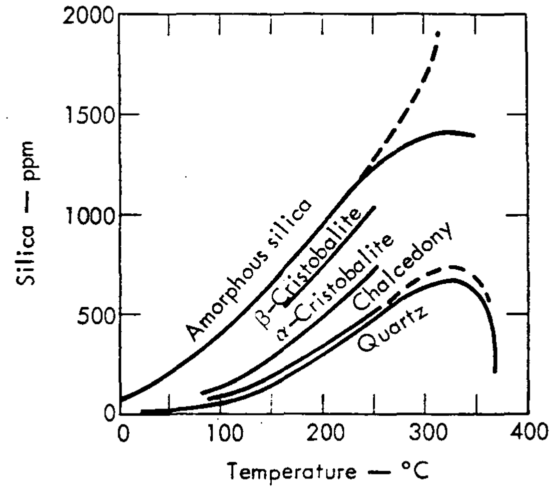


Fig. 3-1. Solubilities of various silica phases along two-phase curve (water plus vapor, pH = 7.0) (Ref. 35)

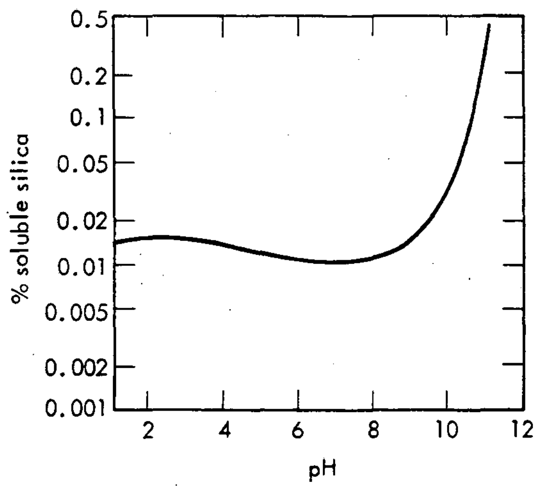


Fig. 3-2. Solubility of silica in water (25°C) (Ref. 36)

and liquid fractions formed as the brine moved from the geothermal reservoir, up the wellbore to the surface. Although the separated liquid phase was used for the initial brine modification experiments, subsequent work will involve remixing of liquid and vapor fractions prior to the chemical additions. Average temperature and pressure of the brine were about 220°C and 265 psi, respectively. System through-put varied between 18,000 and 24,000 pounds of brine per hour. Flow through nozzles (8:1 expansion ratio, 1/4 inch diameter throat) was 1.25 pounds of brine per second. The nominal pH of unmodified brine flowing from the separator varied from 5.5 to 5.8. Dissolved solids content of the brine prior to and after expansion through nozzles was 18 weight percent to 22 weight percent, respectively. Nozzles and wearplates were fabricated from Ti-6Al-4V alloy. Three independent nozzles were operated simultaneously. During each acidification run, at least one nozzle was always operated as a control station flowing unmodified brine.

Thus far, four experiments, each of 20 hours duration, have been completed. Nominal scaling (copper sulfide, native silver, and iron-rich amorphous silica) from unmodified brine resulted in closure of up to 10% of the cross-sectional areas of nozzle throats. Thickness of scale formed on wearblades ranged between 0.019 mm to 0.04 mm. However, when brine was acidified to pH 1.5, 2.3, and 4.0, scaling in nozzles was eliminated and substantially reduced on wearblades. Acidified brine effluents remained clear several hours after collection. However, unmodified brine was slightly turbid when collected, with precipitates forming a few minutes after samples were taken. (Ref. 31)

(2) Addition of Base. Brine treatment methods for controlling silica scaling based on the addition of ammonia or sodium hydroxide have also been investigated. An attempt was made to control silica deposition at Sinclair wells by injecting ammonia, the idea being to alter the nature of the precipitate so that it would not adhere to surfaces. Results of laboratory experiments on ammonia injection indicate that silica precipitation cannot be prevented, but that it may be possible to control where precipitation will occur (Ref. 1).

The solubility of silica increases at pH 8.5 or higher because the dissociation products of silicic acid are more soluble than the undissociated monomer, H_4SiO_4.

In low-pH solutions, silica exists primarily in the form of monomers and polymers of silicic acid. Polymerization occurs rapidly at near neutral pH. As the pH is further increased, soluble complex ions begin to form, as shown by the following equilibria:

$$(H_2SiO_3)_m = mH_2SiO_3 \tag{6}$$

$$H_2SiO_3 + mH_2O = H^+ + (HSiO_3 \cdot nH_2O)^{2-} \tag{7}$$

$$(HSiO_3 \cdot nH_2O)^- = H^+ + (SiO_3 \cdot nH_2O)^{2-} \tag{8}$$

$$H^+ + OH^- = H_2O \tag{9}$$

> As base (OH^-) is added, H^+ will be removed as in Eq. (9) and the equilibria shown in Eqs. (7) and (8) will be shifted to the right. Thus, silica will be in soluble form. (Ref. 37)

However, increasing the pH can cause precipitation of heavy metal hydroxides (e.g., $Fe(OH)_2$, $Mn(OH)_2$), carbonates, and sulfides at pH 6-9 thereby requiring pre-utilization removal of the precipitates to control erosion. An additional parameter associated with addition of base is the buffering action of the brine which would require increased quantities of added base and hence increased cost of the brine treatment.

b. Water Dilution. Addition of water was successful in reducing silica scaling at Namafjall, Iceland. Before dilution, scale was deposited from 95°C water as loose, leaf-like flakes which grew to 15 to 30 mm inside an 8 inch pipe. The scaling was reduced by mixing unflashed fluid from the drillhole to a 35% dilution with cold water at atmospheric pressure. Addition of dilution water reduced the silica content of the fluid from 347 ppm to 188 ppm (Ref. 25).

Addition of dilution water should be approached with caution:

> Before relying on dilution to reduce silica precipitation, one needs to consider that:
>
> The dilutant must be chemically compatible with the brine. For instance, attempts by the San Diego Gas and Electric Company to reduce scaling in their GLEF at Niland by addition of steam condensate to brine actually resulted in higher rates of scale and solids formation. This was a result of the high ammonia and carbonate content of the condensate and its correspondingly high pH (9-10). The problem is that when steam containing noncondensibles is cooled, redistribution of species occurs with most of the ammonia redissolving. This raises the pH of condensate and promotes dissolution of CO_2 into the condensate. (Ref. 38)

Other disadvantages of dilution water include the possible reduction in enthalpy of the geothermal brine and the quantity of clean water that may be required for dilution of the brine. Owen estimates for a typical well flow rate of 1.8×10^5 kg/hr at the SSGF that 35% dilution would require about 6.3×10^4 kg/hr of water (Ref. 38).

c. Magnesium Addition. In treatment of water for use in cooling, heating, and steam generation the addition of magnesium salts (e.g., dolomite) during hot-lime softening reduces the silica content of the water (Ref. 39). The reaction produces insoluble magnesium silicate:

$$H_2O + 2Mg^{++} + SiO_3^{=} \rightarrow Mg_2SiO_4 + 2H^+$$

Optimum separation efficiency of silica using MgO_2 or $MgCO_3$ is achieved at a pH $>$ 9, and about 15 minutes of residence time is required for efficient silica removal (Ref. 40, 41, 42). The method may have merit for fresh geothermal brines; however, the requirement for elevated pH will have the same shortcomings as noted previously under "Addition of Base." Furthermore, retaining the fluids for required residence times results in reduction of fluid enthalpy, and removal of solids (e.g., Mg_2SiO_4) may be required to control erosion effects.

d. Application of Electrical Potential. Experiments at Lawrence Livermore Laboratory on brine from a flowing geothermal well (Sinclair No. 4) studied the influence of electrical potential on scale deposition. Fluid from a 51 mm diameter pipe was flowed through a 6° nozzle and was subsequently exposed to six spherical stainless steel electrodes (9.53 mm diameter) for periods of up to 2 hours. Experiments were run with +5 volts, -5 volts, and +30 volts applied potentials, and more scale formed on negative than on either positive or neutral electrodes. Table 3-2 shows that there are significant differences among +5V, -5V, and neutral electrodes. The authors feel that the results of the preliminary experiments were encouraging: scale was formed on the electrodes (as opposed to corrosion) and there were decided differences produced by varying the charge on the electrode. According to the authors, the lack of a positive correlation between oppositely charged electrodes suggests that species [e.g., $Pb(OH)^+$, $(FeOH)^+$] are being precipitated in the presence of an electric field which would remain in solution otherwise (Ref. 43).

2. Sulfide Treatment Methods

Fig. 3-3 is a schematic diagram proposed for typical reactions in sulfide scale formation (Ref. 44). While Cu_2S is illustrated, it is only one of other heavy metal sulfides that may be present (e.g., FeS, PbS); thus the number of reactions involved is undoubtedly greater than those illustrated. As seen, acid addition may result in removal of gaseous H_2S, dissolution of Cu_2S, and will shift the equilibrium to favor CO_2 formation, as shown by equation 4. Removal of CO_2 and H_2S will limit subsequent precipitation of carbonates and sulfides.

a. pH Adjustment. Addition of acid to sulfide solutions favors formation of H_2S in solution, and the likelihood of an increase in the gas (noncondensible) phase. This and other pH-dependent reactions are illustrated (Ref. 37):

$$S^{2-} + H^+ = HS^-$$

$$HS^- + H^+ = H_2S \text{ (gas)}$$

Table 3-2

SPECTROCHEMICAL ANALYSIS REPORT

Selected elements were examined for direct comparison of relative amounts in each sample. One sample (indicated by b) was selected as a reference for each element, and the values for other samples determined by relative intensity ratios. (Ref. 43)

Charge	Si	Fe	Cu	Ag	Al	B	Ga	Cr	Be	Ba	Pb[a]
+5 V	26%	14%	7%	0.5%	1 %	0.3%	0.04%	0.06%	0.06%	0.03%	
+5 V	24	17	5[b]	0.3[b]	0.8	0.3	0.05	0.08	0.05	0.03	
+5 V	26	16	8	0.5	1	0.2	0.05	0.06	0.05	0.03	
0	22	10	8	2	0.8	0.2	0.04	0.01	0.04	0.01	
0	24	10	10	2	1	0.2	0.05	0.02	0.05	0.02	
0	26	16	8	2	0.8	0.2	0.05	0.03	0.04	0.02	
-5 V	10[b]	5[b]	10	1	0.3[b]	0.1[b]	0.01[b]	0.02[b]	0.01[b]	0.01[b]	
-5 V	11	6	9	0.7	0.3	0.1	0.02	0.02	0.01	0.02	
-5 V	16	8	20	2	0.5	0.2	0.03	0.02	0.02	0.01	
Pipe	10	8	6	0.0	0.3	0.1	0.03	0.01	0.01	0.02	
Nozzle	12	6	6	1	0.6	0.09	0.02	0.05	0.01	0.01	

[a]Differences in lead concentrations were too great to apply this method.

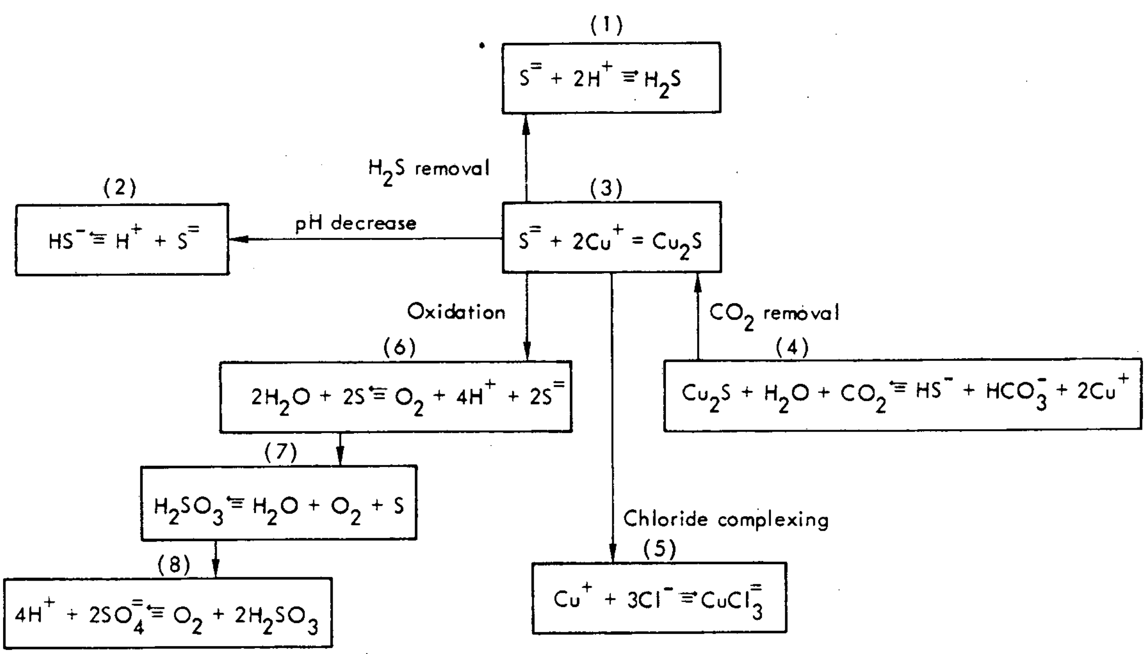


Fig. 3-3. Schematic diagram of typical reactions in sulfide scale formation (Ref. 44)

As base is added, the S^{2-} concentration increases and insoluble sulfides start to precipitate as follows:

$$2M^{+x} + xS^{2-} = M_2S_x$$

b. Oxidation. Oxidation of sulfide to sulfur or sulfate has been proposed as a means of controlling sulfide scale deposition (Ref. 44). The overall, simplified reaction is schematically:

$$\begin{array}{lclcl} & & Cl_2\ ) & & & & Cl^-\ ) \\ S^=\ ) & + & HNO_3\ ) & \rightarrow & SO_4^=\ ) & + & NO_3^-\ ) \\ H_2S\ ) & & NaOCl\ ) & & S\ ) & & Cl^-\ ) \\ & & FeCl_3\ ) & & & & Fe^{++}\ ) \end{array}$$

oxidant — sulfur product

A possible problem here is the formation of insoluble metal sulfates (e.g., $CaSO_4$), as well as elemental sulfur which may cause erosion of piping and plugging of injection systems. Addition of a dispersing agent may be desirable to prevent the solids from settling out, or filtration may be required.

c. Diffused-Air Aerators. In water quality treatment, diffused-air aerators are used to remove gases such as H_2S and CO_2. The method utilizes injection of compressed air through a perforated pipe or similar system to produce fine bubbles. The H_2S gas is exchanged from the water phase to the gas phase, according to the equations:

Gas absorption:

$$C_t = S - (S - C_0)10^{-k(A/V)t} \quad (1)$$

Gas release:

$$C_t = S + (C_0 - S)10^{-k(A/V)t} \quad (2)$$

These formulas and the differential equations from which they are derived indicate that:

1. At any instant, the rate of gas transfer is directly proportional to the difference between the gas saturation concentration S and the actual concentration C_t in the water.

2. The rate of gas transfer is directly proportional to the ratio of the exposed area to the volume of water, A/V.

3. The rate of gas transfer is directly proportional to the gas transfer coefficient k which in turn is dependent on the diffusivity of the gas in question and the film resistance.

4. The total amount of gas transfer is greater as the time of aeration increases.

5. The percentage change in gas saturation deficit $S-C_t$ or surplus C_t-S for any given time period t is constant based on the deficit or surplus at the beginning of the time period.

6. Temperature and pressure are important factors because they influence gas solubility S. Temperature also influences diffusivity and film resistance and hence the value of k.

The term C_0 is the concentration of gas originally present in the water. (Ref. 45)

An advantage of aeration for H_2S removal is the low cost of air used in aeration. However, aeration can cause formation of sulfate and subsequent deposition of insoluble metal sulfates.

3. Calcite Treatment Methods

Calcite, or calcium carbonate ($CaCO_3$), is a common scaling problem associated with water intended for cooling, heating, and steam generation purposes. The solubility of $CaCO_3$ in water and brine depends on a number of parameters including the following: CO_2 gas partial pressure, temperature, pH, and the chemical composition of the brines. Methods for preventing $CaCO_3$ scale formation are based on the suitable control of one or more of these parameters.

a. CO_2 Pressure. As the brine flows in a geothermal well from the reservoir, it depressurizes and CO_2 is released as a result of the fluid boiling. This release of CO_2 causes an increase in brine pH, thus increasing the possibility of depositing calcite (Ref. 46).

Fig. 3-4 shows the results of allowing a geothermal brine containing a high concentration of dissolved CO_2 to flash in a well. Note that the deposition of calcite scale begins immediately above the point of flashing and that the maximum thickness of the $CaCO_3$ scaling inside the well is just above the flash point.

Experiments at the East Mesa test site using brine from Well 6-1 indicate that no scale was formed until the brine was allowed to flash (Ref. 4).

In summary, maintaining a CO_2 pressure may have merit in minimizing calcite precipitation. However, a disadvantage of maintaining a high back pressure on the well

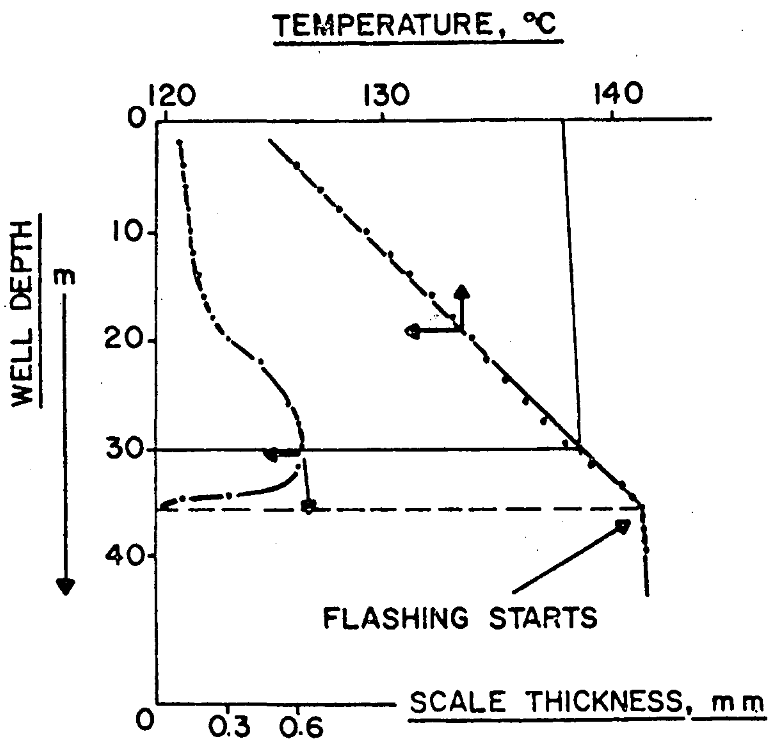


Fig. 3-4. Thermometry and thickness of $CaCO_3$ layer formed within 6 hours in a drillhole in the Bolshe-Banny area, Kamchatka, USSR (Ref. 48)

is that the flow rate will be reduced considerably below that of a free flowing well. This disadvantage may possibly be overcome by use of a downhole pump (Ref. 47).

b. pH Adjustment. Addition of acid favors removal of carbonate by formation of CO_2 according to the reactions:

$$CO_3^{2-} + H^+ = HCO_3^-$$

$$HCO_3^- + H^+ = H_2CO_3$$

$$H_2CO_3 = H_2O + CO_2^-(\text{gas})$$

Removal of carbonate prevents formation of calcite; however, large amounts of acid may be required due to any buffering action by the brine.

c. Phosphate Addition. In steam generating systems, calcium is precipitated in the form of a sludge by addition of alkaline phosphate (Ref. 49). This sludge is often removed by subsequent settling or filtration.

$$10Ca^{++} + 6PO_4^{\equiv} + 2OH^- \rightarrow \underset{(\text{sludge})}{3Ca_3(PO_4)_2Ca(OH)_2}$$

The sludge formed is less likely to scale than $CaCO_3$ because it is relatively nonadherent to boiler metals and is easily removed by manual blowdown. Sometimes a synthetic polymer is included to enhance flocculation and settling and to make the sludge less adherent and more easily dispersed. A disadvantage of this method is the possibility of precipitation of insoluble substances (e.g., sulfides, hydroxides, carbonates) at the elevated pH required for phosphate precipitation.

d. <u>Sulfate Addition</u>. This method of controlling scale in boiler water is based on the hundredfold greater solubility of $CaSO_4$ as compared to $CaCO_3$ (Ref. 50, 51):

$$Ca(HCO_3)_2 + H_2SO_4 \rightarrow CaSO_4 + 2CO_2 + 2H_2O$$

A disadvantage in application to geothermal brines is the formation of other insoluble sulfates (e.g., $BaSO_4$) which may form scales, and plugging of injection systems by the formed $CaSO_4$.

B. SPENT FLUID TREATMENT

Fluid production from a geothermal field for power generation will be in large volumes (e.g., 1.8×10^5 kg/hr/well in SSGF) which contain silica, carbonates, chlorides of sodium, potassium, and calcium, and various undesirable elements, e.g., B, CO_2, H_2S, NH_3, As, Hg. Disposal of geothermal effluents poses a problem of environmental pollution in the development of geothermal resources. Methods for disposal of geothermal effluents could include: surface disposal in local waterways, evaporation ponds, or subsurface injection. Disposal by injection has some advantages over other forms of disposal, for example elimination of thermal and chemical pollution of the environment and reduction of ground subsidence. Injection of wastewaters and brines through wells has been frequently used by the industrial wastewater and oilfield industries. In several geothermal fields, e.g., the Geysers steam field and Niland area of the Imperial Valley, Valles Caldera in New Mexico, Ahuachapan in El Salvador, and Hachimantai in Japan, disposal of effluents through injection has been or is being tried experimentally. The problem of scale formation in pipes and reservoir rocks, however, may be a serious long-term limitation (Ref. 52).

In the oilfield industry, brine is treated prior to injection so that it is chemically compatible with the receiving rock formation; otherwise, formation plugging will necessitate high injection pressures.

In this section, we discuss existing geothermal and other methods used to treat spent brines prior to disposal. Currently, spent geothermal brines are not treated to a significant extent and little data is available on the effectiveness of the various treatment steps. Thus, this section draws on oilfield and industrial wastewater treatment techniques which appear appropriate for application to geothermal fluids, for example, the use of closed systems, coagulation, filtration, and sedimentation. See Table 3-3 for a listing of current geothermal spent brine treatment methods. Spent geothermal fluids will have a lower temperature than fresh geothermal fluids; thus some oilfield treatment techniques, e.g., addition of decomposable sequestrants, may be applicable and are included here. Table 3-4 gives a listing of common chemicals and their uses in the treatment of industrial wastewater. In evaluating geothermal effluent treatment possibilities, however, one will have to consider a variety of parameters including chemical compatibility of the additive with brine, mechanical requirements for removal of solids (precipitates), and cost. Economic analysis of various treatment methods is beyond the scope of this report and hence not presented.

A complete brine treatment system could include the following: aeration, closed systems, sedimentation and coagulation, filtration, chlorination, and sequestration. See Table 3-5 and Fig. 3-5. For additional information, the reader is referred to Subsurface Salt-Water Disposal (Ref. 17), Brine Disposal Practices Relating to the Oil Production Industry (Ref. 12), and Underground Waste Management and Environmental Implications (Ref. 19).

1. Silica Treatment Methods

This section covers mainly a discussion of wastewater treatment methods that have been applied to spent geothermal hot waters to remove silica.

Table 3-3

TYPICAL TREATMENT METHODS FOR SPENT GEOTHERMAL BRINES (SUGGESTED OR USED)

Treatment Objective	Treatment Method	Comment	Reference
Calcite ($CaCO_3$) bore plugging prevention	Exclude air (closed system); maintain CO_2 pressure	--	Ref. 2 Ref. 4
Formation plugging prevention	Sedimentation in holding pond	Gravity	Ref. 2
Silica and arsenic removal	Add slaked lime	Precipitation	Ref. 53
$CaCO_3$ downhole deposits removal	Pump 15% HCl into injection well	Acidizing	Ref. 21

Table 3-4

COMMON TREATMENT CHEMICALS (REF. 54)

Chemical	Process Use	Points of Application
Alum	coagulation color removal	Coagulation and sedimentation systems; prior to pressure filters for removal of suspended matter and oil.
Sodium Aluminate	coagulation	Usually added with soda ash to softeners; used to some extent for internal boiler water treatment.
Ferric Salts	coagulation color removal oil removal	Prior to coagulation and filtration systems.
Lime (Hydrated)	pH adjustment softening	Prior to coagulation systems; to softeners; to treated water lines for adjustment of pH.
Soda Ash (Crystalline)	pH adjustment	Prior to pressure filters.
Soda Ash (Anhydrous)	pH and alkalinity adjustment softening	To domestic systems, feed lines, softeners, coagulation and filtration systems; boilers.
Caustic Soda	pH adjustment alkalinity adjustment softening	To softeners; oil removal systems; domestic water systems; boilers
Acid Feed (H_2SO_4) (H_3PO_4) ($NaHSO_4$)	pH adjustment reduction of alkalinity	Treated water lines, prior to degassifiers or de-aerating heaters; H_3PO_4 to phosphate softeners (for both softening and alkalinity reduction).
Surface Active Phosphates	prevent calcium carbonate deposits eliminate "red water"	Treated water lines.
Ortho-phosphates (Monosodium Phosphate) (Disodium Phosphate) (Trisodium Phosphate)	prevent scale in boilers	Added continuously to boiler drums; shot-fed to drums or boiler feed line.
Sodium Sulfite	prevent corrosion due to oxygen in boilers, feedlines, economizers	Storage section of de-aerating heater; suction or pressure side of boiler feed pumps.
Sodium Nitrate	inhibition of embrittlement	Any point in boiler feed lines or direct to boilers.
Sodium and Potassium Chromates	corrosion inhibitor	To brine systems and various circulating cooling and hot water systems.
Reactive Colloids (Sodium Manuronate) Protective Colloids (Starches) (Tannins)	coagulation particle absorption and adsorption	To boiler feed lines; circulating cooling systems.
Amines and Related Organic Compounds	prevention of return line corrosion	Application depends upon material used. Some materials may be added to boilers and volatilize with steam; others are added to steam line direct, requiring pumps.

Table 3-5

BASIC PRETREATMENT STEPS (REF. 55)

I.	Raw-waste storage--open, closed
II.	Corrosion control--pH, inhibitors
III.	Solids separation--settling, coagulation
IV.	Filtration--fine, medium, coarse
V.	Slime control--bactericides, shock

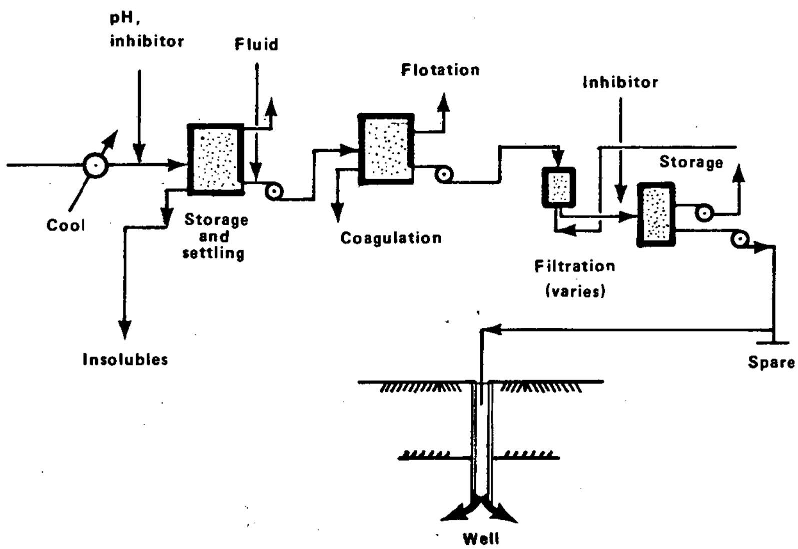


Fig. 3-5. Surface design for pretreatment of wastes where extensive treatment cleanup is required prior to subsurface injection (Ref. 55).

a. <u>Sedimentation and Coagulation</u>. Sedimentation is a commonly used wastewater treatment practice in which suspended materials settle from the fluid under the influence of gravity. This settling process, or "plain sedimentation," usually takes place in specially designed circular or rectangular basins with either horizontal or vertical fluid flow. The design of the settling basin depends on the overflow rate of the basin, V, which is expressed as

$$\underset{(\text{ft./hr.})}{V} = \frac{Q}{A} = \frac{\text{inflow rate, cu. ft./hr.}}{\text{surface area of the settling basin, sq. ft.}}$$

The overflow rate of the basin is a function of the specific gravity and viscosity of the wastewater, and the specific gravity, size, shape, and concentration of the particles which will settle out:

$$V = \frac{64.4\ (\sigma - \rho)\ D^2}{\mu}$$

(ft/hr)

D = particle diameter, mm
ρ = fluid density, g/cm^3
σ = particle density, g/cm^3
μ = liquid viscosity, poise

This equation holds rigorously for spherical particles undergoing free settling by gravity at low Reynolds numbers with viscous resistance to settling. See Ref. 56.

In coagulation, chemicals are added to the wastewater prior to settling process, with the idea to gather all suspended particles (e.g., colloids), enhance settling, and prevent the small particles from passing through or plugging filters. The addition of a coagulant essentially enlarges the small particles by causing the aggregation of fine particles to produce a floc which settles rapidly, thus increasing the efficiency of the sedimentation process. Coagulation-sedimentation is beneficial in that it requires smaller sedimentation basins and lower initial cost than plain sedimentation.

In a coagulation process, coagulant is added to the water with initial rapid mixing, followed by a slow mixing speed once floc has formed; the coagulated material separates from the fluid by gravity (see Fig. 3-6). Coagulation of turbid water depends on several factors; for example, the kind and quantity of coagulant used, extent of mixing, pH of the water, and water temperature.

The most commonly used coagulants, composed of iron or aluminum compounds, include ferric sulfate, ferrous sulfate, ferric chloride, aluminum sulfate (alum), sodium aluminate. The coagulant on reaction with a turbid water neutralizes the negative charge of the impurities and produces positively charged colloidal hydrous oxide flocs. These flocs attract and adsorb negatively charged colloidal impurities, forming still larger floc particles. The chemical reactions of various coagulants with turbid waters are shown in Table 3-6.

The optimum pH range for effective coagulation is shown in Table 3-7; for aluminum sulfate, the optimum is 6-7. The pH of the water may be adjusted by the addition of hydrated lime. Where coagulating agents alone do not give satisfactory results, compounds called coagulation aids (e.g., activated silica, organic polyelectrolytes) which by themselves are not necessarily effective coagulants are added to form larger flocs.

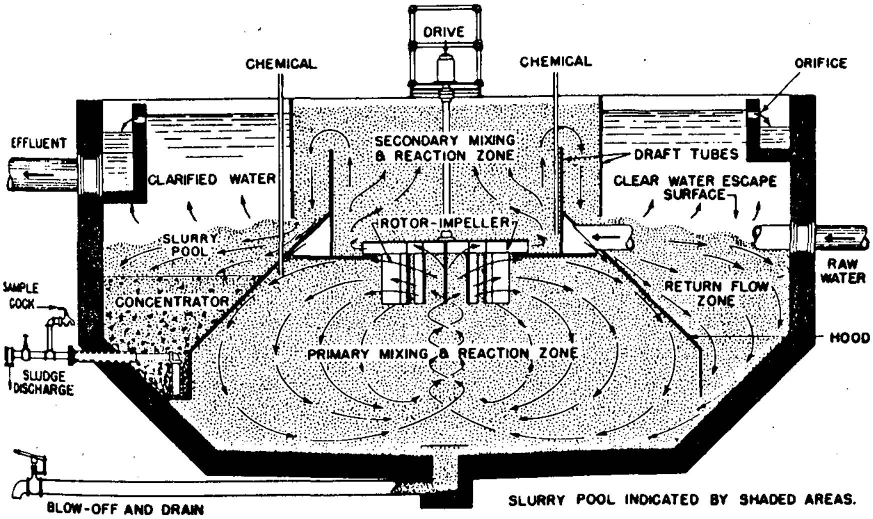


Fig. 3-6. Suspended-solids contact unit (Ref. 18). (This is for a single stage unit which is most often used for low flow situations. Separate coagulation, flocculation, and sedimentation basins are usually used for large flows.)

Table 3-6

TYPICAL REACTIONS OF COAGULANTS WITH ALKALINE SUBSTANCES IN WATER (REF. 18)

Aluminum Sulfate

$$Al_2(SO_4)_3 \cdot 18H_2O + 3Ca(HCO_3)_2 \rightarrow 2Al(OH)_3\downarrow + 3CaSO_4 + 6CO_2 + 18H_2O$$

$$Al_2(SO_4)_3 \cdot 18H_2O + 3Ca(OH)_2 \rightarrow 2Al(OH)_3\downarrow + 3CaSO_4 + 18H_2O$$

Ferric Sulfate

$$Fe_2(SO_4)_3 + 3Ca(HCO_3)_2 \rightarrow 2Fe(OH)_3\downarrow + 3CaSO_4 + 6CO_2$$

$$Fe_2(SO_4)_3 + 3Ca(OH)_2 \rightarrow 2Fe(OH)_3\downarrow + 3CaSO_4$$

Ferrous Sulfate

$$2FeSO_4 \cdot 7H_2O + 2Ca(HCO_3)_2 + \tfrac{1}{2}O_2 \rightarrow 2Fe(OH)_3\downarrow + 2CaSO_4 + 4CO_2 + 13H_2O$$

$$2FeSO_4 \cdot 7H_2O + 2Ca(OH)_2 + \tfrac{1}{2}O_2 \rightarrow 2Fe(OH)_3\downarrow + 2CaSO_4 + 6H_2O$$

Chlorinated Copperas

$$2FeSO_4 \cdot 7H_2O + 3Ca(HCO_3)_2 + Cl_2 \rightarrow 2Fe(OH)_3\downarrow + 2CaSO_4 + CaCl_2 + 6CO_2 + 14H_2O$$

$$2FeSO_4 \cdot 7H_2O + 3Ca(OH)_2 + Cl_2 \rightarrow 2Fe(OH)_3\downarrow + 2CaSO_4 + CaCl_2 + 14H_2O$$

Potash Alum

$$Al_2(SO_4)_3 \cdot K_2SO_4 \cdot 24H_2O + 3Ca(HCO_3)_2 \rightarrow 2Al(OH)_3\downarrow + 3CaSO_4 + K_2SO_4 + 6CO_2 + 24H_2O$$

$$Al_2(SO_4)_3 \cdot K_2SO_4 \cdot 24H_2O + 3Ca(OH)_2 \rightarrow 2Al(OH)_3\downarrow + 3CaSO_4 + K_2SO_4 + 24H_2O$$

Table 3-7

CHARACTERISTICS OF TYPICAL COAGULANTS (REF. 57)

Coagulant	Common name	Purpose	Normal dosage	pH range	Charge	Precipitate produced	Remarks
Aluminium sulfate	filter alum	main coagulant to assist coagulation with sodium aluminate	5–50 2–20	5.5–8.0 (optimum: 6–7)	positive	hydrated alumina	Floc is relatively light and will generally not settle against an upward flow greater than about 3 ft/h. Higher rates are obtainable, however, in a sludge-blanket type of plant.
Sodium aluminate	——	main coagulant to assist coagulation with aluminium sulphate	5–15 2 or 0.1–0.05 of alum dosage	4.0–7.0	negative	hydrated alumina	Floc formed by double coagulation usually coarser than that from filter alum alone. Aluminate should be added ½–2 min before alum. Sometimes useful as main coagulant for surface waters of variable composition.
Ferrous sulfate	copperas	main coagulant	5–50	4.0–11.0	positive*	hydrated ferric oxide	At low pH values oxidation to ferric state may not be complete and treated water may contain residual iron. Floc heavier than that of alumina and settles faster.
Ferric chloride	——	main coagulant	5–50	4.0–11.0	positive*	hydrated ferric oxide	Floc heavier than that of alumina and settles faster.
Ferric chloride/ ferric Sulfate	chlorinated copperas	main coagulant	5–50	4.0–11.0	positive*	hydrated ferric oxide	Floc heavier than that of alumina and settles faster. Reagent solution prepared as required by passing chlorine into ferrous sulfate solution.
Activated silica sol	——	to assist coagualtion with aluminium sulfate	1–15 (expressed as silica)	5.5–8.0	negative	hydrated silica	Used as a coagulant aid in conjunction with aluminium sulfate rapidly produces strong, coarse floc which settles quickly. May give effective treatment during periods of spate and at low temperatures.
Bentonite or other clays	——	main coagulant or to assist coagulation with aluminium sulfate	2–12	——	——	——	Increases density of floc formed from filter alum and thus gives faster settling. Should be added to water before filter alum.
Calcium carbonate	chalk	to assist coagulation with aluminium sulfate	——	——	——	——	Increases density of floc formed from filter alum and thus gives faster settling. Should be added to water before filter alum.
Nalco 600	——	main coagulant	1	——	——	——	Cationic polyelectrolyte.

*May be negative at high pH values.

The coagulation treatment method was applied to remove both silica and arsenic from cooled (90°C) geothermal discharge waters at Wairakei and Broadlands by addition of slaked lime:

> A pilot plant was built for studying this process on a continuous basis. Discharge water at 90°C is first "aged" to allow silica to polymerize; addition of slaked lime to the water then rapidly precipitates a flocculent, hydrated calcium silicate gel, which is readily separated in settling tanks. If arsenic has been preoxidized to the pentavalent state, most of it is coprecipitated.
>
> Optimum operating conditions for a water containing about 1000 g/tonne silica involve addition of 700 g/tonne quick-lime; the resulting calcium silicate filtered well to give a gel with 30% solid content. This could be dried with geothermal heat to give an amorphous powder, having a bulk

density of 0.20 g/cm^3 and a SiO_2/CaO ratio of 1.7, which can find uses in wallboards or insulants. Smaller lime-addition rates remove part of the silica as a silica-rich calcium silicate, while higher lime-addition rates give almost quantitative silica and arsenic removal as a calcium-rich calcium silicate. (Ref. 53).

The untreated cooled discharge waters had the composition shown in Table 3-8; the effect of treatment with slaked lime, hypochlorite, and added flocculant is shown in Tables 3-9 and 3-10. The cost of this chemical treatment process is approximately $20,000 per annum which is the same figure that was expended previously for mechanically cleaning the discharge drains (Ref. 1).

Fig. 3-7 is a sketch of the pilot plant used for continuous brine treatment at Broadlands.

Table 3-8

ANALYSES OF COOLED DISCHARGE WATERS FROM WAIRAKEI AND BROADLANDS BORES, NEW ZEALAND (ALL FIGURES EXCEPT pH IN g/TONNE) (REF. 53)

	Wairakei Bore 67	Wairakei "mixed" bores	Broadlands Bore 22
pH at 20°C	7.8	7.9	8.6
SiO_2 (total)	650	560	980
(monomeric)	100	115	110
(M.W. 200 to 150 000)	0	n.a.	0
(M.W. over 150 000 approx.)	500	n.a.	700
Na	1230	1190	1054
K	194	185	228
Li	12	11	13
Rb	2.5	n.a.	2.0
Cs	2.4	n.a.	2.0
Ca	18	23	2.6
Mg	0.06	n.a.	0.03
Cl	2126	2100	1873
SO_4	31	32	10
B	29	28	60
As	4.5	4.3	4.3
Dissolved CO_2	20	13	150

n.a. = not analysed

Table 3-9

ANALYSES OF DISCHARGE WATERS FROM WAIRAKEI "MIXED BORES" (AGED 2-1/2 HOURS) AFTER TREATMENT WITH SLAKED LIME. (ALL QUANTITIES IN g/TONNE) (REF. 53)

Added CaO	Added active chlorine (as hypochlorite)	Added flocculant (polyflok 90 AP)	Monomeric SiO_2	Total SiO_2	CaO	As	B	pH
0	0	0	390	560	32	4.30	28	7.9
350	0	0	167	136	210	2.50	n.a.	11.2
350	10	0	159	117	221	0.45	n.a.	11.3
410	0	0	94	87	216	2.03	25	11.4
425	0	1	75	73	210	1.55	n.a.	11.5
580	0	0	37	33	255	0.51	22	11.6
780	0	0	15	15	435	0.13	n.a.	11.7
985	0	0	6	6	575	0.06	n.a.	11.9
1000	0	1	10	10	545	0.12	20	12.0

n.a. = not analysed

Table 3-10

ANALYSES OF DISCHARGE WATERS FROM BROADLANDS BORE 22 (AGED 1/2 HOUR) AFTER TREATMENT WITH SLAKED LIME (REF. 53)

Added CaO (g/tonne)	Added active chlorine (g/tonne)	Length of run (hours)	Monomeric SiO_2	Total SiO_2	CaO (All quantities in g/tonne)	As (chemical)	As (V) (polarog.)	B	pH value
0	0	—	410	910	2	4.3	1.5	60	8.6
460	0		280	258	170	3.3	0.3	55	10.3
	5	4 1/2	290	263	170	2.8	0.2	n.a.	10.3
	10		250	237	172	1.6	0.0	n.a.	10.4
	20		240	230	172	1.4	0.1	n.a.	10.4
605	0	3	165	165	196	2.6	0.8	n.a.	11.1
685	0		95	93	208	2.0	0.2	52	11.4
	5		130	126	190	2.2	0.3	n.a.	11.3
	10	4 3/4	120	116	190	1.7	0.2	n.a.	11.3
	20		120	115	190	0.9	0.2	n.a.	11.3
815	0	1 1/4	70	70	228	1.2	0.0	n.a.	11.5
1120	0	2 1/2	6	7	440	0.1	0.0	49	12.0

n.a. = not analysed

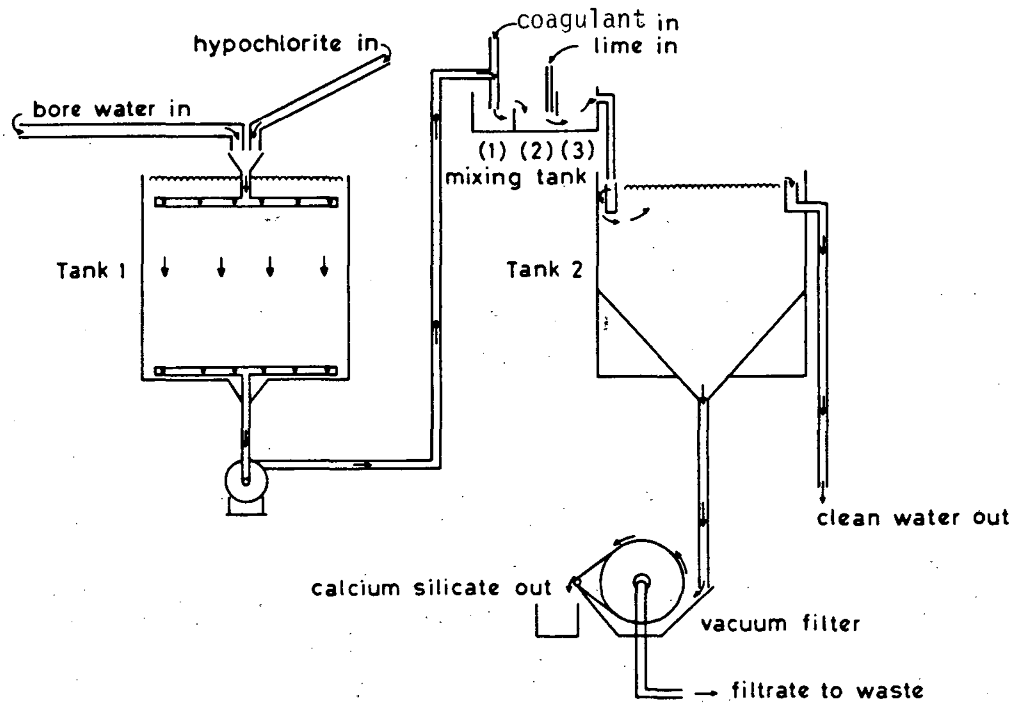
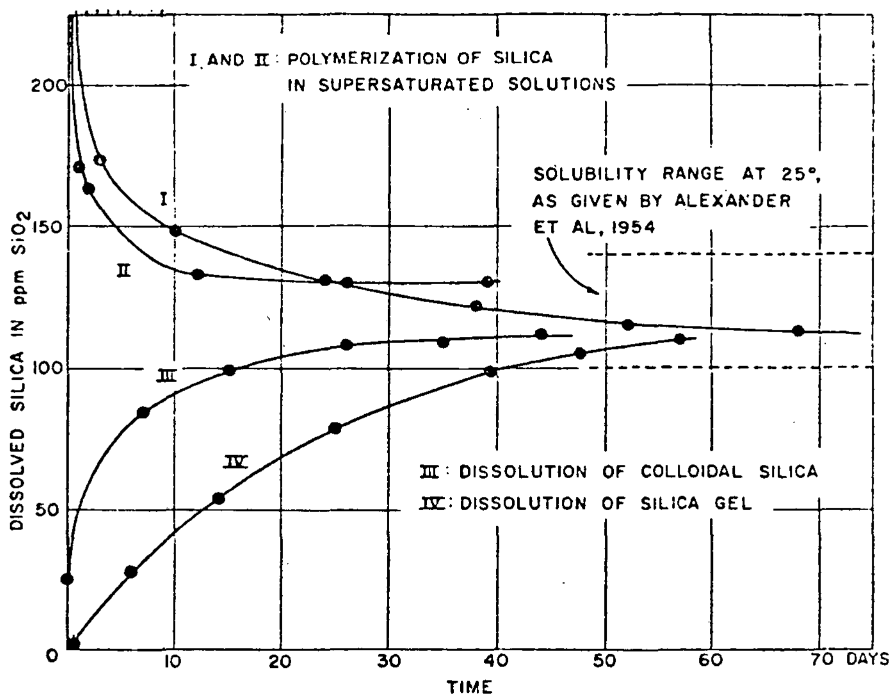


Fig. 3-7. Sketch of pilot plant adapted for continuous operation in Broadlands, New Zealand (Ref. 53)

b. Holding Tank. This illustrates application of plain sedimentation treatment to silica control. The precipitation of silica from supersaturated solution is a progressive process in which a colloidal silica is produced which gradually forms gel or precipitate. Fig. 3-8 shows the rate of precipitation and the rate of dissolution of silica at 22 to 27°C. As can be seen, several days or weeks may be required to reach equilibrium in this temperature range. Because of the slowness of precipitation, geothermal brines which appear clear become cloudy after standing at ambient temperatures for a few hours. This cloudiness may turn into a heavy precipitate which subsequently settles (Ref. 4).

A retention tank with a series of baffles was used at the Otake geothermal plant in Japan to control silica scale in hot water pipes (Ref. 58, 59). See Fig. 3-9. It was found that one hour retention was sufficient to reduce silica scale formation before discharging the brines to pipelines. This delay in time permitted the



Curve I: Hot-spring water boiled to dissolve most of the silica. Initial total SiO_2 320 ppm; initial dissolved SiO_2 284 ppm; pH during run 7.7-8.3.

Curve II: Na_2SiO_3 solution neutralized with HCl. Initial total SiO_2 975 ppm; initial soluble SiO_2 544 ppm; pH during run 7.3-7.9.

Curve III: Na_2SiO_3 solution neutralized with HCl, aged and diluted. Initial SiO_2 187 ppm; initial dissolved SiO_2 25 ppm; pH 8.3-7.4.

Curve IV: Silica gel in distilled water. pH 5.2-5.6.

Fig. 3-8. Kinetics of silica solubility. Representative runs showing approach to the solubility equilibrium from both sides. Temperature 22-27°C. (Ref. 60)

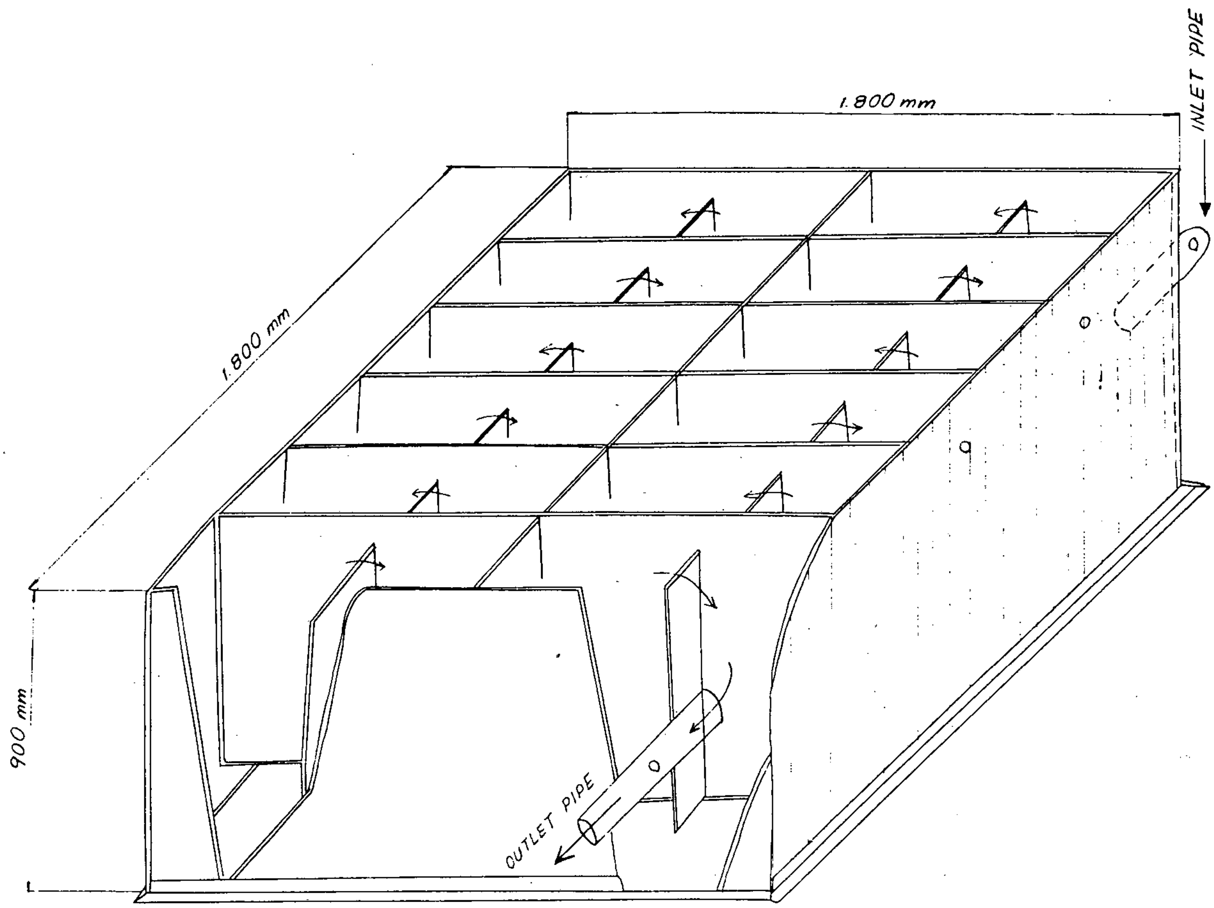


Fig. 3-9. Experimental retaining tank to control silica scale in hot water pipes, Otake Geothermal Plant, Japan (Ref. 58)

silica to change from the monomeric state to the amorphous settleable state, where it deposited on the walls of the concrete holding tank. See Tables 3-11 and 3-12 for water and scale composition. Similar methods were used at Ahuachapan, El Salvador, to prevent silica deposition in a disposal culvert (Ref. 61).

c. Filtration. Filtration is a process for separating undissolved solids from turbid waters using a porous or filter medium. It is used to remove colloidal silica and other floc particles which are not removed in a sedimentation process. The filters generally operate at constant rate and constant pressure; however, the pressure drop across the filter increases as the filter loads up. In oilfield brine treatment, both slow and rapid sand filters are commonly used.

Slow sand filters contain sand bedding with the top layer used as the filtering media. The disadvantages of slow sand filters are that they require large filter area, have low filtration rates per square foot of filter surface, have high initial cost, and the sand bedding material cannot be backwashed to permit unclogging. Rapid sand filters have a layer of sand on layers of coarser gravel (sometimes anthracite coal and sometimes graded sand), use smaller filter area, and have provision for backwashing. They may be gravity or pressure operated.

Gravity filters are usually open to the atmosphere and have operating rates for municipal water supplies of 4-5 gal/min per sq. ft. of bed area, with a maximum of 8-10 gal/min per sq. ft. (Ref. 51).

Pressure sand filters are most widely used in industry and are particularly applicable in closed water systems. Filtering under pressure increases the filtration rate by a factor of about 1.5 and has the advantage over gravity filters in higher capacity and requiring less area. For details on the design of these and other filters, the reader is referred to Ref. 18, 51, and 56.

2. Calcite Treatment Methods

Calcite can also be removed by sedimentation and coagulation processes, using methods similar to those discussed under silica treatment. In this section, other methods to prevent calcium carbonate scales are discussed.

a. Scale Inhibitors and Sequestrants. Sequestration is the process of maintaining scale-forming cations (e.g., calcium, barium, iron) as soluble complex metallic ions by addition of chelating or sequestering agents to the wastewater. The most

Table 3-11

CHEMICAL ANALYSIS OF THE HOT WATER (PPM), OTAKE, JAPAN (REF. 58)

Chemical Composition	Wells No. 7	No. 8	No. 9	No. 10
Li^{+}	4.50	4.35	5.15	5.68
K^{+}	105	108	131	143
Na^{+}	846	805	936	1098
NH_4^{+}	0.11	0.05	0.06	0.15
Ca^{++}	9.9	19.8	12.3	20.1
Mg^{++}	0.025	0.055	0.190	0.010
Fe^{++}	0.05	0.05	0.03	0.06
Al^{+++}	0.09	0.02	0.02	0.03
Mn^{++}	0.00	0.00	0.00	0.00
F^{-}	3.80	4.18	4.65	4.20
Cl^{-}	1219	1243	1474	1753
Br^{-}	2.48	2.82	3.40	4.15
I^{-}	0.26	0.22	0.26	0.33
SO_4^{--}	214	202	136	112
HCO_3^{-}	76	65	46	66
CO_3^{--}	2.10	1.80	1.44	1.86
pH	8.4	8.4	8.2	8.4

Table 3-12

ANALYTICAL RESULTS OF OTAKE SCALES (REF. 58)

Sample No.	Distance from the entrance of the pipeline (in meters)	SiO_2 (%)	Al_2O_3 (%)	Fe_2O_3 (%)	TiO_2 (%)	H_2O (%)
1	0	78.45	4.62	3.22	0.34	8.34
2	950	87.98	2.36	0.66	0.07	7.31
3	3863	93.25	0.99	0.15	0.11	4.60

popular sequestering agents in water treatment are inorganic polymetaphosphates; see, for example, Table 3-13. These adsorb on the surface of existing scale and cause the scale to redissolve. Care should be taken to avoid using acids along with polymetaphosphates since acids promote formation of orthophosphate ion which reacts with calcium in the water to form insoluble calcium phosphate (Ref. 62).

Scale formed on downhole oilwell tubing and pumps has been controlled by introducing phosphates in one of the following ways: (1) lowering a wire basket containing the phosphates on the bottom of the tubing string; (2) passing the produced water through a feeder containing the phosphate, and then recycling it through the annulus, and (3) fracturing the formation of a producing well with sand, oil, and 12 to 40 mesh phosphate (Ref. 63). A dosage of 2 to 10 ppm of phosphate in the produced water is usually sufficient to prevent scale formation.

Ethylenediaminetetraacetic acid (EDTA) and its sodium salts are used as scale inhibitors in boiler water treatment. EDTA forms stable soluble complexes with nearly all metallic ions, e.g., Mg^{++}, Ca^{++}, Sn^{++}, Ba^{++}, and has an advantage over polymetaphosphate in not hydrolyzing. The maximum complexing or chelating efficiency of EDTA for Ca is obtained at pH 6, and thereafter remains nearly constant (Fig. 3-10). Other metals are effectively complexed at lower pH (Ref. 64). Table 3-14 gives some data on the solubility of EDTA salts in water and the quantity of various EDTA salts necessary to complex 1 ppm of calcium. The higher cost of EDTA as compared to polymetaphosphates may limit its use (Ref. 64, 65).

Citric acid and gluconic acid and their sodium salts are used as sequestering agents for calcium and ferric iron. The effectiveness of the free acids is enhanced by an increase in the solution pH. Fig. 3-11 shows the effect of pH on the iron-sequestering power of sodium tetraphosphate, sodium citrate, and sodium gluconate; Fig. 3-12 shows the effect of pH change on the chelating power of selected calcium sequestrants.

An additive based on polymeric carboxylic acid (trade name Belgard EV) for controlling scale deposition in high temperature multistage flash commercial desalting plants has been developed. It prevents hard scale formation by threshold effect retarding the precipitation and by crystal distortion and is reported to be effective for use with brines up to 121°C (250°F) or higher temperature (Ref. 78).

Table 3-13

TYPICAL POLYMETAPHOSPHATES USED FOR PREVENTING SCALE FORMATION (REF. 18)

Name of Phosphate	Formula
Tetrasodium pyrophosphate	$Na_4P_2O_7$
Sodium triphosphate	$Na_5P_3O_{10}$
Trisodium tripolyphosphate	$Na_3P_3O_9$
Hexasodium hexametaphosphate	$Na_6P_6O_{18}$
Sodium-calcium phosphate	$Na_2O \cdot CaO \cdot P_2O_5$
Sodium-magnesium phosphate	$Na_2O \cdot MgO \cdot P_2O_5$
Sodium-zinc phosphate	$Na_2O \cdot ZnO \cdot P_2O_5$

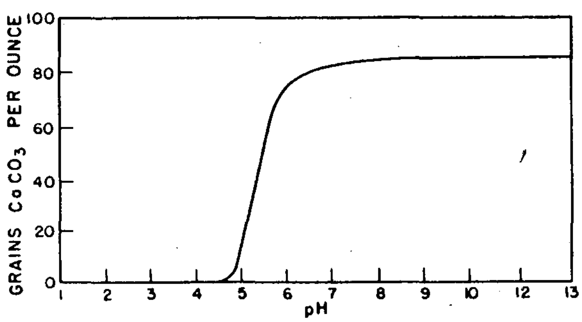


Fig. 3-10. Effect of pH on chelating power of EDTA (Ref. 66). (This is for Ca only. pH curves for other metals vary.)

Table 3-14

CONCENTRATION OF EDTA AND ITS SODIUM SALTS NECESSARY TO COMPLEX 1 PPM CALCIUM ION, MAGNESIUM ION, AND BARIUM ION (REF. 18)

	Solubility g/100 cc H_2O @ 26°C (79°F)	pH of Water Solution	ppm necessary to complex 1 ppm of Alkaline Earth Metal Mg^{++}	Ca^{++}	Ba^{++}
Ethylenediaminetetra-acetic acid	0.02	2.3	12.0	7.4	2.1
Disodium ethylenediaminetetra-acetate dihydrate	11.1	5.0	15.4	9.5	2.7
Trisodium ethylenediaminetetra-acetate monohydrate	57.0	8.4	15.6	9.6	2.8
Tetrasodium ethylenediamine-tetraacetate dihydrate	103.0	10.3	16.9	10.4	3.0

b. Closed Treatment Systems. A closed treatment system has the objective to exclude atmospheric oxygen and thereby aid in maintaining a constant wastewater composition. The closed system also minimizes escape of CO_2 gas from the water causing undesirable chemical reactions; for example, loss of CO_2 will increase the likelihood of $CaCO_3$ formation.

In oilfield brine treatment, a blanket of natural gas is maintained in the brine-containing vessels to insure the absence of air. Here, closed systems were found effective in maintaining brine chemistry, but success of the method depends partially on gathering brine from only a few wells and minimizing leaks in piping and other equipment (Ref. 20).

3. Treatment for Controlling Microorganisms

Growth of algae and bacteria is controlled by use of oxidizing agents such as chlorine. Chlorination is used to control microorganisms in flow lines, filters, cooling towers, ion exchange units, condensers, and water storage. In oilfield

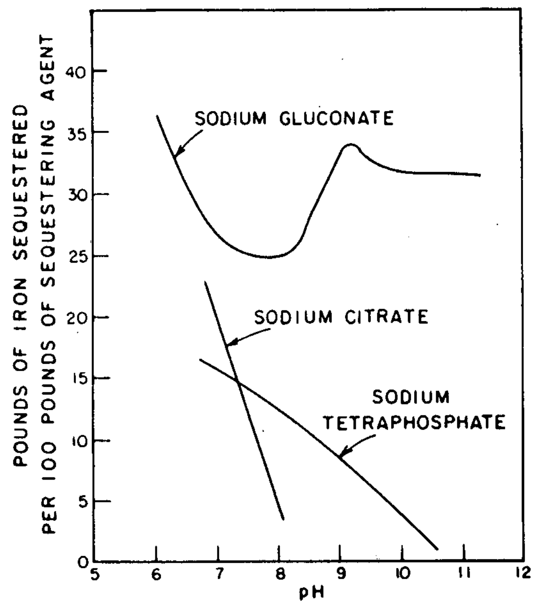


Fig. 3-11. Influence of pH on the chelating power of some iron sequestrants (Ref. 67)

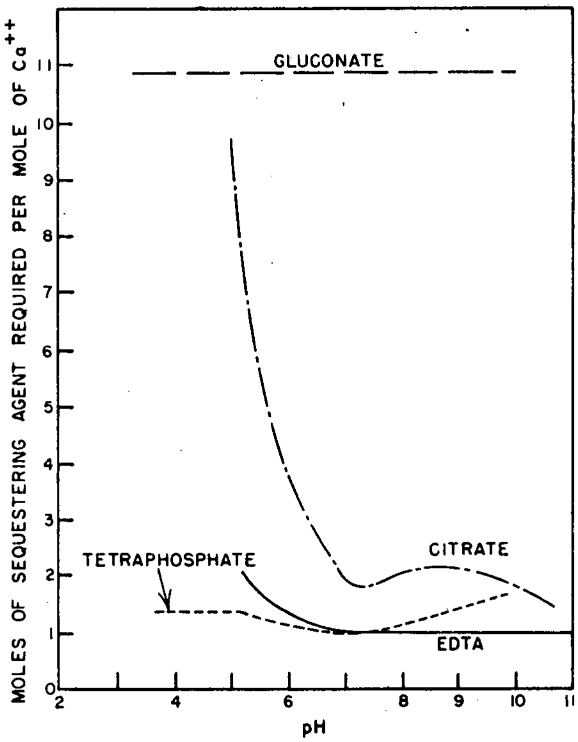


Fig. 3-12. Influence of pH on the chelating power of some calcium sequestrants (Ref. 68)

treatment chlorine may be added as a liquid, or generated in situ by electrolysis of the brine (Ref. 20). Chlorine added to water hydrolyzes to form hypochlorous and hydrochloric acids, as shown below:

$$H_2O + Cl_2 \rightleftarrows H^+ + Cl^- + HOCl$$

$$HOCl \rightleftarrows H^+ + OCl^-$$

The above reaction is influenced by pH and temperature. Chlorine is a strong oxidizing agent and converts any ferrous iron present in the water to the ferric form. This may eventually hydrolyze to insoluble $Fe(OH)_3$. Chlorination oxidizes hydrogen sulfide present in the water to $SO_4^=$ or sulfur.

Excessive amounts of residual chlorine may cause corrosion and should be avoided. Normally 0.2 ppm residual chlorine is sufficient to control microorganisms in water. Besides chlorine, other inorganic bactericides used are chromates and silver or mercury compounds.

At Cerro Prieto geothermal power plant, excessive corrosive bacteria proliferation caused a lowering in brine pH and an increase in sulfates in the cooling water. This was controlled using biocides containing organotin, bithiocyanite, polychlorophenol, and dispersants, and by periodic hand removal of the deposits (Ref. 14).

Sodium hypochlorite was used as an oxidizing agent to preoxidize As(III) to As(V), thereby substantially improving the efficiency of arsenic removal by coagulation from geothermal discharge waters in New Zealand (Ref. 53).

Section 4

BRINE TREATMENT FOR CORROSION CONTROL

The following section covers methods currently in use, or which may be useful in controlling geothermal corrosion. The methods generally fall into one of two categories: (1) removal of brine constituents which cause corrosion (e.g., CO_2, H_2S), and (2) development of corrosion-resistant materials.

Geothermal fluids contain appreciable quantities of dissolved salts and gases that are generally more corrosive to materials of construction than other standard environments for the production of electrical power. In a geothermal power system corrosion takes place in well casings (downhole corrosion), surface lines, separators, turbines, heat exchangers, cooling towers, and discharge lines. Corrosion rates in geothermal plants are dependent primarily on fluid pH, mineral content, temperature, flow rate (velocity), partial pressures of CO_2, H_2S, NH_3, and H_2, and the oxygen content of the system. (See Table 1-1.) Because geothermal fluids vary in composition from one field to another, treatment to prevent corrosion may require extensive tests and analyses of brine data for each geothermal site.

The forms of corrosion damage to metals commonly occuring in a geothermal environment include the following:

- Uniform surface corrosion--ordinary rusting on the surface of the metal resulting in reduction of metal thickness by a uniform amount. See Table 4-1.
- Pitting corrosion--a localized corrosive attack resulting in the formation of a shallow or deep pit.
- Stress corrosion and sulfide stress cracking--cracking of a metal due to constant tensile stresses in a corrosive environment.
- Erosion-corrosion due to mechanical abrasion of the passive film on a metal resulting in corrosion. This is traceable to the high velocity entrained particulate matter (e.g., sand or precipitated solids) in the geothermal fluids, and is particularly important where wearing is maximized due to high fluid velocity.

Table 4-1

SURFACE CORROSION RATES OF METALS IN GEOTHERMAL MEDIA (REF. 68)

Metal	Bore water[2] > 200 °C	Water[3] ~ 125 °C	Steam[4] 100-200 °C	Aerated steam[5] ~ 100 °C	Condensate[6] ~ 70 °C	Condensate/ fresh water mixture[7] ~ 50 °C	Highly acid thermal water[8]
Titanium	0	0	0	0	—	—	0
Chromium (plating on steel)	0		0	0	—	—	—
Aluminium	I	0.8-P	0-P-I	0-P	0.2	9	28
Zinc (coating on steel)	S[14]	1	0-I-P	S	—	S	—
Austenitic stainless steels[9]	0.1	0	0	0	0	0	22
Ferritic stainless steels[10]	0-0.1	0.1-P	0-0.3-P	1-P	0.1-P	0-0.5	—
Carbon and low alloy steels	0.3-0.4	0.3-0.5	0.3-6	20	3	30-170	1,000
Grey cast iron	1	0.4	1-3	10	—	90	—
High silicon cast iron	—	—	0.5	1	—	—	8
Brasses[11]	5	0.3	0.3-0.6	40	0.2	—	—
Bronze	20	—	2	9	—	—	—
Aluminium bronzes	10	—	2-3	10	1	—	—
Silicon bronze	—	—	3	20	—	—	—
Cupronickel	9	—	2	—	—	—	—
Beryllium copper	10	—	4	—	—	—	—
Copper	20	10	2	40	5	—	—
Nickel	6	—	1	8	2	—	—
Monel and K Monel	8-10	1	2-4	10	4	—	14
Nimonic 75	0.3	—	0	—	—	—	—
Inconel	1	0	0-0.3	80	—	—	20
Lead, antimonial lead	—	—	0.5	2.5-P	—	1	6

1. 1 mil = 0.001 inch. Data mainly from references 1, 4, 5 and 12.
2. Tests in water at bottom of a closed geothermal bore.
3. Water separated from wet geothermal steam at wellhead.
4. Steam separated from discharging geothermal bore.
5. Geothermal steam mixed with injected air.
6. Geothermal steam separated and condensed under pressure.
7. Geothermal steam condensed with freshwater to stimulate fluid in a jet condenser hot well.
8. Natural water in a volcanic crater (Tombs, 1960).
9. 18/8 CrNi, 18/8/3 CrNiMo, and 18/12/2 CrNiMo varieties.
10. 13 Cr, 17 Cr, 17/2 CrNi varieties.
11. 60/40 CuZn, arsenical 70/30 CuZn varieties.

I = internal attack with embrittlement.
P = pitting.
S = zinc coating stripped.

In addition to the above, corrosion fatigue, hydrogen infusion, galvanic corrosion, and hydrogen-induced delayed fracture are also common in a geothermal environment. For additional details, see Ref. 2, 68, and 69.

A. AERATION AND DEGASIFICATION

Aeration is a process used in "open-type" systems involving a mass transfer between the water and gas phases. Aeration speeds up the rate of interchange between air and water by producing a large contact surface area, and is effective in removing acidic gases (e.g., H_2S and CO_2).

$$H_2S + \frac{1}{2} O_2 \rightleftarrows H_2O + S$$

Typical aeration equipment includes cooling towers, spray nozzles, and forced draft blowers where air flows countercurrent to a flow of water cascading over splash trays.

However, over-aeration causes additional corrosion due to introduction of excess dissolved oxygen, probably the main cause of corrosion in oilfield brines (Ref. 12).

Degasification is a chemical process with the objective mainly to remove dissolved oxygen from water. The equipment used for oxygen removal includes open heaters, deaerating heaters, spray type deaerating heaters, tray type deaerating heaters, vacuum deaerators. For details of deaerators, see Ref. 18 and 56.

Chemical degasification is used to remove oxygen selectively from the water by adding a chemical such as sodium sulfite or hydrazine to remove O_2 from oilfield brines and boiler feed water. Sodium sulfite reacts with dissolved oxygen to form sulfate as follows:

$$\frac{1}{2} O_2 + Na_2SO_3 \rightarrow Na_2SO_4$$

The rate of the reaction is slow at ambient temperatures, requiring the use of catalysts (Mn, Cu, CO, Ni, Fe) to increase the reaction rate. See Fig. 4-1. Addition of a catalyst reduces the cost of treatment by about 25% (Ref. 18).

As discussed earlier, production of sulfate causes undesired precipitation of insoluble metal sulfates. Another problem with sodium sulfite is that it decomposes into corrosive SO_2 at high temperatures. Hydrazine (N_2H_4) is effective for reducing oxygen even at high temperatures. The reaction with O_2 is as follows:

$$N_2H_4 + O_2 \rightarrow N_2 + 2H_2O$$

In one experiment, hydrazine removed 81% of the oxygen from boiler feed water at 47°C (117°F); the removal increased to 94% when the feed water temperature was raised to 54°C (130°F). The presence of a catalyst (e.g., Cu^{++}, Mn^{++}) increases the reaction rates (Ref. 71).

Sodium sulfite (10 ppm Na_2SO_3 per 1 ppm O_2) was added to the 86°C water in the Reykjavik Municipal Heating System, Iceland, to reduce oxygen and thereby control internal corrosion of metals in the heating system (Ref. 72).

Tables 4-2 and 4-3 show the effect of air-aeration and degasification of geothermal brines on corrosion of various metals tested.

B. MATERIALS SELECTION

There is an active research and development effort centered on developing alloys with resistance to geothermal corrosion. The current status of this work is summarized in tabular form in Table 4-4. The reader is referred to Ref. 73 and 10 for a thorough review of corrosion resistance of metals in hot brines.

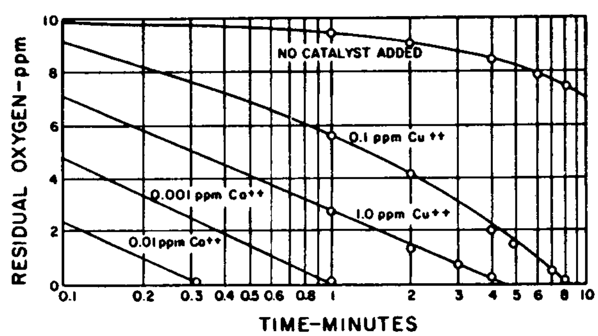


Fig. 4-1. Effect of catalysts on rate of oxygen-sulfite reaction (Ref. 70)

Table 4-2

CORROSION DATA AT 105°C AND 1 ATM, 15 DAYS (REF. 74)[1]

	General corrosion, mpy				Crevice corrosion[2]			
	Air-aerated		Deaerated		Air-aerated		Deaerated	
	Holtville brine (3w/o)	Niland brine (28w/o)	Holtville brine (3w/o)	Niland brine (28w/o)	Holtville brine (3w/o)	Niland brine (28w/o)	Holtville brine (3w/o)	Niland brine (28w/o)
Iron Base:								
Carbon steel	40.9	5.8	17.3	4.2	--	--	--	--
4130 steel	10.7	--	0.2	--	1	--	1	--
Sandvik 3RE-60	0.1	0.9	.4	0.0	3	6	1	2
E-Brite 26-1	.0	3.6	.0	.0	1	1	1	1
Type 302 ss	.1	--	.0	--	2	--	1	--
Type 316L ss	.0	4.0	.0	0.0	2	6	2	2
Carpenter 20 ss	.2	2.2	.1	.0	1	5	1	2
Nickel Base:								
Monel 400	2.5	3.7	0.2	2.8	4	5	1	4
Inconel X-750	0.1	3.4	0.0	0.0	--	5	--	3
Inconel 625	.0	0.0	.0	.0	1	1	1	1
Hastelloy S	.1	.0	.1	.0	1	4	1	1
Hastelloy G	.1	.1	.1	.0	1	4	1	1
Hastelloy C-276	.1	.0	.1	.0	1	1	1	1
Copper Base:								
Copper	63.1	12.5	1.9	3.1	--	1	--	1
Copper-2Iron	11.6	13.3	3.7	2.7	--	--	--	--
90-10 brass	3.6	--	2.2	--	4	--	1	--
70-30 brass	4.3	--	1.2	--	4	--	1	--
90-10 cupronickel	3.7	--	0.9	--	1	--	1	--
70-30 cupronickel	17.9	5.8	5.7	0.6	--	4	--	3
Titanium Base:								
Titanium	0.0	0.0	0.0	0.0	2	2	1	1
Titanium-1.7W	.0	.0	.0	.0	1	1	1	1
Titanium-2Ni	.1	.0	.0	.0	--	1	--	1
Titanium-10V	.0	.0	.0	.0	--	1	--	1
Aluminum Base:								
2024-T3	[3]45.4	34.9	4.9	[3]1.3	--	6	--	6
6061-T6	2.1	56.6	2.1	[3]30.4	--	1	--	1
Molybdenum Base:								
TZM	3.0	1.4	0.2	0.0	--	5	--	1

[1]Dashes (--) indicate that metal was not tested.

[2]Numbers indicate extent of corrosion as follows:

1. Not detected
2. Very slight (< 0.1 mpy)
3. Slight (> 0.1 mpy but < 1 mpy)
4. Moderate (> 1 mpy but < 5 mpy)
5. Severe (> 5 mpy but < 50 mpy)
6. Very severe (> 50 mpy).

[3]Pits 60 mils deep.

Table 4-3

CORROSION DATA IN DEAERATED NILAND (28 W/O) BRINE
AT 232°C, 15 DAYS (REF. 74)

	Type of Corrosion		
	General mpy	Crevice[1]	Stress
Iron Base:			
Sandvik 3RE-60	2.0	4	Detected
E-Brite 26-1	0.1	1	Not detected
Type 316L ss	.0	2	Detected
Carpenter 20 ss	.3	3	Detected
Nickel Base:			
Monel 400	19.8	1	Not detected
Inconel X-750	0.3	3	Not detected
Inconel 625	.0	1	Not detected
Hastelloy S	.0	2	Not detected
Hastelloy G	.1	2	Not detected
Hastelloy C-276	.0	1	Not detected
Copper Base:			
70-30 Cupronickel	15.2	1	Not detected
Titanium Base:			
Titanium	0.3[2]	4	Not detected
Ti-1.7W	.0	1	Not detected
Ti-2Ni	.1	3	Not detected
Ti-10V	.0	1	Not detected
Molybdenum Base:			
TZM	0.6	1	Not detected

[1]Numbers indicate extent of corrosion as follows:

1. Not detected
2. Slight (< 1 mpy)
3. Moderate (> 1 mpy but < 5 mpy)
4. Severe (> 5 mpy)

[2]Pitting 2.0 to 6.0 mils deep.

Table 4-4

CORROSION RESISTANT CANDIDATE MATERIALS FOR OXYGEN-FREE GEOTHERMAL SYSTEMS (REF. 75)

	120°C (250°F)		120°C-180°C (250°F-350°F)		180°C (>350°F)	
	Material	Problems	Material	Problems	Material	Problems
Dry Steam	Carbon Steel Low alloy steels 12 Cr steel	Corrosion fatigue Erosion High corrosion if steam condenses	Carbon Steel Low alloy steels 12 Cr steel Titanium Zirconium	Corrosion fatigue Erosion Specify corrosion allowance	Cr-Mo steels 12 Cr steels	Corrosion fatigue Erosion Specify significant corrosion allowance R&D on turbine materials
					Zirconium Titanium	Lack of data
Water						
pH >8	Carbon steel	Erosion	Carbon steel Low alloy steels	Hydrogen embrittlement Erosion Specify corrosion allowance	Alloy steels (for strength	Hydrogen embrittlement Erosion Specify corrosion allowance Need R&D for data
pH 6-8	Carbon steel	Erosion	Carbon steel Low alloy steels	Erosion Specify corrosion allowance	R&D Required	
	Aluminum	Test for pitting				
	Titanium		Aluminum	Test for pitting	Titanium or 56Ni-15Cr-16Mo*	
	316 SST	<50 ppm Cl^- required	Titanium	Test for pitting and crevice corrosion (especially in brines)		
			56Ni-15Cr-16Mo			
pH 4-6	Carbon steel	Short life uses only				
	Aluminum	Test for pitting	Aluminum	Pitting Test required		
	Titanium		Titanium			
	Zirconium		Zirconium		R&D Required Titanium or 56Ni-15Cr-16Mo*	
	316 SST	<50 ppm Cl^- required	56Ni-16Cr-16Mo*			
	56Ni-15Cr-16Mo*					
pH 4	Titanium	R&D Required	Titanium	R&D Required	R&D Required	
	Zirconium		Zirconium			
	56Ni-15Cr-16Mo*					

*Such as Hastalloy C

Section 5

SCALE AND INCRUSTANTS REMOVAL

In this section, we discuss methods currently being used or proposed for removal of scale once it has been formed in production wells, power plant equipment, and injection wells (Fig. 5-1). There are several approaches for removing deposited scale, depending on its location and composition. Commonly used methods to remove deposits are described below. See Table 5-1 for a listing of typical methods of scale removal.

A. ACIDIZING

Acidizing is a method used to clean boreholes of scale by injecting an acid into the borehole. The type of acid used depends on the composition of the deposit, e.g., HCl for $CaCO_3$ deposits, HF for sand or silica. Calcite reacts with HCl to form soluble $CaCl_2$ according to the reaction:

$$CaCO_3 + 2HCl \rightarrow Ca^{++} + H_2O + CO_2 \uparrow + 2Cl^-$$

Acid cleaning of $CaCO_3$ deposits with HCl was accomplished in East Mesa Well 5-1 by pumping 19,000 liters of inhibited 15% HCl into the bore (Ref. 21). East Mesa 5-1 has the following casing parameters:

Casing (O.D., inches)	Depth Interval (meters)	Slotted Interval (meters)	Average Saraband Sand Permeability
20	0-18	--	--
13-3/8	0-312	--	--
7-5/8	0-1830	1525-1830	69 millidarcies

On acidizing, sufficient deposit was removed to permit lowering of small diameter downhole instruments into the bore; this previously was prevented by the $CaCO_3$ scale.

Acidizing appears to be fairly common practice in the geothermal industry. For example, acid treatment to descale well casings is practiced in Hungary (Ref. 22)

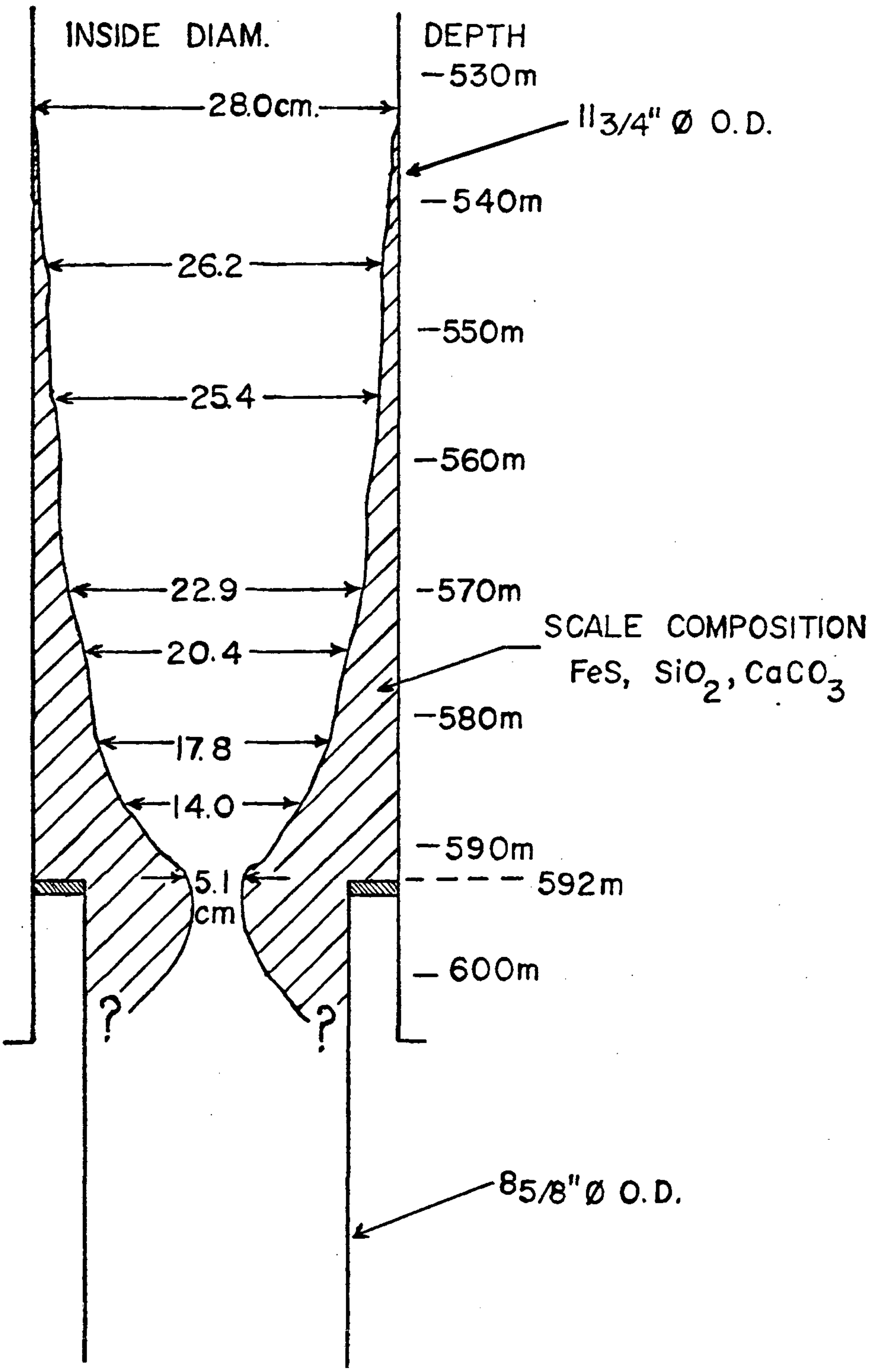


Fig. 5-1. Profile of scale in Well M-13, Cerro Prieto Geothermal Field, Mexico (Ref. 15).

Table 5-1

TYPICAL TREATMENT METHODS FOR SCALE REMOVAL

Scale Type	Treatment Method	Comments
	CURRENT METHODS:	
$CaCO_3$ (calcite) in borehole	Pump inhibited HCl into the well	Acidizing used at East Mesa Well 5-1 and Otake, Japan
Calcite in well casings	Wash with inhibited HCl	Used in Hungary and Kawerau, New Zealand
Silica in flow control equipment and heat exchangers	Wash with ammonium bifluoride	Acidizing, used at Hveragerdi, Iceland
Silica in borehole	Pump NaOH solution into the well	Used at Matsukawa, Japan
Calcite in borehole	Reaming or redrilling	Used in New Zealand, Hungary, and Mexico
Mixed scales in turbine components	Spaced injection of heavy diesel oils	Used at Larderello, Italy
Mixed scales in injection and brine drain lines	Hydroblasting followed by water flush	Used at Niland Geothermal Test Facility, California
	DEVELOPING METHODS:	
Mixed scales in heat exchanger tubing and piping	Cavitation descaling	Laboratory experiments
Calcite scale (test probe)	Application of thermal shock	Laboratory experiments

and inhibited hydrochloric acid has been used with minor success in the Kawerau Geothermal Field in New Zealand to remove calcite deposits from well casing slots (Ref. 23). In Otake, Japan, acid cleaning of a bore choked at a depth of 260 meters with calcite scale was carried out using 5000 kg of 35% HCl containing 75 kg of inhibitor (Ref. 24). Water was injected into the well to maintain a 3-5% acid concentration. Although the deposit was not removed completely, the discharge from the well approximately doubled as shown in the following table:

	Separator Pressure kg/cm^2 G*	Steam t/h	Hot Water t/h	Shut In Pressure kg/cm^2 G*
before acid cleaning	2.1	4	25	2.2
after acid cleaning	2.1	8	56	2.8

*G=Gauge

Chemical cleaning to remove silica scale from flow control equipment and heat exchangers using ammonium bifluoride has been tried with fair success at Hveraqerdi, Iceland (Ref. 25). Caution is required in use of the acid; injected HF reacts with certain metals (e.g., Ca) to form insoluble fluorides which could precipitate within the borehole.

B. ADDITION OF BASE

Though very insoluble in water and acid, silica scale dissolves in sodium hydroxide solutions to form soluble silicate:

$$SiO_2 + 2OH^- \rightarrow SiO_3^= + H_2O$$

Scale containing 90% silica was removed from a well in Matsukawa, Japan, using sodium hydroxide (NaOH) as follows: "125 kg of NaOH was dissolved in 300 liters of water. The solution was put into the wellhead for 8 minutes while maintaining high temperature and pressure. The wellhead was then washed with pure water for 15 minutes and the process was repeated. The scale was completely removed in 30 minutes" (Ref. 13).

A disadvantage in scale removal with NaOH is the possibility of precipitating metal hydroxides in the formation. These precipitates, if formed, would require addition of acid (e.g., HCl) for their removal.

C. REAMING

As used here, reaming is defined as use of mechanical means such as scratching to clean scale deposits from the wall or casing of a well and from pipelines. In a well, the scratcher or reamer is lowered into the bore and deposits scratched by simultaneous rotary and transverse motion of the reamer.

Reaming of geothermal wells to remove calcite has been tried with limited success in New Zealand (Ref. 23), Hungary (Ref. 22), and Mexico. A 1974 estimate of the cost of reaming is obtained from the following data: Low enthalpy wells (~400 Btu/lb) at Cerro Prieto are expected to plug with calcite in about one year, and the high enthalpy wells (~650 Btu/lb) with silica in three to four years. Reaming a typical plugged-up well involving redrilling takes five to ten days at Cerro Prieto and costs about $1200/day. Based on these figures, a rework cost of $10,000 to $30,000 is estimated in a Salton Sea well, assuming that the rework rig was available with no move-in or mobilization charge (Ref. 2).

Scrapers are used to remove scales formed in pipelines by running them through the lines at regular intervals; they are inserted and removed at inlet and outlet scraper traps. The scrapers frequently used in salt-water gathering systems are variously called steel-balls, chained rubber-balls, plugs and wire-brushes, go-devils, and spiral-brush pigs. A disadvantage of scrapers is the possibility of damage to any plastic lining of the pipes and mechanical abrasion of the pipe itself.

D. CAVITATION DESCALING AND HYDROBLASTING

Cavitation descaling employs pulsating high pressure jets of water which are directed against the scale surfaces. If the water velocity is such that repetitive low- and high-pressure areas are developed, bubbles form and collapse at the solid-liquid interface. This phenomenon is termed cavitation (Ref. 26). The collapse of these bubbles or cavities results in shock pressures reaching several hundred atmospheres in localized areas. The resultant impact tears out sections of porous or brittle material adhering to pipes.

Application of waterjet or cavitation descaling to remove scale from geothermal heat exchanger tubing and pipes is currently being investigated by studying the cleaning rates of various scale-filled pipes as a function of nozzle and jet parameters. In tests conducted so far, a 2 inch inside diameter pipe which had been reduced to 1-1/4 inches by an iron-rich silica scale was cleaned out completely by a cavitation hydrojet (Ref. 27, 76). Hydroblasting was used to clean portions of the reinjection line and brine drain lines at Niland Geothermal Loop Experimental Facility (GLEF), California. Approximately 1,200 feet of the reinjection line was cleaned by hydroblasting. Depending upon drainage and length of the line, the hydroblasting was followed by a water flush. Several combinations of hydroblast nozzle geometries, number and size of orifices, high pressure pump flows and pressures were tried. The best cleaning was generally achieved with a low number of orifices, moderately high pressure (5,000 psig), high pump flow rates, and an impingement angle of 30° from the pipe center line (Ref. 77).

E. THERMAL SHOCK

In tests conducted at the East Mesa KGRA on brine from Well 6-1, a thermal shock method was used to remove calcite scale from a test probe in a simulated vertical tube evaporator. See Tables 2-1 and 2-2 for brine and scale composition. An electrically heated probe was placed inside a test section of pyrex pipe through which geothermal brine was flowing at a constant rate. Buildup of scale on the probe was monitored by measuring the change in heat transfer due to scale buildup. The scaled system was subjected to a thermal shock by closing the liquid flow to the test section, thus causing the temperature of the probe to rise. See Fig. 5-2. During this temperature rise, boiling of the liquid caused slugs of vapor to move up the test section and the liquid to flow down, which may have increased the thermal shock effect. Differential expansion of the metal probe and scale along with the rapid vaporization of moisture in the scale next to the heated probe is thought to be partly responsible for the effectiveness of thermal shock in scale removal. About 30 to 40% of this scale fell free leaving the probe clear and wet. The result on heat transfer resistance is shown in Fig. 5-3, which appears to indicate that a larger percentage of the scale was removed than was estimated from a visual observation (Ref. 4).

F. OIL INJECTION

The injection of heavy diesel oils was used to aid in scale removal from turbine blades at Larderello:

> Scaling can occur anywhere in the turbine. The components are always the same: iron sulfide, clay, ammonium, calcium and alkaline metal salts of boric, sulfuric, hydrochloric and carbonic acid. As a rule, iron sulfide prevails in the first row of blades, whereas later rows show partially hydrated ammonium borates, silica and various silicates. These scales are up to 5 mm thick and show a crystal consistency and structure that suggests an actual separation by supersaturation crystallization. Since it is impossible to prevent their formation, practical methods are used to diminish their danger such as, for instance, the spaced injection of heavy diesel oils into the turbine to make the scales softer and easy to remove. (Ref. 28)

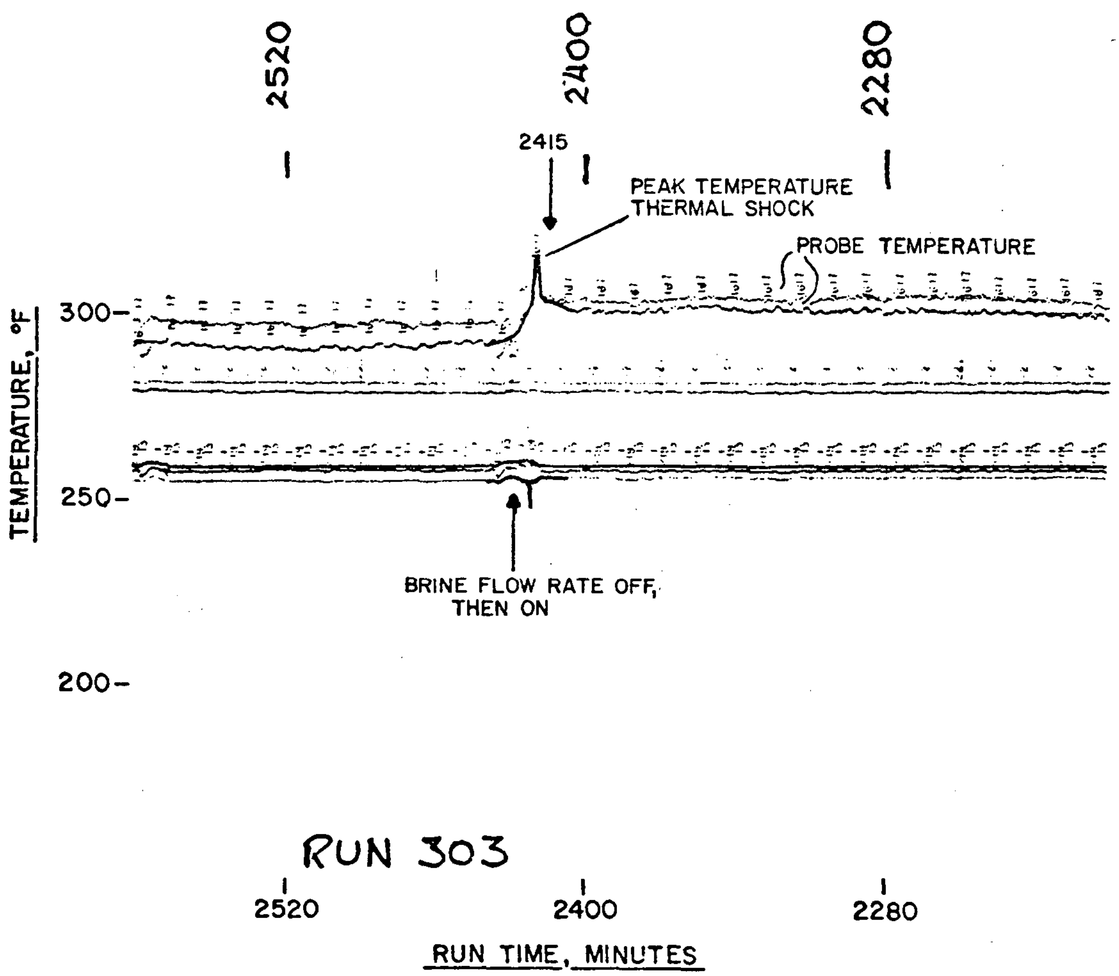


Fig. 5-2. Part of the temperature record for Run 303 showing the thermal shock effecting descaling in Fig. 5-3 (Ref. 4).

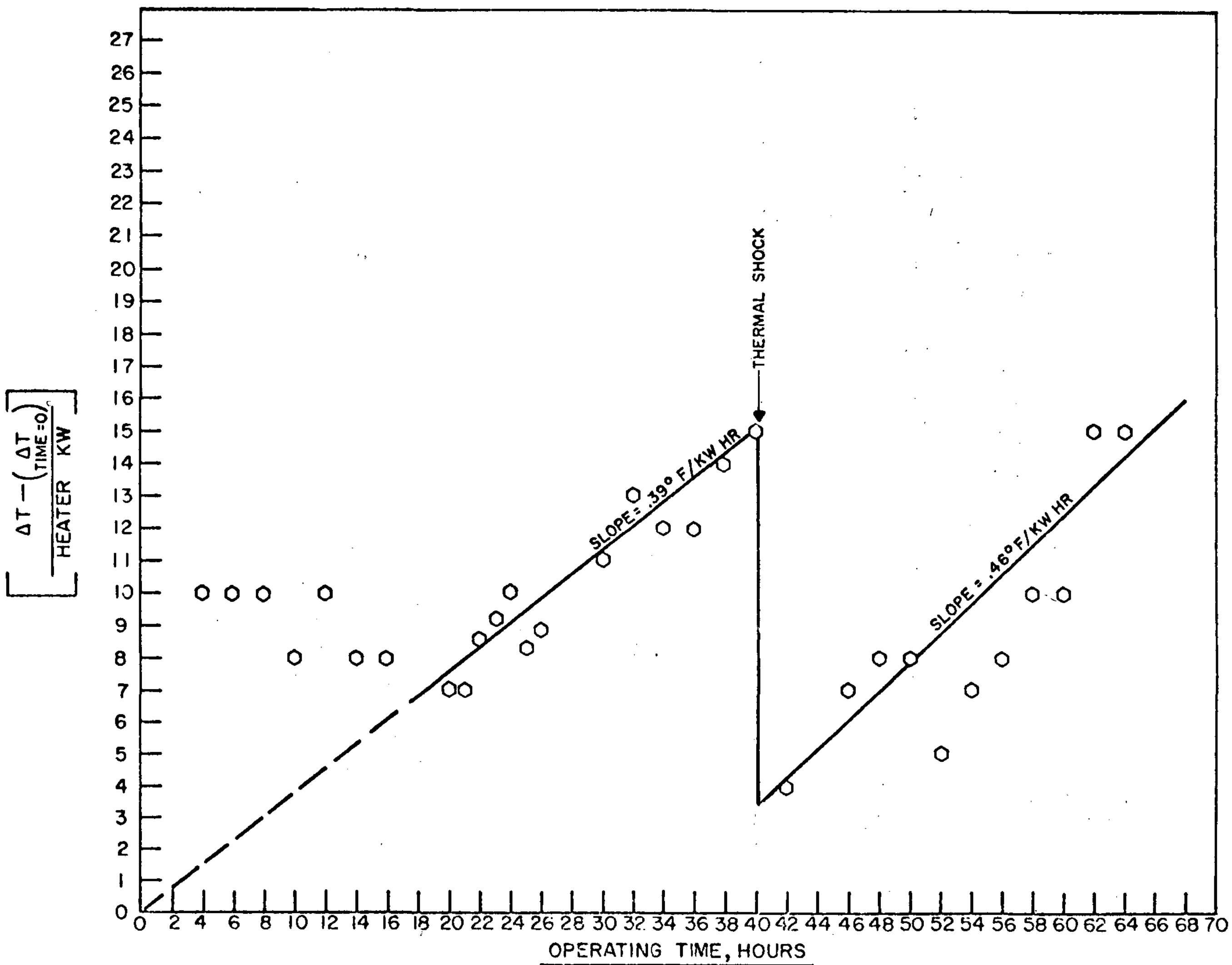


Fig. 5-3. Effect of thermal shock on scale resistance. Heat transfer scale resistance for Run 303. (Ref. 4)

G. SCALING CONTROL BY MAGNETIC FIELD

CEPI of Belgium has proposed an apparatus using magnetic field for removal of scaling:

> The device consists essentially of a permanent magnet where the core is an iron cylinder 40 to 50 cm long and 10 to 20 cm in diameter. Water flows through the system and the crystal structure of the precipitate is modified under the influence of the magnetic field and as a consequence can be easily removed from the pipeline. Unfortunately, this method is unsuitable for scaling control in thermal water wells as its setting into the well at about 40 to 50 m depth is very difficult due to its outer diameter. (Ref. 29)

H. SUMMARY

In summary, scale is removed by either mechanical (e.g., reaming) or chemical (e.g., acidizing) methods. An advantage of mechanical methods is that most scales can be removed. Disadvantages of mechanical methods include the following: (1) removal of scale from wellbores requires a drill rig and can be expensive; (2) the well or piping system must be shut down prior to reaming; (3) in a well, only the bore itself is cleaned so that any deposits in the formation are untouched; (4) drill cuttings may be squeezed into any pipe perforations, causing an impermeable layer to form and hot water production to fall off; (5) mechanical removal from a plugged slotted liner is very difficult; (6) plastic pipe lining may be damaged. Because of these factors, chemical methods are preferred in the oilfield industry (Ref. 30).

Depending on scale composition, chemical treatment such as acidizing is generally economical and effective in removing scale from boreholes. A disadvantage of chemical treatment is the possible "eating a hole" through the scale, thereby leaking the chemical into the formation without dissolving scale.

Although the methods of scale cleanup described above are satisfactory in some respects, they have at least four significant drawbacks associated with these "after the fact" solutions:

- The well must be taken out of service to perform cleanout.
- Frequency of cleanout for some wells may be prohibitively high.
- Scale buildup causes gradual reduction of pressure and flow with time during the interval between cleaning.
- Chemical or mechanical methods of cleaning may damage well casings and piping.

For additional information on scale removal, see the papers, "Oilfield Scale--Can We Handle It?" (Ref. 30) and "Inhibiting Deposition of Siliceous Scale" (Ref. 31).

Section 6

SUMMARY AND RECOMMENDATIONS

Present methods for controlling scale deposition and materials corrosion in the geothermal industry are mainly cleanup and replacement of pipes and other components on an as-required basis. Scale or incrustations due to deposition of scales (e.g., silica, sulfide) from hot brines are usually removed from boreholes by acidizing or reaming; that in piping is mechanically removed by wire-brushing or by using scrapers. Materials rendered unserviceable by corrosion are replaced with new parts.

There is a current effort focused on geothermal brine treatment with the purpose of minimizing silica, sulfide, and calcite deposition from fresh brine, and to remove arsenic and silica prior to spent brine disposal. Examples of some of the methods used to control scaling at geothermal installations include the following: At Namafjall, Iceland, addition of cold dilution water to fresh fluid was effective in reducing silica scale. At Otake, Japan, a holding tank for spent brines was included as part of a treatment system to allow formation of colloidal silica in the retention tank so that the silica deposition in the transport lines or in the injection well is minimized. At Wairakei and Broadlands, New Zealand, a coagulation treatment was used to remove arsenic and silica from spent fluid prior to disposal of the fluid to the Waikato River. However, detailed investigation of the economics of these as well as the other methods described in this report is necessary for assessing the commercial feasibility of one or the other method of brine treatment.

It is clear that utilization of geothermal hot water for electric power production will be aided by adequate brine treatment methods. Research and development activities centered around geothermal scale and corrosion control by treatment of brines have been increasing within the past two years. An ideal brine treatment program would include the following:

1. Characterization of brine chemistry and deposited scales in order to determine the causes and possible means of control. The scale and corrosion products

reflect the variable brine composition for different geothermal areas. Brine treatment methods can then be devised for the particular production fluid and for the particular method of disposal under consideration.

2. Basic laboratory investigations on the mechanisms and rates of scale formation due to corrosion or scale deposition. Basic data are transferable to all geothermal sites and will be needed to select, for example, additives and materials which would control scaling and corrosion.

3. Development of additives (e.g., inhibitors, sequestrants) and instruments to monitor the important geothermal brine scale and corrosion parameters (e.g., silica, pH, H_2S). The instrument sensors should be sufficiently rugged to monitor geothermal fresh fluids in a reliable manner.

4. Correlation of laboratory test results with actual tests in field conditions. In this way, feedback on the predictions based on laboratory results can be quickly verified and incorporated into brine treatment programs.

5. Development of laboratory screening methods for commercially available scale and corrosion inhibitors, with the idea to evaluate their effectiveness under geothermal conditions. The inhibitors should be effective at the elevated temperatures and pressures encountered in geothermal systems and should not react with brine constituents either to form harmful products or to reduce the effectiveness of the additive.

Section 7

REFERENCES

1. Hoffman, M.R., Brine Chemistry--Scaling and Corrosion, EQL Memorandum No. 14, California Institute of Technology, Pasadena (July 1975).

2. Shannon, D.W., Economic Impact of Corrosion and Scaling Problems in Geothermal Energy Systems, Report #BNWL-1866 UC-4, Battelle Pacific Northwest Labs., Richland, Wash. (January 1975).

3. Lyon, R.N., and Kolstad, G.A., A Recommended Research Program in Geothermal Chemistry, Report #WASH-1344, USAEC, Washington, D.C. (October 1974).

4. Wahl, E.F., Yen, I.K., and Bartel, W.J., Silicate Scale Control in Geothermal Brines--Final Report, Report #GR&D 74-048, Garrett Research and Development Co., Inc., LaVerne, Calif. (September 1974).

5. Wahl, E.F. and Yen, I.K., Scale Deposition and Control Research for Geothermal Utilization, Report #GRD 75-050, Garrett Research and Development Co., Inc., LaVerne, Calif. (May 1975).

6. Materials Problems Associated with the Development of Geothermal Energy Resources, USBM Grant #P0150296, B.A. Hall (ed.), Geothermal Resources Council, Davis, Calif. (May 1975).

7. Second Workshop on Materials Problems Associated with the Development of Geothermal Energy Systems. Proceedings of the Workshop Held May 16-18, 1975 at El Centro, California, USBM Grant #P0152088, B.A. Hall (ed.), Geothermal Resources Council, Davis, Calif. (1976).

8. Conference on Scale Management in Geothermal Energy Development, San Diego, California, August 2-4, 1976, Report #COO-2607-4, Energy Research and Development Administration (Division of Geothermal Energy), Washington, D.C. (1976).

9. "Corrosion Encountered in Energy Extraction from Geothermal Brines and Steams," Extended Abstracts of 150th Society Meeting, Las Vegas, Nevada, October 17-22, 1976, The Electrochemical Society, Inc., Princeton, N.J., Vol. 76-2, p. 289-327 (1976).

10. Miller, R.L., Corrosion Engineering in the Utilization of the Raft River Geothermal Resource, Report #ANCR-1342, Idaho National Engineering Lab., Idaho Falls (August 1976).

11. Compilation of Geothermal Well Fluid Data, Report #LBL-5936, Lawrence Berkeley Lab., Univ. of California, Berkeley (To Be Published).

12. Reid, G.W., Streebin, L.E., Canter, L.W., and Smith, J.R., Brine Disposal Treatment Practices Relating to the Oil Production Industry, Report #EPA 660/2-74-0, Environmental Protection Agency, Washington, D.C. (May 1974).

13. Ozawa, T., and Fujii, Y., "A Phenomenon of Scaling in Production Wells and the Geothermal Power Plant in the Matsukawa Area," Geothermics, Special Issue 2, 2(2), 1613-1618 (1970).

14. Mercado, S.G., "Cerro Prieto Geothermoelectric Project: Pollution and Basic Protection," Proceedings Second United Nations Symposium on the Development and Use of Geothermal Resources, San Francisco, California, May 20-29, 1975, Lawrence Berkeley Lab., Univ. of California, Berkeley, Vol. 2, p. 1417-1425, (1976).

15. Mercado, S., and Guiza, J., "Problems of Silica Scaling at Cerro Prieto Geothermal Field," Conference on Scale Management in Geothermal Energy Development, San Diego, California, August 2-4, 1976, Report #COO-2607-4, Energy Research and Development Administration (Division of Geothermal Energy), Washington, D.C., p. 59-87 (1976).

16. Water Quality and Treatment--A Handbook of Public Water Supplies, 3rd edition, McGraw-Hill Book Co., New York (1971).

17. Subsurface Salt-Water Disposal--Book 3 of the Vocational Training Series, American Petroleum Institute (Production Division), Dallas, Texas (1960).

18. Ostroff, A.G., Introduction to Oilfield Water Technology, Prentice-Hall, Inc., Englewood Cliffs, N.J. (1965).

19. Underground Waste Management and Environmental Implications. Proceedings of the Symposium held December 6-9, 1971, in Houston, Texas, Memoir 18, T.D. Cook (ed.), American Association of Petroleum Geologists, Tulsa, Okla. (1972).

20. Salt Water Disposal--East Texas Oil Field, 2nd edition, Petroleum Extension Service, Univ. of Texas, Austin (1958).

21. Mathias, K.E., "The Mesa Geothermal Field--A Preliminary Evaluation of Five Geothermal Wells," Proceedings Second United Nations Symposium on the Development and Use of Geothermal Resources, San Francisco, California, May 20-29, 1975, Lawrence Berkeley Lab., Univ. of California, Berkeley, Vol. 2, p. 1741-1747 (1976).

22. Facca, G., "The Status of World Geothermal Development," Geothermics, Special Issue 2, 1, 8-23 (1970).

23. Smith, J.H., "Geothermal Development in New Zealand," Geothermics, Special Issue 2, 2(1), 232-247 (1970).

24. Hayashida, T., and Ezima, Y., "Development of Otake Geothermal Field," Geothermics, Special Issue 2, 2(1), 208-220 (1970).

25. Thorhallsson, S., Ragnars, K., Arnorsson, S., and Kristmanndottir, H., "Rapid Scaling of Silica in Two District Heating Systems," Proceedings Second United Nations Symposium on the Development and Use of Geothermal Resources, San Francisco, California, May 20-29, 1975, Lawrence Berkeley Lab., Univ. of California, Berkeley, Vol. 2, p. 1445-1449 (1976).

26. Uhlig, H.H., Corrosion and Corrosion Control--An Introduction to Corrosion Science and Engineering, 2nd edition, John Wiley & Sons, Inc., New York (1971).

27. "Task of Developing Cavitation Descaling Techniques and Hardware for Scaled-up and Stopped-up Geothermal Heat Exchanger Tubing and Pipes...," Geothermal Report, 5(21), 3-4 (November 1976).

28. Allegrini, G., and Benvenuti, G., "Corrosion Characteristics and Geothermal Power Plant Protection (Collateral Processes of Abrasion, Erosion, and Scaling)," Geothermics, Special Issue 2, 2(1), 865-881 (1970).

29. Belteky, L., Problems Related to Operating Thermal Wells Subject to Scaling in Hungary," Geothermics, 4(1-4), 57-65 (1975).

30. Vetter, O.J., "Oilfield Scale--Can We Handle It?", J. Pet. Technol., 28, 1402-1048 (1976).

31. Grens, J.Z., and Owen, L.B., "Inhibiting Deposition of Siliceous Scale," Conference on Scale Management in Geothermal Energy Development, San Diego, California, August 2-4, 1976, Report #COO-2607-4, Energy Research and Development Administration (Division of Geothermal Energy), Washington, D.C., p. 161-168 (1976).

32. Owen, L.B., Precipitation of Amorphous Silica from High Temperature Hyper-Saline Geothermal Brines, Report #UCRL-51866, Lawrence Livermore Lab., Univ. of California, Livermore (June 1975).

33. Fournier, R.O., "The Solubility of Amorphous Silica at High Temperatures and High Pressures," Conference on Scale Management in Geothermal Energy Development, San Diego, California, August 2-4, 1976, Report #COO-2607-4, Energy Research and Development Administration (Division of Geothermal Energy), Washington, D.C., p. 19-23 (1976).

34. Barnes, H.L., and Rimstidt, J.D., "Chemistry of Silica Scale Formation," Second Workshop on Materials Problems Associated with the Development of Geothermal Energy Systems. Proceedings of the Workshop Held May 16-18, 1975 at El Centro, California, USBM Grant #P0152088, B.A. Hall (ed.), Geothermal Resources Council, Davis, Calif., p. 1-13 (1976).

35. Fournier, R.O., "Silica in Thermal Waters: Laboratory and Field Investigations," Proceedings of Symposium on Hydrogeochemistry and Biogeochemistry, Tokyo, Japan, September 7-9, 1970, The Clarke Company, Washington, D.C., Vol 1 (Hydrogeochemistry), p. 122-139 (1973).

36. Alexander, G.B., Heston, W.M., and Iler, R.K., "The Solubility of Amorphous Silica in Water," J. Phys. Chem., 58, 453-455 (1954).

37. Catalano, E., and Hill, J.H., Comments on the Possible Effects of Additives on Scaling by Geothermal Brines, Report #UCRL-51756, Lawrence Livermore Lab., Univ. of California, Livermore (February 1975).

38. Owen, L.B., Private Communication (March 1977).

39. Sussman, S., "Treatment of Water for Cooling, Heating, and Steam Generation" (Chapter 16), Water Quality and Treatment--A Handbook of Public Water Supplies, 3rd edition, McGraw-Hill Book Co., New York, p. 499-525 (1971).

40. Betz, L.D., Noll, C.A., and Maguire, J.J., "Removal of Silica from Water by Cold Processes," Ind. Eng. Chem., 32, 1320-1323 (1940).

41. Betz, L.D., Noll, C.A., and Maguire, J.J., "Removal of Silica from Water by Hot Processes," Ind. Eng. Chem., 32, 1320-1323 (1940).

42. Behrman, A.S., and Gustafson, H., "Removal of Silica from Water," Ind. Eng. Chem., 32, 468-472 (1940).

43. Schock, R.N., and Duba, A., The Effect of Electrical Potential on Scale Formation in Salton Sea Brine, Report #UCRL-51944, Lawrence Livermore Lab., Univ. of California, Livermore (November 1975).

44. Jackson, D.D., and Hill, J.J., Possibilities for Controlling Heavy Metal Sulfides in Scale from Geothermal Brines, Report #UCRL-51977, Lawrence Livermore Lab., Univ. of California, Livermore (January 1976).

45. Scott, G.R., "Aeration" (Chapter 2), Water Quality and Treatment--A Handbook of Public Water Supplies, 3rd edition, McGraw-Hill Book Co., New York, p. 52-65 (1971).

46. Holland, D.E., "Gangue Minerals in Hydrothermal Deposits" (Chapter 9), Geochemistry of Hydrothermal Ore Deposits, H.L. Barnes (ed.), Holt, Rinehart and Winston, Inc., New York, p. 382-436 (1967).

47. Matthews, H.B., and McBee, W.D., "Geothermal Down-Well Pumping System," Proceedings of the Conference on Research for the Development of Geothermal Energy Resources, Pasadena, California, September 23-25, 1974, Report #NSF-RA-N-74-159, California Institute of Technology, Pasadena, p. 281-291 (1974).

48. Kryukov, P.A., and Larionov, E.G., "Physico-chemical Sampling of High-Temperature Wells in Connection with Their Encrustation by Calcium Carbonate," Geothermics, Special Issue 2, 2(2), 1624-1628 (1970).

49. Gelosa, L.R., and Andrade, R.C., "Water Treatment Programs for Steam Generating Systems," Ind. Water Eng., 14(2), 18-22 (1976).

50. Gaupp, R.H., and Nygren, J.A., "Corrosion and Scale Control," Ind. Water Eng., 11(3), 18-20 (1974).

51. Weber, W.J., Physicochemical Processes for Water Quality Control, Wiley-Interscience, New York (1972).

52. Einarsson, S.S., Vides, A.R., and Cuellar, G., "Disposal of Geothermal Waste Water by Reinjection," Proceedings Second United Nations Symposium on the Development and Use of Geothermal Resources, San Francisco, California, May 20-29, 1975, Lawrence Berkeley Lab., Univ. of California, Berkeley, Vol. 2, p. 1349-1363 (1976).

53. Rothbaum, H.P., and Anderton, B.H., "Removal of Silica and Arsenic from Geothermal Discharge Waters by Precipitation of Useful Calcium Silicates," Proceedings Second United Nations Symposium on the Development and Use of Geothermal Resources, San Francisco, California, May 20-29, 1975, Lawrence Berkeley Lab., Univ. of California, Berkeley, Vol. 2, p. 1417-1425 (1976).

54. Betz Handbook of Industrial Water Conditioning, 6th edition, Betz Lab., Philadelphia (1962).

55. Sadow, R.D., "Pretreatment of Industrial Waste Waters for Subsurface Injection," Underground Waste Management and Environmental Implications. Proceedings of the Symposium held December 6-9, 1971, in Houston, Texas, Memoir 18, T.D. Cook (ed.), American Association of Petroleum Geologists, Tulsa, Okla., p. 93-101 (1972).

56. Fair, G.M., Geyer, J.C., and Okun, D.A., Water and Wastewater Engineering, John Wiley & Sons, New York (1968).

57. Hamer, P., Jackson, J., and Thurston, E.F., Industrial Water Treatment Practice, Butterworth & Co., London, 514 p. (1961).

58. Yanagase, T., Suginohara, Y., and Yanagase, K., "The Properties of Scales and Methods To Prevent Them," Geothermics, Special Issue 2, 2(2), 1619-1623 (1970).

59. James, R., "Collection and Transmission of Geothermal Fluids," Geothermics, Special Issue 2, 1, 99-105 (1970).

60. Krauskopf, K.B., "The Geochemistry of Silica in Sedimentary Environments," Soc. Econ. Paleontol. Mineral., Spec. Publ. 7, 4-19 (1959).

61. Ceullar, G., "Behavior of Silica in Geothermal Waste Waters," Proceedings Second United Nations Symposium on the Development and Use of Geothermal Resources, San Francisco, California, May 20-29, 1975, Lawrence Berkeley Lab., Univ. of California, Berkeley, Vol. 2, p. 1343-1347 (1976).

62. VanWazer, J.R., Phosphorus and Its Compounds, Interscience Publishers, New York, Vol. 1 (1958).

63. Earllougher, R.C., and Love, W.W., "Sequestering Agents for Prevention of Scale Deposition in Oil Wells," J. Pet. Technol., 9, 17-20 (1957).

64. Welcher, F.J., The Analytical Uses of Ethylenediaminetetraacetic Acid, D. Van Nostrand, Princeton, N.J. (1958).

65. Chaberek, S., and Martell, A.E., Organic Sequestering Agents, John Wiley & Sons, Inc., New York (1959).

66. Martell, A.E., and Calvin, M., Chemistry of the Metal Chelate Compounds, Prentice-Hall, Inc., Englewood Cliffs, N.J. (1952).

67. Ostroff, A.G., Introduction to Oilfield Water Technology, Prentice-Hall, Inc., Englewood Cliffs, N.J., p. 90 (1965).

68. Marshall, T., and Braithwaite, W.R., "Corrosion Control in Geothermal Systems," Geothermal Energy, Earth Sciences Series No. 12, H.C.H. Armstead (ed.), UNESCO, Paris, p. 151-160 (1973).

69. Foster, P.K., Marshall, T., and Tombs, A., "Corrosion Investigations in Hydrothermal Media at Wairakei, New Zealand," New Sources of Energy. Proceedings of the Conference, Rome, 21-31 August 1961, United Nations, New York, Vol. 3 (Geothermal Energy: II), p. 186-195 (1964).

70. Pye, D.J., "Chemical Fixation of Oxygen," J. Am. Water Works Assoc., 39, 1121-1127 (1947).

71. Leichester, J., "The Chemical Deaeration of Boiler Water--The Use of Hydrazine Compounds," Trans. ASME, 78, 273 (1956).

72. Hermannsson, S., "Corrosion of Metals and the Forming of a Protective Coating on the Inside of Pipes Carrying Thermal Waters Used by the Reykjavik Municipal District Heating Service," Geothermics, Special Issue 2, 2(2), 1602-1612 (1970).

73. Banning, L.H., and Oden, L.L., Corrosion Resistance of Metals in Hot Brines--A Literature Review, Report #IC-8601, U.S. Bureau of Mines, Washington, D.C. (1973).

74. Carter, J.P., and Cramer, S.D., "Corrosion Resistance of Some Commercially Available Metals and Alloys to Geothermal Brines," Corrosion Problems in Energy Conversion and Generation, The Electrochemical Society, Princeton, N.J., p. 240-250 (1974).

75. Kukacka, L.E., Fontane, J., Horn, W., and Amars, J., Concrete-Polymer Materials for Geothermal Applications, Progress Report #8, January-March 1976, Informal Report, Report #BNL-21244, Brookhaven National Lab., Upton, N.Y., 18 pp. (1976).

76. Thiruvengadem, A.P., "Cavitation Descaling Techniques for Geothermal Applications," Conference on Scale Management in Geothermal Energy Development, San Diego, California, August 2-4, 1976, Report #COO-2607-4, Energy Research and Development Administration (Division of Geothermal Energy), Washington, D.C., p. 247-256 (1976).

77. Geothermal Loop Experimental Facility, Report #SAN/1137-5, San Diego Gas and Electric, San Diego, Calif. (March 1977).

78. Technical Service Bulletin WT 10.0, Industrial Chemicals Division, CIBA-Geigy (UK) Ltd., Manchester, England, 8 p., (July 1975).

79. Glossary--Water and Wastewater Control Engineering, American Public Health Association, American Society of Civil Engineers, American Water Works Association, and Water Pollution Control Federation (1969).

80. Webster's Third New International Dictionary (1961).

81. Chambers Dictionary of Science and Technology, T.C. Collocott edition, Barnes and Noble, New York (1972).

82. Water Quality Criteria 1972, A Report of the Committee on Water Quality Criteria, Report #EPA·R3·73·033 March 1973, Environmental Protection Agency, Washington, D.C., p. 372-375 (1972).

Section 8

GLOSSARY OF TYPICAL BRINE TREATMENT TERMS

Unless noted otherwise, the following are from Reference 79.

Acidizing--A chemical scrubbing process which consists of pumping an acid (e.g., HCl, HF) into a bore. (Ref. 1)

Aeration--The bringing about of intimate contact between air and a liquid by one or more of the following methods: (1) spraying the liquid in the air; (2) bubbling air through the liquid; (3) agitating the liquid to promote surface absorption of air.

Aeration period--(1) The theoretical time, usually expressed in hours, during which mixed liquor is subjected to aeration in an aeration tank, while undergoing activated sludge treatment. It is equal to the volume of the tank divided by the volumetric rate of flow of the wastewater and return sludge. (2) The theoretical time during which water is subjected to aeration.

Aeration tank--A tank in which sludge, wastewater, or other liquid is aerated.

Alkaline water--(1) Water having a pH greater than 7.0. (2) Water high in percent sodium (approaching and exceeding 60), but relatively low in total dissolved solids.

Alum--A common name, in the water and wastewater treatment field, for commercial-grade aluminum sulfate.

Aluminum sulfate--A chemical, formerly sometimes called "waterworks alum" in water or wastewater treatment, prepared by combining a mineral known as bauxite with sulfuric acid.

Brine--Concentrated salt solution containing more than 36,000 mg/l of total dissolved solids.

Cavitation--(1) The action resulting from forcing a flowing stream to change direction in which reduced internal pressure causes dissolved gases to expand, creating negative pressure. Cavitation frequently causes pitting of the hydraulic structure affected. (2) The formation of a cavity between the downstream surface of a moving body, for example, the blade of a propeller, and a liquid normally in contact with it.

Coagulation--In water and wastewater treatment, the destabilization and initial aggregation of colloidal and finely divided suspended matter by the addition of a floc-forming chemical or by biological processes.

Corrosion--The gradual deterioration or destruction of a substance or material by chemical action, frequently induced by electrochemical processes. The action proceeds inward from the surface.

Corrosion control--(1) In water treatment, any method that keeps the discharge of the metallic ions of a conduit from going into solution, such as increasing the pH of the water, removing free oxygen from the water, or controlling the carbonate balance of the water. (2) The sequestration of metallic ions and the formation of protective films on metal surfaces by chemical treatment.

Dispersion--(1) Scattering and mixing. (2) The mixing of polluted fluids with a large volume of water in a stream or other body of water. (3) The outward percolation of water from an artesian basin or aquifier through confining formations. (4) The repelling action of an electric potential on fine particles in suspension in water, as in a stream carrying clay. This dispersion usually is ended by contact with ocean water which causes flocculation and precipitation of the clay, a common cause of shoaling in harbors. (5) In a continuous flow treatment unit, the phenomenon of short-circuiting. (6) The breaking down of soil aggregates, resulting in a single grain structure.

Disposal by dilution--A method of disposing of wastewater or treated effluent by discharging it into a stream or body of water.

Dissolved oxygen--The oxygen dissolved in water, wastewater, or other liquid, usually expressed in milligrams per liter, parts per million, or percent of saturation. Abbreviated DO.

Dissolved-oxygen sag curve--A curve that represents the profile of dissolved oxygen content along the course of a stream resulting from deoxygenation associated with biochemical oxidation of organic matter and reoxygenation through the absorption of atmospheric oxygen and biological photosynthesis. Also called oxygen-sag curve.

Dissolved solids--Theoretically, the anhydrous residues of the dissolved constituents in water. Actually, the term is defined by the method used in determination. In water and wastewater treatment, the Standard Methods tests are used.

Erosion--Surface destruction of a metal or refractory material effected by the abrasive action of a moving liquid or gas and often accelerated by solid particles in suspension. (Ref. 80)

Effluent--(1) A liquid which flows out of a containing space. (2) Wastewater or other liquid, partially or completely treated, or in its natural state, flowing out of a reservoir basin, treatment plant, or industrial treatment plant, or part thereof. (3) An outflowing branch of a main stream or lake.

Evaporation--The process by which water becomes a vapor at a temperature below the boiling point. (2) The quantity of water that is evaporated; the rate is expressed in depth of water, measured as liquid water, removed from a specified surface per unit of time, generally in inches or centimeters per day, month, or year.

Evaporation area--The surface area of a body of water and of any adjacent moist land to which water was supplied from the body of water, from which water is lost to the atmosphere by evaporation.

Evaporation discharge--Discharge into the atmosphere, in the gaseous state, of water derived from the saturation zone. Evaporation discharge may be divided into vegetal discharge and soil discharge.

Evaporation gage--A means of measuring evaporation.

Evaporation opportunity--The ratio of the rate of evaporation from a land or water surface in contact with the atmosphere to the evaporativity under the existing atmospheric conditions; that is, the ratio of the actual to the potential rate of evaporation. Also called relative evaporation.

Evaporation pan--A pan used to hold water during observations for the determination of the quantity of evaporation at a given location. Such pans are of various sizes and shapes, the most commonly used being circular or square.

Filter--A device or structure for removing solid or colloidal material, usually of a type that cannot be removed by sedimentation, from water, wastewater, or other liquid. The liquid is passed through a filtering medium, usually a granular material but sometimes finely woven cloth, unglazed porcelain, or specially prepared paper. There are many types of filters used in water or wastewater treatment.

Filter bed--(1) A type of bank revetment consisting of layers of filtering medium of which the particles gradually increase in size from the bottom upward. Such a filter allows the groundwater to flow freely, but it prevents even the smallest soil particles from being washed out. (2) A tank for water filtration having a false bottom covered with sand, as a rapid sand filter. (3) A pond with sand bedding, as a sand filter or slow sand filter.

Filter bottom--(1) The underdrainage system for collecting the water that has passed through a rapid sand filter and for distributing the wash water that cleans the filtering medium. (2) The underdrainage system supporting the graded gravel of a biological bed. It may consist of specially fabricated tile or concrete blocks containing waterways and slots in the top for convening the underdrainage, or it may consist of inverted half tile.

Floc--Small gelatinous masses formed in a liquid by the reaction of a coagulant added thereto, through biochemical processes, or by agglomeration.

Flocculating tank--A tank used for the formation of floc by the gentle agitation of liquid suspensions, with or without the aid of chemicals.

Flocculation--In water and wastewater treatment, the agglomeration of colloidal and finely divided suspended matter after coagulation by gentle stirring by either mechanical or hydraulic means. In biological wastewater treatment where coagulation is not used, agglomeration may be accomplished biologically.

Flocculation agent--A coagulating substance which, when added to water, forms a flocculent precipitate which will entrain suspended matter and expedite sedimentation; examples are alum, ferrous sulfate, and lime.

Flocculation limit--The water content of a soil when it is in the condition of a deflocculated sediment.

Flocculation ratio--The void ratio of a soil when it is in the condition of a deflocculated sediment.

Flocculator--(1) A mechanical device to enhance the formation of floc in a liquid. (2) An apparatus for the formation of floc in water and wastewater.

Incrustants--Dense solids formed as a crust on the inside surface of a pipe as a result of hardness and other characteristics of the water carried.

Mechanical aeration--(1) The mixing, by mechanical means, of wastewater and activated sludge in the aeration tank of the activated sludge process to bring fresh surfaces of liquid into contact with the atmosphere. (2) The introduction of atmospheric oxygen into a liquid by the mechanical action of paddle, paddle wheel, spray, or turbine mechanisms.

Mechanical aerator--A mechanical device for the introduction of atmospheric oxygen into a liquid. See mechanical aeration.

Mechanical agitation--The introduction of atmospheric oxygen into a liquid by the mechanical action of paddle, paddle wheel, spray, or turbine mechanism. Also see mechanical aeration.

Noncondensable--Gaseous matter not liquified under the existing conditions.

Nozzle--(1) A short, cone-shaped tube used as an outlet for a hose or pipe. The velocity of the merging stream of water is increased by the reduction in cross-sectional area of the nozzle. (2) A short piece of pipe with a flange on one end and a saddle flange on the other end. (3) A side outlet attached to a pipe by means such as riveting, brazing, or welding.

pH--The logarithm of the reciprocal of the hydrogen-ion activity or log (1/hydrogen-ion activity). Pure neutral water has a pH of 7, acids a pH value of less than 7, and alkalies a pH of more than 7.

Rapid sand filter--A filter for the purification of water, in which water that has been previously treated, usually by coagulation and sedimentation, is passed downward through a filtering medium. The medium consists of a layer of sand, prepared anthracite coal, or other suitable material, usually 24-30 in. thick, resting on a supporting bed of gravel or a porous medium such as carborundum. The filtrate is removed by an underdrainage system which also distributes the wash water. The filter is cleaned periodically by reversing the flow of the water upward through the filtering medium, sometimes supplementing by mechanical or air agitation during washing, to remove mud and other impurities which have lodged in the sand. It is characterized by a rapid rate of filtration, commonly from two to three gallons per minute per square foot of filter area.

Rapid sand filter rating--The design rate at which water is to be passed through a rapid sand filter.

Rapid sand filter strainer--A perforated device inserted in the underdrains of a rapid sand filter through which the filtered water is collected and through which the wash water is distributed when the filter is washed. Also called strainer head.

Saline water--Water containing dissolved salts--usually from 10,000 to 33,000 mg/l.

Salinity--(1) The relative concentration of salts, usually sodium chloride, in a given water. It is usually expressed in terms of the number of parts per million of chlorine (Cl). (2) A measure of the concentration of dissolved mineral substances in water.

Sand filter--A filter in which sand is used as a filtering medium. Also see rapid sand filter, slow sand filter.

Scale--(1) An accumulation of solid material precipitated out of waters containing certain mineral salts in solution and formed on interior surfaces, such as those of pipelines, tanks, boilers, under certain physical conditions. May also be formed from interaction of water with metallic pipe. (2) Loose, thin fragments of rock threatening to break or fall from either roof or wall. (3) A series of graduations representing lengths or distances on a map, drawing, or rule. (4) The dimension of a drawing, map, or model relative to the actual dimension of the object, usually expressed as a ratio, as 1:100. (5) To remove scale.

Scraper--(1) A device for insertion in pipelines that is pushed or hauled through by some method or device such as water pressure, rope, cable, to remove accumulated organic or mineral deposits. Scrapers are used principally in pipes too small for access by man and are of various designs and sizes. (2) A device used in the bottom of a sedimentation tank to move settled sludge to a discharge port. (3) A blade used to separate accumulated sediment from filter or screen surfaces.

Screen--(1) A device with openings, generally of uniform size, used to retain or remove suspended or floating solids in flowing water or wastewater and to prevent them from entering an intake or passing a given point in a conduit. The screening element may consist of parallel bars, rods, wires, grating, wire mesh, or perforated plate, and the openings may be of any shape, although they are usually circular or rectangular. (2) A device used to segregate granular material such as sand, crushed rock, and soil into various sizes.

Seawater--Water in the seas containing from 33,000 to 36,000 mg/l of total dissolved solids.

Sedimentation--(1) The process of subsidence and deposition of suspended matter carried by water, wastewater, or other liquids, by gravity. It is usually accomplished by reducing the velocity of the liquid below the point at which it can transport the suspended material. Also called settling. (2) In geology, sedimentation consists of five fundamental processes: weathering, erosion, transportation, deposition, and diagnesis or consolidation into rock.

Sedimentation basin--A basin or tank in which water or wastewater containing settleable solids is retained to remove by gravity a part of the suspended matter. Also called sedimentation tank, settling basin, settling tank.

Sedimentation compartment--(1) The portion of a water or wastewater treatment tank used as a settling tank; for example, the flowing-through chamber of an Imhoff tank. (2) The settling section of a chemical flocculation and sedimentation unit.

Sedimentation tank--A basin or tank in which water or wastewater containing settleable solids is retained to remove by gravity a part of the suspended matter. Also called sedimentation basin, settling basin, settling tank.

Sediment concentration--The ratio of the weight of the sediment in a water-sediment mixture to the total weight of the mixture. Sometimes expressed as the ratio of the volume of sediment to the volume of mixture. It is dimensionless and is usually expressed in percentage for high values of concentrations and in parts per million for low values.

Sequester--To form a stable, water-soluble complex.

Sequestering agent--A chemical that causes the coordination complex of certain phosphates with metallic ions in solution so that they may no longer be precipitated. Hexametaphosphates are an example: calcium soap precipitates are not produced from hard water treated with them. Also, any agent that prevents an ion from exhibiting its usual properties because of close combination with an added material.

Sequestration--The inactivation of an ion by addition of a reagent that combines it and, in effect, prevents it from participating in other reactions. Also called complexation.

Settling--The process of subsidence and deposition of suspended matter carried by water, wastewater, or other liquids, by gravity. It is usually accomplished by reducing the velocity of the liquid below the point at which it can transport the suspended material. Also called sedimentation.

Settling basin--A basin or tank in which water or wastewater containing settleable solids is retained to remove by gravity a part of the suspended matter. Also called sedimentation basin, sedimentation tank, settling tank.

Settling chamber--(1) A basin or tank in which water or wastewater containing settleable solids is retained to remove by gravity a part of the suspended matter. (2) The second or final element of the so-called biolytic tank, which is a combination of a flocculating tank and a settling tank. (3) Sometimes, the sedimentation compartment of a two-story tank, as in the case of an Imhoff tank.

Settling solids--Solids that are settling in sedimentation tanks or sedimentation chambers and other such tanks that are constructed for the purpose of removing this fraction of suspended solids.

Settling tank--A basin or tank in which water or wastewater containing settleable solids is retained to remove by gravity a part of the suspended matter. Also called sedimentation basin, sedimentation tank, settling basin.

Settling velocity--The velocity at which subsidence and deposition of the settleable suspended solids in water and wastewater will occur.

Slake--To become mixed with water so that a true chemical combination takes place, as in the slaking of lime.

Slow sand filter--A filter for the purification of water in which water without previous treatment is passed downward through a filtering medium consisting of a layer of sand or other suitable material, usually finer than for a rapid sand filter and from 24 to 40 in. thick. The filtrate is removed by an underdrainage system and the filter is cleaned by scraping off and replacing the clogged layer. It is characterized by a slow rate of filtration, commonly 3-6 mgd/acre of filter area.

Sludge--(1) The accumulated solids separated from liquids, such as water or wastewater, during processing, or deposits on bottoms of streams or other bodies of water. (2) The precipitate resulting from chemical treatment, coagulation, or sedimentation of water or wastewater.

Standard methods--(1) Methods for the examination of water and wastewater published jointly by the American Public Health Association, the American Water Works Association, and the Water Pollution Control Federation. (2) Methods published by professional organizations and agencies covering specific fields. These include, among others: American Public Health Association, American Public Works Association, American Society of Civil Engineers, American Society of Mechanical Engineers, American Society for Testing and Materials, American Water Works Association, United States Bureau of Standards, United States of America Standards Institute (formerly American Standards Association), United States Public Health Service, Water Pollution Control Federation.

Standard oxidation-reduction potential (Eh)--The potential established at an inert electrode dipping into a solution containing equimolecular amounts of an ion or molecule in two states of oxidation. (Ref. 81)

Suspended matter--(1) Solids in suspension in water, wastewater, or effluent. (2) Solids in suspension that can be removed readily by standard filtering procedures in a laboratory. See suspended solids.

Suspended sediment--The very fine soil particles that remain in suspension in water for a considerable period of time without contact with the solid-fluid boundary at or near the bottom. They are maintained in suspension by the upward components of turbulent currents or may be fine enough to form a colloidal suspension.

Suspended solids--(1) Solids that either float on the surface of, or are in suspension in, water, wastewater, or other liquids, and which are largely removable by laboratory filtering. See suspended matter. (2) The quantity of material removed from wastewater in a laboratory test, as prescribed in "Standard Methods for the Examination of Water and Wastewater" and referred to as nonfilterable residue.

Vacuum deaeration--Equipment operating under vacuum to remove dissolved gases from liquid.

Waste--Something that is superfluous or rejected; something that can no longer be used for its originally intended purpose.

Waste-disposal plant--(1) A plant equipped for treatment and disposal of waste. (2) An arrangement of devices and structures for treating wastewater, industrial wastes, and sludge.

Waste treatment--Any process to which wastewater or industrial waste is subjected to make it suitable for subsequent use.

Waste water--In a legal sense, water that is not needed or that has been used and is permitted to escape, or that unavoidably escapes from ditches, canals, or other conduits, or reservoirs of the lawful owners of such structures.

APPENDIX A

(Reference 82)

BASIC WATER TREATMENT PROCESSES

A wide range of treatment processes is available to produce water of the required quality for industry at the point of use. Treatment methods fall into two general categories: external and internal. External treatment refers to processes utilized in altering water quality prior to the point of use. The typical household water softening unit is an external treatment. Internal treatment refers to processes limited basically to chemical additives utilized to alter water quality at the point of use or within the process. Water softening compounds used in laundering are forms of internal treatment. Water treatment processes are in themselves users of water. Normally, 2 to 10 per cent of the feed water ends up as waste generated by treatment processes (see Table VI-3). Thus, the actual water intake is greater than the treated water produced.

EXTERNAL WATER TREATMENT PROCESSES

Figure VI-1 is a schematic diagram of the most common external water treatment processes. Properly applied, alone or in various combinations, these processes can convert any incoming water quality to a usable quality. A dramatic example is the conversion of brackish water to a water that exceeds the quality of distilled water.

Note that the flow chart illustrates many processes and that a particular process is applied to remove a particular contaminant. If that contaminant does not appear in the water or is harmless for the intended use of the water, that process would not be used. For example, a clear well water might not need filtration prior to further treatment. In addition, the water use determines the extent of treatment. For example, to use Mississippi River water for cooling, rough screening to remove the floating debris may be sufficient for some applications, whereas clarification and filtration may be required for other uses. To use that same water for makeup for a super critical pressure boiler would require further treatment by ion exchange, perhaps strong cation, strong anion, and mixed bed exchangers.

As previously stated, industry's need for water can be met even under the poorest conditions. However, the use of water treatment systems is not without consequence. External water treatment processes concentrate a particular contaminant or contaminants. Thus, in the quest for pure water, a waste product is generated. The waste product is a pollutant and the cost of its disposal must be considered as part of the overall cost of water treatment.

The estimates of waste volume and solids in Table VI-3 are based on treating a water with an analysis such as shown in Table VI-4. Table VI-4 also illustrates an analysis of several common forms of water treatment. The estimates are thus typical only of the water described and will vary with different water supplies. Waste volumes are stated as a percentage of inlet flow. Thus, a 2,000 gallon per minute (gpm) clarifier will discharge 40 to 100 gpm of sludge.

The following paragraphs briefly describe the available treatment methods, outline their capabilities, and combined with Table VI-3, provide a general idea of the waste produced. (The groupings A, B, and C do not imply treatment schemes or necessarily indicate a sequence of treatment.) The processes are applicable to various water characteristics; it is immaterial whether the supply is surface or ground water. Since the equipment used can be of appreciable size, available land area can be an important factor in the selection of a particular process.

Group A Processes

Rough Screens Generally installed at the actual point of intake, rough screens are simple bars or mesh screens used to trap large objects and prevent damage to pumps and other mechanical equipment.

Sedimentation This process takes place in large open basins used to reduce the water velocity so that heavier suspended particles can settle out.

Clarification Chemical additives (e.g., aluminum salts, iron salts, lime) are used in large open basins so that practically all suspended matter, color, odors, and organic compounds can be removed efficiently.

Lime Softening (cold) The equipment used here is similar to that used for clarification. In addition to flocculent chemicals, lime and sometimes soda ash are used in large open basins. Clarification is obtained, and a large portion of the calcium and magnesium bicarbonates are removed.

Lime Softening (hot) The process is, in general, the same as cold except that it is carried out at or above 212 F. The results are the same but with the added benefit of silica removal. The characteristics of wastes are the same but at a high temperature. Note that further treatment of hot lime

TABLE VI-3—Waste Generated by Treatment Processes

Treatment process[a]	Character of waste produced	Waste volume percentage flow	Example of waste weight[b] dry basis pounds solids/1,000 gal processed
Rough screens	Large objects, debris		
Sedimentation	Sand, mud slurry	5-10	
Clarification	Usually acidic chemical sludge and settled matter	2-5	1.3
Cold lime softening	Alkaline chemical sludge and settled matter	2-5	1.7
Hot lime softening (+212 F)	Alkaline chemical sludge and settled matter	2-5	1.7
Aeration	Gaseous, possible air pollutant, such as hydrogen sulfide		
Filtration, gravity, or pressure	Sludge, suspended solids	2-5 (for packed bed units)	0.1-0.2
Adsorption, activated carbon for odors, tastes, color, organics	Exhausted carbon if not regenerated. Small amounts carbon fines and other solids can appear in backwash. Carbon regeneration is separate process (usually thermal) in which air pollution problems must be met.	2-5	
Manganese zeolite, for iron removal	Iron oxide suspended solids	Similar to other filtration prodesses	
Miscellaneous, e.g., precoat, membrane, dual media filtration fine straining	As in other filters. Precoat waste includes precoat materials.	1-5	0.1-0.2 (plus precoat materials when used)
Reverse osmosis[c]	Suspended and 90-99 percent of dissolved solids plus chemical pretreatment if required	10-50	1.0-2.0
Electrodialysis[c]	Suspended and 80-95 percent of dissolved solids plus chemical pretreatment if required	10-50	1.0-2.0
Distillation	Concentrated dissolved and suspended solids	10-75	1.5
Ion exchange processes[d]			
Sodium cation	Dissolved calcium, magnesium and sodium chlorides	4-6	1.3
2-bed demineralization	Dissolved solids from feed plus regenerants	10-14	4-5
Mixed bed demineralization	Dissolved solids from feed plus regenerants	10-14	>5
Internal processes	Chemicals are added directly into operating cycle. At least a portion of process steam containing added chemicals, dissolved and suspended solids from feed, and possibly contamination from process can be extracted from the cycle for disposal or treatment and recycle.		

[a] Processes are used alone or in various combinations, depending upon need.
[b] Amounts based on application of process to raw water shown in Table VI-4. These values do not necessarily apply when these processes are used in combinations.
[c] Feed must be relatively free of suspended matter.
[d] There are many variations. Listed here are a few of the most important.

TABLE VI-4—Typical Raw Water Analyses and Operating Results (mg/l, unless otherwise indicated)

Constituent	Expressed as	Raw water[a]	After clarification and filtration	After cold lime softening and filtration	After clarification, filtration, and sodium-cation exchange softening	After clarification, filtration, and demineralization
Cations[a]						
Calcium	$CaCO_3$	51.5	51.5	38.7	1.0	0
Magnesium	"	19.5	19.5	17.5	1.0	0
Sodium	"	18.6	18.6	18.6	87.6	1-2
Potassium	"	1.8	1.8	1.8	1.8	0
Total Cations	"	91.4	91.4	76.6	91.4	1-2
Anions[a]						
Bicarbonate	"	56.8	47.8	0	47.8	0
Carbonate	"	0	0	33.0	0	0
Hydroxide	"	0	0	0	0	1-2
Sulfate	"	21.8	30.8	30.8	30.8	0
Chloride	"	12.0	12.0	12.0	12.0	0
Nitrate	"	0.8	0.8	0.8	0.8	0
Total Anions	"	91.4	91.4	76.6	91.4	1-2
Iron[a]	Fe	0.16	Nil	Nil	Nil	Nil
Silica[a]	SiO_2	9.0	9.0	9.0	9.0	0.01
Color[b]	units	15.0	2-5	2-5	Nil	Nil
Turbidity[b]	"	100.0	0-2	0-2	Nil	Nil
pH[a]	"	6.5-7.5	6.0-8.0	9.0-11.0	6.0-8.0	7.0-9.0

[a] Taken from Livingstone 1963[9]; adjusted slightly for ion balance and for expression as $CaCO_3$ equivalents.
[b] Developed by the Panel for illustrative purposes.

effluent is generally limited to filtration and sodium cation exchange.

Aeration This process, which can be in several different physical forms, is applied to reduce the concentration of carbon dioxide, thereby reducing the chemicals required for cold lime softening. Aeration oxidizes iron and manganese to allow their removal by clarification, lime softening, or filtration. No solid wastes flow from an aerator, but released gases such as hydrogen sulfide can present a problem.

Miscellaneous There are other special variations of all the primary treatment methods that can be applied under specific circumstances.

Group B Processes

Filtration This process uses gravity or pressure units in which traces of suspended matter are removed by passage through a bed of sand, anthracite coal, or other granular material. In general, the effluent at the primary stage must be filtered prior to further treatment. Some waters can be filtered without primary treatment. A filter is cleaned by reversing the direction of the water flow (backwashing).

Adsorption This is a separation process designed primarily to remove dissolved organic materials including odor, taste, and color-producing compounds. Activated carbon is generally used for this purpose. Backwashing of fixed adsorption units produces small amounts of solids as the feed has generally been filtered prior to passage over the carbon. Expanded bed adsorption units do not require regular backwashing. Chemical or thermal regeneration of

(Items not enclosed in boxes indicate typical water uses for treatment methods shown.)

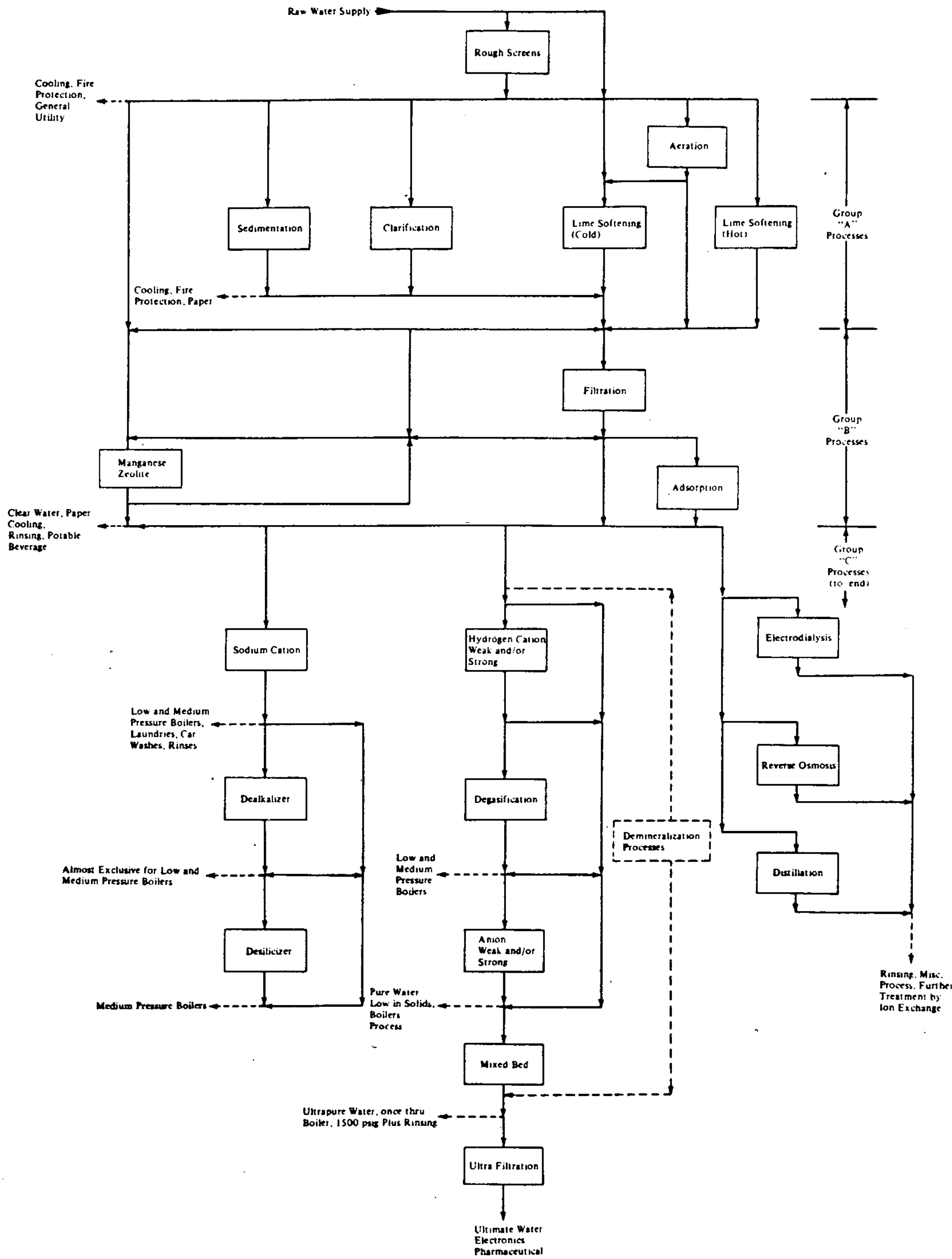


FIGURE VI-1—External Water Treatment Processes

(Items not enclosed in boxes indicate typical water uses for treatment methods shown.)

carbon can remove adsorbed impurities and restore adsorptive efficiency and capacity.

Manganese Zeolite This process, specifically used for iron removal, is a special combined form of oxidation and filtration with a feed of potassium permanganate.

Miscellaneous Many specialized forms applicable to specific conditions are available. These include precoated filters, membrane filters, strainers, and dual media filters.

Group C Processes

Ultrafiltration Various types of pressure filters including membranes, cartridges, and discs can remove suspended solids larger than 0.1 to 1.0 micron, depending on the application.

Reverse Osmosis This relatively new development uses high pressures to force water through a membrane, preventing the passage of all suspended matter and up to 90–99 per cent of dissolved solids. The product water can be used directly or may require further treatment by ion exchange. The influent must be essentially free of suspended solids.

Electrodialysis A relatively new development, this process uses cationic and anionic membranes with applied direct current to remove dissolved solids. The product water can be used directly or may require further treatment by ion exchange. The feed must be essentially free of suspended matter.

Distillation This process uses thermal evaporation and condensation of water so that the condensate is free of suspended solids and 98–99 per cent of the dissolved solids are removed. Certain conditions may require the addition of special chemicals. The product water can be used directly or may require further treatment by ion exchange. The feed must be relatively free of suspended matter.

Ion Exchange Ion exchange is a versatile process with several dozen variations. Ion exchange technology is rapidly advancing. New resins, regeneration techniques, and operation modes are being introduced. Some of the more common applications are shown in Table VI-3. The exact arrangement of an ion exchange system depends upon raw water quality, desired treated water quality, flow rate, and economics. Total demineralization can remove in excess of 99 per cent of dissolved solids with feeds as high as 2,000 parts per million (ppm) or more. The waste produced by an ion exchanger includes the backwash and rinse waters, the regeneration effluent containing the exchanged ions, and the excess regenerative chemical. In general, the feed to any ion exchanger should contain no or only small quantities of suspended matter, color, and organics.

Cation Cation exchange removes cations from the water and replaces them with other cations from an ion exchanger. When in the hydrogen or acid form, strong cation (i.e., strong acid) can exchange hydrogen ions for the cations of either weak or strong acids, whereas weak cation (i.e., weak acid) exchanges hydrogen only for that fraction of cations equivalent to the weakly acidic anions present, such as bicarbonate.

Sodium Cation This is the simplest form of ion exchange. Sodium ions are exchanged for hardness ions (e.g., calcium, magnesium).

Anion Anion exchange removes anions from the water and replaces them with other anions from the ion exchanger. When in the base form, strong anion exchangers are capable of exchanging hydroxyl ions for the anions of either weak or strong acids, whereas weak anion exchangers exchange only with anions of strong acids.

Demineralization In industrial water treatment, demineralization refers to a sequence of cation exchange in which hydrogen ions are substituted for other cations followed by anion exchange in which hydroxyl ions are substituted for other anions. The product is H^+ plus OH^-; i.e., water.

Mixed Bed Mixed bed exchange provides complete demineralization in one step by the use of an intimate mixture of cation and anion resin in one unit. It is generally used for the polishing service step of high purity water. A cation-anion exchange system might produce a water containing 1.0 ppm of dissolved solids. After treatment by mixed bed, the solids would be down as low as 0.01 ppm.

Miscellaneous There are several specialty ion exchangers including: dealkalizers—chloride anion exchange for the removal of alkalinity; desilicizers—hydroxide anion exchange for the removal of silica (without previous hydrogen cation). Degasification equipment is used to remove carbon dioxide in order to reduce the work of the strong anion units that follow.

INTERNAL WATER TREATMENT PROCESSES

Internal water treatment processes are numerous. They include the addition of acid and alkali for pH control; polyphosphates, phosphonates, or polyelectrolytes for scale control; polymers for dispersal of sediment; phosphates and alkali for precipitation of hardness; amines, chromates, zinc, or silicates for corrosion control; sulfites or hydrazine for oxygen scavenging; and polyphosphates for sequestration of iron or manganese. Here again, the chemical feed is determined by the requirements. The industrial user produces the water quality that is needed, but a problem can be created when the user must dispose of all or part of the treated water. The choice of chemicals added to water must be considered in light of their potential as pollutants.

APPENDIX B

ANNOTATED BIBLIOGRAPHY

1

BARLOW 72
BRINE TREATMENT/SPENT FLUID DISPOSAL

TITLE- BASIC DISPOSAL-WELL DESIGN.

AUTHOR- BARLOW, A.C. [DU PONT DE NEMOURS (E.I.) AND CO., WILMINGTON, DEL. (USA). ENGINEERING DEPT.].

COOK, T.D. (ED.)

REFERENCE- UNDERGROUND WASTE MANAGEMENT AND ENVIRONMENTAL IMPLICATIONS. AM. ASSOC. PET. GEOL., TULSA, OKLA., DEC 1972, MEMOIR 18, P. 72-76.

DESCRIPTORS- DEEP WELLS; INJECTION WELLS; UNDERGROUND DISPOSAL; WASTE DISPOSAL; WELL CASINGS; WELL CEMENTING; WELL COMPLETION; WELL DESIGN.

2

BARNES 72
BRINE TREATMENT/SPENT FLUID DISPOSAL

TITLE- WATER-MINERAL REACTIONS RELATED TO POTENTIAL FLUID-INJECTION PROBLEMS.

AUTHOR- BARNES, I. [GEOLOGICAL SURVEY, MENLO PARK, CALIF. (USA). WATER RESOURCES DIV.].

COOK, T.D. (ED.)

REFERENCE- UNDERGROUND WASTE MANAGEMENT AND ENVIRONMENTAL IMPLICATIONS. AM. ASSOC. PET. GEOL., TULSA, OKLA., DEC 1972, MEMOIR 18, P. 294-297.

DESCRIPTORS- CARBONATES; CHEMICAL ANALYSIS; CHEMICAL REACTIONS; CLAY MINERALS; FREE ENERGY; HYDROXIDES; INJECTION WELLS; LIQUID WASTES; ROCK-FLUID INTERACTIONS; SILICATES; SULFIDES; THERMODYNAMICS; UNDERGROUND DISPOSAL.

3

BERGSTROM 68
BRINE TREATMENT/SPENT FLUID DISPOSAL

TITLE- FEASIBILITY OF SUBSURFACE DISPOSAL OF INDUSTRIAL WASTES IN ILLINOIS.

AUTHOR- BERGSTROM, R.E. [ILLINOIS STATE GEOLOGICAL SURVEY, URBANA, ILL. (USA)].

REFERENCE- FEASIBILITY OF SUBSURFACE DISPOSAL OF INDUSTRIAL WASTES IN ILLINOIS. CIRCULAR 426, ILL. STATE GEOLOGICAL SURVEY, URBANA, ILL., 1968, 18 P..

DESCRIPTORS- AQUIFERS; DEEP WELLS; FEASIBILITY STUDIES; GEOLOGY; HYDROLOGY; INJECTION WELLS; LIMESTONE; LIQUID WASTES; LITHOLOGY; PERMEABILITY; POLLUTION; POROSITY; REGULATIONS; ROCKS; SANDSTONE; UNDERGROUND DISPOSAL; WATER POLLUTION; WATER QUALITY; ILLINOIS; ILLINOIS BASIN.

4

BOOTH 72
BRINE TREATMENT/SPENT FLUID DISPOSAL

TITLE- FINAL DISPOSAL OF EFFLUENT BRINES FROM INLAND DESALTING PLANTS.

AUTHOR- BOOTH, J.R. , JR.;SHEPHERD, B.P.;MCILHENNY, W.F. [DOW CHEMICAL CO., FREEPORT, TEX. (USA)].

REFERENCE- FINAL DISPOSAL OF EFFLUENT BRINES FROM INLAND DESALTING PLANTS. INT-OSW-RDPR-72-817, OFFICE OF SALINE WATER, WASHINGTON, MAY 1972, 181 P..

DESCRIPTORS- AQUIFERS; BIOLOGICAL FOULING; BRINE TREATMENT; BRINES; CASE HISTORIES; CHEMICAL ANALYSIS; CHEMICAL COMPOSITION; CRYSTALLIZATION; DEEP WELLS; DESALINATION; DESALTING PLANTS; DISPOSAL FORMATIONS;

DISSOLVED SOLIDS: DOLOMITE RCCKS; ECCNCMICS; ELECTRODIALYSIS; ENVIRONMENTAL EFFECTS; EVAPORATION PONDS; RESERVOIR PRESSURE; GEOLOGY; GRAVEL PACKING; INJECTION WELLS; LEGAL ASPECTS; LIQUID WASTES; LITHOLOGY; PERMEABILITY; PERMEABILITY RESTORATION; PG VALUE; PORCSITY; REVERSE OSMOSIS; SANDSTONE; STRATIGRAPHY; UNDERGROUND DISFOSAL; WASTE DISPOSAL; WELL DESIGN; WELL LCGGING; SAN JUAN BASIN; KANSAS; COLORADO: TEXAS; NEW MEXICO; NORTH DAKCTA.

5

CAVIS 72
BRINE TREATMENT/SPENT FLUID DISPOSAL

TITLE- CONTROL OF UNCCNSOLIDATED SANDS IN WASTE-DISPOSAL WELLS.

AUTHOR- DAVIS, K.E.;FUNK, R.J. [SUBSURFACE DISPOSAL CORPORATION, HOUSTON, TEX. (USA)].

COOK, T.D. (ED.)

REFERENCE- UNDERGROUND WASTE MANAGEMENT AND ENVIRONMENTAL IMPLICATIONS. AM. ASSOC. PET. GEOL., TULSA, OKLA., DEC 1972, MEMOIR 18, P. 112-118.

DESCRIPTORS- CASE HISTORIES; DEEP WELLS; DISPOSAL FORMATIONS; EXPERIMENTAL RESULTS; FIELD STUDERGROUND DISPOSAL; WASTE DISPOSAL; WELL COMPLETION; WELL DESIGN; TEXAS; LOUISIANA; IES; FORMATION CAPACITY; GRAVEL PACKING; OILFIELD BRINES; SAND CONTROL; SANDSTONE; UND*E

SC=DONALDSON 72.

6

BRINE TREATMENT/SPENT FLUID DISPOSAL

TITLE- INJECTION WELLS AND OPERATIONS TODAY.

AUTHOR- DONALDSON, E.C. [BUREAU OF MINES, BARTLESVILLE, OKLA. (USA). BARTLESVILLE ENERGY RESEARCH CENTER].

COOK, T.D. (ED.)

REFERENCE- UNDERGROUND WASTE MANAGEMENT AND ENVIRONMENTAL IMPLICATIONS. AM. ASSOC. PET. GEOL., TULSA, OKLA., DEC 1972, MEMOIR 18, P. 24-46.

DESCRIPTORS- ACIDIZATION; BACTERIA; CASE HISTORIES; CHEMICAL ANALYSIS; CHEMICAL COMPATIBILITY; CHEMICAL COMPOSITION; CLAY MINERALS; CORROSION; CORROSION INHIBITORS; DEEP WELLS; DISPOSAL FORMATIONS; DOLOMITE ROCKS; ECONOMICS; ENVIRONMENTAL EFFECTS; FILTRATION; FLUID MECHANICS; FLOCCULATING AGENTS; FLOW RATE; GEOLOGY; GROUND WATER; HYDRAULIC FRACTURING; INDUSTRIAL WASTES; INJECTION WELLS; LIMESTONE; LIQUID WASTES; LITHOLOGY; MATHEMATICAL MODELS; MEASURING METHODS; OILFIELD BRINES; PERMEABILITY; PH ADJUSTMENT; PH VALUE; PLUGGING; POROSITY; PRECIPITATION; PRE-INJECTION TREATMENT; RESERVOIR PROPERTIES; SANDSTONE; SCALING; SCALING CONTROL; SPECIFIC INJECTIVITY INDEX; SURFACE EQUIPMENT; SUSPENDED SOLIDS; THEORETICAL TREATMENTS; TRANSMISSIVITY; UNDERGROUND DISPOSAL; WASTE DISPOSAL; WASTE MANAGEMENT; WASTE WATER; WELL CASINGS.

7

DONALDSON 74
BRINE TREATMENT/SPENT FLUID DISPOSAL

TITLE- SUBSURFACE WASTE INJECTION IN THE UNITED STATES. FIFTEEN CASE HISTORIES.

AUTHOR- DONALDSON, E.C.;THOMAS, R.D.;JOHNSTON, K.H. [BARTLESVILLE ENERGY RESEARCH CENTER, BARTLESVILLE, OKLA. (USA)].

REFERENCE- SUBSURFACE WASTE INJECTION IN THE UNITED STATES. FIFTEEN CASE HISTORIES. INFORMATION CIRCULAR 8636, BUREAU OF MINES, WASHINGTON,D.C., 1974, 72 P..

DESCRIPTORS- ACIDIZATION; AQUIFERS; BIOLOGICAL FOULING; CASE HISTORIES; CHEMICAL COMPATIBILITY; CHEMICAL REACTIONS; CLAY MINERALS; CORROSION; DEEP WELLS; DISPOSAL FORMATIONS; DOLOMITE ROCKS; ECONOMICS; FILTRATION; FLOCCULATION; FLOW RATE; GEOLOGY; GROUND WATER; HYDRAULIC FRACTURING; HYDRAULICS; HYDRODYNAMICS; HYDROGEOLOGY; HYDROLOGY; HYDRODYNAMIC GRADIENT; INDUSTRIAL WASTES; INJECTION PRESSURE; INJECTION RATES; INJECTION WELLS; LEGAL ASPECTS; LIMESTONE; LIQUID WASTES; LITHOLOGY; PERMEABILITY; PH ADJUSTMENT; PLUGGING; POLLUTION; POROSITY; PRECIPITATION; PRE-INJECTION TREATMENT; RESERVOIR PROPERTIES; RESERVOIR PRESSURE; SANDSTONE; SEDIMENTATION; SHALE; STORAGE CAPACITY; STRATIGRAPHY;

SUBSURFACE RESERVOIRS; SURFACE EQUIPMENT; SUSPENDED SOLIDS; UNDERGROUND DISPOSAL; WASTE DISPOSAL.

8

EHRLICH 72
BRINE TREATMENT/SPENT FLUID DISPOSAL

TITLE- ROLE OF BIOTA IN UNDERGROUND WASTE INJECTION AND STORAGE.

AUTHOR- EHRLICH, G.G. [GEOLOGICAL SURVEY, MENLO PARK, CALIF. (USA)].

COOK, T.D. (ED.)

REFERENCE- UNDERGROUND WASTE MANAGEMENT AND ENVIRONMENTAL IMPLICATIONS. AM. ASSOC. PET. GEOL., TULSA, OKLA., DEC 1972, MEMOIR 18, P. 298-307.

DESCRIPTORS- BACTERIA; BIOLOGICAL EFFECTS; BIOLOGICAL FOULING; CHEMICAL REACTIONS; CORROSION; GROUND WATER; INJECTION WELLS; MICROORGANISMS; OILFIELD BRINES; PETROLEUM INDUSTRY; PLUGGING; UNDERGROUND DISPOSAL; WASTE DISPOSAL.

9

FERRIS 72
BRINE TREATMENT/SPENT FLUID DISPOSAL

TITLE- RESPONSE OF HYDROLOGIC SYSTEMS TO WASTE STORAGE.

AUTHOR- FERRIS, J.G. [GEOLOGICAL SURVEY, WASHINGTON, D.C. (USA). WATER RESOURCES DIV.].

COOK, T.D. (ED.)

REFERENCE- UNDERGROUND WASTE MANAGEMENT AND ENVIRONMENTAL IMPLICATIONS. AM. ASSOC. PET. GEOL., TULSA, OKLA., DEC 1972, MEMOIR 18, P. 126-132.

DESCRIPTORS- AQUIFERS; AQUITARDS; DEEP WELLS; ENVIRONMENTAL EFFECTS; FLUID MECHANICS; FLOW RATE; GEOLOGY; GROUND WATER; HYDROLOGY;

INJECTION PRESSURE; LIQUID WASTES; PERMEABILITY; PRESSURE BUILDUP; TRANSMISSIVITY; UNDERGROUND DISPOSAL; WASTE DISPOSAL; WASTE FRONT.

10

FRYBERGER 72
BRINE TREATMENT/SPENT FLUID DISPOSAL

TITLE- REHABILITATION OF A BRINE-POLLUTED AQUIFER.

AUTHOR- FRYBERGER, J.S. [ENGINEERING ENTERPRISES, NORMAN, OKLA. (USA)].

REFERENCE- REHABILITATION OF A BRINE-POLLUTED AQUIFER. EPA-R2-72-014, ENVIRONMENTAL PROTECTION AGENCY, WASHINGTON, DEC 1972, 61 P..

DESCRIPTORS- AQUIFER REHABILITATION; AQUIFERS; BRINES; CHEMICAL COMPOSITION; CHEMICAL REACTIONS; DEEP WELLS; DESALINATION; ECONOMICS; ENVIRONMENTAL EFFECTS; EVAPORATION PONDS; FEASIBILITY STUDIES; FLOW RATE; GEOLOGY; GROUND WATER; HYDRAULICS; HYDROLOGY; INJECTION WELLS; OILFIELD BRINES; POLLUTION; POLLUTION REGULATIONS; STRATIGRAPHY; UNDERGROUND DISPOSAL; WASTE DISPOSAL; WATER CHEMISTRY; WATER POLLUTION; WELL DESIGN; ARKANSAS.

11

GALLEY 72
BRINE TREATMENT/SPENT FLUID DISPOSAL

TITLE- GEOLOGIC FRAMEWORK FOR SUCCESSFUL UNDERGROUND WASTE MANAGEMENT.

AUTHOR- GALLEY, J.E. [GEOLOGICAL CONSULTANT, KERRVILLE, TEX. (USA)].

COOK, T.D. (ED.)

REFERENCE- UNDERGROUND WASTE MANAGEMENT AND ENVIRONMENTAL IMPLICATIONS. AM. ASSOC. PET. GEOL., TULSA, OKLA., DEC 1972, MEMOIR 18, P. 119-125.

DESCRIPTORS- AQUIFERS; CHEMICAL ANALYSIS; CHEMICAL COMPATIBILITY; CHEMICAL REACTIONS; CLAY MINERALS; DEEP WELLS; DISPOSAL FORMATIONS; DOLOMITE ROCKS; ECONOMICS; ENVIRONMENTAL EFFECTS; FLOW RATE; GEOLOGY; GROUND WATER; HYDROGEOLOGY; HYDROLOGY; HYDRODYNAMIC GRADIENT; LIMESTONE; LIQUID WASTES; LITHOLOGY; PERMEABILITY; POROSITY; POROUS MEDIA; RESERVOIR PROPERTIES; ROCKS; SANDSTONE; SEDIMENTARY ROCKS; SEISMOLOGY; SHALE; SUBSURFACE RESERVOIRS; UNDERGROUND DISPOSAL; WASTE DISPOSAL; WASTE MANAGEMENT; WELL DRILLING; WELL INTERFERENCE; WELL LOGGING.

12

GREENFIELD 72
BRINE TREATMENT/SPENT FLUID DISPOSAL

TITLE- EPA--THE ENVIRONMENTAL WATCHMAN.

AUTHOR- GREENFIELD, S.M. [ENVIRONMENTAL PROTECTION AGENCY, WASHINGTON, D.C. (USA)].

COOK, T.D. (ED.)

REFERENCE- UNDERGROUND WASTE MANAGEMENT AND ENVIRONMENTAL IMPLICATIONS. AM. ASSOC. PET. GEOL., TULSA, OKLA., DEC 1972, MEMOIR 18, P. 14-18.

DESCRIPTORS- CASE HISTORIES; DEEP WELLS; DISPOSAL FORMATIONS; EARTHQUAKES; ENVIRONMENTAL EFFECTS; ENVIRONMENTAL PROTECTION AGENCY; EVAPORATION PONDS; GROUND WATER; INJECTION WELLS; MONITORING; POLLUTION; POLLUTION REGULATIONS; UNDERGROUND DISPOSAL; WASTE DISPOSAL.

13

GRUBBS 72
BRINE TREATMENT/SPENT FLUID DISPOSAL

TITLE- COMPATIBILITY OF SUBSURFACE RESERVOIRS WITH INJECTED LIQUID WASTES.

AUTHOR- GRUBBS, D.M.;HAYNES, C.D.;HUGHES, T.H.;STOW, S.H. [ALABAMA UNIV., UNIVERSITY (USA). NATURAL RESOURCES CENTER].

REFERENCE- COMPATIBILITY OF SUBSURFACE RESERVOIRS WITH INJECTED LIQUID WASTES. REPORT 721, THE UNIVERSITY OF ALABAMA, UNIVERSITY, ALA., JUN 1972, 128 P..

DESCRIPTORS- CARBONATES; CHEMICAL ANALYSIS; CHEMICAL COMPATIBILITY; CHEMICAL REACTIONS; CLAY MINERALS; COMPUTER CALCULATIONS; DEEP WELLS; DOLOMITE ROCKS; EXPERIMENTAL RESULTS; FLUID MECHANICS; FLOW RATE; GEOCHEMISTRY; HYDRODYNAMICS; HYDROXIDES; INDUSTRIAL WASTES; INJECTION PRESSURE; INJECTION WELLS; LIQUID WASTES; MATHEMATICAL MODELS; MEASURING INSTRUMENTS; MEASURING METHODS; MINERALOGY; PERMEABILITY; PETROGRAPHY; PLUGGING POROSITY; POROUS MEDIA; PRECIPITATION; ROCK-FLUID INTERACTIONS; ROCKS; SUBSURFACE RESERVOIRS; SUSPENDED SOLIDS; THEORETICAL TREATMENTS; UNDERGROUND DISPOSAL; WASTE DISPOSAL; WASTE WATER.

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GRUBBS 73
BRINE TREATMENT/SPENT FLUID DISPOSAL

TITLE- PERMEABILITY RESTORATION IN UNDERGROUND DISPOSAL RESERVOIRS.

AUTHOR- GRUBBS, D.M.;HAYNES, C.D.;WHITTLE, G.P. [ALABAMA UNIV., UNIVERSITY (USA). NATURAL RESOURCES CENTER].

REFERENCE- PERMEABILITY RESTORATION IN UNDERGROUND DISPOSAL RESERVOIRS. REPORT 733, THE UNIVERSITY OF ALABAMA, UNIVERSITY, ALA., SEP 1973, 138 P..

DESCRIPTORS- ABRASION; ACIDIZATION; BRINES; CARBONATES; CHEMICAL ANALYSIS; CHEMICAL REACTIONS; CLAY MINERALS; COMPUTER CALCULATIONS; DEEP WELLS; DISPOSAL FORMATIONS; ECONOMICS; FLOW RATE; HYDRAULIC FRACTURING; INJECTION PRESSURE; INJECTION WELLS; LIQUID WASTES; MEASURING INSTRUMENTS; MEASURING METHODS; PERMEABILITY; PERMEABILITY RESTORATION; PH ADJUSTMENT; PLUGGING; PRECIPITATION; PRESSURE BUILDUP; REAMING; ROCKS; SANDSTONE; SCALING; UNDERGROUND DISPOSAL; WASTE PROCESSING.

15

HANSHAW 72
BRINE TREATMENT/SPENT FLUID DISPOSAL

TITLE- NATURAL-MEMBRANE PHENOMENA AND SUBSURFACE WASTE EMPLACEMENT.

AUTHOR- HANSHAW, B.B. [GEOLOGICAL SURVEY, WASHINGTON, D.C. (USA)].

COOK, T.D. (ED.)

REFERENCE- UNDERGROUND WASTE MANAGEMENT AND ENVIRONMENTAL IMPLICATIONS. AM. ASSOC. PET. GEOL., TULSA, OKLA., DEC 1972, MEMOIR 18, P. 308-317.

DESCRIPTORS- AQUIFERS; AQUITARDS; CHEMICAL REACTIONS; CLAY MINERALS; DEEP WELLS; GEOLOGY; HYDRAULIC FRACTURING; HYDRODYNAMICS; MATHEMATICAL MODELS; OSMOSIS; PRESSURE BUILDUP; REVERSE OSMOSIS; SALINE AQUIFERS; SALINITY; SHALE; SUBSURFACE RESERVOIRS; TRANSMISSIVITY; UNDERGROUND DISPOSAL; WASTE DISPOSAL; ZETA POTENTIAL; SAN JUAN BASIN.

16

HARRISON 72
BRINE TREATMENT/SPENT FLUID DISPOSAL

TITLE- FEDERAL REGULATIONS AS THEY RELATE TO UNDERGROUND WASTE MANAGEMENT.

AUTHOR- HARRISON, T.P., II [ENVIRONMENTAL PROTECTION AGENCY, DALLAS, TEX. (USA)].

COOK, T.D. (ED.)

REFERENCE- UNDERGROUND WASTE MANAGEMENT AND ENVIRONMENTAL IMPLICATIONS. AM. ASSOC. PET. GEOL., TULSA, OKLA., DEC 1972, MEMOIR 18, P. 376-380.

DESCRIPTORS- ENVIRONMENTAL EFFECTS; ENVIRONMENTAL PROTECTION AGENCY; INJECTION WELLS; LEGAL ASPECTS; POLLUTION LAWS; POLLUTION REGULATIONS; REGULATIONS; UNDERGROUND DISPOSAL; WASTE MANAGEMENT; WATER POLLUTION.

17

HAYNES 69
BRINE TREATMENT/SPENT FLUID DISPOSAL

TITLE- DESIGN AND COST OF LIQUID-WASTE DISPOSAL SYSTEMS.

AUTHOR- HAYNES, C.D.;GRUBBS, D.M. [ALABAMA UNIV., UNIVERSITY (USA). NATURAL RESOURCES CENTER].

REFERENCE- DESIGN AND COST OF LIQUID-WASTE DISPOSAL SYSTEMS. REPORT 692, UNIVERSITY OF ALABAMA, UNIVERSITY, ALA., DEC 1969, 120 P..

DESCRIPTORS- BRINES; CHEMICAL COMPATIBILITY; CHEMICAL REACTIONS; COMPUTER CALCULATIONS; CORROSION; CORROSION INHIBITORS; DEEP WELLS; DISPOSAL FORMATIONS; ECONOMICS; FEASIBILITY STUDIES; FILTRATION; HYDRODYNAMICS; INJECTION WELLS; LIQUID WASTES; OILFIELD BRINES; PERMEABILITY; PIPELINES; PRECIPITATION; PRE-INJECTION TREATMENT; SUBSURFACE RESERVOIRS; SURFACE EQUIPMENT; SUSPENDED SOLIDS; UNDERGROUND DISPOSAL; WASTE DISPOSAL; WELL CASINGS; WELL CEMENTING; WELL DATA; WELL DESIGN; WELL LOGGING; ALABAMA.

18

HENRY 72
BRINE TREATMENT/SPENT FLUID DISPOSAL

TITLE- CIRCULATION PATTERNS OF SALINE GROUNDWATER AFFECTED BY GEOTHERMAL HEATING--AS RELATED TO WASTE DISPOSAL.

AUTHOR- HENRY, H.R. [ALABAMA UNIV., TUSCALOOSA, ALA. (USA). DEPT. OF CIVIL AND MINERAL ENGINEERING].

KOHOUT, F.A. [GEOLOGICAL SURVEY, WASHINGTON, D.C. (USA)].

COOK, T.D. (ED.)

REFERENCE- UNDERGROUND WASTE MANAGEMENT AND ENVIRONMENTAL IMPLICATIONS. AM. ASSOC. PET. GEOL., TULSA, OKLA., DEC 1972, MEMOIR 18, P. 202-221.

DESCRIPTORS- AQUIFERS; COMPUTER CALCULATIONS; CONVECTION; DEEP WELLS; DIFFUSION; DISPOSAL FORMATIONS; DOLOMITE ROCKS; ENVIRONMENTAL

EFFECTS; EXPERIMENTAL RESULTS; FLOW RATE; GEOLOGY; GEOTHERMAL ENERGY; GROUND WATER; HYDRAULICS; HYDROGEOLOGY; INJECTION WELLS; LIMESTONE; LIQUID WASTES; MATHEMATICAL MODELS; SALINE AQUIFERS; SALINITY; TEMPERATURE LOGGING; THEORETICAL TREATMENTS; TEMPERATURE GRADIENTS; UNDERGROUND DISPOSAL; WASTE DISPOSAL; WATER CHEMISTRY; FLORIDA.

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HILL 72
BRINE TREATMENT/SPENT FLUID DISPOSAL

TITLE- REGULATION OF SUBSURFACE DISPOSAL IN TEXAS.

AUTHOR- HILL, R. [TEXAS WATER QUALITY BOARD, AUSTIN, TEX. (USA)].

COOK, T.D. (ED.)

REFERENCE- UNDERGROUND WASTE MANAGEMENT AND ENVIRONMENTAL IMPLICATIONS. AM. ASSOC. PET. GEOL., TULSA, OKLA., DEC 1972, MEMOIR 18, P. 381-385.

DESCRIPTORS- DEEP WELLS; ENVIRONMENTAL EFFECTS; GEOLOGY; GROUND WATER; HYDROLOGY; INJECTION WELLS; LEGAL ASPECTS; LIQUID WASTES; LITHOLOGY; MONITORING; OILFIELD BRINES; PRESSURE BUILDUP; REGULATIONS; SUBSURFACE RESERVOIRS; UNDERGROUND DISPOSAL; WASTE DISPOSAL; WASTE PROCESSING; WELL COMPLETION; WELL DATA; WELL DESIGN; TEXAS.

20

HOOVER 69
BRINE TREATMENT/SPENT FLUID DISPOSAL

TITLE- SEISMIC ACTIVITY DURING THE 1968 TEST PUMPING AT THE ROCKY MOUNTAIN ARSENAL DISPOSAL WELL.

AUTHOR- HOOVER, D.B.;DIETRICH, J.A. [GEOLOGICAL SURVEY, CARMEL, CALIF. (USA)].

REFERENCE- SEISMIC ACTIVITY DURING THE 1968 TEST PUMPING AT THE ROCKY MOUNTAIN ARSENAL DISPOSAL WELL. CIRCULAR 613, GEOLOGICAL SURVEY, WASHINGTON, 1969, 35 P..

DESCRIPTORS- CHEMICAL ANALYSIS; CONNATE WATER; DEEP WELLS; LIQUID WASTES; MONITORING; SEISMOLOGY; TEMPERATURE LOGGING; TRANSMISSIVITY; UNDERGROUND DISPOSAL; WASTE DISPOSAL; WASTE WATER; WATER POLLUTION; ROCKY MOUNTAINS; COLORADO; DENVER BASIN.

21

HOWER 72
BRINE TREATMENT/SPENT FLUID DISPOSAL

TITLE- COMPATIBILITY OF INJECTION FLUIDS WITH RESERVOIR COMPONENTS.

AUTHOR- HOWER, W.F.;LASATER, R.M.;MIHRAM, R.G. [HALLIBURTON SERVICES, DUNCAN, OKLA. (USA)].

COOK, T.D. (ED.)

REFERENCE- UNDERGROUND WASTE MANAGEMENT AND ENVIRONMENTAL IMPLICATIONS. AM. ASSOC. PET. GEOL., TULSA, OKLA., DEC 1972, MEMOIR 18, P. 287-293.

DESCRIPTORS- BACTERIA; BIOLOGICAL FOULING; BRINES; CARBONATES; CASE HISTORIES; CHEMICAL COMPATIBILITY; CHEMICAL REACTIONS; CLAY MINERALS; DEEP WELLS; HYDRAULIC FRACTURING; INJECTION WELLS; LIQUID WASTES; PERMEABILITY; PERMEABILITY RESTORATION; PH ADJUSTMENT; PH VALUE; PLUGGING; PRECIPITATION; PRE-INJECTION TREATMENT; RESERVOIR PROPERTIES; ROCK-FLUID INTERACTIONS; SANDSTONE; SILICA MINERALS; SUBSURFACE RESERVOIRS; SUSPENDED SOLIDS; UNDERGROUND DISPOSAL; WASTE DISPOSAL.

22

LACEY 71
BRINE TREATMENT/SPENT FLUID DISPOSAL

TITLE- DEMINERALIZATION OF WASTEWATER BY THE TRANSPORT-DEPLETION PROCESS.

AUTHOR- LACEY, R.E.;HUFFMAN, E.L. [SOUTHERN RESEARCH INST., BIRMINGHAM, ALA. (USA)].

REFERENCE- DEMINERALIZATION OF WASTEWATER BY THE TRANSPORT-DEPLETION PROCESS. WATER POLLUTION CONTROL RESEARCH SERIES NO. 17040EUN02/71, ENVIRONMENTAL PROTECTION AGENCY, WASHINGTON, D.C., FEB 1971, 86 P..

DESCRIPTORS- DEMINERALIZATION; DESALINATION; ECONOMICS; ELECTRODIALYSIS; SCALING; WASTE PROCESSING; WASTE WATER.

23

LEGROS 69
BRINE TREATMENT/SPENT FLUID DISPOSAL

TITLE- A STUDY OF DEEP-WELL DISPOSAL OF DESALINATION BRINE WASTE.

AUTHOR- LEGROS, P.G.;GUSTAFSON, C.E.;NEVILL, G.L.;MAJESKE, E.C.;MATHEWS, R.D.;TALBOT, J.S.;MCILHENNY, W.F. [DOW CHEMICAL CO., MIDLAND, MICH. (USA)].

REFERENCE- A STUDY OF DEEP-WELL DISPOSAL OF DESALINATION BRINE WASTE. RESEARCH AND DEVELOPMENT PROGRESS REPORT NO. 456, OFFICE OF SALINE WATER, WASHINGTON, JUN 1969, 259 P..

DESCRIPTORS- BRINES; CASE HISTORIES; CHEMICAL ANALYSIS; DEEP WELLS; DESALINATION; DISPOSAL FORMATIONS; ECONOMICS; EVAPORATION PONDS; FEASIBILITY STUDIES; GEOLOGY; INJECTION PRESSURE; INJECTION WELLS; LEGAL ASPECTS; MONITORING; SURFACE EQUIPMENT; UNDERGROUND DISPOSAL; WASTE DISPOSAL; WELL DESIGN; OKLAHOMA; TEXAS; KANSAS; COLORADO; SOUTH DAKOTA.

24

MALINA 72
BRINE TREATMENT/SPENT FLUID DISPOSAL

TITLE- DISPOSAL-WELL DIMENSIONS-INJECTION RATES AND COST RESPONSES.

AUTHOR- MALINA, J.F., JR. [TEXAS UNIV., AUSTIN (USA). DEPT. OF CIVIL ENGINEERING].

MOSELEY, J.C.,II [DIV. OF COORDINATION AND PLANNING OFFICE OF THE GOVERNOR OF TEXAS, AUSTIN (USA)].

COOK, T.D. (ED.)

REFERENCE- DISPOSAL-WELL DIMENSIONS-INJECTION RATES AND COST RESPONSES. AM. ASSOC. PET. GEOL., TULSA, OKLA., DEC 1972, MEMOIR 18, P. 102-111.

DESCRIPTORS- DEEP WELLS; ECONOMICS; ENVIRONMENTAL EFFECTS; FLOW RATE; INDUSTRIAL WASTES; INJECTION PRESSURE; INJECTION RATES; INJECTION WELLS; LIQUID WASTES; MATHEMATICAL MODELS; PERMEABILITY; POROSITY; PRE-INJECTION TREATMENT; RESERVOIR PROPERTIES; SURFACE EQUIPMENT; UNDERGROUND DISPOSAL; WASTE DISPOSAL; WELL DESIGN.

25

MC WILLIAMS 72
BRINE TREATMENT/SPENT FLUID DISPOSAL

TITLE- LARGE SALTWATER-DISPOSAL SYSTEMS AT EAST TEXAS AND HASTINGS OIL FIELDS, TEXAS.

AUTHOR- MC WILLIAMS, J. [AMOCO PRODUCTION CO., HOUSTON, TEX. (USA)].

COOK, T.D. (ED.)

REFERENCE- UNDERGROUND WASTE MANAGEMENT AND ENVIRONMENTAL IMPLICATIONS. AM. ASSOC. PET. GEOL., TULSA, OKLA., DEC 1972, MEMOIR 18, P. 331-340.

DESCRIPTORS- CASE HISTORIES; CORROSION; DEEP WELLS; ENVIRONMENTAL EFFECTS; INJECTION PRESSURE; INJECTION WELLS; LIQUID WASTES; OILFIELD BRINES; POLLUTION; PRE-INJECTION TREATMENT; PRESSURE DECLINE; STRATIGRAPHY; UNDERGROUND DISPOSAL; WELL DESIGN; TEXAS.

26

MECHEM 63
BRINE TREATMENT/SPENT FLUID DISPOSAL

TITLE- DEEP INJECTION DISPOSAL WELL FOR LIQUID TOXIC WASTE.

AUTHOR- MECHEM, O.E.;GARRETT, J.H. [E.A.POLUMBUS, JR., AND ASSOCS., INC., PETROLEUM ENGNG. CONSULTANTS, DENVER, COLO. (USA)].

REFERENCE- PROCEEDINGS OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS, JOURNAL OF THE CONSTR. DIV., V. 89 (CO2), P. 111-121(SEP 1963).

DESCRIPTORS- AQUIFERS; DEEP WELLS; ECONOMICS; GEOLOGY; INDUSTRIAL WASTES; INJECTION PRESSURE; INJECTION RATES; INJECTION WELLS; LIQUID WASTES; LITHOLOGY; PERMEABILITY; POROSITY; SANDSTONE; SHALE; STRATIGRAPHY; SUBSURFACE RESERVOIRS; TEMPERATURE LOGGING; UNDERGROUND DISPOSAL; WASTE DISPOSAL; WELL COMPLETION; WELL DATA; WELL DESIGN; WELL DRILLING; WELL LOGGING; COLORADO; DENVER BASIN.

27

ORSANCO 73
BRINE TREATMENT/SPENT FLUID DISPOSAL

TITLE- UNDERGROUND INJECTION OF WASTEWATERS IN THE OHIO VALLEY REGION.

AUTHOR- OHIO RIVER VALLEY WATER SANITATION COMMISSION, ORSANCO ADVISORY COMMITTEE ON UNDERGROUND INJECTION OF WASTEWATERS, CINCINNATI, OHIO.

REFERENCE- UNDERGROUND INJECTION OF WASTEWATERS IN THE OHIO VALLEY REGION. OHIO RIVER VALLEY WATER SANITATION COMMISSION, CINCINNATI, AUG 1973, 63 P..

DESCRIPTORS- AQUIFERS; GEOLOGY; GROUND WATER; HYDRODYNAMICS; HYDROGEOLOGY; INJECTION WELLS; LEGAL ASPECTS; MINERALS; MONITORING; SEISMOLOGY; SURFACE EQUIPMENT; UNDERGROUND DISPOSAL; WASTE PROCESSING; WELL DESIGN; WELL DRILLING; OHIO.

28

PIPER 69
BRINE TREATMENT/SPENT FLUID DISPOSAL

TITLE- DISPOSAL OF LIQUID WASTES BY INJECTION UNDERGROUND--NEITHER MYTH NOR MILLENNIUM.

AUTHOR- PIPER, A.M. [GEOLOGICAL SURVEY, CARMEL, CALIF. (USA)].

REFERENCE- DISPOSAL OF LIQUID WASTES BY INJECTION UNDERGROUND--NEITHER MYTH NOR MILLENNIUM. CIRCULAR 631, GEOLOGICAL SURVEY, WASHINGTON, 1969, 15 P..

DESCRIPTORS- AQUIFERS; CHEMICAL ANALYSIS; CHEMICAL COMPOSITION; CHEMICAL COMPATIBILITY; CHEMICAL REACTIONS; DEEP WELLS; EARTHQUAKES; ENVIRONMENTAL EFFECTS; GEOCHEMISTRY; GEOLOGY; HYDRAULIC FRACTURING; HYDRODYNAMICS; HYDROGEOLOGY; HYDROLOGY; INJECTION PRESSURE; INJECTION RATES; INJECTION WELLS; LEGAL ASPECTS; LIQUID WASTES; MONITORING; OILFIELD BRINES; PERMEABILITY; PH ADJUSTMENT; PRE-INJECTION TREATMENT; RADIOACTIVE WASTES; SEISMOLOGY; TRANSMISSIVITY; UNDERGROUND DISPOSAL; WASTE DISPOSAL; WASTE MANAGEMENT; COLORADO; DENVER BASIN.

29

RALEIGH 72
BRINE TREATMENT/SPENT FLUID DISPOSAL

TITLE- EARTHQUAKES AND FLUID INJECTION.

AUTHOR- RALEIGH, C.B. [GEOLOGICAL SURVEY, MENLO PARK, CALIF. (USA). NATIONAL CENTER FOR EARTHQUAKE RESEARCH].

COOK, T.D. (ED.)

REFERENCE- UNDERGROUND WASTE MANAGEMENT AND ENVIRONMENTAL IMPLICATIONS. AM. ASSOC. PET. GEOL., TULSA, OKLA., DEC 1972, MEMOIR 18, P. 273-279.

DESCRIPTORS- AQUITARDS; DEEP WELLS; EARTHQUAKES; FAULT ACTIVATION; HYDRAULIC FRACTURING; INJECTION WELLS; LIQUID WASTES; MONITORING; PORE PRESSURE; PRESSURE BUILDUP; RESERVOIR PROPERTIES; SANDSTONE; SEISMOLOGY; SUBSURFACE RESERVOIRS; UNDERGROUND DISPOSAL; WASTE DISPOSAL; COLORADO; DENVER BASIN.

30

SADOW 72
BRINE TREATMENT/SPENT FLUID DISPOSAL

TITLE- PRETREATMENT OF INDUSTRIAL WASTE WATERS FOR SUBSURFACE INJECTION.

AUTHOR- SADOW, R.D. [MONSANTO POLYMERS AND PETROCHEMICALS COMPANY, TEXAS CITY, TEX. (USA)].

COOK, T.D. (ED.)

REFERENCE- UNDERGROUND WASTE MANAGEMENT AND ENVIRONMENTAL IMPLICATIONS. AM. ASSOC. PET. GEOL., TULSA, OKLA., DEC 1972, MEMOIR 18, P. 93-101.

DESCRIPTORS- BACTERIA; BIOLOGICAL FOULING; CHEMICAL COMPATIBILITY; CORROSION; CORROSION INHIBITORS; CORROSION RESISTANT ALLOYS; CORROSIVE EFFECTS; DEEP WELLS; DISPOSAL FORMATIONS; FILTRATION; GEOLOGY; INDUSTRIAL WASTES; INJECTION PRESSURE; INJECTION RATES; OILFIELD BRINES; PERMEABILITY; PH ADJUSTMENT; PH VALUE; PLUGGING; POLYMERIZATION; POROSITY; PRECIPITATION; PRE-INJECTION TREATMENT; PRESSURE BUILDUP; SURFACE EQUIPMENT; SUSPENDED SOLIDS; UNDERGROUND DISPOSAL; WASTE DISPOSAL; WASTE WATER; WELL DESIGN; TEXAS.

31

SCEVA 68
BRINE TREATMENT/SPENT FLUID DISPOSAL

TITLE- LIQUID WASTE DISPOSAL IN THE LAVA TERRANE OF CENTRAL OREGON.

AUTHOR- SCEVA, J.E. [FEDERAL WATER POLLUTION CONTROL ADMINISTRATION, NORTHWEST REGION, CORVALLIS, OREG. (USA). PACIFIC NORTHWEST WATER LAB.].

REFERENCE- LIQUID WASTE DISPOSAL IN THE LAVA TERRANE OF CENTRAL OREGON. REPORT NO. FR-4, FEDERAL WATER POLLUTION CONTROL ADMINISTRATION, NORTHWEST REGION, CORVALLIS, OREG., MAY 1968, 66 P., APPENDIX 96 P..

DESCRIPTORS- ENVIRONMENTAL EFFECTS; GEOLOGY; HYDROLOGY; INJECTION WELLS; LIQUID WASTES; POLLUTION; UNDERGROUND DISPOSAL; WASTE DISPOSAL; WASTE WATER; WATER CHEMISTRY; OREGON.

32

SWOLFS 72
BRINE TREATMENT/SPENT FLUID DISPOSAL

TITLE- CHEMICAL EFFECTS OF PORE FLUIDS ON ROCK PROPERTIES.

AUTHOR- SWOLFS, H.S. [TERRA TEK, INC., SALT LAKE CITY, UTAH (USA)].

COOK, T.D. (ED.)

REFERENCE- UNDERGROUND WASTE MANAGEMENT AND ENVIRONMENTAL IMPLICATIONS. AM. ASSOC. PET. GEOL., TULSA, OKLA., DEC 1972, MEMOIR 18, P. 224-234.

DESCRIPTORS- CHEMICAL REACTIONS; FREE ENERGY; GROUND SUBSIDENCE; LIQUID WASTES; MECHANICAL PROPERTIES; PORE PRESSURE; PRESSURE BUILDUP; ROCK-FLUID INTERACTIONS; ROCK MECHANICS; ROCK PROPERTIES; SANDSTONE; UNDERGROUND DISPOSAL; WASTE DISPOSAL; ZETA POTENTIAL.

33

TALBOT 72
BRINE TREATMENT/SPENT FLUID DISPOSAL

TITLE- REQUIREMENTS FOR THE MONITORING OF INDUSTRIAL DEEP-WELL WASTE-DISPOSAL SYSTEMS.

AUTHOR- TALBOT, J.S. [DOW CHEMICAL CO., HOUSTON, TEX.: (USA)].

COOK, T.D. (ED.)

REFERENCE- UNDERGROUNC WASTE MANAGEMENT AND ENVIRONMENTAL IMPLICATIONS. AM. ASSOC. PET. GEOL., TULSA, OKLA., DEC 1972, MEMOIR 18, P. 85-92.

DESCRIPTORS- CORROSION MONITORING; DEEP WELLS; DISPOSAL FORMATIONS; ENVIRONMENTAL EFFECTS; INDUSTRIAL WASTES; INJECTION PRESSURE; INJECTION WELLS; MONITORING; OBSERVATION WELLS; REGULATIONS; SEISMOLOGY; SUBSURFACE RESERVOIRS; SURFACE EQUIPMENT; TEMPERATURE LOGGING; UNDERGROUND DISPOSAL; WASTE DISPOSAL; WELL COMPLETION; WELL DESIGN.

34

TWQB 72
BRINE TREATMENT/SPENT FLUID DISPOSAL

TITLE- THE DISPOSAL WELL ACT.

AUTHOR- TEXAS WATER QUALITY BOARD (USA).

REFERENCE- THE DISPOSAL WELL ACT. AGENCY PUBLICATION NUMBER 72-01, TEXAS WATER QUALITY BOARD, FEB 1972, 15 P..

DESCRIPTORS- INJECTION WELLS; LEGAL ASPECTS; OILFIELD BRINES; REGULATIONS; UNDERGROUND DISPOSAL; WASTE DISPOSAL; WASTE WATER; WATER QUALITY; TEXAS.

35

VAN EVERDINGEN 71
BRINE TREATMENT/SPENT FLUID DISPOSAL

TITLE- SUBSURFACE DISPOSAL OF WASTE IN CANADA. INJECTION OF LIQUID INDUSTRIAL WASTE IN DEEP WELLS--A PRELIMINARY APPRAISAL.

AUTHOR- VAN EVERDINGEN, R.O.;FREEZE, R.A. [DEPARTMENT OF THE ENVIRONMENT, OTTAWA, ONTARIO (CANADA). INLAND WATERS BRANCH].

REFERENCE- SUBSURFACE DISPOSAL OF WASTE IN CANADA. INJECTION OF LIQUID INDUSTRIAL WASTE IN DEEP WELLS--A PRELIMINARY APPRAISAL. TECHNICAL BULLETIN NO. 49, DEPT. OF THE ENVIRONMENT, INLAND WATERS BRANCH, OTTAWA (CANADA), 1971, 64

DESCRIPTORS- CASE HISTORIES; ECONOMICS; FAILURES; GROUND SUBSIDENCE; INJECTION WELLS; LIQUID WASTES; MONITORING; REGULATIONS; SAFETY; SUBSURFACE RESERVOIRS; UNDERGROUND DISPOSAL; WASTE DISPOSAL; WASTE MANAGEMENT; WASTE PROCESSING; CANADA.

36

VECCHIOLI 72
BRINE TREATMENT/SPENT FLUID DISPOSAL

TITLE- PRELIMINARY RESULTS OF INJECTING HIGHLY TREATED SEWAGE-PLANT EFFLUENT INTO A DEEP SAND AQUIFER AT BAY PARK, NEW YORK. DEEP-WELL ARTIFICIAL RECHARGE EXPERIMENTS AT BAY PARK, LONG ISLAND, NEW YORK.

AUTHOR- VECCHIOLI, ..;KU, H.F.H. [GEOLOGICAL SURVEY, WASHINGTON, D.C. (USA)].

REFERENCE- PRELIMINARY RESULTS OF INJECTING HIGHLY TREATED SEWAGE-PLANT EFFLUENT INTO A DEEP SAND AQUIFER AT BAY PARK, NEW YORK. DEEP-WELL ARTIFICIAL RECHARGE EXPERIMENTS AT BAY PARK, LONG ISLAND, NEW YORK. PROFESSIONAL PAPER 751-A, GEOLOGICAL SURVEY, WASHINGTON, 1972, 14

DESCRIPTORS- AQUIFERS; ARTIFICIAL RECHARGE; BACTERIA; BIOLOGICAL FOULING; CHEMICAL ANALYSIS; CHEMICAL COMPOSITION; DEEP WELLS; DEGASIFICATION; FILTRATION; FLOW RATE; GRAVEL PACKING; HYDRAULICS; INJECTION RATES; INJECTION WELLS; LIQUID WASTES; MATHEMATICAL MODELS; OBSERVATION WELLS; PLUGGING; PRECIPITATION; PRE-INJECTION TREATMENT; PRESSURE BUILDUP; SANDSTONE; SUSPENDED SOLIDS; THEORETICAL TREATMENTS; UNDERGROUND DISPOSAL; WASTE DISPOSAL; WASTE WATER; WATER CHEMISTRY; WELL COMPLETION; WELL DESIGN; NEW YORK.

37

WARNER 65
BRINE TREATMENT/SPENT FLUID DISPOSAL

TITLE- DEEP WELL INJECTION OF LIQUID WASTE. A REVIEW OF EXISTING KNOWLEDGE AND AN EVALUATION OF RESEARCH NEEDS.

88084805826

AUTHOR- WARNER, D.L. [ROBERT A. TAFT SANITARY ENGINEERING CENTER, CINCINNATI, OHIO (USA). BASIC AND APPLIED SCIENCES BRANCH].

REFERENCE- DEEP WELL INJECTION OF LIQUID WASTE. A REVIEW OF EXISTING KNOWLEDGE AND AN EVALUATION OF RESEARCH NEEDS. PUBLIC HEALTH SERVICE PUBLICATION NO. 999-WP-21, DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE, CINCINNATI, OHIO, APR 1965, 55 P..

DESCRIPTORS- ACIDIZATION; AQUIFERS; BACTERIA; BIOLOGICAL FOULING; CARBONATES; CHEMICAL COMPATIBILITY; CHEMICAL COMPOSITION; CHEMICAL REACTIONS; CLAY MINERALS; CORROSION; CORROSION RESISTANT ALLOYS; DEEP WELLS; DISPOSAL FORMATIONS; DOLOMITE ROCKS; ECONOMICS; ENVIRONMENTAL EFFECTS; FAILURES; FEASIBILITY STUDIES; FLOW RATE; GEOLOGY; GROUND WATER; HYDRAULIC FRACTURING; INDUSTRIAL WASTES; INJECTION PRESSURE; INJECTION RATES; INJECTION WELLS; LEGAL ASPECTS; LIMESTONE; LIQUID WASTES; MATHEMATICAL MODELS; MEASURING METHODS; MINERALOGY; MONITORING; OILFIELD BRINES; PERMEABILITY; PLUGGING; POROSITY; PRECIPITATION; RADIOACTIVE WASTES; REGULATIONS; RESERVOIR PROPERTIES; SALINITY; SANDSTONE; SEDIMENTARY ROCKS; SEISMOLOGY; STRATIGRAPHY; SUBSURFACE RESERVOIRS; TEMPERATURE LOGGING; UNDERGROUND DISPOSAL; WELL CASINGS.

38

WARNER 67
BRINE TREATMENT/SPENT FLUID DISPOSAL

TITLE- DEEP WELLS FOR INDUSTRIAL WASTE INJECTION IN THE UNITED STATES. SUMMARY OF DATA.

AUTHOR- WARNER, D.L. [FEDERAL WATER POLLUTION CONTROL ADMINISTRATION, CINCINNATI, OHIO (USA). WATER RESEARCH LAB.].

REFERENCE- DEEP WELLS FOR INDUSTRIAL WASTE INJECTION IN THE UNITED STATES. SUMMARY OF DATA. WATER POLLUTION CONTROL RESEARCH SERIES PUBLICATION NO. WP-20-10, FEDERAL WATER POLLUTION CONTROL ADMINISTRATION, CINCINNATI, OHIO, NOV 1967, 45 P..

DESCRIPTORS- DEEP WELLS; DISPOSAL FORMATIONS; DOLOMITE ROCKS; GEOLOGY; INDUSTRIAL WASTES; INJECTION PRESSURE; INJECTION RATES; INJECTION WELLS; LIMESTONE; LIQUID WASTES; SAND; SANDSTONE; UNDERGROUND DISPOSAL; WASTE DISPOSAL; WELL DATA; USA.

39

WARNER 72
BRINE TREATMENT/SPENT FLUID DISPOSAL

TITLE- SUBSURFACE INDUSTRIAL WASTEWATER INJECTION IN ILLINOIS.

AUTHOR- WARNER, D.L. (OHIO RIVER VALLEY SANITATION COMMITTEE ON SUBSURFACE INDUSTRIAL WASTEWATER INJECTION (USA)).

REFERENCE- SUBSURFACE INDUSTRIAL WASTEWATER INJECTION IN ILLINOIS. IIEQ DOCUMENT NO. 72-2, ILLINOIS INSTITUTE FOR ENVIRONMENTAL QUALITY, CHICAGO, FEB 1972, 116 P..

DESCRIPTORS- AQUIFERS; BRINES; CHEMICAL COMPOSITION; DEEP WELLS; DISPOSAL FORMATIONS; DOLOMITE ROCKS; ECONOMICS; ENVIRONMENTAL PROTECTION AGENCY; GEOLOGY; GROUND WATER; HYDRAULIC FRACTURING; HYDROGEOLOGY; HYDROLOGY; INDUSTRIAL WASTES; INJECTION PRESSURE; INJECTION RATES; INJECTION WELLS; LIMESTONE; MONITORING; PERMEABILITY; POLLUTION REGULATIONS; POROSITY; REGULATIONS; RESERVOIR PROPERTIES; SALINE AQUIFERS; SAND; SANDSTONE; SEDIMENTARY ROCKS; STRATIGRAPHY; SUBSURFACE RESERVOIRS; SURFACE EQUIPMENT; SUSPENDED SOLIDS; TEMPERATURE LOGGING; UNDERGROUND DISPOSAL; WASTE DISPOSAL; WASTE WATER; WELL CEMENTING; WELL CHARACTERISTICS; WELL COMPLETION; WELL DESIGN; ILLINOIS; NEW YORK; ILLINOIS BASIN; USA.

40

WILSON 71
BRINE TREATMENT/SPENT FLUID DISPOSAL

TITLE- INVESTIGATIONS ON THE SUBSURFACE DISPOSAL OF WASTE EFFLUENTS AT INLAND SITES.

AUTHOR- WILSON, L.G. (ARIZONA UNIV., TUCSON (USA)).

REFERENCE- INVESTIGATIONS ON THE SUBSURFACE DISPOSAL OF WASTE EFFLUENTS AT INLAND SITES. RESEARCH AND DEVELOPMENT PROGRESS REPORT NO. 650, OFFICE OF SALINE WATER, WASHINGTON, MAY 1971, 106 P..

DESCRIPTORS- ARTIFICIAL RECHARGE; BRINES; DEEP WELLS; DESALINATION; EVAPORATION PONDS; HYDRAULICS; HYDRODYNAMIC DISPERSION;

HYDRODYNAMICS; HYDROGEOLOGY; INJECTION WELLS; OBSERVATION WELLS; POROUS MEDIA; UNDERGROUND DISPOSAL; WASTE DISPOSAL; WELL DESIGN.

41

WITHERSPOON 72
BRINE TREATMENT/SPENT FLUID DISPOSAL

TITLE- HYDRODYNAMICS OF FLUID INJECTION.

AUTHOR- WITHERSPOON, P.A. [CALIFORNIA UNIV., BERKELEY (USA)].

NEUMAN, S.P. [VOLCANI INST. OF AGRICULTURAL RESEARCH, BET DAGAN (ISRAEL)].

COOK, T.D. (ED.)

REFERENCE- UNDERGROUND WASTE MANAGEMENT AND ENVIRONMENTAL IMPLICATIONS. AM. ASSOC. PET. GEOL., TULSA, OKLA., DEC 1972, MEMOIR 18, P. 258-272.

DESCRIPTORS- AQUIFERS; AQUITARDS; DISPOSAL FORMATIONS; DOLOMITE ROCKS; ENVIRONMENTAL EFFECTS; FIELD STUDIES; FLUID MECHANICS; FLOW RATE; HYDRODYNAMICS; INJECTION WELLS; LIMESTONE; LIQUID WASTES; MATHEMATICAL MODELS; MONITORING; PERMEABILITY; POROSITY; POROUS MEDIA; PRESSURE BUILDUP; SANDSTONE; THEORETICAL TREATMENTS; TRANSMISSIVITY; UNDERGROUND DISPOSAL; WASTE DISPOSAL.

42

BROWN 73
BRINE TREATMENT/SPENT FLUID DISPOSAL

TITLE- ARTIFICIAL RECHARGE--STATE OF THE ART.

AUTHOR- BROWN, R.F.;SIGNOR, D.C. [GEOLOGICAL SURVEY, LUBBOCK, TEX. (USA)].

BRAUNSTEIN, J. (ED.)

REFERENCE- UNDERGROUND WASTE MANAGEMENT AND ARTIFICIAL RECHARGE. AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS, TULSA, OKLA., 1973, V. 2, P. 668-686.

DESCRIPTORS- AQUIFERS: ARTIFICIAL RECHARGE; BACTERIA; BIOLOGICAL EFFECTS; BIOLOGICAL FOULING; CARBONATES; CHEMICAL REACTIONS; CHEMICAL COMPATIBILITY; CLAY MINERALS; DISPOSAL FORMATIONS; ECONOMICS; EXPERIMENTAL RESULTS; FEASIBILITY STUDIES; FLOW RATE; GEOLOGY; GROUND WATER; HYDRODYNAMIC DISPERSION; HYDROGEOLOGY; HYDROLOGY; INJECTION WELLS; LIMESTONE; LITHOLOGY; MEASURING METHODS; MICROORGANISMS; PERMEABILITY; PLUGGING; PRE-INJECTION TREATMENT; RESERVOIR PROPERTIES; SANDSTONE; SUBSURFACE RESERVOIRS; SUSPENDED SOLIDS; TRACE AMOUNTS; UNDERGROUND DISPOSAL; WASTE DISPOSAL; WASTE STORAGE; WATER POLLUTION; WATER QUALITY; ISRAEL; USA; UNITED KINGDOM; JAMAICA; FRANCE; ELEMENTS.

43

BRIGGS 68
BRINE TREATMENT/SPENT FLUID DISPOSAL

TITLE- GEOLOGY OF SUBSURFACE WASTE DISPOSAL IN MICHIGAN BASIN.

AUTHOR- BRIGGS, L.I., JR. [MICHIGAN UNIV., ANN ARBOR (USA)].

GALLEY, J.E. (ED.)

REFERENCE- SUBSURFACE DISPOSAL IN GEOLOGIC BASINS--A STUDY OF RESERVOIR STRATA. AM. ASSOC. PET. GEOL., TULSA, OKLA,, AUG 1968, MEMOIR 10, P. 128-153.

DESCRIPTORS- ACIDIZATION; CARBONATES; DEEP WELLS; DISPOSAL FORMATIONS; DOLOMITE ROCKS; EXPERIMENTAL RESULTS; GEOLOGY; HYDRAULIC FRACTURING; HYDRODYNAMICS; INJECTION PRESSURE; INJECTION RATES; INJECTION WELLS; LIMESTONE; LIQUID WASTES; LITHOLOGY; MEASURING METHODS; MINERALOGY; PERMEABILITY; PETROGRAPHY; POROSITY; RADIOACTIVE WASTES; RESERVOIR PROPERTIES; SANDSTONE; SEDIMENTARY ROCKS; SHALE; STRATIGRAPHY; SUBSURFACE RESERVOIRS; UNDERGROUND DISPOSAL; WASTE DISPOSAL; MICHIGAN; MICHIGAN BASIN.

44

CLEARY 69
BRINE TREATMENT/SPENT FLUID DISPOSAL

TITLE- PERSPECTIVE ON THE REGULATION OF UNDERGROUND INJECTION OF WASTEWATERS.

AUTHOR- CLEARY, E.J. [OHIO RIVER VALLEY WATER SANITATION COMMISSION, CINCINNATI, OHIO (USA)].

WARNER, D.L. [MISSOURI UNIV., ROLLA (USA)].

REFERENCE- PERSPECTIVE ON THE REGULATION OF UNDERGROUND INJECTION OF WASTEWATERS. OHIO RIVER VALLEY WATER SANITATION COMMISSION, CINCINNATI, OHIO, DEC 1969, 88 P..

DESCRIPTORS- DEEP WELLS; GEOLOGY; HYDRODYNAMICS; HYDROLOGY; INJECTION WELLS; LEGAL ASPECTS; PLUGGING; REGULATIONS; SEISMOLOGY; UNDERGROUND DISPOSAL; WASTE DISPOSAL; WASTE WATER; OHIO.

45

DENNISON 73
BRINE TREATMENT/SPENT FLUID DISPOSAL

TITLE- HYDROGEOLOGIC AND ECONOMIC FACTORS IN DECISION MAKING UNDER UNCERTAINTY FOR NORMATIVE SUBSURFACE DISPOSAL OF FLUID WASTES, NORTHERN WILLISTON BASIN, SASKATCHEWAN, CANADA.

AUTHOR- DENNISON, E.G.;SIMPSON, F. [SASKATCHEWAN DEPT. OF MINERAL RESOURCES, REGINA (CANADA)].

BRAUNSTEIN, J. (ED.)

REFERENCE- UNDERGROUND WASTE MANAGEMENT AND ARTIFICIAL RECHARGE. AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS, TULSA, OKLA., 1973, V. 2, P. 879-927.

DESCRIPTORS- AQUIFERS; BRINES; CARBONATES; CHEMICAL COMPATIBILITY; DEEP WELLS; DISPOSAL FORMATIONS; ECONOMICS; ENVIRONMENTAL EFFECTS; GEOLOGY; HYDRAULICS; HYDROGEOLOGY; INDUSTRIAL WASTES; INJECTION PRESSURE; INJECTION RATES; INJECTION WELLS; LEGAL ASPECTS; LIQUID WASTES; LITHOLOGY; MONITORING; OBSERVATION WELLS; OILFIELD BRINES; OIL WELLS; PERMEABILITY; POROSITY; REGULATIONS;

SALINE AQUIFERS; SANDSTONE; SEDIMENTARY ROCKS; STRATIGRAPHY; SUBSURFACE RESERVOIRS: SURFACE EQUIPMENT; UNDERGROUND DISPOSAL; WASTE DISPOSAL: WELL CASINGS; WELL CEMENTING; WELL COMPLETION: WELL DESIGN: WELL LOGGING; WILLISTON BASIN; CANADA.

46

EDMUND 68
BRINE TREATMENT/SPENT FLUID DISPOSAL

TITLE- SUBSURFACE WASTE-DISPOSAL POTENTIAL IN SALINA BASIN OF KANSAS.

AUTHOR- EDMUND, R.W. [AUGUSTANA COLLEGE, ROCK ISLAND, ILL. (USA)].

GOEBEL, E.D. [KANSAS STATE GEOLOGICAL SURVEY, LAWRENCE, KAN. (USA)].

GALLEY, J.E. (ED.)

REFERENCE- SUBSURFACE DISPOSAL IN GEOLOGIC BASINS--A STUDY OF RESERVOIR STRATA. AM. ASSOC. PET. GEOL., TULSA, OKLA., AUG 1968, MEMOIR 10, P. 154-164.

DESCRIPTORS- AQUIFERS: GEOLOGY: HYDROGEOLOGY; HYDROLOGY; LIMESTONE: SALINE AQUIFERS: SANDSTONE; SALT DEPOSITS: SEDIMENTARY ROCKS; SHALE; STRATIGRAPHY: SUBSURFACE RESERVOIRS; TRANSMISSIVITY; UNDERGROUND DISPOSAL: WASTE DISPOSAL; KANSAS; SALINA BASIN.

47

EPA 74
BRINE TREATMENT/SPENT FLUID DISPOSAL

TITLE- COMPILATION OF INDUSTRIAL AND MUNICIPAL INJECTION WELLS IN THE UNITED STATES.

AUTHOR- WASHINGTON, D.C. (USA). OFFICE OF WATER PROGRAM OPERATIONS.

REFERENCE- COMPILATION OF INDUSTRIAL AND MUNICIPAL INJECTION WELLS IN THE UNITED STATES. EPA-520/9-74-020, ENVIRONMENTAL PROTECTION AGENCY, WASHINGTON, D.C., OCT 1974, V. 1, 23

DESCRIPTORS- AQUIFERS; CARBONATES; DEEP WELLS; ENVIRONMENTAL PROTECTION AGENCY; GEOLOGY; HYDROGEOLOGY; INJECTION WELLS; LIQUID WASTES; SAFETY; SANDSTONE; SURFACE EQUIPMENT; WASTE DISPOSAL; WELL DATA; WELL DESIGN; USA.

48

GALLEY 68
BRINE TREATMENT/SPENT FLUID DISPOSAL

TITLE- ECONOMIC AND INDUSTRIAL POTENTIAL OF GEOLOGIC BASINS AND RESERVOIR STRATA.

AUTHOR- GALLEY, J.E. (ED.) [GEOLOGICAL CONSULTANT, KERRVILLE, TEX. (USA)].

REFERENCE- SUBSURFACE DISPOSAL IN GEOLOGIC BASINS--A STUDY OF RESERVOIR STRATA. AM. ASSOC. PET. GEOL., TULSA, OKLA., AUG 1968, MEMOIR 10, P. 1-10.

DESCRIPTORS- AQUIFERS; CHEMICAL COMPATIBILITY; DEEP WELLS; DISPOSAL FORMATIONS; ECONOMICS; ENVIRONMENTAL EFFECTS; GEOLOGY; HYDRAULIC FRACTURING; HYDRODYNAMICS; INDUSTRIAL WASTES; INJECTION WELLS; LIQUID WASTES; OILFIELD BRINES; PLUGGING; RADIOACTIVE WASTES; RESERVOIR PROPERTIES; SALT DEPOSITS; SEISMOLOGY; SHALE; STRATIGRAPHY; SUBSURFACE RESERVOIRS; UNDERGROUND DISPOSAL; WASTE DISPOSAL.

49

GARBARINI 68
BRINE TREATMENT/SPENT FLUID DISPOSAL

TITLE- POTENTIAL OF DENVER BASIN FOR DISPOSAL OF LIQUID WASTES.

AUTHOR- GARBARINI, G.S. [SUN OIL CO., DENVER, COLO. (USA)].

VEAL, H.K. [WOLF EXPLORATION CO., DALLAS, TEX. (USA)].

GALLEY, J.E. (ED.)

REFERENCE- SUBSURFACE DISPOSAL IN GEOLOGIC BASINS--A STUDY OF RESERVOIR STRATA. AM. ASSOC. PET. GEOL., TULSA, OKLA., AUG 1968, MEMOIR 10, P. 165-185.

DESCRIPTORS- AQUIFERS; CASE HISTORIES; DEEP WELLS; DISPOSAL FORMATIONS; GEOLOGY; GROUND WATER; HYDRAULIC FRACTURING; INJECTION WELLS; LIQUID WASTES; PERMEABILITY; POROSITY; RESERVOIR PROPERTIES; SANDSTONE; SEDIMENTARY ROCKS; SEISMOLOGY; SHALE; STRATIGRAPHY; SUBSURFACE RESERVOIRS; UNDERGROUND DISPOSAL; WASTE DISPOSAL; WELL LOGGING; COLORADO; DENVER BASIN.

50

GARCIA-BENGOCHEA 73
BRINE TREATMENT/SPENT FLUID DISPOSAL

TITLE- ARTIFICIAL RECHARGE OF TREATED WASTE WATERS AND RAINFALL RUNOFF INTO DEEP SALINE AQUIFERS OF PENINSULA OF FLORIDA.

AUTHOR- GARCIA-BENGOCHEA, J.I.;SPROUL, C.R. [BLACK, CROW AND EIDSNESS, INC., GAINESVILLE, FLA. (USA)].

VERNON, R.O.;WOODARD, H.J. [FLORIDA STATE DEPARTMENT OF NATURAL RESOURCES, TALLAHASSEE (USA). DIV. OF INTERIOR RESOURCES].

BRAUNSTEIN, J. (ED.)

REFERENCE- UNDERGROUND WASTE MANAGEMENT AND ARTIFICIAL RECHARGE. AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS, TULSA, OKLA., 1973, V. 1, P. 505-525.

DESCRIPTORS- AQUICLUDES; AQUIFERS; ARTIFICIAL RECHARGE; CASE HISTORIES; CHEMICAL COMPOSITION; DEEP WELLS; DOLOMITE ROCKS; ENVIRONMENTAL EFFECTS; GROUND WATER; HYDROGEOLOGY; INJECTION PRESSURE; INJECTION RATES; INJECTION WELLS; LIMESTONE; MEASURING INSTRUMENTS; MEASURING METHODS; MONITORING; PH VALUE; PRE-INJECTION TREATMENT; SALINE AQUIFERS; TRANSMISSIVITY; UNDERGROUND DISPOSAL; WASTE WATER; WATER QUALITY; WELL CASINGS; WELL DATA; WELL DRILLING; WELL LOGGING; FLORIDA.

51

HALL 73
BRINE TREATMENT/SPENT FLUID DISPOSAL

TITLE- U.S. ENVIRONMENTAL PROTECTION AGENCY POLICY ON SUBSURFACE EMPLACEMENT OF FLUIDS BY WELL INJECTION.

AUTHOR- HALL, C.W.; BALLENTINE, R.K. [ENVIRONMENTAL PROTECTION AGENCY, WASHINGTON, D.C. (USA)].

BRAUNSTEIN, J. (ED.)

REFERENCE- UNDERGROUND WASTE MANAGEMENT AND ARTIFICIAL RECHARGE. AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS, TULSA, OKLA., 1973, V. 2, P. 783-794.

DESCRIPTORS- DEEP WELLS; ECONOMICS; ENVIRONMENTAL EFFECTS; ENVIRONMENTAL PROTECTION AGENCY; GEOLOGY; GROUND WATER; HYDROLOGY; INDUSTRIAL WASTES; INJECTION WELLS; LEGAL ASPECTS; LIQUID WASTES; OILFIELD BRINES; POLLUTION; REGULATIONS; RESERVOIR PROPERTIES; UNDERGROUND DISPOSAL; WASTE DISPOSAL; WELL DESIGN.

52

HANBY 73
BRINE TREATMENT/SPENT FLUID DISPOSAL

TITLE- SUBSURFACE DISPOSAL OF LIQUID INDUSTRIAL WASTES IN ALABAMA--A CURRENT STATUS REPORT.

AUTHOR- HANBY, K.P.;KIDD, R.E. [GEOLOGICAL SURVEY OF ALABAMA UNIVERSITY, ALA. (USA)].

LAMOREAUX, P.E. [STATE OIL AND GAS BOARD, UNIVERSITY, ALA. (USA)].

BRAUNSTEIN, J. (ED.)

REFERENCE- UNDERGROUND WASTE MANAGEMENT AND ARTIFICIAL RECHARGE. AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS, TULSA, OKLA., 1973, V. 1, P. 72-90.

DESCRIPTORS- CARBONATES; CHEMICAL REACTIONS; DISPOSAL FORMATIONS; DOLOMITE ROCKS; GEOLOGY; GROUND WATER; INDUSTRIAL WASTES; INJECTION PRESSURE; INJECTION RATES; INJECTION WELLS;

LIQUID WASTES; LITHOLOGY; MONITORING; PERMEABILITY; PLUGGING; POROSITY; PRE-INJECTION TREATMENT; SANDSTONE; SURFACE EQUIPMENT; UNDERGROUND DISPOSAL; WASTE DISPOSAL; WELL CEMENTING; WELL COMPLETION; WELL DRILLING; ALABAMA; BLACK WARRIOR BASIN.

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HARDAWAY 68
BRINE TREATMENT/SPENT FLUID DISPOSAL

TITLE- POSSIBILITIES FOR SUBSURFACE WASTE DISPOSAL IN A STRUCTURAL SYNCLINE IN PENNSYLVANIA.

AUTHOR- HARDAWAY, J.E. [ISOTOPES-TELEDYNE, WESTWOOD, N.J. (USA)].

GALLEY, J.E. (ED.)

REFERENCE- SUBSURFACE DISPOSAL IN GEOLOGIC BASINS--A STUDY OF RESERVOIR STRATA. AM. ASSOC. PET. GEOL., TULSA, OKLA., AUG 1968, MEMOIR 10, P. 93-127.

DESCRIPTORS- AQUIFERS; BRINES; CHEMICAL ANALYSIS; CONNATE WATER; DEEP WELLS; GEOLOGY; HYDRAULIC FRACTURING; HYDRODYNAMICS; HYDROLOGY; INJECTION WELLS; LIQUID WASTES; LITHOLOGY; POROSITY; SALINE AQUIFERS; SANDSTONE; SHALE; STRATIGRAPHY; SUBSURFACE RESERVOIRS; UNDERGROUND DISPOSAL; WASTE DISPOSAL; WELL LOGGING; PENNSYLVANIA.

54

HEIDARI 74
BRINE TREATMENT/SPENT FLUID DISPOSAL

TITLE- ANALYSIS OF LIQUID-WASTE INJECTION WELLS IN ILLINOIS BY MATHEMATICAL MODELS.

AUTHOR- HEIDARI, M.;CARTWRIGHT, K. [ILLINOIS STATE GEOLOGICAL SURVEY (USA)].

SAYLOR, P.E. [ILLINOIS UNIV., URBANA (USA). DEPT. OF COMPUTER SCIENCE].

REFERENCE- ANALYSIS OF LIQUID-WASTE INJECTION WELLS IN ILLINOIS BY MATHEMATICAL MODELS. WRC RESEARCH REPORT NO. 77, ILLINOIS UNIV., WATER RESOURCES CENTER, URBANA, JAN 1974, 114 P..

DESCRIPTORS- AQUIFERS; CASE HISTORIES; COMPUTER CALCULATIONS; CONVECTION; DEEP WELLS; DIFFUSION; ECONOMICS; EXPERIMENTAL RESULTS; GEOLOGY; HYDRODYNAMIC DISPERSION; HYDROGEOLOGY; INJECTION WELLS; LIQUID WASTES; LITHOLOGY; MASS TRANSFER; MATHEMATICAL MODELS; PERMEABILITY; POROSITY; POROUS MEDIA; PRESSURE BUILDUP; SANDSTONE; STRATIGRAPHY; SUBSURFACE RESERVOIRS; UNDERGROUND DISPOSAL; WASTE DISPOSAL; ILLINOIS.

55

HIDALGO 73
BRINE TREATMENT/SPENT FLUID DISPOSAL

TITLE- EDP AS AN AID FOR DECISION MAKING IN SUBSURFACE INJECTION OF LIQUID WASTES.

AUTHOR- HIDALGO, R.V.;WOODFORK, L.D. [WEST VIRGINIA GEOLOGICAL SURVEY, MORGANTOWN (USA)].

BRAUNSTEIN, J. (ED.)

REFERENCE- UNDERGROUND WASTE MANAGEMENT AND ARTIFICIAL RECHARGE. AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS, TULSA, OKLA., 1973, V. 1, P. 133-146.

DESCRIPTORS- COMPUTER CALCULATIONS; DISPOSAL FORMATIONS; ECONOMICS; FEASIBILITY STUDIES; GEOLOGY; GROUND WATER; HYDRAULIC FRACTURING; INDUSTRIAL WASTES; INJECTION WELLS; LIQUID WASTES; SUBSURFACE RESERVOIRS; UNDERGROUND DISPOSAL; WASTE DISPOSAL; WELL DATA; WELL LOGGING; WEST VIRGINIA.

56

KRAUS 70
BRINE TREATMENT/SPENT FLUID DISPOSAL

TITLE- APPLICATION OF HYPERFILTRATION TO TREATMENT OF MUNICIPAL SEWAGE EFFLUENTS.

AUTHOR- KRAUS, K.A. [OAK RIDGE NATIONAL LAB., TENN. (USA)].

REFERENCE- APPLICATION OF HYPERFILTRATION TO TREATMENT OF MUNICIPAL SEWAGE EFFLUENTS. WATER POLLUTION CONTROL RESEARCH SERIES ORD-17030EOH 01/70, FEDERAL WATER QUALITY ADMINISTRATION, WASHINGTON, D.C., JAN 1970, 71 P..

DESCRIPTORS- ADDITIVES; POLLUTION; REVERSE OSMOSIS; WASTE PROCESSING; WASTE WATER.

57

LATTA 73
BRINE TREATMENT/SPENT FLUID DISPOSAL

TITLE- SUBSURFACE DISPOSAL OF WASTE IN KANSAS.

AUTHOR- LATTA, B.F. [KANSAS STATE DEPT. OF HEALTH, TOPEKA (USA)].

BRAUNSTEIN, J. (ED.)

REFERENCE- UNDERGROUND WASTE MANAGEMENT AND ARTIFICIAL RECHARGE. AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS, TULSA, OKLA., 1973, V. 1, P. 622-633.

DESCRIPTORS- ACIDIZATION; AREAL EXTENT; BRINES; CHEMICAL COMPATIBILITY; CORROSION; CORROSION INHIBITORS; DEEP WELLS; DISPOSAL FORMATIONS; DOLOMITE ROCKS; FAILURES; GROUND WATER; INDUSTRIAL WASTES; INJECTION PRESSURE; INJECTION WELLS; LEGAL ASPECTS; LIMESTONE; LIQUID WASTES; LITHOLOGY; OILFIELD BRINES; PERMEABILITY; PLUGGING; POLLUTION; POLLUTION LAWS; POROSITY; PRECIPITATION; PRE-INJECTION TREATMENT; REGULATIONS; SALT DEPOSITS; SANDSTONE; SURFACE WATERS; UNDERGROUND DISPOSAL; WASTE DISPOSAL; WELL COMPLETION; WELL DESIGN; WELL LOGGING; WELL OPERATION; KANSAS.

58

LOFGREN 73
BRINE TREATMENT/SPENT FLUID DISPOSAL

TITLE- HAZARDS OF WASTE DISPOSAL IN GROUNDWATER BASINS.

AUTHOR- LOFGREN, B.E. [GEOLOGICAL SURVEY, SACRAMENTO, CALIF. (USA)].

BRAUNSTEIN, J. (ED.)

REFERENCE- UNDERGROUND WASTE MANAGEMENT AND ARTIFICIAL RECHARGE. AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS, TULSA, OKLA., 1973, V. 2, P. 715-728.

DESCRIPTORS- AQUIFERS; AQUITARDS; ENVIRONMENTAL EFFECTS; EXPERIMENTAL RESULTS; FAILURES; GROUND SUBSIDENCE; GROUND WATER; HYDRAULICS; HYDROGEOLOGY; INJECTION WELLS; MEASURING INSTRUMENTS; MONITORING; SOIL MECHANICS; UNDERGROUND DISPOSAL; WASTE DISPOSAL; WATER POLLUTION; CALIFORNIA.

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MC CANN 68
BRINE TREATMENT/SPENT FLUID DISPOSAL

TITLE- POSSIBILITIES FOR DISPOSAL OF INDUSTRIAL WASTES IN SUBSURFACE ROCKS ON NORTH FLANK OF APPALACHIAN BASIN IN NEW YORK.

AUTHOR- MC CANN, T.P. [SHELL CANADIAN EXPLORATION CO., HOUSTON, TEX. (USA)].

PRIVRASKY, N.C. [TIDEWATER OIL CO., PITTSBURGH, PA. (USA)].

STEAD, F.L. [CONSULTING GEOLOGIST, MAGNOLIA, ARKANSAS (USA)].

WILSON, J.E. [CONSOLIDATED GAS SUPPLY CORPORATION, CLARKSBURG, W. VA. (USA)].

GALLEY, J.E. (ED.)

REFERENCE- SUBSURFACE DISPOSAL IN GEOLOGIC BASINS--A STUDY OF RESERVOIR STRATA. AM. ASSOC. PET. GEOL., TULSA, OKLA., AUG 1968, MEMOIR 10, P. 43-92.

DESCRIPTORS- CHEMICAL COMPOSITION; DEEP WELLS; DISPOSAL FORMATIONS; DOLOMITE ROCKS; EARTHQUAKES; FEASIBILITY STUDIES; GEOLOGY; HYDRAULIC FRACTURING; HYDRODYNAMICS; INDUSTRIAL WASTES; INJECTION WELLS; LIMESTONE; LIQUID WASTES; PERMEABILITY; PH VALUE; POROSITY; RESERVOIR PROPERTIES; SALT DEPOSITS; SANDSTONE; SEDIMENTARY ROCKS; SEISMOLOGY; SHALE; STRATIGRAPHY; SUBSURFACE RESERVOIRS; WELL DATA; NEW YORK; APPALACHIAN BASIN.

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MEERS 73
BRINE TREATMENT/SPENT FLUID DISPOSAL

TITLE- DESIGN, DRILLING AND COMPLETION, OPERATION, AND COST OF UNDERGROUND WASTE-DISPOSAL WELLS IN GULF COAST REGION OF TEXAS AND LOUISIANA.

AUTHOR- MEERS, R.J. [POLLUTION CONTROL AND WASTE DISPOSAL, INC., NEW ORLEANS, LA. (USA)].

BRAUNSTEIN, J. (ED.)

REFERENCE- UNDERGROUND WASTE MANAGEMENT AND ARTIFICIAL RECHARGE. AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS, TULSA, OKLA., 1973, V. 1, P. 337-345.

DESCRIPTORS- AREAL EXTENT; BACTERIA; CHEMICAL COMPATIBILITY; CORROSION; CORROSION INHIBITORS; CORROSTION PROTECTION; ECONOMICS; FEASIBILITY STUDIES; INJECTION WELLS; LIQUID WASTES; MONITORING; PERMEABILITY; PLUGGING; POROSITY; PRE-INJECTION TREATMENT; REGULATIONS; RESERVOIR PROPERTIES; SUBSURFACE RESERVOIRS; SUSPENDED SOLIDS; UNDERGROUND DISPOSAL; WASTE DISPOSAL; WELL CASINGS; WELL CEMENTING; WELL COMPLETION; WELL DESIGN; WELL DRILLING; WELL LOGGING; WELL OPERATION; TEXAS; LOUISIANA.

61

MOHR 73
BRINE TREATMENT/SPENT FLUID DISPOSAL

TITLE- DECISION MAPPING--TOOL FOR UNDERGROUND WASTE MANAGEMENT.

AUTHOR- MOHR, C.M.; O'BRIEN, P.J. [ARTHUR D. LITTLE, INC., CAMBRIDGE, MASS. (USA)].

BRAUNSTEIN, J. (ED.)

REFERENCE- UNDERGROUND WASTE MANAGEMENT AND ARTIFICIAL RECHARGE. AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS, TULSA, OKLA., 1973, V. 2, P. 731-737.

DESCRIPTORS- BRINE TREATMENT; DEEP WELLS; ECONOMICS; FEASIBILITY STUDIES; INDUSTRIAL WASTES; INJECTION WELLS; LIQUID WASTES; MATHEMATICAL MODELS; REGULATIONS; UNDERGROUND DISPOSAL; WASTE DISPOSAL; WASTE MANAGEMENT.

62

MOSELEY 68
BRINE TREATMENT/SPENT FLUID DISPOSAL

TITLE- RELATIONSHIPS BETWEEN SELECTED PHYSICAL PARAMETERS AND COST RESPONSES FOR THE DEEP-WELL DISPOSAL OF AQUEOUS INDUSTRIAL WASTES.

AUTHOR- MOSELEY, J.C.,II;MALINA, J.F.,JR. [TEXAS UNIV., AUSTIN (USA). CENTER FOR RESEARCH IN WATER RESOURCES].

REFERENCE- RELATIONSHIPS BETWEEN SELECTED PHYSICAL PARAMETERS AND COST RESPONSES FOR THE DEEP-WELL DISPOSAL OF AQUEOUS INDUSTRIAL WASTES. EHE 08-6801, CRWR 28, TEXAS UNIV., CENTER FOR RESEARCH IN WATER RESOURCES, AUSTIN, AUG 1968, 276 P..

DESCRIPTORS- ACIDIZATION; BACTERIA; BIOLOGICAL FOULING; CHEMICAL COMPATIBILITY; COMPUTER CALCULATIONS; CORROSION; CORROSION RESISTANT ALLOYS; DEEP WELLS; DISPOSAL FORMATIONS; ECONOMICS; FLOW RATE; GEOLOGY; HYDRAULIC FRACTURING; HYDRODYNAMICS; INDUSTRIAL WASTES; INJECTION PRESSURE; INJECTION RATES; INJECTION WELLS; LITHOLOGY; MATHEMATICAL MODELS; PERMEABILITY; PIPELINES; POROSITY; POROUS MEDIA; PRE-INJECTION TREATMENT; PRESSURE BUILDUP; RADIUS OF INFLUENCE; RESERVOIR PROPERTIES; SUBSURFACE RESERVOIRS; SURFACE EQUIPMENT; SUSPENDED SOLIDS; TEMPERATURE LOGGING; UNDERGROUND DISPOSAL; WASTE DISPOSAL; WELL COMPLETION; WELL DESIGN; WELL DRILLING; WELL LOGGING; WELL STIMULATION; TEXAS; CALIFORNIA; COLORADO; FLORIDA; ILLINOIS; INDIANA; IOWA; KANSAS; LOUISIANA; MICHIGAN; NEW MEXICO.

63

PETERSON 68
BRINE TREATMENT/SPENT FLUID DISPOSAL

TITLE- SEDIMENTARY HISTORY AND ECONOMIC GEOLOGY OF SAN JUAN BASIN, NEW MEXICO AND COLORADO.

AUTHOR- PETERSON, J.A. [MONTANA UNIV., MISSOULA (USA)].

LOLEIT, A.J.;ULLRICH, R.A. [EL PASO NATURAL GAS CO., FARMINGTON, N. MEX. (USA)].

SPENCER, C.W. [TEXACO, INC.].

GALLEY, J.E. (ED.)

REFERENCE- SUBSURFACE DISPOSAL IN GEOLOGIC BASINS--A STUDY OF RESERVOIR STRATA. AM. ASSOC. PET. GEOL., TULSA, OKLA., AUG 1968, MEMOIR 10, P. 186-231.

DESCRIPTORS- AQUIFERS; DEEP WELLS; DISPOSAL FORMATIONS; DOLOMITE ROCKS; ECONOMICS; FEASIBILITY STUDIES; GEOLOGY; GROUND WATER; LIMESTONE; OIL WELLS; PERMEABILITY; POROSITY; SANDSTONE; SEDIMENTARY ROCKS; SHALE; STRATIGRAPHY; NEW MEXICO; COLORADO; SAN JUAN BASIN.

64

SCHICHT 73

BRINE TREATMENT/SPENT FLUID DISPOSAL

TITLE- DEEP-WELL INJECTION OF DESALTING-PLANT WASTE BRINE.

AUTHOR- SCHICHT, R.J. [ILLINOIS STATE WATER SURVEY, URBANA (USA)].

BRAUNSTEIN, J. (ED.)

REFERENCE- UNDERGROUND WASTE MANAGEMENT AND ARTIFICIAL RECHARGE. AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS, TULSA, OKLA., 1973, V. 1, P. 652-663.

DESCRIPTORS- AQUIFERS; BRINE TREATMENT; BRINES; CHEMICAL ANALYSIS; DEEP WELLS; DESALINATION; ECONOMICS; ELECTRODIALYSIS; ENVIRONMENTAL EFFECTS; FEASIBILITY STUDIES; GROUND WATER; HYDRAULICS; HYDROLOGY; INJECTION PRESSURE; INJECTION RATES; INJECTION WELLS; LIQUID WASTES; MATHEMATICAL MODELS; PRESSURE BUILDUP; REVERSE OSMOSIS; SANDSTONE; STRATIGRAPHY; TRANSMISSIVITY; UNDERGROUND DISPOSAL; WASTE DISPOSAL; WATER QUALITY; WELL CASINGS; WELL DESIGN; ILLINOIS.

65

VAN EVERDINGEN 68

BRINE TREATMENT/SPENT FLUID DISPOSAL

TITLE- FLUID MECHANICS OF DEEP-WELL DISPOSALS.

AUTHOR- VAN EVERDINGEN, A.F. [DE GOLYER AND MAC NAUGHTON, DALLAS, TEX. (USA)].

GALLEY, J.E. (ED.)

REFERENCE- SUBSURFACE DISPOSAL IN GEOLOGIC BASINS--A STUDY OF RESERVOIR STRATA. AM. ASSOC. PET. GEOL., TULSA, OKLA., AUG 1968, MEMOIR 10, P. 32-42.

DESCRIPTORS- ACIDIZATION; AREAL EXTENT; DEEP WELLS; DISPOSAL FORMATIONS; FEASIBILITY STUDIES; FLUID MECHANICS; FLOW RATE; INJECTION PRESSURE; INJECTION RATES; INJECTION WELLS; LIQUID WASTES; MATHEMATICAL MODELS; PERMEABILITY; POROSITY; PRESSURE BUILDUP; RESERVOIR ENGINEERING; RESERVOIR PROPERTIES; THEORETICAL TREATMENTS; UNDERGROUND DISPOSAL; WASTE DISPOSAL; WELL DATA; WELL INTERFERENCE; WELL STIMULATION.

66

WALKER 73
BRINE TREATMENT/SPENT FLUID DISPOSAL

TITLE- LEGAL AND INSTITUTIONAL CONSIDERATIONS OF DEEP-WELL WASTE DISPOSAL.

AUTHOR- WALKER, W.R.;COX, W.E. [VIRGINIA POLYTECHNIC INST. AND STATE UNIV., BLACKSBURG (USA). VIRGINIA WATER RESOURCES RESEARCH CENTER].

BRAUNSTEIN, J. (ED.)

REFERENCE- UNDERGROUND WASTE MANAGEMENT AND ARTIFICIAL RECHARGE. AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS, TULSA, OKLA., 1973, V. 1, P. 3-19.

DESCRIPTORS- AQUIFERS; DEEP WELLS; EARTHQUAKES; ENVIRONMENTAL EFFECTS; ENVIRONMENTAL PROTECTION AGENCY; GROUND SUBSIDENCE; INJECTION PRESSURE; INJECTION RATES; INJECTION WELLS; LEGAL ASPECTS; LIQUID WASTES; MONITORING; POLLUTION; POLLUTION LAWS; POLLUTION REGULATIONS; RADIOACTIVE WASTES; REGULATIONS; SEISMOLOGY; UNDERGROUND DISPOSAL; WASTE DISPOSAL; WATER POLLUTION; WELL OPERATION.

67

WARNER 68
BRINE TREATMENT/SPENT FLUID DISPOSAL

TITLE- SUBSURFACE DISPOSAL OF LIQUID INDUSTRIAL WASTES BY DEEP-WELL INJECTION.

AUTHOR- WARNER, D.L. [FEDERAL WATER POLLUTION CONTROL ADMINISTRATION (USA). CINCINNATI WATER RESEARCH LABORATORY, OHIO].

GALLEY, J.E. (ED.)

REFERENCE- SUBSURFACE DISPOSAL IN GEOLOGIC BASINS--A STUDY OF RESERVOIR STRATA. AM. ASSOC. PET. GEOL., TULSA, OKLA., AUG 1968, MEMOIR 10, P. 11-20.

DESCRIPTORS- AREAL EXTENT; BACTERIA; CHEMICAL COMPATIBILITY; CLAY MINERALS; CORROSION; DEEP WELLS; DISPOSAL FORMATIONS; DOLOMITE ROCKS; EARTHQUAKES; ECONOMICS; FEASIBILITY STUDIES; FLOW RATE; GEOLOGY; HYDRAULIC FRACTURING; HYDRODYNAMIC DISPERSION; HYDRODYNAMICS; INDUSTRIAL WASTES; INJECTION PRESSURE; INJECTION RATES; INJECTION WELLS; LEGAL ASPECTS; LIMESTONE; LIQUID WASTES; MATHEMATICAL MODELS; MINERALOGY; PERMEABILITY; PLUGGING; POLLUTION; POROSITY; PRE-INJECTION TREATMENT; REGULATIONS; ROCK PROPERTIES; SANDSTONE; SEDIMENTARY ROCKS; SEISMOLOGY; SHALE; STRATIGRAPHY; SUBSURFACE RESERVOIRS; SUSPENDED SOLIDS; UNDERGROUND DISPOSAL; WASTE DISPOSAL; WATER POLLUTION; WELL STIMULATION.

68

WARNER 73
BRINE TREATMENT/SPENT FLUID DISPOSAL

TITLE- INDUSTRIAL WASTEWATER-INJECTION WELLS IN UNITED STATES--STATUS OF USE AND REGULATION, 1973.

AUTHOR- WARNER, D.L. [MISSOURI UNIV., ROLLA (USA)].

ORCUTT, D.H. [WAPORA, INC., WASHINGTON, D.C. (USA)].

BRAUNSTEIN, J. (ED.)

REFERENCE- UNDERGROUND WASTE MANAGEMENT AND ARTIFICIAL RECHARGE. AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS, TULSA, OKLA., 1973, V. 2, P. 687-697.

DESCRIPTORS- CHEMICAL COMPATIBILITY; DEEP WELLS; DOLOMITE ROCKS; EARTHQUAKES; ENVIRONMENTAL EFFECTS; FAILURES; GROUND WATER; HYDROLOGY; INDUSTRIAL WASTES; INJECTION PRESSURE; INJECTION RATES; INJECTION WELLS; LEGAL ASPECTS; LIMESTONE; LIQUID WASTES; OILFIELD BRINES; POLLUTION LAWS; POLLUTION REGULATIONS; REGULATIONS; SALINE AQUIFERS; SAND; SANDSTONE; UNDERGROUND DISPOSAL; WASTE DISPOSAL; WATER POLLUTION; USA.

69

YAMAMOTO 73
BRINE TREATMENT/SPENT FLUID DISPOSAL

TITLE- UNDERGROUND WASTE DISPOSAL AND ARTIFICIAL RECHARGE IN JAPAN.

AUTHOR- YAMAMOTO, S. (TOKYO UNIV. OF EDUCATION (JAPAN). FACULTY OF SCIENCE).

BRAUNSTEIN, J. (ED.)

REFERENCE- UNDERGROUND WASTE MANAGEMENT AND ARTIFICIAL RECHARGE. AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS, TULSA, OKLA., 1973, V. 1, P. 60-71.

DESCRIPTORS- AQUIFERS; ARTIFICIAL RECHARGE; CHEMICAL ANALYSIS; FILTRATION; GEOLOGY; GEOTHERMAL BRINES; GEOTHERMAL FIELDS; GROUND SUBSIDENCE; HYDROLOGY; INDUSTRIAL WASTES; INJECTION RATES; MONITORING; OBSERVATION WELLS; PH VALUE; PLUGGING; STRATIGRAPHY; TRANSMISSIVITY; UNDERGROUND DISPOSAL; WASTE DISPOSAL; WELL COMPLETION; WELL DESIGN; WELL INTERFERENCE; JAPAN.

70

API 60
BRINE TREATMENT/SPENT FLUID DISPOSAL

TITLE- SUBSURFACE SALT-WATER DISPOSAL. BOOK 3 OF THE VOCATIONAL TRAINING SERIES.

AUTHOR- AMERICAN PETROLEUM INSTITUTE, DALLAS, TEXAS.

REFERENCE- SUBSURFACE SALT-WATER DISPOSAL. BOOK 3 OF THE VOCATIONAL TRAINING SERIES. AMERICAN

PETROLEUM INSTITUTE, PROD. DIV., DALLAS, TEXAS, 1960, 101 P..

DESCRIPTORS- ACIDIZATION; AREAL EXTENT; BRINE TREATMENT; CASE HISTORIES; DEEP WELLS; DISPOSAL FORMATIONS; ECONOMICS; FIELD STUDIES; FILTRATION; FLOW RATE; HYDRAULIC FRACTURING; INJECTION WELLS; LEGAL ASPECTS; OILFIELD BRINES; PERMEABILITY; PIPELINES; PLUGGING; POROSITY; PRE-INJECTION TREATMENT; REGULATIONS; RESERVOIR PROPERTIES; SEDIMENTATION; SURFACE EQUIPMENT; UNDERGROUND DISPOSAL; WASTE DISPOSAL; WELL CASINGS; WELL COMPLETION; WELL DESIGN; WELL DRILLING; WELL STIMULATION.

71

BLAIR 51
BRINE TREATMENT/SPENT FLUID DISPOSAL

TITLE- TREATMENT OF PRODUCED SALT WATER--PRIOR TO UNDERGROUND DISPOSAL IN SAND FORMATIONS.

AUTHOR- BLAIR, J.V. [SINCLAIR OIL AND GAS CO., TULSA, OKLA. (USA)].

REFERENCE- OIL GAS J., V. 49 (42), P. 176-185(FEB 1951).

DESCRIPTORS- BRINE TREATMENT; CARBONATES; CHEMICAL ANALYSIS; CHEMICAL COMPATIBILITY; CORROSION; CORROSION RESISTANT ALLOYS; DEEP WELLS; ECONOMICS; FILTRATION; FLOW RATE; INJECTION WELLS; OILFIELD BRINES; PERMEABILITY; PIPELINES; PIPELINE PIGS; PLUGGING; POROSITY; PRE-INJECTION TREATMENT; SANDSTONE; SCALING; SCALING CONTROL; SEDIMENTATION; SURFACE EQUIPMENT; SUSPENDED SOLIDS; UNDERGROUND DISPOSAL; WASTE DISPOSAL; TEXAS.

72

BLEAKLEY 70
BRINE TREATMENT/SPENT FLUID DISPOSAL

TITLE- SHELL'S SWD MEETS POLLUTION STANDARDS.

AUTHOR- BLEAKLEY, W.B. (ED.)

REFERENCE- OIL GAS J., V. 68 (38), P. 144-146(SEP 1970).

DESCRIPTORS- CORROSION; DEEP WELLS; DISSOLVED SOLIDS; ECONOMICS; ENVIRONMENTAL EFFECTS; EVAPORATION PONDS; INJECTION WELLS; OILFIELD BRINES; POLLUTION REGULATIONS; SURFACE EQUIPMENT; SUSPENDED SOLIDS; UNDERGROUND DISPOSAL; WASTE DISPOSAL.

73

BODVARSSON 72
BRINE TREATMENT/SPENT FLUID DISPOSAL

TITLE- THERMAL PROBLEMS IN THE SITING OF REINJECTION WELLS.

AUTHOR- BODVARSSON, G. [OREGON STATE UNIV., CORVALLIS (USA). DEPT. OF OCEANOGRAPHY].

REFERENCE- GEOTHERMICS, V. 1 (2), P. 63-66(JUN 1972).

DESCRIPTORS- DIFFUSION; DISPOSAL FORMATIONS; FLOW RATE; GEOTHERMAL BRINES; GEOTHERMAL ENERGY; GEOTHERMAL FLUIDS; GEOTHERMAL RESERVOIRS; GROUND WATER; HEAT TRANSFER; INJECTION WELLS; MATHEMATICAL MODELS; PERMEABILITY; POROUS MEDIA; RADIUS OF INFLUENCE; THEORETICAL TREATMENTS; THERMAL POLLUTION.

74

CALAMAI 73
BRINE TREATMENT/SPENT FLUID DISPOSAL

TITLE- A REINJECTION EXPERIMENT IN THE VICO 1 WELL.

AUTHOR- CALAMAI, A.;CERON, P.;FERRARA, G.;MANETTI, G. [ENEL, DIREZIONE STUDI E RICERCHE, PISA (ITALY). CENTRO DI RECERCA GEOTERMICA].

REFERENCE- GEOTHERMICS, V. 2 (3-4), P. 117-118(SEP-DEC 1973).

DESCRIPTORS- AQUIFERS; CARBONATES; CHEMICAL ANALYSIS; DISPOSAL FORMATIONS; DISSOLVED SOLIDS; ENVIRONMENTAL EFFECTS; EXPERIMENTAL RESULTS; FLOW RATE; GEOTHERMAL BRINES; GEOTHERMAL FLUIDS; GEOTHERMAL RESERVOIRS; HYDROGEOLOGY; INJECTION PRESSURE; INJECTION WELLS; LITHOLOGY; PERMEABILITY; POROSITY;

SEISMOLOGY; TEMPERATURE LOGGING; THERMAL EFFLUENTS; UNDERGROUND DISPOSAL; WASTE DISPOSAL; ITALY.

75

CECIL 50
BRINE TREATMENT/SPENT FLUID DISPOSAL

TITLE- UNDERGROUND DISPOSAL OF PROCESS WASTE WATER.

AUTHOR- CECIL, L.K. [INFILCO INC., TULSA, OKLA. (USA)].

REFERENCE- IND. ENG. CHEM., V. 42 (4), P. 594-599(APR 1950).

DESCRIPTORS- ACIDIZATION; BACTERIA; BIOLOGICAL FOULING; CASE HISTORIES; CHEMICAL ANALYSIS; CHEMICAL COMPOSITION; COOLING TOWERS; CORROSION; CORROSION INHIBITORS; DEEP WELLS; DISPOSAL FORMATIONS; FILTRATION; FLOW RATE; INDUSTRIAL WASTES; INJECTION PRESSURE; INJECTION WELLS; LIMESTONE; OILFIELD BRINES; PH ADJUSTMENT; PLUGGING; PRECIPITATION; PRE-INJECTION TREATMENT; SANDSTONE; SCALING CONTROL; SURFACE EQUIPMENT; SUSPENDED SOLIDS; UNDERGROUND DISPOSAL; WASTE DISPOSAL; WASTE WATER; WELL COMPLETION.

76

CHASTEEN 74
BRINE TREATMENT/SPENT FLUID DISPOSAL

TITLE- GEOTHERMAL STEAM CONDENSATE REINJECTION.

AUTHOR- CHASTEEN, A.J. [UNION OIL CO., SANTA ROSA, CALIF. (USA)].

REFERENCE- PROCEEDINGS--CONFERENCE ON RESEARCH FOR THE DEVELOPMENT OF GEOTHERMAL ENERGY RESOURCES. JET PROPULSION LAB./CALIF. INST. OF TECH., PASADENA, CALIF., DEC 1974, P. 340-344.

DESCRIPTORS- CASE HISTORIES; COOLING TOWERS; CORROSION; DEEP WELLS; DISPOSAL FORMATIONS; FLOW RATE; GEOTHERMAL BRINES; GEOTHERMAL RESERVOIRS; INJECTION PRESSURE; INJECTION WELLS; MONITORING; PERMEABILITY; PIPELINES; PLUGGING; SEISMOLOGY; SUBSURFACE RESERVOIRS;

SURFACE EQUIPMENT; UNDERGROUND DISPOSAL; WASTE DISPOSAL; WASTE WATER; WELL DESIGN; GEYSERS GEOTHERMAL FIELD; IMPERIAL VALLEY; VALLES CALDERA GEOTHERMAL FIELD; CALIFORNIA; NEW

77

COLLINS 70
BRINE TREATMENT/SPENT FLUID DISPOSAL

TITLE- FINDING PROFITS IN OIL-WELL WASTE WATERS.

AUTHOR- COLLINS, A.G. [BUREAU OF MINES, BARTLESVILLE, OKLA. (USA). BARTLESVILLE PETROLEUM RESEARCH CENTER].

REFERENCE- CHEM. ENG. (N.Y.), P. 165-168(SEP 21, 1970).

DESCRIPTORS- DEEP WELLS; DESALINATION; ECONOMICS; ENVIRONMENTAL EFFECTS; MINERAL RECOVERY; OILFIELD BRINES; POLLUTION; UNDERGROUND DISPOSAL; WASTE DISPOSAL; WASTE PROCESSING; WASTE WATER.

78

COLLINS 74
BRINE TREATMENT/SPENT FLUID DISPOSAL

TITLE- SALINE GROUNDWATERS PRODUCED WITH OIL AND GAS.

AUTHOR- COLLINS, A.G. [BUREAU OF MINES, BARTLESVILLE, OKLA. (USA). BARTLESVILLE ENERGY RESEARCH CENTER].

REFERENCE- SALINE GROUNDWATERS PRODUCED WITH OIL AND GAS. EPA-660/2-74-010, ENVIRONMENTAL PROTECTION AGENCY, OFFICE OF RESEARCH AND DEVELOPMENT, WASHINGTON, D.C., APR 1974, 68 P..

DESCRIPTORS- CHEMICAL ANALYSIS; CHEMICAL COMPATIBILITY; BRINE TREATMENT; DEEP WELLS; DESALINATION; DISPOSAL FORMATIONS; DISSOLVED SOLIDS; ECONOMICS; ENVIRONMENTAL EFFECTS; ENVIRONMENTAL PROTECTION AGENCY; EVAPORATION PONDS; GROUND WATER; MATHEMATICAL MODELS; MINERAL RECOVERY; MONITORING; OILFIELD BRINES; PERMEABILITY; POLLUTION; PROGRAMMING; SALINE

AQUIFERS; SALINITY; SALINITY MAPS; SCALING CONTROL; SEDIMENTARY ROCKS; UNDERGROUND DISPOSAL; WATER ANALYSIS; WELL DESIGN; TEXAS; ANADAKRO BASIN; WILLISTON BASIN; USA.

79

EPA 76
BRINE TREATMENT/SPENT FLUID DISPOSAL

TITLE- STATE RULES FORM BASIS FOR EPA INJECTION REGS.

AUTHOR- EPA

REFERENCE- OIL GAS J., V. 74 (17), P. 69(APR 1976).

DESCRIPTORS- BRINES; ECONOMICS; ENVIRONMENTAL PROTECTION AGENCY; INJECTION WELLS; POLLUTION REGULATIONS; REGULATIONS; UNDERGROUND DISPOSAL.

80

GARG 75
BRINE TREATMENT/SPENT FLUID DISPOSAL

TITLE- SIMULATION OF FLUID-ROCK INTERACTIONS IN A GEOTHERMAL BASIN.

AUTHOR- GARG, S.K.;BLAKE, T.R.;BROWNELL, D.H.,JR.;NAYFEH, A.H.;PRITCHETT, J.W. [SYSTEMS, SCIENCE AND SOFTWARE, LA JOLLA, CALIF. (USA)].

REFERENCE- SIMULATION OF FLUID-ROCK INTERACTIONS IN A GEOTHERMAL BASIN. SSS-R-76-2734, SYSTEMS, SCIENCE AND SOFTWARE, LA JOLLA, CALIF. (USA), SEP 1975, 63 P..

DESCRIPTORS- COMPUTER CALCULATIONS; CONVECTION; GEOTHERMAL RESERVOIRS; GROUND SUBSIDENCE; HEAT TRANSFER; HEAT TRANSFER COEFFICIENT; HYDRODYNAMIC DISPERSION; MATHEMATICAL MODELS; PERMEABILITY; POROSITY; POROUS MEDIA; ROCK-FLUID INTERACTIONS; THEORETICAL TREATMENTS.

81

HEALY 68
BRINE TREATMENT/SPENT FLUID DISPOSAL

TITLE- THE DENVER EARTHQUAKES.

AUTHOR- HEALY, J.H.;RALEIGH, C.B. [GEOLOGICAL SURVEY, MENLO PARK, CALIF. (USA)].

RUBEY, W.W.;GRIGGS, D.T. [CALIFORNIA UNIV., LOS ANGELES (USA). INST. OF GEOPHYSICS AND PLANETARY PHYSICS].

REFERENCE- SCIENCE, V. 161 (3848), P. 1301-1310(SEP 27, 1968).

DESCRIPTORS- DEEP WELLS; FAULT ACTIVATION; INJECTION PRESSURE; INJECTION RATES; INJECTION WELLS; LIQUID WASTES; MATHEMATICAL MODELS; MONITORING; ROCK-FLUID INTERACTIONS; SEISMOLOGY; UNDERGROUND DISPOSAL; WASTE DISPOSAL; COLORADO; DENVER BASIN.

82

JESSEN 49
BRINE TREATMENT/SPENT FLUID DISPOSAL

TITLE- SUBSURFACE DISPOSAL OF OIL FIELD BRINES.

AUTHOR- JESSEN, F.W. [CONSULTING ENGINEER, HOUSTON, TEX. (USA)].

REFERENCE- CHEM. ENG. PROG., V. 45 (1), P. 11-16(JAN 1949).

DESCRIPTORS- BACTERIA; CHEMICAL REACTIONS; CORROSION; CORROSION PROTECTION; CORROSION RESISTANT ALLOYS; DEEP WELLS; ECONOMICS; FILTRATION; INJECTION WELLS; OILFIELD BRINES; PIPELINES; PRE-INJECTION TREATMENT; REGULATIONS; SURFACE EQUIPMENT; UNDERGROUND DISPOSAL; WASTE DISPOSAL; WELL COMPLETION.

83

KREITLER 76
BRINE TREATMENT/SPENT FLUID DISPOSAL

TITLE- GEOTHERMAL RESOURCES OF THE TEXAS GULF COAST--ENVIRONMENTAL CONCERNS ARISING FROM THE PRODUCTION AND DISPOSAL OF GEOTHERMAL WATERS. PHASE 0--SCOPE-OF-WORK AND MANAGEMENT STUDY.

AUTHOR- KREITLER, C.W.;GUSTAVSON, T.C. [TEXAS UNIV., AUSTIN (USA). BUREAU OF ECONOMIC GEOLOGY].

VANSTON, J.H.;ELMER, D.B.;GUSTAFSON, T.C.;KREITLER, C.W.;LETLOW, K.;LOPREATO, S.C.;MERIWETHER, M.;RAMSEY, P.;ROGERS, K.E.;WILLIAMSON, J.K. (EDS.)

REFERENCE- PROCEEDINGS--SECOND GEOPRESSURED GEOTHERMAL ENERGY CONFERENCE, VOL. V. LEGAL, INSTITUTIONAL AND ENVIRONMENTAL. TEXAS UNIV., CENTER FOR ENERGY STUDIES, AUSTIN, FEB 1976, V. 5, PART 3--ENVIRONMENTAL, 55 P..

DESCRIPTORS- BRINES; CHEMICAL ANALYSIS; DEEP WELLS; ENVIRONMENTAL EFFECTS; EVAPORATION PONDS; FAULT ACTIVATION; GEOTHERMAL BRINES; GEOTHERMAL FLUIDS; GROUND SUBSIDENCE; GROUND WATER; INJECTION PRESSURE; INJECTION RATES; INJECTION WELLS; LEGAL ASPECTS; MATHEMATICAL MODELS; POLLUTION; POROSITY; REGULATIONS; RESERVOIR COMPACTION; SALINE AQUIFERS; SEDIMENTARY ROCKS; SURFACE EQUIPMENT; THERMAL POLLUTION; WASTE DISPOSAL; WATER CHEMISTRY; WATER POLLUTION; WATER QUALITY; WELL DRILLING; WELL OPERATION; TEXAS.

84

LEE 50
BRINE TREATMENT/SPENT FLUID DISPOSAL
BRINE TREATMENT/SCALING
BRINE TREATMENT/CORROSION

TITLE- THROW YOUR WASTES DOWN A WELL.

AUTHOR- LEE, J.A. (ED.)

REFERENCE- CHEM. ENG. (N.Y.), P. 137-139(SEP 1950).

DESCRIPTORS- ACIDIZATION; BACTERIA; BIOLOGICAL EFFECTS; BIOLOGICAL FOULING; CASE HISTORIES; CHEMICAL COMPATIBILITY; CORROSION; DEEP WELLS; DISPOSAL FORMATIONS; ECONOMICS; FLOW RATE; INDUSTRIAL WASTES; INJECTION WELLS; LEGAL ASPECTS; LIMESTONE; LIQUID WASTES; OILFIELD BRINES; PLUGGING; POLLUTION REGULATIONS; SANDSTONE; SUSPENDED SOLIDS; UNDERGROUND DISPOSAL; WASTE DISPOSAL; WASTE WATER; WELL STIMULATION.

85

MC KELVEY 72
BRINE TREATMENT/SPENT FLUID DISPOSAL

TITLE- UNDERGROUND SPACE--AN UNAPPRAISED RESOURCE.

AUTHOR- MC KELVEY, V.E. [GEOLOGICAL SURVEY, WASHINGTON, D.C. (USA)].

COOK, T.D. (ED.)

REFERENCE- UNDERGROUND WASTE MANAGEMENT AND ENVIRONMENTAL IMPLICATIONS. AM. ASSOC. PET. GEOL., TULSA, OKLA., DEC 1972, MEMOIR 18, P. 1-5.

DESCRIPTORS- ECONOMICS; LEGAL ASPECTS; LIQUID WASTES; REGULATIONS; UNDERGROUND DISPOSAL; WASTE DISPOSAL.

86

RASCHKE 65
BRINE TREATMENT/SPENT FLUID DISPOSAL

TITLE- LET ENGINEERING KNOW-HOW SOLVE SALT-POLLUTION PROBLEMS.

AUTHOR- RASCHKE, A.;SMITH, J.E.;WILLS, M.E. [RAILROAD COMMISSION OF TEXAS (USA)].

REFERENCE- OIL GAS J., V. 63 (32), P. 75-79(AUG 1965).

DESCRIPTORS- ADDITIVES; BRINES; CHEMICAL ANALYSIS; CHEMICAL COMPOSITION; GEOLOGY; INJECTION PRESSURE; INJECTION RATES; INJECTION WELLS; OILFIELD BRINES; POLLUTION; PRESSURE BUILD-UP; PRESSURE DECLINE; STRATIGRAPHY; TRACE AMOUNTS; UNDERGROUND DISPOSAL; WATER ANALYSIS; WELL DATA; WELL INTERFERENCE; WELL LOGGING.

87

REID 74
BRINE TREATMENT/SPENT FLUID DISPOSAL

TITLE- BRINE DISPOSAL TREATMENT PRACTICES RELATING TO THE OIL PRODUCTION INDUSTRY.

AUTHOR- REID, G.W.;STREEBIN, L.E.;CANTER, L.W.;SMITH, J.R. [OKLAHOMA UNIV. RESEARCH INST., NORMAN (USA)].

REFERENCE- BRINE DISPOSAL TREATMENT PRACTICES RELATING TO THE OIL PRODUCTION INDUSTRY. EPA-660/2-74-037, ENVIRONMENTAL PROTECTION AGENCY, WASHINGTON, D.C., MAY 1974, 275 P..

DESCRIPTORS- BRINE TREATMENT; BRINES; CORROSION; CORROSION INHIBITORS; ECONOMICS; EVAPORATION PONDS; INJECTION WELLS; OILFIELD BRINES; PIPELINES; PLUGGING; REGULATIONS; SCALING; SCALING CONTROL; SURFACE EQUIPMENT; UNDERGROUND DISPOSAL; WASTE DISPOSAL; WELL COMPLETION.

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SELM 60
BRINE TREATMENT/SPENT FLUID DISPOSAL

TITLE- DEEP WELL DISPOSAL OF INDUSTRIAL WASTES.

AUTHOR- SELM, R.F.;HULSE, B.T.

REFERENCE- CHEM. ENG. PROG., V. 56 (5), P. 138-144(MAY 1960).

DESCRIPTORS- BACTERIA; BIOLOGICAL FOULING; CHEMICAL COMPATIBILITY; DEEP WELLS; ECONOMICS; FLOW RATE; INDUSTRIAL WASTES; LEGAL ASPECTS; OILFIELD BRINES; PLUGGING; PRE-INJECTION TREATMENT; SUSPENDED SOLIDS; UNDERGROUND DISPOSAL; WASTE DISPOSAL; WELL DESIGN.

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SHANNON 75
BRINE TREATMENT/SPENT FLUID DISPOSAL
BRINE TREATMENT/SCALING
BRINE TREATMENT/CORROSION

TITLE- ECONOMIC IMPACT OF CORROSION AND SCALING PROBLEMS IN GEOTHERMAL ENERGY SYSTEMS.

AUTHOR- SHANNON, D.W. [BATTELLE PACIFIC NORTHWEST LABS., RICHLAND, WASH. (USA). AC=9 580 022].

REFERENCE- ECONOMIC IMPACT OF CORROSION AND SCALING PROBLEMS IN GEOTHERMAL ENERGY SYSTEMS.

BNWL-1866, UC-4, BATTELLE PACIFIC NORTHWEST
LABS., RICHLAND, WASH., JAN 1975, 115 P..

DESCRIPTORS- AQUIFERS; ARTIFICIAL RECHARGE; BACTERIA; CARBONATES; CHEMICAL REACTIONS; BRINE TREATMENT; CHLORIDES; CORROSION; CORROSION PROTECTION; CORROSION RESISTANT ALLOYS; CORROSIVE EFFECTS; DEEP WELLS; DESALINATION; ECONOMICS; FILTRATION; ELECTROCHEMICAL CORROSION; GEOTHERMAL BRINES; GEOTHERMAL ENERGY; GEOTHERMAL FLUIDS; GEOTHERMAL WELLS; INJECTION PRESSURE; INJECTION WELLS; IRON OXIDES; PERMEABILITY; PH VALUE; PITTING CORROSION; PLUGGING; PRECIPITATION; PRE-INJECTION TREATMENT; SCALING; SCRUBBERS; SILICA MINERALS; STEAM SCRUBBERS; STEAM SEPARATORS; STRESS CORROSION; SURFACE EQUIPMENT; SUSPENDED SOLIDS; TURBINE BLADES; UNDERGROUND DISPOSAL; WASTE WATER; WATER CHEMISTRY.

90

SHELDRICK 69
BRINE TREATMENT/SPENT FLUID DISPOSAL

TITLE- DEEP-WELL DISPOSAL--ARE SAFEGUARDS BEING IGNORED .

AUTHOR- SHELDRICK, M.G. (ED.)

REFERENCE- CHEM. ENG. (N.Y.), P. 74-78(APR 7, 1969).

DESCRIPTORS- CASE HISTORIES; DEEP WELLS; DISPOSAL FORMATIONS; ENVIRONMENTAL EFFECTS; FAILURES; GEOLOGY; GROUND WATER; HYDROLOGY; INJECTION PRESSURE; INJECTION WELLS; LEGAL ASPECTS; LIQUID WASTES; MONITORING; POLLUTION; REGULATIONS; SAFETY; SEDIMENTARY ROCKS; SEISMOLOGY; UNDERGROUND DISPOSAL; WASTE

91

SLAGLE 69
BRINE TREATMENT/SPENT FLUID DISPOSAL

TITLE- OIL FIELDS YIELD NEW DEEP-WELL DISPOSAL TECHNIQUE.

AUTHOR- SLAGLE, K.A.;STOGNER, J.M. (HALLIBURTON

SERVICES, DIV. OF HALLIBURTON CO., DUNCAN, OKLA. (USA)].

REFERENCE- WATER AND SEWAGE WORKS, V. 116 (6), P. 238-244(1969).

DESCRIPTORS- ACIDIZATION; BACTERIA; BIOLOGICAL FOULING; CASE HISTORIES; CHEMICAL COMPATIBILITY; CLAY MINERALS; CORROSION; CORROSION RESISTANT ALLOYS; DEEP WELLS; DISPOSAL FORMATIONS; DOLOMITE ROCKS; HYDRAULIC FRACTURING; INJECTION PRESSURE; INJECTION RATES; INJECTION WELLS; LEGAL ASPECTS; LIMESTONE; LIQUID WASTES; MONITORING; OILFIELD BRINES; PERMEABILITY; POROSITY; RADIOACTIVE WASTES; SAND; SANDSTONE; SHALE; SURFACE EQUIPMENT; UNDERGROUND DISPOSAL; WASTE DISPOSAL; WATER POLLUTION; WELL CASINGS; WELL CEMENTING; WELL COMPLETION; WELL DESIGN.

92

SMITH 76
BRINE TREATMENT/SPENT FLUID DISPOSAL

TITLE- INJECTION-PUMP STUDY CAN CUT COSTS.

AUTHOR- SMITH, R.S. [WORLEY ENGINEERING LTD., LONDON (UK)].

REFERENCE- OIL GAS J., V. 74 (8), P. 99-102(FEB 1976).

DESCRIPTORS- CORROSION; DEEP WELLS; ECONOMICS; FLOW RATE; INJECTION PRESSURE; INJECTION RATES; INJECTION WELLS; LIQUID WASTES; RESERVOIR ENGINEERING; RESERVOIR PROPERTIES; SURFACE EQUIPMENT; UNDERGROUND DISPOSAL; WASTE DISPOSAL; WELL DESIGN.

93

TALBOT 64
BRINE TREATMENT/SPENT FLUID DISPOSAL

TITLE- THE DEEP WELL METHOD OF INDUSTRIAL WASTE DISPOSAL.

AUTHOR- TALBOT, J.S. [DOWELL SCHLUMBERGER, PARIS (FRANCE)].

BEARDON, P. (DOW INDUSTRIAL SERVICE, MIDLAND, MICH. (USA)).

REFERENCE- CHEM. ENG. PROG., V. 60 (1), P. 49-52(JAN 1964).

DESCRIPTORS- ACIDIZATION; AQUICLUDES; BIOLOGICAL EFFECTS; PRE-INJECTION TREATMENT; CORROSION; CORROSION RESISTANT ALLOYS; DEEP WELLS; DISPOSAL FORMATIONS; ECONOMICS; FILTRATION; FLOCCULATION; FLOW RATE; GEOLOGY; GROUND WATER; HYDRAULIC FRACTURING; HYDROLOGY; INDUSTRIAL WASTES; INJECTION PRESSURE; INJECTION RATES; INJECTION WELLS; LEGAL ASPECTS; LIMESTONE; LIQUID WASTES; OILFIELD BRINES; PERMEABILITY; PLUGGING; POLLUTION; POLLUTION LAWS; POROSITY; RESERVOIR PROPERTIES; SANDSTONE; SEDIMENTATION; SURFACE EQUIPMENT; SUSPENDED SOLIDS; UNDERGROUND DISPOSAL; WASTE DISPOSAL; WELL CEMENTING; WELL DESIGN; WELL DRILLING; WELL LOGGING; CALIFORNIA; COLORADO; INDIANA; IOWA; KANSAS; LOUISIANA; MICHIGAN; NEW MEXICO; OKLAHOMA; PENNSYLVANIA.

94

OIL GAS J. 76
BRINE TREATMENT/SPENT FLUID DISPOSAL

TITLE- NEW TEXAS H2S RULE COVERS MANY FIELD OPERATIONS.

AUTHOR- OIL GAS J.

REFERENCE- OIL GAS J., V. 74 (16), P. 60-62(APR 1976).

DESCRIPTORS- DEEP WELLS; FLOW RATE; HYDROGEN SULFIDES; INJECTION WELLS; POLLUTION; POLLUTION LAWS; REGULATIONS; SURFACE EQUIPMENT; WELL DRILLING; TEXAS.

95

TRELEASE 72
BRINE TREATMENT/SPENT FLUID DISPOSAL

TITLE- LIABILITY FOR HARM FROM UNDERGROUND WASTE DISPOSAL.

AUTHOR- TRELEASE, F.J. (WYOMING UNIV., LARAMIE

COOK, T.D. (ED.)

REFERENCE- UNDERGROUND WASTE MANAGEMENT AND ENVIRONMENTAL IMPLICATIONS. AM. ASSOC. PET. GEOL., TULSA, OKLA., DEC 1972, MEMOIR 18, P. 369-375.

DESCRIPTORS- ENVIRONMENTAL EFFECTS; GROUND WATER; LEGAL ASPECTS; POLLUTION; POLLUTION REGULATIONS; UNDERGROUND DISPOSAL; WASTE DISPOSAL.

96

UNDERHILL 76
BRINE TREATMENT/SPENT FLUID DISPOSAL

TITLE- BRINE DISPOSAL, CHAPTER VIII.

AUTHOR- UNDERHILL, G.K.;CARLSON, R.A.;CLENDINNING, W.A.;ERDOS, J.;GAULT, J.;HALL, J.W.;JONES, R.L.;MICHAEL, H.K.;POWELL, P.H.;RIEMANN, C.F.;RIOS-CASTELLON, L.;SHEPHERD, B.P.;WILSON, J.S. (EDS.)

REFERENCE- PROCEEDINGS--SECOND GEOPRESSURED GEOTHERMAL ENERGY CONFERENCE, VOL. IV. SURFACE TECHNOLOGY AND RESOURCE UTILIZATION. TEXAS UNIV., CENTER FOR ENERGY STUDIES, AUSTIN, TEX., FEB 1976, V. 4, P. 183-191.

DESCRIPTORS- AQUIFERS; BRINES; CORROSION; CORROSION INHIBITORS; DEEP WELLS; DISPOSAL FORMATIONS; ECONOMICS; ENVIRONMENTAL EFFECTS; GEOLOGY; GEOTHERMAL BRINES; GEOTHERMAL FLUIDS; INJECTION PRESSURE; INJECTION RATES; INJECTION WELLS; OILFIELD BRINES; PERMEABILITY; PH ADJUSTMENT; POROSITY; RESERVOIR ENGINEERING; SURFACE EQUIPMENT; SUSPENDED SOLIDS; THERMAL POLLUTION; UNDERGROUND DISPOSAL; WASTE DISPOSAL; WELL DATA; WELL DESIGN.

97

WARNER 65
BRINE TREATMENT/SPENT FLUID DISPOSAL

TITLE- DEEP-WELL DISPOSAL OF INDUSTRIAL WASTES.

AUTHOR- WARNER, D.L. [ROBERT A. TAFT SANITARY ENGINEERING CENTER, CINCINNATI, OHIO (USA)].

REFERENCE- CHEM. ENG. (N.Y.), P. 73-78(JAN 4, 1965).

DESCRIPTORS- AQUIFERS; AREAL EXTENT; BIOLOGICAL FOULING; CHEMICAL REACTIONS; CHEMICAL COMPATIBILITY; CORROSION; DEEP WELLS; DISPOSAL FORMATIONS; DOLOMITE ROCKS; ECONOMICS; FEASIBILITY STUDIES; FLOW RATE; GEOLOGY; INDUSTRIAL WASTES; INJECTION PRESSURE; INJECTION RATES; INJECTION WELLS; LEGAL ASPECTS; LIMESTONE; MONITORING; OILFIELD BRINES; PERMEABILITY; PLUGGING; POLLUTION REGULATIONS; POROSITY; PRECIPITATION; PRE-INJECTION TREATMENT; REGULATIONS; RESERVOIR PROPERTIES; SANDSTONE; SHALE; UNDERGROUND DISPOSAL; WASTE DISPOSAL; WELL CASINGS; WELL CEMENTING; WELL DRILLING; WELL STIMULATION.

98

WARNER 66
BRINE TREATMENT/SPENT FLUID DISPOSAL

TITLE- DEEP WELL WASTE INJECTION--REACTION WITH AQUIFER WATER.

AUTHOR- WARNER, D.L. [FEDERAL WATER POLLUTION CONTROL ADMINISTRATION, CINCINNATI, OHIO (USA). WATER RESEARCH LAB.].

REFERENCE- J. SANIT. ENG. DIV., AM. SOC. CIV. ENG., V. 92 (SA 4), P. 45-69(AUG 1966).

DESCRIPTORS- AQUIFERS; CHEMICAL ANALYSIS; CHEMICAL COMPATIBILITY; CHEMICAL REACTIONS; DEEP WELLS; ECONOMICS; HYDRODYNAMIC DISPERSION; INJECTION WELLS; LIQUID WASTES; MEASURING INSTRUMENTS; MEASURING METHODS; PERMEABILITY; PLUGGING; POROUS MEDIA; PRECIPITATION; RADIUS OF INFLUENCE; RESERVOIR PROPERTIES; SANDSTONE; THEORETICAL TREATMENTS; UNDERGROUND DISPOSAL; WASTE DISPOSAL.

99

WATKINS 54
BRINE TREATMENT/SPENT FLUID DISPOSAL

TITLE- ANALYTICAL METHODS OF TESTING WATERS TO BE INJECTED INTO SUBSURFACE OIL-PRODUCTIVE STRATA.

AUTHOR- WATKINS, J.W. [BUREAU OF MINES, BARTLESVILLE, OKLA. (USA)].

REFERENCE- ANALYTICAL METHODS OF TESTING WATERS TO BE INJECTED INTO SUBSURFACE OIL-PRODUCTIVE STRATA. REPORT OF INVESTIGATIONS 5031, UNITED STATES DEPARTMENT OF THE INTERIOR, BUREAU OF MINES, FEB 1954, 29 P..

DESCRIPTORS- CHEMICAL ANALYSIS; CHEMICAL COMPOSITION; CHEMICAL REACTIONS; CORROSION; DEEP WELLS; DISPOSAL FORMATIONS; FLOW RATE;

ELECTROCHEMICAL CORROSION; INJECTION RATES; INJECTION WELLS; MEASURING INSTRUMENTS; MEASURING METHODS; OILFIELD BRINES; OIL WELLS; PH VALUE; PLUGGING; PRE-INJECTION TREATMENT; UNDERGROUND DISPOSAL; WASTE DISPOSAL; KANSAS; OKLAHOMA; TEXAS.

100

WILSON 76
BRINE TREATMENT/SPENT FLUID DISPOSAL

TITLE- A STUDY OF A PHASE "0" PLAN FOR THE PRODUCTION OF ELECTRICAL POWER FROM U.S. GULF COAST GEOPRESSURED GEOTHERMAL WATERS.

AUTHOR- WILSON, J.S.;MICHAEL, H.K.;SHEPHERD, B.P. [DOW CHEMICAL CO. (USA). TEXAS DIV.].

DITZLER, C.C.;THOMAS, L.E. [DOW CHEMICAL CO. (USA). OIL AND GAS DIV.].

BRADFORD, B.B.;STEANSON, R. [DOW CHEMICAL CO. (USA). DOWELL DIV.].

UNDERHILL, G.K.;CARLSON, R.A.;CLENDINNING, W.A.;ERDOS, J.;GAULT, J.;HALL, J.W.;MICHAEL, H.K.;JONES, R.L.;POWELL, P.H.;RIEMANN, C.F.;RIOS-CASTELLON, L.;SHEPHERD, B.P.;WILSON, J.S. (EDS.)

REFERENCE- PROCEEDINGS--SECOND GEOPRESSURED GEOTHERMAL ENERGY CONFERENCE. VOL. IV. SURFACE TECHNOLOGY AND RESOURCE UTILIZATION. TEXAS UNIV., CENTER FOR ENERGY STUDIES, AUSTIN, TEX., FEB 1976, APPENDIX B, 69 P..

DESCRIPTORS- DEEP WELLS; DISPOSAL FORMATIONS; ECONOMICS; FLOW RATE; GEOLOGY; HYDRAULIC FRACTURING; INJECTION PRESSURE; INJECTION RATES; INJECTION WELLS; PERMEABILITY; PIPELINES; PLUGGING; POROSITY; SEDIMENTARY ROCKS; SILICA MINERALS; SURFACE EQUIPMENT; SUSPENDED SOLIDS; TEMPERATURE LOGGING; UNDERGROUND DISPOSAL; WASTE DISPOSAL; WELL CASINGS; WELL CEMENTING; WELL COMPLETION; WELL DESIGN; WELL DRILLING; WELL LOGGING; WELL STIMULATION.

101

WOOD 74

BRINE TREATMENT/SPENT FLUID DISPOSAL

TITLE- USE OF UNDERGROUND SPACE FOR WASTE STORAGE THROUGH INJECTION WELLS.

AUTHOR- WOOD, L.A. [GEOLOGICAL SURVEY, RESTON, VA. (USA)].

DEJU, R.A. (ED.) [WRIGHT STATE UNIV., DAYTON, OHIO (USA). DEPT. OF GEOLOGY].

REFERENCE- EXTRACTION OF MINERALS AND ENERGY--TODAY'S DILEMMAS. ANN ARBOR SCIENCE PUBLISHERS INC., ANN ARBOR, MICH., 1974, P. 193-202.

DESCRIPTORS- BIOLOGICAL FOULING; CHEMICAL REACTIONS; DEEP WELLS; DISPOSAL FORMATIONS; ECONOMICS; ENVIRONMENTAL EFFECTS; ENVIRONMENTAL PROTECTION AGENCY; GROUND WATER; HYDROLOGY; INDUSTRIAL WASTES; INJECTION WELLS; LEGAL ASPECTS; OILFIELD BRINES; PERMEABILITY; PLUGGING; POLLUTION; PRECIPITATION; PRE-INJECTION TREATMENT; PRESSURE BUILDUP; REGULATIONS; SUSPENDED SOLIDS; UNDERGROUND DISPOSAL; WASTE STORAGE; WELL DESIGN.

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WATER WELL JOURNAL 65

BRINE TREATMENT/SPENT FLUID DISPOSAL

TITLE- OPERATION DEEP WELL.

AUTHOR- WATER WELL J.

REFERENCE- WATER WELL J., V. 19 (5), P. 28-29(MAY 1965).

DESCRIPTORS- BRINES; DEEP WELLS; ECONOMICS; FLOW RATE; INDUSTRIAL WASTES; INJECTION PRESSURE; INJECTION RATES; INJECTION WELLS; LIMESTONE; LIQUID WASTES; RADIUS OF INFLUENCE; SURFACE EQUIPMENT; UNDERGROUND DISPOSAL; WASTE DISPOSAL; WELL DESIGN; PENNSYLVANIA.

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BAFFA 70
BRINE TREATMENT/SPENT FLUID DISPOSAL

TITLE- INJECTION WELL EXPERIENCE AT RIVERHEAD, N.Y..

AUTHOR- BAFFA, J.J. [JOHN J. BAFFA CONSULTING ENGINEERS, NEW YORK, N.Y. (USA)].

REFERENCE- J. AM. WATER WORKS ASSOC., V. 62 (1), P. 41-46(JAN 1970).

DESCRIPTORS- ARTIFICIAL RECHARGE; EXPERIMENTAL RESULTS; FLOW RATE; GRAVEL PACKING; GROUND WATER; HYDRAULICS; INJECTION RATES; INJECTION WELLS; MEASURING INSTRUMENTS; MEASURING METHODS; OBSERVATION WELLS; PLUGGING; WASTE WATER; WELL DESIGN; NEW YORK.

104

BARRACLOUGH 66
BRINE TREATMENT/SPENT FLUID DISPOSAL

TITLE- WASTE INJECTION INTO A DEEP LIMESTONE IN NORTHWESTERN FLORIDA.

AUTHOR- BARRACLOUGH, J.T. [GEOLOGICAL SURVEY, IDAHO FALLS, IDAHO (USA)].

REFERENCE- GROUND WATER, V. 4 (1), P. 22-24(1966).

DESCRIPTORS- AQUICLUDES; AQUIFERS; CASE HISTORIES; CHEMICAL ANALYSIS; CLAY MINERALS; DEEP WELLS; FLOW RATE; GEOLOGY; HYDRAULICS; HYDROLOGY; INDUSTRIAL WASTES; INJECTION PRESSURE; INJECTION RATES; INJECTION WELLS; LIMESTONE; LIQUID WASTES; MONITORING; OBSERVATION WELLS; SHALE; STRATIGRAPHY; SUSPENDED SOLIDS;

UNDERGROUND DISPOSAL; WASTE DISPOSAL; FLORIDA; ALABAMA.

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BERGSTROM 68B
BRINE TREATMENT/SPENT FLUID DISPOSAL

TITLE- FEASIBILITY CRITERIA FOR SUBSURFACE WASTE DISPOSAL IN ILLINOIS.

AUTHOR- BERGSTROM, R.E. [ILLINOIS STATE GEOLOGICAL SURVEY, URBANA (USA)].

REFERENCE- GROUND WATER, V. 6 (5), P. 5-9(1968).

DESCRIPTORS- DEEP WELLS; DISPOSAL FORMATIONS; ENVIRONMENTAL EFFECTS; FEASIBILITY STUDIES; GROUND WATER; HYDROGEOLOGY; INDUSTRIAL WASTES; INJECTION PRESSURE; INJECTION RATES; INJECTION WELLS; LEGAL ASPECTS; LIQUID WASTES; MONITORING; OBSERVATION WELLS; PERMEABILITY; PLUGGING; PRE-INJECTION TREATMENT; REGULATIONS; SANDSTONE; SHALE; STRATIGRAPHY; UNDERGROUND DISPOSAL; WASTE DISPOSAL; WELL DESIGN; WELL LOGGING; ILLINOIS; ILLINOIS BASIN.

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CAMELI 76
BRINE TREATMENT/SPENT FLUID DISPOSAL

TITLE- SEISMIC CONTROL DURING A REINJECTION EXPERIMENT IN THE VITERBO REGION (CENTRAL ITALY).

AUTHOR- CAMELI, G.M. [ENTE NAZIONALE PER L'ENERGIA ELETTRICA, PISA (ITALY). CENTRO DI RICERCA GEOTERMICA].

CARABELLI, E. [ISTITUTO DI GEOFISICA APPLICATA DEL POLITECNICO DE MILANO (ITALY)].

REFERENCE- PROCEEDINGS--SECOND UNITED NATIONS SYMPOSIUM ON THE DEVELOPMENT AND USE OF GEOTHERMAL RESOURCES. LAWRENCE BERKELEY LABORATORY, UNIVERSITY OF CALIFORNIA, BERKELEY, 1976, V. 2, P. 1329-1334.

DESCRIPTORS- DEEP WELLS; DISPOSAL FORMATIONS; EXPERIMENTAL RESULTS; FLOW RATE; GEOTHERMAL FLUIDS; INJECTION WELLS; MEASURING INSTRUMENTS; MEASURING METHODS; MONITORING; SEISMOLOGY;

107

CUELLAR 76
BRINE TREATMENT/SPENT FLUID DISPOSAL

TITLE- BEHAVIOR OF SILICA IN GEOTHERMAL WASTE WATERS.

AUTHOR- CUELLAR, G. [CEL, SAN SALVADOR (EL SALVADOR). LABORATORIO GEOQUIMICO].

REFERENCE- PROCEEDINGS--SECOND UNITED NATIONS SYMPOSIUM ON THE DEVELOPMENT AND USE OF GEOTHERMAL RESOURCES. LAWRENCE BERKELEY LABORATORY, UNIVERSITY OF CALIFORNIA, BERKELEY, 1976, V. 2, P. 1343-1347.

DESCRIPTORS- CHEMICAL ANALYSIS; CHEMICAL COMPOSITION; DEEP WELLS; DESALINATION; ECONOMICS; EVAPORATION PONDS; EXPERIMENTAL RESULTS; FEASIBILITY STUDIES; FLOW RATE; GEOTHERMAL BRINES; GEOTHERMAL FLUIDS; GEOTHERMAL RESERVOIRS; INJECTION PRESSURE; INJECTION WELLS; LIQUID WASTES; MEASURING INSTRUMENTS; MEASURING METHODS; MINERAL RECOVERY; PERMEABILITY; PH ADJUSTMENT; PRE-INJECTION TREATMENT; SCALING; SILICA MINERALS; SURFACE EQUIPMENT; UNDERGROUND DISPOSAL; WASTE DISPOSAL; WASTE WATER; AHUACHAPAN GEOTHERMAL FIELD; EL SALVADOR.

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EINARSSON 76
BRINE TREATMENT/SPENT FLUID DISPOSAL

TITLE- DISPOSAL OF GEOTHERMAL WASTE WATER BY REINJECTION.

AUTHOR- EINARSSON, S.S. [OTC, UNITED NATIONS, MANAGUA (NICARAGUA)].

VIDES, A.R.;CUELLAR, G. [COMISION EJECUTIVA HIDROELECTRICA DEL RIO LEMPA, SAN SALVADOR (EL SALVADOR)].

REFERENCE- PROCEEDINGS--SECOND UNITED NATIONS SYMPOSIUM ON THE DEVELOPMENT AND USE OF GEOTHERMAL RESOURCES. LAWRENCE BERKELEY LABORATORY, UNIVERSITY OF CALIFORNIA, BERKELEY, 1976, V. 2, P. 1349-1363.

DESCRIPTORS- AQUIFERS; CHEMICAL ANALYSIS; DEEP WELLS; DESALINATION; ECONOMICS; EXPERIMENTAL RESULTS; FEASIBILITY STUDIES; FLOW RATE; GEOTHERMAL BRINES; GEOTHERMAL FLUIDS; GEOTHERMAL WELLS; INJECTION RATES; INJECTION WELLS; LIQUID WASTES; MONITORING; OBSERVATION WELLS; PERMEABILITY; PIPELINES; POLLUTION; PRESSURE BUILDUP; RESERVOIR PROPERTIES; SCALING; SILICA MINERALS; SURFACE EQUIPMENT; TEMPERATURE LOGGING; TRACE AMOUNTS; UNDERGROUND DISPOSAL; WASTE DISPOSAL; WASTE WATER; WELL DESIGN; AHUACHAPAN GEOTHERMAL FIELD; EL SALVADOR; ELEMENTS.

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GOOLSBY 71
BRINE TREATMENT/SPENT FLUID DISPOSAL

TITLE- HYDROGEOCHEMICAL EFFECTS OF INJECTING WASTES INTO A LIMESTONE AQUIFER NEAR PENSACOLA, FLORIDA.

AUTHOR- GOOLSBY, D.A. (GEOLOGICAL SURVEY, OCALA, FLA. (USA)).

REFERENCE- GROUND WATER, V. 9 (1), P. 13-19(1971).

DESCRIPTORS- AQUICLUDES; AQUIFERS; CHEMICAL ANALYSIS; CHEMICAL COMPOSITION; CHEMICAL REACTIONS; DEEP WELLS; DISPOSAL FORMATIONS; EXPERIMENTAL RESULTS; FLOW RATE; GEOCHEMISTRY; GEOLOGY; HYDRAULICS; HYDROGEOLOGY; INDUSTRIAL WASTES; INJECTION PRESSURE; INJECTION RATES; INJECTION WELLS; LIMESTONE; LIQUID WASTES; MONITORING; OBSERVATION WELLS; PH ADJUSTMENT; PH VALUE; RADIUS OF INFLUENCE; STRATIGRAPHY; TRANSMISSIVITY; UNDERGROUND DISPOSAL; WASTE DISPOSAL; WELL DESIGN; WELL INTERFERENCE; WELL LOGGING; WELL STIMULATION; FLORIDA.

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HUNDLEY 63
BRINE TREATMENT/SPENT FLUID DISPOSAL

TITLE- DEEP WELL DISPOSAL.

AUTHOR- HUNDLEY, C.L. [FMC, NEWPORT, IND. (USA). CENTRAL ENGINEERING DEPARTMENT].

MATULIS, J.T. [FMC, NEWPORT, IND. (USA). CHEMICAL CORPS FACILITY].

REFERENCE- GROUND WATER, V. 1 (2), P. 15-17, 33(1963).

DESCRIPTORS- CASE HISTORIES; CHEMICAL COMPATIBILITY; CORROSION PROTECTION; DEEP WELLS; DISPOSAL FORMATIONS; ECONOMICS; GEOLOGY; INJECTION PRESSURE; INJECTION RATES; INJECTION WELLS; LIQUID WASTES; PERMEABILITY; PH ADJUSTMENT; POROSITY; PRE-INJECTION TREATMENT; SANDSTONE; STRATIGRAPHY; SUBSURFACE RESERVOIRS; SURFACE EQUIPMENT; UNDERGROUND DISPOSAL; WASTE DISPOSAL; WELL CEMENTING; WELL COMPLETION; WELL DESIGN; WELL DRILLING; WELL LOGGING; INDIANA.

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KUBOTA 76
BRINE TREATMENT/SPENT FLUID DISPOSAL

TITLE- REINJECTION OF GEOTHERMAL HOT WATER AT THE OTAKE GEOTHERMAL FIELD.

AUTHOR- KUBOTA, K.;AOSAKI, K. [KYUSHU ELECTRIC POWER CO., INC., FUKUOKA (JAPAN). RESEARCH DEPT.].

REFERENCE- PROCEEDINGS--SECOND UNITED NATIONS SYMPOSIUM ON THE DEVELOPMENT AND USE OF GEOTHERMAL RESOURCES. LAWRENCE BERKELEY LABORATORY, UNIVERSITY OF CALIFORNIA, BERKELEY, 1976, V. 2, P. 1379-1383.

DESCRIPTORS- CASE HISTORIES; DEEP WELLS; DISPOSAL FORMATIONS; FLOW RATE; GEOLOGY; GEOTHERMAL BRINES; GEOTHERMAL FIELDS; GEOTHERMAL FLUIDS; GEOTHERMAL RESERVOIRS; INJECTION PRESSURE; INJECTION WELLS; SCALING; SEISMOLOGY; SILICA MINERALS; UNDERGROUND DISPOSAL; WASTE DISPOSAL; WELL CASINGS; WELL DESIGN; OTAKE GEOTHERMAL FIELD; JAPAN.

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MARSH 68
BRINE TREATMENT/SPENT FLUID DISPOSAL

TITLE- DESIGN OF WASTE DISPOSAL WELLS.

AUTHOR- MARSH, J.H. [UOP JOHNSON DIVISION, SAINT PAUL, MINN. (USA)].

REFERENCE- GROUND WATER, V. 6 (2), P. 4-8(1968).

DESCRIPTORS- ACIDIZATION; AQUICLUDES; CASE HISTORIES; CHEMICAL ANALYSIS; CLAY MINERALS; CORROSION; CORROSION INHIBITORS; CORROSION PROTECTION; CORROSION RESISTANT ALLOYS; DEEP WELLS; ECONOMICS; GRAVEL PACKING; INDUSTRIAL WASTES; INJECTION WELLS; LIQUID WASTES; PLUGGING; SAND; SAND CONTROL; SUSPENDED SOLIDS; UNDERGROUND DISPOSAL; WASTE DISPOSAL; WELL CASINGS; WELL CEMENTING; WELL COMPLETION; WELL DESIGN; WELL LOGGING; WELL SCREENS; PH ADJUSTMENT.

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ANGINO 70
BRINE TREATMENT/SPENT FLUID DISPOSAL

TITLE- SELECTIVE ELEMENT RECOVERY FROM OIL FIELD BRINES.

AUTHOR- ANGINO, E.E. [KANSAS UNIV., LAWRENCE (USA)].

REFERENCE- WATER RESOUR. RES., V. 6 (5), P. 1501-1504(OCT 1970).

DESCRIPTORS- BRINE TREATMENT; BRINES; CHEMICAL COMPOSITION; CHEMICAL REACTIONS; DESALINATION; ECONOMICS; MINERAL RECOVERY; OILFIELD BRINES.

114

GARCIA-BENGOCHEA 70
BRINE TREATMENT/SPENT FLUID DISPOSAL

TITLE- DEEP WELL DISPOSAL OF WASTE WATERS IN SALINE AQUIFERS OF SOUTH FLORIDA.

AUTHOR- GARCIA-BENGCCHEA, J.I. [BLACK, CROW AND EIDSNESS, INC., GAINESVILLE, FLA. (USA)].

VERNON, R.O. [GEOLOGICAL SURVEY, TALLAHASSEE, FLA. (USA). BOARD OF CONSERVATION].

REFERENCE- WATER RESOUR. RES., V. 6 (5), P. 1464-1470(OCT 1970).

DESCRIPTORS- AQUIFERS; CHEMICAL COMPOSITION; DEEP WELLS; DISPOSAL FORMATIONS; DOLOMITE ROCKS; HYDROGEOLOGY; INDUSTRIAL WASTES; INJECTION PRESSURE; INJECTION RATES; INJECTION WELLS; LIMESTONE; MONITORING; OBSERVATION WELLS; OILFIELD BRINES; SALINE AQUIFERS; UNDERGROUND DISPOSAL; WASTE DISPOSAL; WASTE WATER; WELL CASINGS; WELL COMPLETION; WELL DESIGN; FLORIDA.

115

JAVANDEL 69
BRINE TREATMENT/SPENT FLUID DISPOSAL

TITLE- A METHOD OF ANALYZING TRANSIENT FLUID FLOW IN MULTILAYERED AQUIFERS.

AUTHOR- JAVANDEL, I. [PAHLAVI UNIV., SHIRAZ (IRAN)].

WITHERSPOON, P.A. [CALIFORNIA UNIV., BERKELEY (USA)].

REFERENCE- WATER RESOUR. RES., V. 5 (4), P. 856-869(AUG 1969).

DESCRIPTORS- AQUIFERS; AQUITARDS; FLOW RATE; HYDROLOGY; MATHEMATICAL MODELS; PERMEABILITY; THEORETICAL TREATMENTS.

116

NEUMAN 69
BRINE TREATMENT/SPENT FLUID DISPOSAL

TITLE- THEORY OF FLOW IN A CONFINED TWO AQUIFER SYSTEM.

AUTHOR- NEUMAN, S.P.;WITHERSPOON, P.A. [CALIFORNIA UNIV., BERKELEY (USA)].

REFERENCE- WATER RESOUR. RES., V. 5 (4), P. 803-816(AUG 1969).

DESCRIPTORS- AQUIFERS; AQUITARDS; FLOW RATE; HYDROLOGY; MATHEMATICAL MODELS; PERMEABILITY; THEORETICAL TREATMENTS.

117

NEUMAN 69B
BRINE TREATMENT/SPENT FLUID DISPOSAL

TITLE- APPLICABILITY OF CURRENT THEORIES OF FLOW IN LEAKY AQUIFERS.

AUTHOR- NEUMAN, S.P.;WITHERSPOON, P.A. [CALIFORNIA UNIV., BERKELEY (USA)].

REFERENCE- WATER RESOUR. RES., V. 5 (4), P. 817-829(AUG 1969).

DESCRIPTORS- AQUIFERS; AQUITARDS; HYDROLOGY; MATHEMATICAL MODELS; PERMEABILITY; THEORETICAL TREATMENTS.

118

PIERCE 70
BRINE TREATMENT/SPENT FLUID DISPOSAL

TITLE- REDUCING LAND SUBSIDENCE IN THE WILMINGTON OIL FIELD BY USE OF SALINE WATERS.

AUTHOR- PIERCE, R.L. [DEPT. OF OIL PROPERTIES, LONG BEACH, CALIF. (USA)].

REFERENCE- WATER RESOUR. RES., V. 6 (5), P. 1505-1514(OCT 1970).

DESCRIPTORS- BACTERIA; CHEMICAL COMPATIBILITY; BRINE TREATMENT; CORROSION; CORROSION INHIBITORS; ECONOMICS; ENVIRONMENTAL EFFECTS; FILTRATION; GRAVEL PACKING; GROUND SUBSIDENCE; INJECTION RATES; INJECTION WELLS; MEASURING METHODS; MONITORING; OILFIELD BRINES; OIL WELLS; PH ADJUSTMENT; PLUGGING; PRECIPITATION; RESERVOIR PROPERTIES; SCALING; SCALING CONTROL; UNDERGROUND DISPOSAL; WASTE DISPOSAL; WASTE WATER; WELL CASINGS; WELL CEMENTING; WELL DESIGN; WELL LOGGING; CALIFORNIA.

119

REBHUN 68
BRINE TREATMENT/SPENT FLUID DISPOSAL

TITLE- CLOGGING AND CONTAMINATION PROCESSES IN RECHARGE WELLS.

AUTHOR- REBHUN, M. [TECHNION-ISRAEL INST. OF TECH., HAIFA].

SCHWARZ, J. [WATER PLANNING FOR ISRAEL LTD. (TAHAL), TEL AVIV].

REFERENCE- WATER RESOUR. RES., V. 4 (6), P. 1207-1217(DEC 1968).

DESCRIPTORS- AQUIFERS; BACTERIA; BIOLOGICAL FOULING; CHEMICAL COMPOSITION; BRINE TREATMENT; DEEP WELLS; DOLOMITE ROCKS; EXPERIMENTAL RESULTS; GROUND WATER; HYDRAULICS; INJECTION RATES; INJECTION WELLS; LIMESTONE; MEASURING INSTRUMENTS; MEASURING METHODS; PLUGGING; SANDSTONE; SUSPENDED SOLIDS; WATER QUALITY; WELL CASINGS; WELL DESIGN; ISRAEL.

120

SHAMIR 67
BRINE TREATMENT/SPENT FLUID DISPOSAL

TITLE- NUMERICAL SOLUTIONS FOR DISPERSION IN POROUS MEDIUMS.

AUTHOR- SHAMIR, U.Y.;HARLEMAN, D.R.F. [MASSACHUSETTS INST. OF TECH., CAMBRIDGE, (USA). HYDRODYNAMICS LAB.].

REFERENCE- WATER RESOUR. RES., V. 3 (2), P. 557-581(1967).

DESCRIPTORS- CASE HISTORIES; COMPUTER CALCULATIONS; DEEP WELLS; FLOW RATE; GROUND WATER; HYDRODYNAMIC DISPERSION; INJECTION WELLS; MATHEMATICAL MODELS; POLLUTION; POROUS MEDIA; THEORETICAL TREATMENTS.

121

WARNER 70
BRINE TREATMENT/SPENT FLUID DISPOSAL

TITLE- REGULATORY ASPECTS OF LIQUID WASTE INJECTION INTO SALINE AQUIFERS.

AUTHOR- WARNER, D.L. (MISSOURI UNIV., ROLLA (USA)).

REFERENCE- WATER RESOUR. RES., V. 6 (5), P. 1458-1463(OCT 1970).

DESCRIPTORS- CHEMICAL COMPATIBILITY; CORROSION; DEEP WELLS; ECONOMICS; FEASIBILITY STUDIES; FILTRATION; GEOLOGY; HYDROGEOLOGY; INDUSTRIAL WASTES; INJECTION PRESSURE; INJECTION RATES; INJECTION WELLS; LIQUID WASTES; MONITORING; PRE-INJECTION TREATMENT; RADIOACTIVE WASTES; REGULATIONS; SALINE AQUIFERS; SEDIMENTATION; SUBSURFACE RESERVOIRS; SURFACE EQUIPMENT; WELL CASINGS; WELL CEMENTING; WELL COMPLETION; WELL DESIGN; WELL LOGGING; WELL OPERATION.

122

MAHON 66
BRINE TREATMENT/SCALING

TITLE- SILICA IN HOT WATER DISCHARGED FROM DRILLHOLES AT WAIRAKEI, NEW ZEALAND.

AUTHOR- MAHON, W.A.J. (DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH, (NEW ZEALAND). CHEMISTRY DIV.).

REFERENCE- N.Z.J. SCI., V. 9, P. 135-144(MAR 1966).

DESCRIPTORS- CHEMICAL ANALYSIS; CONCENTRATION DEPENDENCE; DEEP WELLS; GEOTHERMAL FIELDS; GEOTHERMAL WELLS; MEASURING INSTRUMENTS; MEASURING METHODS; MONITORING; QUARTZ; SILICA MINERALS; SILICA SOLUBILITY; TEMPERATURE DEPENDENCE; TEMPERATURE LOGGING; WELL HEAD PRESSURE; WAIRAKEI GEOTHERMAL FIELD; NEW

123

MARSH 75
BRINE TREATMENT/SCALING

TITLE- POLYMERIZATION KINETICS AND EQUILIBRIA OF SILICIC ACID IN AQUEOUS SYSTEMS.

AUTHOR- MARSH, A.R., III [DOW CHEMICAL COMPANY, MARTINEZ, CALIF. (USA)].

KLEIN, G. [CALIFORNIA UNIV., RICHMOND (USA). SEA WATER CONVERSION LABORATORY].

VERMEULEN, T. [CALIFORNIA UNIV., BERKELEY (USA). DEPT. OF CHEMICAL ENGINEERING].

REFERENCE- POLYMERIZATION KINETICS AND EQUILIBRIA OF SILICIC ACID IN AQUEOUS SYSTEMS. M.S., LBL-4415, CALIFORNIA UNIV., LAWRENCE BERKELEY LAB., BERKELEY, CALIF., OCT. 1975, 172 P..

DESCRIPTORS- AMORPHOUS SILICA; AQUEOUS SOLUTIONS; CARBONATES; CHEMICAL COMPOSITION; CHEMICAL REACTIONS; CONCENTRATION DEPENDENCE; EXPERIMENTAL RESULTS; FLOCCULATION; GEOTHERMAL BRINES; MEASURING METHODS; PH VALUE; PIPELINES; POLYMERIZATION; PRESSURE DEPENDENCE; QUARTZ; SCALE COMPOSITION; SCALING; SILICA MINERALS; SILICA CHEMISTRY; SILICA SOLUBILITY; SOLUBILITY; TEMPERATURE DEPENDENCE; THERMODYNAMICS; TIME DEPENDENCE; TRIDYMITE; JAPAN; ITALY; NEW ZEALAND.

124

MOREY 62
BRINE TREATMENT/SCALING

TITLE- THE SOLUBILITY OF QUARTZ IN WATER IN THE TEMPERATURE INTERVAL FROM 25 DEGREES TO 300 DEGREES C.

AUTHOR- MOREY, G.W.;FOURNIER, R.O.;ROWE, J.J. [GEOLOGICAL SURVEY, WASHINGTON, D.C. (USA)].

REFERENCE- GEOCHIM. COSMOCHIM. ACTA, V. 26, P. 1029-1043(1962).

DESCRIPTORS- AQUEOUS SOLUTIONS; CONCENTRATION DEPENDENCE; EXPERIMENTAL RESULTS; MEASURING

INSTRUMENTS; MEASURING METHODS; QUARTZ; SILICA MINERALS; SILICA CHEMISTRY; SILICA SOLUBILITY; SOLUBILITY; TEMPERATURE DEPENDENCE; TIME DEPENDENCE.

125

MOREY 64
BRINE TREATMENT/SCALING

TITLE- THE SOLUBILITY OF AMORPHOUS SILICA AT 25 DEGREES C.

AUTHOR- MOREY, G.W.;FOURNIER, R.O.;ROWE, J.J. [GEOLOGICAL SURVEY, WASHINGTON, D.C. (USA)].

REFERENCE- J. GEOPHYS. RES., V. 69 (10), P. 1995-2002(MAY 1964).

DESCRIPTORS- AMORPHOUS SILICA; AQUEOUS SOLUTIONS; CRISTOBALITE; EXPERIMENTAL RESULTS; FREE ENERGY; GEOTHERMAL FLUIDS; MEASURING METHODS; PH VALUE; PH DEPENDENCE; QUARTZ; SILICA MINERALS; SILICA CHEMISTRY; SILICA SOLUBILITY; TEMPERATURE DEPENDENCE; TIME DEPENDENCE.

126

OWEN 75
BRINE TREATMENT/SCALING

TITLE- PRECIPITATION OF AMORPHOUS SILICA FROM HIGH-TEMPERATURE HYPERSALINE GEOTHERMAL BRINES.

AUTHOR- OWEN, L.B. [CALIFORNIA UNIV., LIVERMORE (USA). LAWRENCE LIVERMORE LAB.].

REFERENCE- PRECIPITATION OF AMORPHOUS SILICA FROM HIGH-TEMPERATURE HYPERSALINE GEOTHERMAL BRINES. UCRL-51866, CALIFORNIA UNIV., LAWRENCE LIVERMORE LAB., LIVERMORE, CALIF., JUN 1975, 20 P..

DESCRIPTORS- AMORPHOUS SILICA; AQUEOUS SOLUTIONS; CHALCEDONY; CHEMICAL REACTIONS; CONCENTRATION DEPENDENCE; CRISTOBALITE; ECONOMICS; GEOTHERMAL BRINES; HYDROXIDES; METALS; OPALINE SCALE; PH ADJUSTMENT; PH VALUE; PH DEPENDENCE; POLYMERIZATION; PRECIPITATION; PRESSURE DEPENDENCE; QUARTZ; SALINITY; SCALING; SILICA MINERALS; SILICA CHEMISTRY; SILICA SOLUBILITY;

SUSPENDED SOLIDS; TEMPERATURE DEPENDENCE; TIME DEPENDENCE; SALTON SEA GEOTHERMAL FIELD.

127

OZAWA 70
BRINE TREATMENT/SCALING

TITLE- A PHENOMENON OF SCALING IN PRODUCTION WELLS AND THE GEOTHERMAL POWER PLANT IN THE MATSUKAWA AREA.

AUTHOR- OZAWA, T. [TOKYO INST. OF TECH. (JAPAN). DEPT. OF CHEMISTRY].

FUJII, Y. [JAPAN METALS AND CHEMICALS CO., LTD., IWATE (JAPAN)].

REFERENCE- GEOTHERMICS, SPECIAL ISSUE 2, V.2 (2), P. 1613-1618(1970).

DESCRIPTORS- AMORPHOUS SILICA; BRINES; CHEMICAL ANALYSIS; CHEMICAL COMPOSITION; BRINE TREATMENT; CLAY MINERALS; CORROSION; EXPERIMENTAL RESULTS; MEASURING METHODS; GEOTHERMAL BRINES; GEOTHERMAL WELLS; IRON OXIDES; METALS; PH VALUE; PIPELINES; SCALE COMPOSITION; SCALING; DESCALING; SCALING CONTROL; SILICA MINERALS; SILICA CHEMISTRY; SILICA SOLUBILITY; SURFACE EQUIPMENT; SUSPENDED SOLIDS; TURBINE BLADES; WELL INTERFERENCE; MATSUKAWA GEOTHERMAL FIELD; JAPAN.

128

SCHOCK 75
BRINE TREATMENT/SCALING

TITLE- THE EFFECT OF ELECTRICAL POTENTIAL ON SCALE FORMATION IN SALTON SEA BRINE.

AUTHOR- SCHOCK, R.N.;DUBA, A. [CALIFORNIA UNIV., LIVERMORE (USA). LAWRENCE LIVERMORE LAB.].

REFERENCE- THE EFFECT OF ELECTRICAL POTENTIAL ON SCALE FORMATION IN SALTON SEA BRINE. UCRL-51944, CALIFORNIA UNIV., LAWRENCE LIVERMORE LAB., LIVERMORE, CALIF., NOV 1975, 14 P..

DESCRIPTORS- BRINES; CHEMICAL ANALYSIS; EXPERIMENTAL RESULTS; GEOTHERMAL BRINES; MEASURING INSTRUMENTS; MEASURING METHODS; SCALING; SILICA MINERALS; SILICA SOLUBILITY; SALTON SEA GEOTHERMAL FIELD.

129

TOLIVIA 70
BRINE TREATMENT/CORROSION

TITLE- CORROSION MEASUREMENTS IN A GEOTHERMAL ENVIRONMENT.

AUTHOR- TOLIVIA, E.M. [GEOTHERMAL ENERGY COMMISSION, MEXICO CITY (MEXICO). CHEMICAL INVESTIGATION SECTION].

REFERENCE- GEOTHERMICS, SPECIAL ISSUE 2, V.2 (2), P. 1596-1601(1970).

DESCRIPTORS- CHEMICAL COMPOSITION; CHLORIDES; CORROSION; CORROSION PROTECTION; CORROSION RESISTANT ALLOYS; EROSION; EXPERIMENTAL RESULTS; GEOTHERMAL FLUIDS; MEASURING INSTRUMENTS; MEASURING METHODS; SCALING; STRESS CORROSION; TIME DEPENDENCE; CERRO PRIETO GEOTHERMAL FIELD; MEXICO.

130

TREADWELL 35
BRINE TREATMENT/SCALING

TITLE- POLYMERISATION OF PHENOMENA OF SILICIC ACID.

AUTHOR- TREADWELL, W.D. [EIDGENOESSISCHE TECHNISCHE HOCHSCHULE, ZURICH (SWITZERLAND). INORGANIC LAB.].

REFERENCE- TRANS. FARADAY SOC., V. 31, P. 297-304(1935).

DESCRIPTORS- CHEMICAL REACTIONS; ELECTRODIALYSIS; EXPERIMENTAL RESULTS; MEASURING INSTRUMENTS; MEASURING METHODS; PH ADJUSTMENT; PH DEPENDENCE; POLYMERIZATION; SILICA CHEMISTRY; TIME DEPENDENCE.

131

VAN LIER 60
BRINE TREATMENT/SCALING

TITLE- THE SOLUBILITY OF QUARTZ.

AUTHOR- VAN LIER, J.A.;DE BRUYN, P.L.;OVERBEEK, J.TH.G. [MASSACHUSETTS INST. OF TECH., CAMBRIDGE (USA). DEPT. OF METALLURGY].

REFERENCE- J. PHYS. CHEM., V. 64, P. 1675-1682(NOV 1960).

DESCRIPTORS- AQUEOUS SOLUTIONS; CHEMICAL ANALYSIS; CHEMICAL REACTIONS; EXPERIMENTAL RESULTS; MEASURING INSTRUMENTS; MEASURING METHODS; PH DEPENDENCE; QUARTZ; SALINITY; SILICA MINERALS; SILICA CHEMISTRY; SILICA SOLUBILITY; SODIUM CHLORIDES; TIME DEPENDENCE.

132

WAHL 74
BRINE TREATMENT/SCALING

TITLE- SILICATE SCALE CONTROL IN GEOTHERMAL BRINES--FINAL REPORT.

AUTHOR- WAHL, E.F.;YEN, I.K.;BARTEL, W.J. [GARRETT RESEARCH AND DEVELOPMENT CO., INC., LA VERNE, CALIF. (USA)].

REFERENCE- SILICATE SCALE CONTROL IN GEOTHERMAL BRINES--FINAL REPORT. GR-D 74-048, GARRETT RESEARCH AND DEVELOPMENT COMPANY, INC., LA VERNE, CALIF., SEP 1974, 122 P..

DESCRIPTORS- ABRASION; AMORPHOUS SILICA; AQUEOUS SOLUTIONS; BRINES; CARBONATES; CHEMICAL ANALYSIS; CHALCEDONY; CHEMICAL COMPOSITION; CHEMICAL REACTIONS; BRINE TREATMENT; CONCENTRATION DEPENDENCE; CRYSTAL SEEDING; CRISTOBALITE; EXPERIMENTAL RESULTS; FLOW RATE; GEOTHERMAL BRINES; HEAT FLOW; HEAT TRANSFER; HEAT TRANSFER COEFFICIENT; HYDROXIDES; MATHEMATICAL MODELS; MEASURING INSTRUMENTS; MEASURING METHODS; MONITORING; PH ADJUSTMENT; PH VALUE; PH DEPENDENCE; PIPELINES; POLYMERIZATION; PRECIPITATION; QUARTZ; SAND; SCALE COMPOSITION; SCALING; SCALING CONTROL; SILICA MINERALS; SILICA CHEMISTRY; SILICA SOLUBILITY; SILICATES; SURFACE EQUIPMENT;

TEMPERATURE DEPENDENCE; TEMPERATURE LOGGING; THEORETICAL TREATMENTS; TIME DEPENDENCE; TRIDYMITE; WELL CHARACTERISTICS; WELL LOGGING; WELL OPERATION; EAST MESA KGRA; CALIFORNIA.

133

WHITE 56
BRINE TREATMENT/SCALING

TITLE- SILICA IN HOT-SPRING WATERS.

AUTHOR- WHITE, D.E.;BRANNOCK, W.W.;MURATA, K.J. [GEOLOGICAL SURVEY, WASHINGTON, D.C. (USA)].

REFERENCE- GEOCHIM. COSMOCHIM. ACTA, V. 10, P. 27-59(1956).

DESCRIPTORS- AQUEOUS SOLUTIONS; CARBONATES; CHALCEDONY; CHEMICAL COMPOSITION; CHEMICAL REACTIONS; CHLORIDES; CLAY MINERALS; CONNATE WATER; CONCENTRATION DEPENDENCE; CRISTOBALITE; EXPERIMENTAL RESULTS; GEOTHERMAL FLUIDS; MEASURING METHODS; OPAL; PH VALUE; PH DEPENDENCE; POLYMERIZATION; PRECIPITATION; QUARTZ; SALINITY; SCALING; SCALING CONTROL; SILICA MINERALS; SILICA CHEMISTRY; SILICA SOLUBILITY; TEMPERATURE DEPENDENCE; TIME DEPENDENCE; TRIDYMITE; STEAMBOAT SPRINGS;

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WILSON 74
BRINE TREATMENT/SCALING
BRINE TREATMENT/CORROSION

TITLE- LABORATORY PROGRAM TO STUDY FLASHING AND SCALING CHARACTERISTICS OF GEOTHERMAL BRINES.

AUTHOR- WILSON, J.S. [DOW CHEMICAL CO., MIDLAND, MICH. (USA)].

WARREN, G.R.

REFERENCE- LABORATORY PROGRAM TO STUDY FLASHING AND SCALING CHARACTERISTICS OF GEOTHERMAL BRINES. INT-OSW-RDPR-74-969, DOW CHEMICAL CO., MIDLAND, MICH., MAY 1974, 87 P..

DESCRIPTORS- CARBONATES; CHEMICAL ANALYSIS; CHEMICAL COMPOSITION; CHLORIDES; CONCENTRATION

DEPENDENCE; CORROSION; CORROSION RESISTANT ALLOYS; DESALINATION; EXPERIMENTAL RESULTS; FILTRATION; FLASHING; FLOCCULATION; FLOW RATE; GEOTHERMAL BRINES; GEOTHERMAL FLUIDS; GROUND SUBSIDENCE; HYDROGEN SULFIDES; INJECTION WELLS; MEASURING INSTRUMENTS; MEASURING METHODS; PH ADJUSTMENT; PH VALUE; PH DEPENDENCE; PITTING CORROSION; PRESSURE DEPENDENCE; SCALING; SILICA MINERALS; SILICA CHEMISTRY; SILICA SOLUBILITY; SULFIDES; SUSPENDED SOLIDS; TEMPERATURE DEPENDENCE; TIME DEPENDENCE; UNDERGROUND DISPOSAL; WASTE DISPOSAL; WASTE WATER; IMPERIAL VALLEY; CALIFORNIA.

135

ALEXANDER 54
BRINE TREATMENT/SCALING

TITLE- THE SOLUBILITY OF AMORPHOUS SILICA IN WATER.

AUTHOR- ALEXANDER, G.B.;HESTON, W.M.;ILER, R.K. [DU PONT DE NEMOURS (E.I.) AND CO., INC., WILMINGTON, DEL. (USA). GRASSELLI CHEMICALS DEPT.].

REFERENCE- J. PHYS. CHEM., V. 58, P. 453-455(JUN 1954).

DESCRIPTORS- AMORPHOUS SILICA; AQUEOUS SOLUTIONS; CHEMICAL REACTIONS; EXPERIMENTAL RESULTS; MEASURING METHODS; PH VALUE; PH DEPENDENCE; SILICA CHEMISTRY; SILICA SOLUBILITY; TEMPERATURE DEPENDENCE; TIME DEPENDENCE.

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ALEXANDER 54B
BRINE TREATMENT/SCALING

TITLE- THE POLYMERIZATION OF MONOSILICIC ACID.

AUTHOR- ALEXANDER, G.B. [DU PONT DE NEMOURS (E.I.) AND CO., INC., WILMINGTON, DEL. (USA). GRASSELLI CHEMICALS DEPT.].

REFERENCE- AM. CHEM. SOC. J., V. 76, P. 2094-2096(APR 1954).

DESCRIPTORS- EXPERIMENTAL RESULTS; MEASURING METHODS; PH VALUE; PH DEPENDENCE; POLYMERIZATION; SILICA MINERALS; SILICA CHEMISTRY; SILICA SOLUBILITY; TEMPERATURE DEPENDENCE; TIME DEPENDENCE.

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ALLEGRINI 70
BRINE TREATMENT/CORROSION
BRINE TREATMENT/SCALING

TITLE- CORROSION CHARACTERISTICS AND GEOTHERMAL POWER PLANT PROTECTION (COLLATERAL PROCESSES OF ABRASION, EROSION AND SCALING).

AUTHOR- ALLEGRINI, G.;BENVENUTI, G. [ENTE NAZIONALE PER L'ENERGIA ELETTRICA, LARDERELLO (ITALY). COMPARTIMENTO DI FIRENZE, GRUPPO PERFORAZIONI, I.M.].

REFERENCE- GEOTHERMICS, SPECIAL ISSUE 2, V. 2 (1), P. 865-881(1970).

DESCRIPTORS- ABRASION; CHEMICAL COMPOSITION; BRINE TREATMENT; CHLORIDES; COOLING TOWERS; CORROSION; CORROSION PROTECTION; CORROSION RESISTANT ALLOYS; EROSION; EXPERIMENTAL RESULTS; MEASURING METHODS; ELECTROCHEMICAL CORROSION; GEOTHERMAL FLUIDS; GEOTHERMAL POWER PLANTS; HYDROGEN SULFIDES; IRON OXIDES; PH ADJUSTMENT; PH VALUE; PIPELINES; PITTING CORROSION; SCALING; STRESS CORROSION; SULFIDES; SURFACE EQUIPMENT; SUSPENDED SOLIDS; TEMPERATURE DEPENDENCE; TURBINE BLADES; LARDERELLO GEOTHERMAL FIELD; ITALY.

138

BANNING 73
BRINE TREATMENT/CORROSION

TITLE- CORROSION RESISTANCE OF METALS IN HOT BRINES--A LITERATURE REVIEW.

AUTHOR- BANNING, L.H.;ODEN, L.L. [ALBANY METALLURGY RESEARCH CENTER, ALBANY, OREG. (USA)].

REFERENCE- CORROSION RESISTANCE OF METALS IN HOT BRINES--A LITERATURE REVIEW. IC-8601, BUREAU

OF MINES, U.S. DEPT. OF THE INTERIOR, WASHINGTON, D.C., 1973, 39 P..

DESCRIPTORS- BRINES; CHEMICAL ANALYSIS; CHEMICAL COMPOSITION; CHLORIDES; CORROSION; CORROSION RESISTANT ALLOYS; EROSION; EXPERIMENTAL RESULTS; MEASURING METHODS; ELECTROCHEMICAL CORROSION; GEOTHERMAL BRINES; GEOTHERMAL FLUIDS; PH VALUE; PITTING CORROSION; STRESS CORROSION; SULFIDES; HVERAGERDI GEOTHERMAL FIELD; GEYSERS GEOTHERMAL FIELD; MATSUKAWA GEOTHERMAL FIELD; CERRO PRIETO GEOTHERMAL FIELD; IMPERIAL VALLEY; WAIRAKEI GEOTHERMAL FIELD; CALIFORNIA; NEW ZEALAND; MEXICO; JAPAN; ICELAND.

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BEHRMAN 40
BRINE TREATMENT/SCALING

TITLE- REMOVAL OF SILICA FROM WATER.

AUTHOR- BEHRMAN, A.S.;GUSTAFSON, H. [INTERNATIONAL FILTER CO., CHICAGO, ILL. (USA)].

REFERENCE- IND. ENG. CHEM., V. 32 (4), P. 468-472(APR 1940).

DESCRIPTORS- BRINE TREATMENT; EXPERIMENTAL RESULTS; MEASURING METHODS; FLOCCULATION; FLOCCULATING AGENTS; HEAT TRANSFER; HYDROXIDES; IRON OXIDES; METALS; PH ADJUSTMENT; PRECIPITATION; SCALING; DESCALING; SILICA MINERALS.

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CATALANO 75
BRINE TREATMENT/SCALING

TITLE- COMMENTS ON THE POSSIBLE EFFECTS OF ADDITIVES ON SCALING BY GEOTHERMAL BRINES.

AUTHOR- CATALANO, E.;HILL, J.H. [CALIFORNIA UNIV., LIVERMORE (USA). LAWRENCE LIVERMORE LAB.].

REFERENCE- COMMENTS ON THE POSSIBLE EFFECTS OF ADDITIVES ON SCALING BY GEOTHERMAL BRINES. M.S., UCRL-51756, CALIFORNIA UNIV.,LAWRENCE LIVERMORE LAB., LIVERMORE (USA), FEB 1975, 7

DESCRIPTORS- ADDITIVES; CARBONATES; CHEMICAL REACTIONS; CORROSION; GEOTHERMAL BRINES; HYDROXIDES; METALS; PH ADJUSTMENT; PH DEPENDENCE; POLYMERIZATION; PRECIPITATION; SCALING; SCALING CONTROL; SILICA MINERALS; SILICA CHEMISTRY; SULFIDES; THERMODYNAMICS.

141

ELLIS 64
BRINE TREATMENT/SCALING

TITLE- NATURAL HYDROTHERMAL SYSTEMS AND EXPERIMENTAL HOT-WATER/ROCK INTERACTIONS.

AUTHOR- ELLIS, A.J.;MAHON, W.A.J. [DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH, PETONE (NEW ZEALAND). CHEMISTRY DIVISION].

REFERENCE- GEOCHIM. COSMOCHIM. ACTA, V. 28, P. 1323-1357(1964).

DESCRIPTORS- AMORPHOUS SILICA; CHEMICAL ANALYSIS; CHEMICAL COMPOSITION; CHLORIDES; CONCENTRATION DEPENDENCE; CRISTOBALITE; ELEVATED PRESSURE; EXPERIMENTAL RESULTS; GEOTHERMAL BRINES; HYDROGEN SULFIDES; MEASURING METHODS; QUARTZ; ROCK-FLUID INTERACTIONS; ROCKS; SILICA MINERALS; SILICA CHEMISTRY; SILICA SOLUBILITY; ELEVATED TEMPERATURE; TEMPERATURE DEPENDENCE; TIME DEPENDENCE; NEW ZEALAND.

142

FOSTER 61
BRINE TREATMENT/CORROSION

TITLE- CORROSION INVESTIGATIONS IN HYDROTHERMAL MEDIA AT WAIRAKEI, NEW ZEALAND.

AUTHOR- FOSTER, P.K.;MARSHALL, T.;TOMBS, A. [DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH, WELLINGTON (NEW ZEALAND). DOMINION LAB.].

REFERENCE- PROCEEDINGS OF THE UNITED NATIONS CONFERENCE ON NEW SOURCES OF ENERGY. VOLUME 3, GEOTHERMAL ENERGY--II. UNITED NATIONS, NEW YORK, 1964, V.3, GEOTHERMAL ENERGY--II, P.186-195.

DESCRIPTORS- CARBONATES; CATHODIC DEPOLARIZATION; CHLORIDES; CORROSION; CORROSION PROTECTION; CORROSION RESISTANT ALLOYS; EROSION;

EXPERIMENTAL RESULTS; GEOTHERMAL BRINES; HYDROGEN SULFIDES; MEASURING METHODS; MODERATE PRESSURE; PITTING CORROSION; STRESS CORROSION; SULFIDES; ELEVATED TEMPERATURE; MODERATE TEMPERATURE; TEMPERATURE DEPENDENCE; TIME DEPENDENCE; TURBINE BLADES; WAIRAKEI GEOTHERMAL FIELD; NEW ZEALAND.

143

FOURNIER 62
BRINE TREATMENT/SCALING

TITLE- THE SOLUBILITY OF CRISTOBALITE ALONG THE THREE-PHASE CURVE, GAS PLUS LIQUID PLUS CRISTOBALITE.

AUTHOR- FOURNIER, R.O.;ROWE, J.J. [GEOLOGICAL SURVEY, WASHINGTON, D.C. (USA)].

REFERENCE- AM. MINERAL., V. 47, P. 897-902(1962).

DESCRIPTORS- CRISTOBALITE; EXPERIMENTAL RESULTS; FREE ENERGY; MEASURING METHODS; SILICA MINERALS; SILICA SOLUBILITY; MODERATE TEMPERATURE; ELEVATED TEMPERATURE; TEMPERATURE DEPENDENCE; THERMODYNAMICS.

144

HOFFMANN 75
BRINE TREATMENT/SCALING
BRINE TREATMENT/CORROSION

TITLE- BRINE CHEMISTRY--SCALING AND CORROSION. GEOTHERMAL RESEARCH STUDY IN THE SALTON SEA REGION OF CALIFORNIA.

AUTHOR- HOFFMANN, M.R. [CALIFORNIA INST. OF TECH., PASADENA (USA). ENVIRONMENTAL QUALITY LAB.].

REFERENCE- BRINE CHEMISTRY--SCALING AND CORROSION. GEOTHERMAL RESEARCH STUDY IN THE SALTON SEA REGION OF CALIFORNIA. EQL MEMORANDUM NO. 14, CALIFORNIA INST. OF TECH., ENVIRONMENTAL QUALITY LAB., PASADENA, CALIF. (USA), JUL 1975, 48 P..

DESCRIPTORS- BINARY FLUID SYSTEMS; BRINES; CARBONATES; CATHODIC DEPOLARIZATION; CHEMICAL

COMPOSITION; CHEMICAL REACTIONS; BRINE TREATMENT; CHLORIDES; CORROSION; CORROSION RESISTANT ALLOYS; CRYSTAL SEEDING; ECONOMICS; EXPERIMENTAL RESULTS; MEASURING METHODS; FLOCCULATING AGENTS; FLOW RATE; GEOCHEMISTRY; GEOTHERMAL BRINES; GEOTHERMAL FLUIDS; GEOTHERMAL RESERVOIRS; GEOTHERMAL WELLS; HYDROGEN SULFIDES; LEGAL ASPECTS; MINERAL RECOVERY; OPALINE SCALE; PH VALUE; PITTING CORROSION; PRECIPITATION; RESERVOIR PROPERTIES; SCALING; SCALING CONTROL; SCRUBBERS; SILICA MINERALS; SILICA CHEMISTRY; SILICA SOLUBILITY; STRESS CORROSION; TEMPERATURE DEPENDENCE; TOTAL FLOW SYSTEM; TURBINE BLADES; SALTON SEA GEOTHERMAL FIELD; CALIFORNIA.

145

HUANG 75
BRINE TREATMENT/SCALING

TITLE- THE REMOVAL OF AQUEOUS SILICA FROM DILUTE AQUEOUS SOLUTION.

AUTHOR- HUANG, C.P. (DELAWARE UNIV., NEWARK (USA). DEPT. OF CIVIL INGINEERING).

REFERENCE- EARTH PLANET. SCI. LETT., V. 27, P. 265-274(1975).

DESCRIPTORS- AQUEOUS SOLUTIONS; CHEMICAL REACTIONS; CONCENTRATION DEPENDENCE; EXPERIMENTAL RESULTS; FREE ENERGY; MEASURING INSTRUMENTS; MEASURING METHODS; PH VALUE; PH DEPENDENCE; SILICA MINERALS; SILICA CHEMISTRY; SILICA SOLUBILITY; SILICATES; SUSPENDED SOLIDS.

146

ILER 55
BRINE TREATMENT/SCALING

TITLE- THE COLLOID CHEMISTRY OF SILICA AND SILICATES.

AUTHOR- ILER, R.K. (CORNELL UNIV., ITHACA,

REFERENCE- THE COLLOID CHEMISTRY OF SILICA AND SILICATES. CORNELL UNIVERSITY PRESS, ITHACA, NEW YORK, 1955, 324 P..

DESCRIPTORS- AMORPHOUS SILICA; AQUEOUS SOLUTIONS; CHEMICAL REACTIONS; CLAY MINERALS; CONCENTRATION DEPENDENCE; CRISTOBALITE; ENVIRONMENTAL EFFECTS; EXPERIMENTAL RESULTS; METALS; PH VALUE; PH DEPENDENCE; POLYMERIZATION; QUARTZ; SILICA MINERALS; SILICA CHEMISTRY; SILICA SOLUBILITY; MODERATE TEMPERATURE; ELEVATED TEMPERATURE; TEMPERATURE DEPENDENCE; TIME DEPENDENCE; TRIDYMITE.

147

JACKSON 76
BRINE TREATMENT/SCALING

TITLE- POSSIBILITIES FOR CONTROLLING HEAVY METAL SULFIDES IN SCALE FROM GEOTHERMAL BRINES.

AUTHOR- JACKSON, D.D.;HILL, J.H. [CALIFORNIA UNIV., LIVERMORE (USA). LAWRENCE LIVERMORE LAB.].

REFERENCE- POSSIBILITIES FOR CONTROLLING HEAVY METAL SULFIDES IN SCALE FROM GEOTHERMAL BRINES. UCRL-51977, CALIFORNIA UNIV., LAWRENCE LIVERMORE LAB., LIVERMORE, CALIF., JAN 1976, 14 P..

DESCRIPTORS- AMORPHOUS SILICA; CHEMICAL COMPOSITION; CHEMICAL REACTIONS; BRINE TREATMENT; GEOTTHERMAL BRINES; METALS; OXIDATION; PRECIPITATION; PRESSURE DEPENDENCE; SCALING; SCALING CONTROL; DESCALING; SOLUBILITY; SULFIDES; SURFACE EQUIPMENT; SUSPENDED SOLIDS; TEMPERATURE DEPENDENCE; SALTON SEA GEOTHERMAL FIELD.

148

KENNEDY 50
BRINE TREATMENT/SCALING

TITLE- A PORTION OF THE SYSTEM SILICA-WATER.

AUTHOR- KENNEDY, G.C. [HARVARD UNIV., CAMBRIDGE, MASS. (USA). GEOLOGICAL MUSEUM].

REFERENCE- ECON. GEOL., V. 45, P. 629-653(1950).

DESCRIPTORS- AMORPHOUS SILICA; AQUEOUS SOLUTIONS; ELEVATED PRESSURE; EXPERIMENTAL RESULTS; GEOLOGY; GEOTHERMAL FLUIDS; HIGH PRESSURE;

MEASURING INSTRUMENTS; MEASURING METHODS; MODERATE PRESSURE; PRESSURE DEPENDENCE; QUARTZ; SILICA MINERALS; SILICA CHEMISTRY; SILICA SOLUBILITY; ELEVATED TEMPERATURE; HIGH TEMPERATURE; TEMPERATURE DEPENDENCE; TIME DEPENDENCE.

149

KITAHARA 6C
BRINE TREATMENT/SCALING

TITLE- THE POLYMERIZATION OF SILICIC ACID OBTAINED BY THE HYDROTHERMAL TREATMENT OF QUARTZ AND THE SOLUBILITY OF AMORPHOUS SILICA.

AUTHOR- KITAHARA, S. [FUKUOKA GAKUGEI UNIV., TAGAWA (JAPAN)].

REFERENCE- REV. PHYS. CHEM. JAPAN, V. 30 (2), P. 131-137(DEC 1960).

DESCRIPTORS- AMORPHOUS SILICA; CHEMICAL REACTIONS; CONCENTRATION DEPENDENCE; EXPERIMENTAL RESULTS; MEASURING METHODS; PH DEPENDENCE; POLYMERIZATION; QUARTZ; SILICA MINERALS; LOW TEMPERATURE; MODERATE TEMPERATURE; TEMPERATURE DEPENDENCE; TIME DEPENDENCE.

150

KITAHARA 60B
BRINE TREATMENT/SCALING

TITLE- THE SOLUBILITY EQUILIBRIUM AND THE RATE OF SOLUTION OF QUARTZ IN WATER AT HIGH TEMPERATURES AND HIGH PRESSURES.

AUTHOR- KITAHARA, S. [FUKUOKA GAKUGEI UNIV., TAGAWA (JAPAN)].

REFERENCE- REV. PHYS. CHEM. JAPAN, V. 30 (2), P. 122-130(DEC 1960).

DESCRIPTORS- AQUEOUS SOLUTIONS; CHEMICAL REACTIONS; CONCENTRATION DEPENDENCE; ELEVATED PRESSURE; EXPERIMENTAL RESULTS; HIGH PRESSURE; MEASURING METHODS; PRESSURE DEPENDENCE; QUARTZ; SILICA SOLUBILITY; SODIUM CHLORIDES; HIGH TEMPERATURE; TEMPERATURE DEPENDENCE; TIME DEPENDENCE.

151

KITAHARA 60C
BRINE TREATMENT/SCALING

TITLE- THE SOLUBILITY OF QUARTZ IN THE AQUEOUS SODIUM CHLORIDE SOLUTION AT HIGH TEMPERATURES AND HIGH PRESSURES.

AUTHOR- KITAHARA, S. [FUKUOKA GAKUGEI UNIV., TAGAWA (JAPAN)].

REFERENCE- REV. PHYS. CHEM. JAPAN, V. 30 (2), P. 115-121(DEC 1960).

DESCRIPTORS- AQUEOUS SOLUTIONS: CONCENTRATION DEPENDENCE; DATA; EXPERIMENTAL RESULTS; PRESSURE DEPENDENCE: MODERATE PRESSURE; ELEVATED PRESSURE; QUARTZ; CHEMICAL REACTION KINETICS; SOLUBILITY; TEMPERATURE DEPENDENCE; ELEVATED TEMPERATURE; HIGH TEMPERATURE; SODIUM CHLORIDES.

152

KRAUSKOPF 56
BRINE TREATMENT/SCALING

TITLE- DISSOLUTION AND PRECIPITATION OF SILICA AT LOW TEMPERATURES.

AUTHOR- KRAUSKOPF, K.B. [STANFORD UNIV., CALIF. (USA)].

REFERENCE- GEOCHIM. COSMOCHIM. ACTA, V. 10, P. 1-26(1956).

DESCRIPTORS- AMORPHOUS SILICA; CALCITE; CLAY MINERALS; COLLOIDAL SILICA; PH DEPENDENCE; POLYMERIZATION; PRECIPITATION; SEAWATER; SILICA SOLUBILITY; TEMPERATURE DEPENDENCE; LOW TEMPERATURE; MODERATE TEMPERATURE; TIME DEPENDENCE.

153

FLORKE 76
BRINE TREATMENT/SCALING

TITLE- HYDROTHERMAL TRANSPORT AND DEPOSITION OF SILICA.

AUTHOR- FLORKE, O.W. (RUHR-UNIVERSITAT BOCHUM, (GERMANY). INSTITUT FUR MINERALOGIE).

REFERENCE- CONFERENCE ON SCALE MANAGEMENT IN GEOTHERMAL ENERGY DEVELOPMENT. U. S. ERDA, DIV. OF GEOTHERMAL ENERGY, WASHINGTON, D.C., 1976, P. 1-8.

DESCRIPTORS- CHEMICAL REACTIONS; CRYSTALLIZATION; MEASURING METHODS; HYDROTHERMAL SYSTEMS; PRECIPITATION; SILICA MINERALS; TEMPERATURE DEPENDENCE; ELEVATED TEMPERATURE; HIGH TEMPERATURE; CHRISTOBALITE; TRIDYMITE; QUARTZ; CHALCEDONY.

154

DOWNS 76
BRINE TREATMENT/SCALING

TITLE- KINETICS OF SILICA SCALING.

AUTHOR- DOWNS, W.F.;RIMSTIDT, J.D.;BARNES, H.L. (PENNSYLVANIA STATE UNIV., UNIVERSITY PARK (USA). DEPT. OF GEOSCIENCES).

REFERENCE- CONFERENCE ON SCALE MANAGEMENT IN GEOTHERMAL ENERGY DEVELOPMENT. U. S. ERDA, DIV. OF GEOTHERMAL ENERGY, WASHINGTON, D.C., 1976, P. 9-18.

DESCRIPTORS- MEASURING METHODS; PRECIPITATION; ROCK-FLUID INTERACTIONS; SCALING; SILICA MINERALS; TEMPERATURE DEPENDENCE; HYDROTHERMAL SYSTEMS; CHEMICAL REACTION KINETICS; SODIUM CHLORIDES; QUARTZ.

155

FOURNIER 76
BRINE TREATMENT/SCALING

TITLE- THE SOLUBILITY OF AMORPHOUS SILICA AT HIGH
TEMPERATURES AND HIGH PRESSURES.

AUTHOR- FOURNIER, R.O. [GEOLOGICAL SURVEY, MENLO
PARK, CALIF. (USA)].

REFERENCE- CONFERENCE ON SCALE MANAGEMENT IN
GEOTHERMAL ENERGY DEVELOPMENT. U. S. ERDA,
DIV. OF GEOTHERMAL ENERGY, WASHINGTON, D.C.,
1976, P. 19-24.

DESCRIPTORS- AMORPHOUS SILICA; MEASURING METHODS;
PRESSURE DEPENDENCE; HIGH PRESSURE; SILICA
SOLUBILITY; TEMPERATURE DEPENDENCE; MODERATE
TEMPERATURE; ELEVATED TEMPERATURE.

156

HARVEY 76
BRINE TREATMENT/SCALING

TITLE- KINETICS OF SILICA CONDENSATION IN BRINES.

AUTHOR- HARVEY, W.W.;MAKRIDES, A.C.;SLAUGHTER,
J.;TURNER, M.J. [EIC CORPORATION, NEWTON, MASS.
(USA)].

REFERENCE- CONFERENCE ON SCALE MANAGEMENT IN
GEOTHERMAL ENERGY DEVELOPMENT. U. S. ERDA,
DIV. OF GEOTHERMAL ENERGY, WASHINGTON, D.C.,
1976, P. 25-36.

DESCRIPTORS- BRINES; MEASURING METHODS; GEOTHERMAL
FLUIDS; NUCLEATION; PRECIPITATION; SILICA
MINERALS; CHEMICAL REACTION KINETICS; PH
DEPENDENCE; CONCENTRATION DEPENDENCE;
TEMPERATURE DEPENDENCE; SILICIC ACID.

157

MESMER 76
BRINE TREATMENT/SCALING

TITLE- STUDIES ON THE IONIZATION EQUILIBRIA OF
SILICIC ACID AND POLYSILICATE EQUILIBRIA IN
HIGH TEMPERATURE BRINES.

AUTHOR- MESMER, R.E.;BUSEY, R.H. [OAK RIDGE NATIONAL
LAB., TENN. (USA)].

REFERENCE- CONFERENCE ON SCALE MANAGEMENT IN GEOTHERMAL ENERGY DEVELOPMENT. U. S. ERDA, DIV. OF GEOTHERMAL ENERGY, WASHINGTON, D.C., 1976, P. 37-50.

DESCRIPTORS- BRINES; MEASURING METHODS; SILICA MINERALS; SILICATES; TEMPERATURE DEPENDENCE; MODERATE TEMPERATURE; ELEVATED TEMPERATURE; SILICIC ACIDS; CHEMICAL EQUILIBRIUM; HYDROTHERMAL SYSTEMS; SODIUM CHLORIDES.

158

MICHELS 76
BRINE TREATMENT/SCALING

TITLE- MOLECULAR MECHANISMS OF SCALE DEPOSITION.

AUTHOR- MICHELS, D.E.;KEISER, D.D. [IDAHO NATIONAL ENGINEERING LAB., IDAHO FALLS (USA)].

REFERENCE- CONFERENCE ON SCALE MANAGEMENT IN GEOTHERMAL ENERGY DEVELOPMENT. U. S. ERDA, DIV. OF GEOTHERMAL ENERGY, WASHINGTON, D.C., 1976, P. 51-58.

DESCRIPTORS- CRYSTALLIZATION; NUCLEATION; PRECIPITATION; SCALING; SURFACE PROPERTIES; FOULING; GEOLOGIC STRUCTURES; MOLECULAR STRUCTURE.

159

MERCADO 76
BRINE TREATMENT/SCALING

TITLE- PROBLEMS OF SILICA SCALING AT CERRO PRIETO GEOTHERMAL POWER STATION.

AUTHOR- MERCADO, S.;GUIZA, J. [COMISION FEDERAL DE ELECTRICIDAD, MEXICO CITY (MEXICO)].

REFERENCE- CONFERENCE ON SCALE MANAGEMENT IN GEOTHERMAL ENERGY DEVELOPMENT. U. S. ERDA, DIV. OF GEOTHERMAL ENERGY, WASHINGTON, D.C., 1976, P. 59-88.

DESCRIPTORS- GEOTHERMAL FLUIDS; SCALING; SILICA MINERALS; TURBINE BLADES; CERRO PRIETO GEOTHERAL FIELD; FOULING.

160

HUTCHINSON 76
BRINE TREATMENT/SCALING

TITLE- PROGRESS REPORT--PROCESSING OF HYPERSALINE BRINE.

AUTHOR- HUTCHINSON, A.J.L. [THE BEN HOLT CO., PASADENA, CALIF. (USA)].

REFERENCE- CONFERENCE ON SCALE MANAGEMENT IN GEOTHERMAL ENERGY DEVELOPMENT. U. S. ERDA, DIV. OF GEOTHERMAL ENERGY, WASHINGTON, D.C., 1976, P. 89-90.

DESCRIPTORS- GEOTHERMAL BRINES; HEAT EXCHANGERS; HEAT TRANSFER; STEAM SCRUBBERS; WELL DATA; IMPERIAL VALLEY; NILAND; FOULING; FLASHING.

161

MC KAY 76
BRINE TREATMENT/SCALING

TITLE- EXPERIENCE, PLANS, AND A MIXED FLOW EXPANDER.

AUTHOR- MC KAY, R.A. [JET PROPULSION LAB., PASADENA, CALIF. (USA)].

SPRANKLE, R.S. [HYDROTHERMAL POWER CO., LTD., MISSION VIEJO, CALIF. (USA)].

REFERENCE- CONFERENCE ON SCALE MANAGEMENT IN GEOTHERMAL ENERGY DEVELOPMENT. U. S. ERDA, DIV. OF GEOTHERMAL ENERGY, WASHINGTON, D.C., 1976, P. 91-102.

DESCRIPTORS- CORROSION PROTECTION; DISSOLVED SOLIDS; EROSION; GEOTHERMAL FLUIDS; PRECIPITATION; SCALING; SCALING CONTROL; FLOW EXPANDER; TURBINES; MEXICO; FLUID FLOW; GEOTHERMAL POWER PLANTS; PILOT PLANTS.

162

BALAGNA 76
BRINE TREATMENT/SCALING

TITLE- GEOCHEMICAL CONSIDERATIONS FOR HOT, DRY ROCK SYSTEMS.

AUTHOR- BALAGNA, J.;BLATZ, L.;CHARLES, R.;FEBER, R.;HERRICK, C.;HOLLEY, C.;TESTER, J.;VIDALE, R. [LOS ALAMOS SCIENTIFIC LAB., N. MEX. (USA)].

REFERENCE- CONFERENCE ON SCALE MANAGEMENT IN GEOTHERMAL ENERGY DEVELOPMENT. U. S. ERDA, DIV. OF GEOTHERMAL ENERGY, WASHINGTON, D.C., 1976, P. 103-114.

DESCRIPTORS- ADDITIVES; GEOCHEMISTRY; GEOTHERMAL FLUIDS; HEAT EXCHANGERS; HEAT TRANSFER; PERMEABILITY; PRECIPITATION; ROCK-FLUID INTERACTIONS; SCALING; SILICA MINERALS; SILICA SOLUBILITY; ELEVATED TEMPERATURE; HOT-DRY-ROCK SYSTEMS; LASL; GEOTHERMAL SYSTEMS; EXPERIMENTAL MODELS; CHEMICAL EQUILIBRIUM; FLOW MODELS.

163

COLLINS 76
BRINE TREATMENT/SCALING

TITLE- PRIMARY VARIABLES WHICH CAUSE SOME COMMON SCALES IN SALINE WATER SYSTEMS.

AUTHOR- COLLINS, A.G. [BARTLESVILLE ENERGY RESEARCH CENTER, OKLA. (USA)].

REFERENCE- CONFERENCE ON SCALE MANAGEMENT IN GEOTHERMAL ENERGY DEVELOPMENT. U. S. ERDA, DIV. OF GEOTHERMAL ENERGY, WASHINGTON, D.C., 1976, P. 115-126.

DESCRIPTORS- BRINES; CARBONATES; CLAY MINERALS; CORROSION; DISSOLVED SOLIDS; GEOTHERMAL FLUIDS; HYDROXIDES; OILFIELD BRINES; SCALING; SILICA MINERALS; TEMPERATURE DEPENDENCE; BARIUM SULFATES; PRESSURE DEPENDENCE; PH DEPENDENCE; CALCITE; CALCIUM SULFATES; QUARTZ; ANHYDRITE; DISOLVED GASES; CARBON DIOXIDE PARTIAL PRESSURE.

164

NEEDHAM 76
BRINE TREATMENT/SCALING

TITLE- SCALING IN BOTH HIGH-AND LOW-SALINITY BRINES.

AUTHOR- NEEDHAM, P.B., JR.;MURPHY, A.P.;MC CAWLEY, F.V. [BUREAU OF MINES, COLLEGE PARK, MD. (USA)].

REFERENCE- CONFERENCE ON SCALE MANAGEMENT IN GEOTHERMAL ENERGY DEVELOPMENT. U. S. ERDA, DIV. OF GEOTHERMAL ENERGY, WASHINGTON, D.C., 1976, P. 127-144.

DESCRIPTORS- CHEMICAL ANALYSIS; CORROSION; CORROSION RESISTANT ALLOYS; GEOTHERMAL BRINES; MINERAL RECOVERY; SCALE COMPOSITION; SCALING; WELL CHARACTERISTICS; IMPERIAL VALLEY; SALTON SEA KGRA; FIELD STUDIES; EAST MESA KGRA.

165

APPS 76
BRINE TREATMENT/SCALING

TITLE- THE KINETICS OF QUARTZ DISSOLUTION AND PRECIPITATION.

AUTHOR- APPS, J.A. [CALIFORNIA UNIV., BERKELEY (USA). LAWRENCE BERKELEY LAB.].

REFERENCE- CONFERENCE ON SCALE MANAGEMENT IN GEOTHERMAL ENERGY DEVELOPMENT. U. S. ERDA, DIV. OF GEOTHERMAL ENERGY, WASHINGTON, D.C., 1976, P. 145-152.

DESCRIPTORS- CHEMICAL REACTIONS; GEOTHERMAL FIELDS; PRECIPITATION; SILICA MINERALS; TEMPERATURE DEPENDENCE; MODERATE TEMPERATURE; ELEVATED TEMPERATURE; HIGH TEMPERATURE; REVIEWS; DATA; QUARTZ; GEOTHERMAL RESERVOIRS; SOLUBILITY; GEOTHERMAL POWER PLANTS; CHEMICAL REACTION KINETICS.

166

KASTNER 76
BRINE TREATMENT/SCALING

TITLE- CHEMICAL CONTROLS ON THE OPAL-A TO OPAL-CT TRANSFORMATION.

AUTHOR- KASTNER, M.;KEENE, J.B. [SCRIPPS INST. OF OCEANOGRAPHY, LA JOLLA, CALIF. (USA)].

REFERENCE- CONFERENCE ON SCALE MANAGEMENT IN GEOTHERMAL ENERGY DEVELOPMENT. U. S. ERDA, DIV. OF GEOTHERMAL ENERGY, WASHINGTON, D.C., 1976, P. 153-160.

DESCRIPTORS- CARBONATES; CHEMICAL ANALYSIS; MINERALOGY; PRECIPITATION; SILICA MINERALS; SILICA CHEMISTRY; TEMPERATURE DEPENDENCE; PRESSURE DEPENDENCE; OPAL; CHALCEDONY; QUARTZ; DIAGENESIS.

167

GRENS 76
BRINE TREATMENT/SCALING

TITLE- INHIBITING DEPOSITION OF SILICEOUS SCALE.

AUTHOR- GRENS, J.Z.;OWEN, L.B. [CALIFORNIA UNIV., LIVERMORE (USA). LAWRENCE LIVERMORE LAB.].

REFERENCE- CONFERENCE ON SCALE MANAGEMENT IN GEOTHERMAL ENERGY DEVELOPMENT. U. S. ERDA, DIV. OF GEOTHERMAL ENERGY, WASHINGTON, D.C., 1976, P. 161-168.

DESCRIPTORS- ACIDIZATION; ADDITIVES; EXPERIMENTAL RESULTS; GEOTHERMAL BRINES; PH VALUE; SCALINGCONTROL; SILICA MINERALS; TOTAL FLOW SYSTEM; TURBINE BLADES; FOULING; SALTON SEA KGRA; GEOTHERMAL POWER PLANTS; PH DEPENDENCE; DATA; FIELD STUDIES; NOZZLES; PH ADJUSTMENT.

168

VETTER 76
BRINE TREATMENT/SCALING

TITLE- WHAT WE DO NOT KNOW ABOUT SCALING.

AUTHOR- VETTER, O. [UNION OIL RESEARCH CENTER, BREA, CALIF. (USA)].

REFERENCE- CONFERENCE ON SCALE MANAGEMENT IN GEOTHERMAL ENERGY DEVELOPMENT. U. S. ERDA, DIV. OF GEOTHERMAL ENERGY, WASHINGTON, D.C., 1976, P. 169-176.

DESCRIPTORS- ECONOMICS; GEOTHERMAL FLUIDS; SCALING; SCALING CONTROL; FIELD STUDIES; DATA.

169

BOHLMANN 76
BRINE TREATMENT/SCALING

TITLE- SILICA PRECIPITATION AND SCALING IN DYNAMIC GEOTHERMAL SYSTEMS.

AUTHOR- BOHLMANN, E.G.;SHOR, A.J.;BERLINSKI, P. [OAK RIDGE NATIONAL LAB., TENN. (USA)].

REFERENCE- CONFERENCE ON SCALE MANAGEMENT IN GEOTHERMAL ENERGY DEVELOPMENT. U. S. ERDA, DIV. OF GEOTHERMAL ENERGY, WASHINGTON, D.C., 1976, P. 171-186.

DESCRIPTORS- CORROSION; MEASURING METHODS; FLOW RATE; GEOTHERMAL FLUIDS; HEAT EXCHANGERS; PRECIPITATION; SCALING; SILICA MINERALS; GEOTHERMAL SYSTEMS; TEST FACILITIES; TEMPERATURE DEPENDENCE; SODIUM CHLORIDES; DYNAMIC SYSTEMS.

170

ALLEN 76
BRINE TREATMENT/SCALING

TITLE- THE DEVELOPMENT OF LIQUID-FLUIDIZED BED HEAT EXCHANGERS FOR CONTROLLING THE DEPOSITION OF SCALE IN GEOTHERMAL APPLICATIONS.

AUTHOR- ALLEN, C.A.;GRIMMETT, E.S.;MC ATEE, R.E. [IDAHO NATIONAL ENGINEERING LAB., IDAHO FALLS (USA)].

REFERENCE- CONFERENCE ON SCALE MANAGEMENT IN GEOTHERMAL ENERGY DEVELOPMENT. U. S. ERDA, DIV. OF GEOTHERMAL ENERGY, WASHINGTON, D.C., 1976, P. 187-198.

DESCRIPTORS- ECONOMICS; EXPERIMENTAL RESULTS; HEAT TRANSFER; HEAT TRANSFER COEFFICIENT; SCALING; SCALING CONTROL; GEOTHERMAL SYSTEMS; FLUIDIZED BED HEAT EXCHANGER; RAFT RIVER KGRA; EAST MESA KGRA; TEST FACILITIES.

171

WAGNER 76
BRINE TREATMENT/SCALING

TITLE- A PRELIMINARY STUDY OF AMORPHOUS SILICA DEPOSITION IN A BENCH-SCALE LIQUID FLUIDIZED BED HEAT EXCHANGER.

AUTHOR- WAGNER, K.L. [ALLIED CHEMICAL CORPORATION, IDAHO FALLS, IDAHO (USA)].

ALLEN, C.A. [IDAHO NATIONAL ENGINEERING LAB., IDAHO FALLS, (USA)].

REFERENCE- CONFERENCE ON SCALE MANAGEMENT IN GEOTHERMAL ENERGY DEVELOPMENT. U. S. ERDA, DIV. OF GEOTHERMAL ENERGY, WASHINGTON, D.C., 1976, P. 199-206.

DESCRIPTORS- ECONOMICS; MEASURING METHODS; GEOTHERMAL BRINES; HEAT TRANSFER; SCALING CONTROL; SILICA MINERALS; AMORPHOUS SILICA; FOULING; FLUIDIZED BED HEAT EXCHANGER; PILOT PLANTS; GEOTHERMAL POWER PLANTS; CALCITE.

172

WILSON 76
BRINE TREATMENT/SCALING

TITLE- SCALE FORMATION AND SUPPRESSION IN HEAT EXCHANGE SYSTEMS FOR SIMULATED GEOTHERMAL BRINES.

AUTHOR- WILSON, J.S. [DOW CHEMICAL CO., FREEPORT, TEX. (USA)].

REFERENCE- CONFERENCE ON SCALE MANAGEMENT IN GEOTHERMAL ENERGY DEVELOPMENT. U. S. ERDA, DIV. OF GEOTHERMAL ENERGY, WASHINGTON, D.C., 1976, P. 207-214.

DESCRIPTORS- GEOTHERMAL BRINES; HEAT EXCHANGERS; SCALING.

173

JACKSON 76B
BRINE TREATMENT/SCALING

TITLE- COMPUTATIONAL METHODS FOR ESTIMATING PRECIPITATION FROM GEOTHERMAL BRINES.

AUTHOR- JACKSON, D.;PIWINSKII, A.J.;MILLER, D.G. [CALIFORNIA UNIV., LIVERMORE (USA); LAWRENCE LIVERMORE LAB.].

REFERENCE- CONFERENCE ON SCALE MANAGEMENT IN GEOTHERMAL ENERGY DEVELOPMENT. U. S. ERDA, DIV. OF GEOTHERMAL ENERGY, WASHINGTON, D.C., 1976, P. 227-246.

DESCRIPTORS- CHLORIDES; GEOTHERMAL BRINES; PRECIPITATION; ELEVATED TEMPERATURE; THEORETICAL TREATMENTS; SALTON SEA GEOTHERMAL FIELD.

174

SHANNON 76
BRINE TREATMENT/SCALING
BRINE TREATMENT/CORROSION

TITLE- THE GEOSCALE COMPUTER MODEL FOR GEOTHERMAL PLANT SCALING AND CORROSION ANALYSES.

AUTHOR- SHANNON, D.W.;WALTER, R.A.;LESSOR, D.L. [BATTELLE PACIFIC NORTHWEST LAB., RICHLAND, WASH. (USA)].

REFERENCE- CONFERENCE ON SCALE MANAGEMENT IN GEOTHERMAL ENERGY DEVELOPMENT. U. S. ERDA, DIV. OF GEOTHERMAL ENERGY, WASHINGTON, D.C., 1976, P. 215-226.

DESCRIPTORS- CHEMICAL COMPOSITION; COMPUTER CALCULATIONS; CORROSION; GEOTHERMAL BRINES; GEOTHERMAL POWER PLANTS; MATHEMATICAL MODELS; SCALING.

175

THIRUVENGADAM 76
BRINE TREATMENT/SCALING

TITLE- CAVITATION DESCALING TECHNIQUES FOR GEOTHERMAL APPLICATIONS.

AUTHOR- THIRUVENGADAM, A.P. [DAEDALEAN ASSOCIATES, INC., WOODBINE, MD. (USA)].

REFERENCE- CONFERENCE ON SCALE MANAGEMENT IN GEOTHERMAL ENERGY DEVELOPMENT. U. S. ERDA, DIV. OF GEOTHERMAL ENERGY, WASHINGTON, D.C., 1976, P. 247-256.

DESCRIPTORS- EROSION; EXPERIMENTAL RESULTS; MEASURING METHODS; FEASIBILITY STUDIES; GEOTHERMAL ENERGY; DESCALING; SCALING; SILICA MINERALS.

176

REEBER 76
BRINE TREATMENT/SCALING

TITLE- RESEARCH, DEVELOPMENT, AND ENGINEERING NEEDS FOR SCALE MANAGEMENT OF BRINES IN GEOTHERMAL APPLICATIONS.

AUTHOR- REEBER, R.R. (ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION, WASHINGTON, D.C. (USA). GEOTHERMAL DIVISION, TECHNOLOGY UTILIZATION BRANCH).

REFERENCE- CONFERENCE ON SCALE MANAGEMENT IN GEOTHERMAL ENERGY DEVELOPMENT. U. S. ERDA, DIV. OF GEOTHERMAL ENERGY, WASHINGTON, D.C., 1976, P. 257-262.

DESCRIPTORS- GEOTHERMAL BRINES; SCALING; SCALING CONTROL; US ERDA.

177

SMITH 76
BRINE TREATMENT/SCALING

TITLE- TASK OF DEVELOPING CAVITATION DESCALING TECHNIQUES AND HARDWARE FOR SCALED-UP AND STOPPED-UP GEOTHERMAL HEAT EXCHANGER TUBING AND PIPES......

AUTHOR- SMITH, R.A. (ED.)

REFERENCE- GEOTHERMAL REPORT, V. 5 (21), P. 3-4(NOV 1, 1976).

DESCRIPTORS- CAVITATION EROSION; GEOTHERMAL BRINES; GEOTHERMAL ENERGY; HEAT EXCHANGERS; DESCALING; SCALING; SCALING CONTROL; SILICA MINERALS; NILAND.

178

WANG 74
BRINE TREATMENT/SPENT FLUID DISPOSAL
BRINE TREATMENT/SCALING

TITLE- TOTAL WASTE RECYCLE SYSTEM FOR WATER PURIFICATION PLANTS USING ALUM AS PRIMARY COAGULANT.

AUTHOR- WANG, L.K. [RENSSELAER POLYTECHNIC INST., TROY, N.Y. (USA). BIO-ENVIRONMENTAL ENGINEERING DIV.].

YANG, J.Y. [CALSPAN CORP., BUFFALO, N.Y. (USA). ENVIRONMENTAL SYSTEMS DEPT.].

REFERENCE- ENGINEERING BULLETIN OF PURDUE UNIVERSITY, PROCEEDINGS OF THE 29TH INDUSTRIAL WASTE CONFERENCE, MAY 7,8 AND 9, 1974, PART TWO. PURDUE UNIV., LAFAYETTE, IND., 1974, P. 725-739.

DESCRIPTORS- CHEMICAL COMPOSITION; CHEMICAL REACTIONS; EXPERIMENTAL RESULTS; MEASURING METHODS; FLOCCULATION; FLOCCULATING AGENTS; MINERAL RECOVERY; PH ADJUSTMENT; SEDIMENTATION; WASTE DISPOSAL; WASTE WATER.

179

AXTMANN 76
BRINE TREATMENT/CORROSION
BRINE TREATMENT/SCALING

TITLE- GEOTHERMAL CHEMICAL ENGINEERING.

AUTHOR- AXTMANN, R.C.;PECK, L.B. [PRINCETON UNIV., N.J. (USA). DEPT. OF CHEMICAL ENGINEERING].

REFERENCE- AICHE J., V. 22 (5), P. 817-828(SEP 1976).

DESCRIPTORS- BINARY FLUID SYSTEMS; CHEMICAL COMPOSITION; CORROSION; ECONOMICS; ENVIRONMENTAL EFFECTS; FLUID MECHANICS; GEOTHERMAL BRINES; GEOTHERMAL ENERGY; GEOTHERMAL FLUIDS; GEOTHERMAL POWER PLANTS; GEOTHERMAL RESERVOIRS; HEAT EXCHANGERS; INJECTION WELLS; RESERVOIR ENGINEERING; SCALING; TOTAL FLOW SYSTEM.

180

MC KAY 74
BRINE TREATMENT/SCALING
BRINE TREATMENT/CORROSION

TITLE- HELICAL ROTARY SCREW EXPANDER POWER SYSTEM.

AUTHOR- MC KAY, R.A. [JET PROPULSION LAB., PASADENA, CALIF. (USA)].

SPRANKLE, R.S. [HYDROTHERMAL POWER CO., LTD., PASADENA, CALIF. (USA)].

REFERENCE- PROCEEDINGS--CONFERENCE ON RESEARCH FOR THE DEVELOPMENT OF GEOTHERMAL ENERGY RESOURCES. JET PROPULSION LAB., CALIF. INST. OF TECH., PASADENA, CALIF., 1974, P. 301-309.

DESCRIPTORS- CORROSION; EROSION; EXPERIMENTAL RESULTS; FEASIBILITY STUDIES; GEOTHERMAL BRINES; GEOTHERMAL ENERGY; GEOTHERMAL POWER PLANTS; PRECIPITATION; SCALING; TOTAL FLOW SYSTEM.

181

MATTHEWS 74
BRINE TREATMENT/SCALING

TITLE- GEOTHERMAL DOWN-WELL PUMPING SYSTEM.

AUTHOR- MATTHEWS, H.B.;MC BEE, W.D. [SPERRY RAND RESEARCH CENTER, SUDBURY, MASS. (USA)].

REFERENCE- PROCEEDINGS--CONFERENCE ON RESEARCH FOR THE DEVELOPMENT OF GEOTHERMAL ENERGY RESOURCES. JET PROPULSION LAB., CALIF. INST. OF TECH., PASADENA, CALIF., 1974, P. 281-291.

DESCRIPTORS- CARBONATES; MEASURING METHODS; FEASIBILITY STUDIES; FIELD STUDIES; FLASHING; FLOW RATE; GEOTHERMAL POWER PLANTS; GEOTHERMAL WELLS; HEAT EXCHANGERS; HEAT TRANSFER; PRECIPITATION; SILICA MINERALS; SURFACE EQUIPMENT; WELL CASINGS; WELL DESIGN; WELL OPERATION.

182

AUSTIN 74
BRINE TREATMENT/SCALING

TITLE- THE TOTAL FLOW CONCEPT FOR GEOTHERMAL ENERGY CONVERSION.

AUTHOR- AUSTIN, A.L. [CALIFORNIA UNIV., LIVERMORE (USA). LAWRENCE LIVERMORE LAB.].

REFERENCE- PROCEEDINGS--CONFERENCE ON RESEARCH FOR THE DEVELOPMENT OF GEOTHERMAL ENERGY RESOURCES. JET PROPULSION LAB., CALIF. INST. OF TECH., PASADENA, CALIF., 1974, P. 186-193.

DESCRIPTORS- BRINES; CORROSION; DISSOLVED SOLIDS; EROSION; EXPERIMENTAL RESULTS; FIELD STUDIES; FLASHING; GEOTHERMAL BRINES; MEASURING INSTRUMENTS; MEASURING METHODS; MODERATE PRESSURE; PRECIPITATION; SCALING CONTROL; ELEVATED TEMPERATURE; THERMODYNAMICS; TOTAL FLOW SYSTEM; TURBINE BLADES; SALTON SEA.

183

HOLT 74
BRINE TREATMENT/SCALING

TITLE- INVESTMENT AND OPERATING COSTS OF BINARY CYCLE GEOTHERMAL POWER PLANTS.

AUTHOR- HOLT, B.;BRUGMAN, J. [THE BEN HOLT CO., PASADENA, CALIF. (USA)].

REFERENCE- PROCEEDINGS--CONFERENCE ON RESEARCH FOR THE DEVELOPMENT OF GEOTHERMAL ENERGY RESOURCES. JET PROPULSION LAB., CALIF. INST. OF TECH., PASADENA, CALIF., 1974, P. 292-300.

DESCRIPTORS- BINARY FLUID SYSTEMS; ECONOMICS; FLASHING; GEOTHERMAL POWER PLANTS; HEAT EXCHANGERS; MODERATE PRESSURE; SCALING; SCALING CONTROL; SCRUBBERS; SUSPENDED SOLIDS; ELEVATED TEMPERATURE; NILAND; HEBER KGRA; MONO-LONG VALLEY KGRA.

184

SUEMOTO 74
BRINE TREATMENT/SCALING
BRINE TREATMENT/SPENT FLUID DISPOSAL

TITLE- PRELIMINARY RESULTS OF GEOTHERMAL DESALTING OPERATIONS AT THE EAST MESA TEST SITE, IMPERIAL VALLEY, CALIFORNIA.

AUTHOR- SUEMOTO, S.H. [BUREAU OF RECLAMATION, HOLTVILLE, CALIF. (USA)].

MATHIAS, K.E. [BUREAU OF RECLAMATION, BOULDER CITY, NEV. (USA)].

REFERENCE- PROCEEDINGS--CONFERENCE ON RESEARCH FOR THE DEVELOPMENT OF GEOTHERMAL ENERGY RESOURCES. JET PROPULSION LAB., CALIF. INST. OF TECH., PASADENA, CALIF., 1974, P. 225-235.

DESCRIPTORS- CORROSION; DESALINATION; DISSOLVED SOLIDS; FEASIBILITY STUDIES; FLASHING: FLOW RATE; GEOTHERMAL BRINES; GEOTHERMAL WELLS; HEAT TRANSFER COEFFICIENT; PH VALUE; SODIUM CHLORIDES; ELEVATED TEMPERATURE; WATER CHEMISTRY; EAST MESA KGRA.

185

BOEGLY 69
BRINE TREATMENT-SPENT FLUID DISPOSAL

TITLE- THE FEASIBILITY OF DEEP-WELL INJECTION OF WASTE BRINE FROM INLAND DESALTING PLANTS.

AUTHOR- BOEGLY, W.J., JR.;JACOBS, D.G.;LOMENICK, T.F.;SEALAND, O.M. [OAK RIDGE NATIONAL LAB., TENN. (USA)].

REFERENCE- THE FEASIBILITY OF DEEP-WELL INJECTION OF WASTE BRINE FROM INLAND DESALTING PLANTS. RESEARCH AND DEVELOPMENT PROGRESS REPORT NO. 432, OFFICE OF SALINE WATER, WASHINGTON, D.C., MAR 1969, 76 P..

DESCRIPTORS- FEASIBILITY STUDIES; DEEP WELLS; INJECTION WELLS; BRINES; DESALTING PLANTS; GEOLOGY; PRE-INJECTION TREATMENT; ECONOMICS.

186

LEGROS 68
BRINE TREATMENT/SPENT FLUID DISPOSAL

TITLE- A STUDY OF THE DISPOSAL OF THE EFFLUENT FROM A LARGE DESALINATION PLANT.

AUTHOR- LEGROS, P.G.;MANDELLI, E.F.;MCILHENNY, W.F.;WINTHRODE, D.E.;ZEITOUN, M.A. [DOW CHEMICAL CO., MIDLAND, MICH. (USA)].

PEQUEGNAT, W.E.;BLANTON, W.G.;BRIGHT, T.J.;BOTTOMS, K.S. [TEXAS AGRICULTURAL AND MECHANICAL UNIV., COLLEGE STATION (USA)].

REFERENCE- A STUDY OF THE DISPOSAL OF THE EFFLUENT FROM A LARGE DESALINATION PLANT. RESEARCH AND DEVELOPMENT PROGRESS REPORT NO. 316, OFFICE OF SALINE WATER, WASHINGTON, D.C., JAN 1968, 491 P..

DESCRIPTORS- DESALINATION; DESALTING PLANTS; CHEMICAL COMPOSITION; ECONOMICS; ENVIRONMENTAL EFFECTS; MONITORING; SALINITY; MASSACHUSETTS; RHODE ISLAND; CONNECTICUT; NEW YORK; NEW JERSEY; MARYLAND; VIRGINIA; FLORIDA; TEXAS; CALIFORNIA.

187

LEGROS 70
BRINE TREATMENT/SPENT FLUID DISPOSAL

TITLE- SYSTEMS ANALYSIS OF BRINE DISPOSAL FROM REVERSE OSMOSIS PLANTS.

AUTHOR- LEGROS, P.G.;GUSTAFSON, C.E.;SHEPHERD, B.P.;MCILHENNEY, W.F. [DOW CHEMICAL CO., MIDLAND, MICH. (USA)].

REFERENCE- SYSTEMS ANALYSIS OF BRINE DISPOSAL FROM REVERSE OSMOSIS PLANTS. RESEARCH AND DEVELOPMENT PROGRESS REPORT NO. 587, OFFICE OF SALINE WATER, WASHINGTON, D.C., AUG 1970, 201 P..

DESCRIPTORS- DESALINATION; DESALTING PLANTS; REVERSE OSMOSIS; ECONOMICS; PRE-INJECTION TREATMENT; INJECTION WELLS; WASTE DISPOSAL; EVAPORATION PONDS.

188

COLLINS 75
BRINE TREATMENT/SPENT FLUID DISPOSAL
BRINE TREATMENT/SCALING
BRINE TREATMENT/CORROSION

TITLE- GEOCHEMISTRY OF OILFIELD WATERS.

AUTHOR- COLLINS, A.G. [BUREAU OF MINES, BARTLESVILLE, OKLA. (USA). BARTLESVILLE ENERGY RESEARCH CENTER].

REFERENCE- GEOCHEMISTRY OF OILFIELD WATERS. ELSEVIER SCIENTIFIC PUBLISHING CO., AMSTERDAM (NETHERLANDS), 1975, DEVELOPMENTS IN PETROLEUM SCIENCE, 1, 496 P..

DESCRIPTORS- ADDITIVES; AQUEOUS SOLUTIONS; SULFATES; CALCIUM SULFATES; CHEMICAL ANALYSIS; CHEMICAL COMPOSITION; CHEMICAL REACTIONS; CLAY MINERALS; CONNATE WATER; DEMINERALIZATION; DESALINATION; DISPOSAL FORMATIONS; DOLOMITE ROCKS; ECONOMICS; ENVIRONMENTAL EFFECTS; HYDROGEOLOGY; INJECTION PRESSURE; INJECTION WELLS; IONIC STRENGTH; LITHOLOGY; MEASURING INSTRUMENTS; MEASURING METHODS; MINERAL RECOVERY; MONITORING; OILFIELD BRINES; PERMEABILITY; PLUGGING; POLLUTION; POROSITY; PRECIPITATION; PRE-INJECTION TREATMENT; PRESSURE DEPENDENCE; CHEMICAL REACTION KINETICS; REGULATIONS; RESERVOIR PROPERTIES; SCALE MONITORING; SCALING; SCALING CONTROL; SEDIMENTARY ROCKS; SEISMOLOGY; SILICA SOLUBILITY; SILICATES; SODIUM CHLORIDES; SOLUBILITY; STRONTIUM SULFATES; SURFACE EQUIPMENT; SUSPENDED SOLIDS; ELEVATED TEMPERATURE; TEMPERATURE DEPENDENCE; LOW TEMPERATURE.

189

OSTROFF 65
BRINE TREATMENT/SPENT FLUID DISPOSAL
BRINE TREATMENT/SCALING
BRINE TREATMENT/CORROSION

TITLE- INTRODUCTION TO OILFIELD WATER TECHNOLOGY.

AUTHOR- OSTROFF, A.G. [SOCONY MOBIL OIL CO., INC., PRINCETON, N.J. (USA). FIELD RESEARCH LAB.].

REFERENCE- INTRODUCTION TO OILFIELD WATER TECHNOLOGY. PRENTICE-HALL, INC., ENGLEWOOD CLIFFS, N.J., 1965, 412 P..

DESCRIPTORS- WATER POLLUTION; LEGAL ASPECTS; BRINE TREATMENT; BACTERIA; FILTRATION; OILFIELD BRINES; SCALING; SCALING CONTROL; CARBONATES; SULFATES; SILICA MINERALS; WATER ANALYSIS; CORROSION; CORROSION PROTECTION; UNDERGROUND DISPOSAL; WASTE DISPOSAL; MICROORGANISMS; COAGULATION; SEDIMENTATION; AERATION; DEGASIFICATION; PRE-INJECTION TREATMENT; BOILERS; COOLING SYSTEMS.

190

AWWA 71
BRINE TREATMENT/SPENT FLUID DISPOSAL
BRINE TREATMENT/SCALING
BRINE TREATMENT/CORROSION

TITLE- WATER QUALITY AND TREATMENT. A HANDBOOK OF PUBLIC WATER SUPPLIES.

AUTHOR- THE AMERICAN WATER WORKS ASSOCIATION, INC..

REFERENCE- WATER QUALITY AND TREATMENT. A HANDBOOK OF PUBLIC WATER SUPPLIES. 3RD ED., MCGRAW-HILL BOOK CO., NEW YORK, N.Y. (USA), 1971, 654 P..

DESCRIPTORS- WATER QUALITY; BRINE TREATMENT; FLOCCULATION; FILTRATION; CHEMICAL REACTIONS; CORROSION; DESALINATION; WASTE MANAGEMENT.

191

STEVOVICH 75
BRINE TREATMENT/SCALING
BRINE TREATMENT/CORROSION
BRINE TREATMENT/SPENT FLUID DISPOSAL

TITLE- GEOTHERMAL ENERGY.

AUTHOR- STEVOVICH, V.A. [INFORMATICS INC., ROCKVILLE, MD.(USA)].

REFERENCE- GEOTHERMAL ENERGY. AD/A-022 054, INFORMATICS INC., ROCKVILLE, MD., NOV 1975, 523 P..

DESCRIPTORS- GEOTHERMAL FIELDS; GEOTHERMAL FLUIDS; PIPELINES; CORROSION; SCALING; DESALINATION; MINERAL RECOVERY; ECONOMICS; ENVIRONMENTAL EFFECTS.

192

CHOU 74
BRINE TREATMENT/SCALING
BRINE TREATMENT/CORROSION

TITLE- REGENERATIVE VAPOR CYCLE WITH ISOBUTANE AS WORKING FLUID.

AUTHOR- CHOU, J.C.S.;AHLUWALIA, R.K.;WOO, E.Y.K. [HAWAII UNIV., HONOLULU (USA). COLLEGE OF ENGINEERING].

REFERENCE- GEOTHERMICS, V. 3 (3), P. 93-99(SEP 1974).

DESCRIPTORS- BINARY FLUID SYSTEMS; CORROSION; DESALINATION; GEOTHERMAL POWER PLANTS; HEAT EXCHANGERS; PRESSURE DEPENDENCE; SCALING; TEMPERATURE DEPENDENCE.

193

YANAGASE 70
BRINE TREATMENT/SCALING

TITLE- THE PROPERTIES OF SCALES AND METHODS TO PREVENT THEM.

AUTHOR- YANAGASE, T.;SUGINOHARA, Y. [KYUSHU UNIV., FUKUOKA (JAPAN). FACULTY OF ENGINEERING].

YANAGASE, K. [KYUSHU ELECTRIC POWER CO., INC., FUKUOKA (JAPAN). RESEARCH DEPT.].

REFERENCE- GEOTHERMICS, SPECIAL ISSUE 2, V. 2 (2), P. 1619-1623(1970).

DESCRIPTORS- CALCITE; CHEMICAL ANALYSIS; CHEMICAL COMPOSITION; BRINE TREATMENT; EXPERIMENTAL RESULTS; MEASURING METHODS; PIPELINES; SCALING; SCALING CONTROL; SILICA MINERALS; SODIUM CHLORIDES; SURFACE EQUIPMENT; TIME DEPENDENCE; OTAKE GEOTHERMAL FIELD; JAPAN.

194

WEHLAGE 76
BRINE TREATMENT/SCALING
BRINE TREATMENT/CORROSION

TITLE- GEOTHERMAL ENERGY. NEEDED--EFFECTIVE HEAT TRANSFER EQUIPMENT.

AUTHOR- WEHLAGE, E.F. [INTERNATIONAL SOCIETY FOR GEOTHERMAL ENGINEERING, WHITTIER, CALIF. (USA)].

REFERENCE- V. 98 (8), P. 27-33(AUG 1976).

DESCRIPTORS- BINARY FLUID SYSTEMS; CORROSION; DISSOLVED SOLIDS; ECONOMICS; GEOTHERMAL ENERGY; HEAT EXCHANGERS; SCALING; SILICA MINERALS; TEMPERATURE DEPENDENCE.

195

MAHON 70
BRINE TREATMENT/SCALING
BRINE TREATMENT/CORROSION

TITLE- CHEMISTRY IN THE EXPLORATION AND EXPLOITATION OF HYDROTHERMAL SYSTEMS.

AUTHOR- MAHON, W.A.J. [DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH (NEW ZEALAND). CHEMISTRY DIV.].

REFERENCE- GEOTHERMICS, SPECIAL ISSUE 2, V. 2 (2), P. 1310-1322(1970).

DESCRIPTORS- AQUIFERS; CHEMICAL COMPOSITION; CHLORIDES; FLOW RATE; GEOCHEMISTRY; GEOTHERMAL RESERVOIRS; GEOTHERMAL WELLS; HEAT FLOW; MONITORING; PH VALUE; QUARTZ; SILICA MINERALS; SOLUBILITY; ELEVATED TEMPERATURE; TEMPERATURE DEPENDENCE; WAIRAKEI GEOTHERMAL FIELD; BROADLANDS GEOTHERMAL FIELD; WAIOTAPU GEOTHERMAL FIELD; ORAKEIKORATO GEOTHERMAL FIELD; NGAWHA GEOTHERMAL FIELD; NEW ZEALAND.

196

KRYUKOV 70
BRINE TREATMENT/SCALING

TITLE- PHYSICO-CHEMICAL SAMPLING OF HIGH-TEMPERATURE WELLS IN CONNECTION WITH THEIR ENCRUSTATION BY CALCIUM CARBONATE.

AUTHOR- KRYUKOV, P.A.;LARIONOV, E.G. [ACAD. OF SCIENCES, NOVOSIBIRSK (USSR). INST. OF INORGANIC CHEM., SIBERIAN DIV.].

REFERENCE- GEOTHERMICS, SPECIAL ISSUE 2, V. 2 (2), P. 1624-1628(1970).

DESCRIPTORS- CARBONATES; CHEMICAL ANALYSIS; EXPERIMENTAL RESULTS; GEOTHERMAL WELLS; MEASURING INSTRUMENTS; MEASURING METHODS; PH VALUE; SCALING; TEMPERATURE LOGGING; BOLSHEBANNY GEOTHERMAL FIELD; PAUZHETSK GEOTHERMAL FIELD; USSR.

197

ELLIS 75
BRINE TREATMENT/SCALING

TITLE- GEOTHERMAL SYSTEMS AND POWER DEVELOPMENT.

AUTHOR- ELLIS, A.J. [DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH, PETONE (NEW ZEALAND). CHEMISTRY DIV.].

REFERENCE- AM. SCI., V.63, P. 510-521(SEP-OCT 1975).

DESCRIPTORS- CARBONATES; CHEMICAL COMPOSITION; BRINE TREATMENT; GEOCHEMISTRY; GEOTHERMAL BRINES; GEOTHERMAL ENERGY; GEOTHERMAL FIELDS; GEOTHERMAL POWER PLANTS; GEOTHERMAL WELLS; GROUND SUBSIDENCE; HEAT TRANSFER; POLYMERIZATION; PRECIPITATION; RESERVOIR PROPERTIES; SCALING; SILICA MINERALS; TEMPERATURE GRADIENTS.

198

QUONG 76
BRINE TREATMENT/SCALING

TITLE- THE LLL GEOTHERMAL INDUSTRIAL SUPPORT PROGRAM IN CHEMISTRY AND MATERIALS FOR FY76T AND FY77.

AUTHOR- QUONG, R. [CALIFORNIA UNIV., LIVERMORE (USA). LAWRENCE LIVERMORE LAB.].

REFERENCE- THE LLL GEOTHERMAL INDUSTRIAL SUPPORT PROGRAM IN CHEMISTRY AND MATERIALS FOR FY76T AND FY77. UCID-17209, CALIFORNIA UNIV., LAWRENCE LIVERMORE LAB., LIVERMORE, CALIF., 1976, 24 P..

DESCRIPTORS- BRINE TREATMENT; BRINES; CHEMICAL ANALYSIS; CHEMICAL COMPOSITION; CORROSION; CORROSION MONITORING; CORROSION RESISTANT ALLOYS; DISSOLVED SOLIDS; EXPERIMENTAL RESULTS; FAILURES; FIELD STUDIES; INJECTION WELLS; MEASURING INSTRUMENTS; MEASURING METHODS; MONITORING; PH ADJUSTMENT; PH DEPENDENCE; POLYMERIZATION; PRECIPITATION; CHEMICAL REACTION KINETICS; SCALE COMPOSITION; SCALING; SCALING CONTROL; SILICA MINERALS; SUSPENDED SOLIDS; TEMPERATURE DEPENDENCE; IMPERIAL VALLEY.

199

ROTHBAUM 76
BRINE TREATMENT/SCALING

TITLE- REMOVAL OF SILICA AND ARSENIC FROM GEOTHERMAL DISCHARGE WATERS BY PRECIPITATION OF USEFUL CALCIUM SILICATES.

AUTHOR- ROTHBAUM, H.P.;ANDERTON, B.H. (DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH, PETONE (NEW ZEALAND). CHEMISTRY DIV.).

REFERENCE- PROCEEDINGS--SECOND UNITED NATIONS SYMPOSIUM ON THE DEVELOPMENT AND USE OF GEOTHERMAL RESOURCES. CALIFORNIA UNIV., LAWRENCE BERKELEY LAB., BERKELEY, CALIF., 1976, V. 2, P. 1417-1425.

DESCRIPTORS- CHEMICAL ANALYSIS; CHEMICAL COMPOSITION; BRINE TREATMENT; COLLOIDAL SILICA; DEMINERALIZATION; EXPERIMENTAL RESULTS; MEASURING METHODS; FLOCCULATION; FLOCCULATING AGENTS; GEOTHERMAL BRINES; MINERAL RECOVERY; POLYMERIZATION; SILICA MINERALS; SILICATES; WAIRAKEI GEOTHERMAL FIELD; BROADLANDS GEOTHERMAL FIELD; NEW ZEALAND.

200

THORHALLSSON 76
BRINE TREATMENT/SCALING

TITLE- RAPID SCALING OF SILICA IN TWO DISTRICT HEATING SYSTEMS.

AUTHOR- THORHALLSSON, S.;RAGNARS, K.;ARNORSSON, S.;KRISTMANNSDOTTIR, H. [NATIONAL ENERGY AUTHORITY, REYKJAVIK (ICELAND)].

REFERENCE- PROCEEDINGS--SECOND UNITED NATIONS SYMPOSIUM ON THE DEVELOPMENT AND USE OF GEOTHERMAL RESOURCES. CALIFORNIA UNIV., LAWRENCE BERKELEY LAB., BERKELEY, CALIF., 1976, V. 2, P. 1445-1449.

DESCRIPTORS- AMORPHOUS SILICA: CHEMICAL ANALYSIS: EXPERIMENTAL RESULTS: MEASURING METHODS: GEOTHERMAL ENERGY; GEOTHERMAL WELLS; PH VALUE; SCALING; SILICA MINERALS: NAMAFJALL GEOTHERMAL FIELD; HVERAGERDI GEOTHERMAL FIELD: ICELAND.

201

EPA 72
BRINE TREATMENT/SPENT FLUID DISPOSAL

TITLE- SUBSURFACE WATER POLLUTION--A SELECTIVE ANNOTATED BIBLIOGRAPHY. PART I, SUBSURFACE WASTE INJECTION.

AUTHOR- ENVIRONMENTAL PROTECTION AGENCY, WASHINGTON, D.C. (USA). OFFICE OF WATER PROGRAMS.

REFERENCE- SUBSURFACE WATER POLLUTION--A SELECTIVE ANNOTATED BIBLIOGRAPHY. PART I, SUBSURFACE WASTE INJECTION. ENVIRONMENTAL PROTECTION AGENCY, WASHINGTON, D.C., MAR 1972, 156 P..

DESCRIPTORS- INJECTION WELLS; INJECTION; WASTE DISPOSAL; WASTES; GROUND WATER; WASTE WATER; HYDRODYNAMICS; GEOCHEMISTRY; FLUID MECHANICS; HYDROGEOLOGY; ROCK PROPERTIES; WASTE PROCESSING; UNDERGROUND DISPOSAL.

202

RIMA 71
BRINE TREATMENT/SPENT FLUID DISPOSAL

TITLE- SUBSURFACE WASTE DISPOSAL BY MEANS OF WELLS--A SELECTIVE ANNOTATED BIBLIOGRAPHY.

AUTHOR- RIMA, D.R.;CHASE, E.B.;MYERS, B.M. [GEOLOGICAL SURVEY, WASHINGTON, D.C. (USA)].

REFERENCE- SUBSURFACE WASTE DISPOSAL BY MEANS OF WELLS--A SELECTIVE ANNOTATED BIBLIOGRAPHY. GEOLOGICAL SURVEY WATER SUPPLY PAPER 2020, GEOLOGICAL SURVEY, WASHINGTON, D.C., 1971, 305 P..

DESCRIPTORS- INJECTION WELLS; WASTE DISPOSAL; INDUSTRIAL WASTES; BRINES; GROUND WATER; HYDRODYNAMICS; HYDROGEOLOGY; GEOCHEMISTRY; ROCK PROPERTIES; FLUID MECHANICS; ENVIRONMENTAL EFFECTS.

203

TOFFLEMIRE 70
BRINE TREATMENT/SPENT FLUID DISPOSAL

TITLE- DEEP-WELL INJECTION (LITERATURE REVIEW).

AUTHOR- TOFFLEMIRE, T.J. [WATER POLLUTION CONTROL FEDERATION, WASHINGTON, D.C. (USA)].

REFERENCE- J. WATER POLLUT. CONTROL FED., V. 42 (6), P. 1231-1235(1970).

DESCRIPTORS- INDUSTRIAL WASTES; DEEP WELLS; INJECTION WELLS; WASTE WATER; PRE-INJECTION TREATMENT; WASTE DISPOSAL; GEOLOGY.

204

YOSHIDA 69
BRINE TREATMENT/SCALING
BRINE TREATMENT/CORROSION

TITLE- CORROSION CONTROL IN GEOTHERMAL STEAM TURBINES.

AUTHOR- YOSHIDA, H.;HOASHI, J.;MIYAZAKI, M. [TOKYO SHIBAURA ELECTRIC CO., YOKOHAMA (JAPAN). TURBINE WORKS].

REFERENCE- PROCEEDINGS OF THE AMERICAN POWER CONFERENCE, 1968. AMERICAN POWER CONFERENCE, CHICAGO, ILL., 1969, V. 30, P. 965-973.

DESCRIPTORS- CHEMICAL COMPOSITION; CORROSION; CORROSION PROTECTION; CORROSION RESISTANT ALLOYS; EXPERIMENTAL RESULTS; GEOTHERMAL FLUIDS; GEOTHERMAL POWER PLANTS; MEASURING METHODS; PITTING CORROSION; SCALING; SILICA MINERALS; STRESS CORROSION; TURBINES; MATSUKAWA GEOTHERMAL FIELD; JAPAN.

205

CARTER 74
BRINE TREATMENT/CORROSION

TITLE- CORROSION RESISTANCE OF SOME COMMERCIALLY AVAILABLE METALS AND ALLOYS TO GEOTHERMAL BRINES.

AUTHOR- CARTER, J.P.;CRAMER, S.D. [BUREAU OF MINES, COLLEGE PARK, MD. (USA). COLLEGE PARK METALLURGY RESEARCH CENTER].

REFERENCE- CORROSION PROBLEMS IN ENERGY CONVERSION AND GENERATION. THE ELECTROCHEMICAL SOCIETY. CORROSION DIV., PRINCETON, N.J., 1974, P. 240-250.

DESCRIPTORS- CORROSION; CORROSION RESISTANT ALLOYS; DISSOLVED SOLIDS; EXPERIMENTAL RESULTS; GEOTHERMAL BRINES; IRON OXIDES; MEASURING METHODS; MODERATE PRESSURE; PITTING CORROSION; STRESS CORROSION; ELEVATED TEMPERATURE; EAST MESA KGRA; NILAND; IMPERIAL VALLEY; USA.

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CRAMER 74
BRINE TREATMENT/CORROSION

TITLE- SOLUBILITY OF OXYGEN IN GEOTHERMAL BRINES.

AUTHOR- CRAMER, S.D. [BUREAU OF MINES, COLLEGE PARK, MD. (USA). COLLEGE PARK METALLURGY RESEARCH CENTER].

REFERENCE- CORROSION PROBLEMS IN ENERGY CONVERSION AND GENERATION. THE ELECTROCHEMICAL SOCIETY, CORROSION DIV., PRINCETON, N.J., 1974, P. 251-262.

DESCRIPTORS- CHEMICAL ANALYSIS; CORROSION; EXPERIMENTAL RESULTS; GEOTHERMAL BRINES; INJECTION WELLS; MEASURING METHODS; MODERATE PRESSURE; SOLUBILITY; MODERATE TEMPERATURE; ELEVATED TEMPERATURE; THEORETICAL TREATMENTS; THERMODYNAMICS.

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HERMANNSSON 70
BRINE TREATMENT/SCALING
BRINE TREATMENT/CORROSION

TITLE- CORROSION OF METALS AND THE FORMING OF A PROTECTIVE COATING ON THE INSIDE OF PIPES CARRYING THERMAL WATERS USED BY THE REYKJAVIK MUNICIPAL DISTRICT HEATING SERVICE.

AUTHOR- HERMANNSSON, S. [REYKJAVIK MUNICIPAL DISTRICT HEATING SERVICE, REYKJAVIK (ICELAND)].

REFERENCE- GEOTHERMICS, SPECIAL ISSUE 2, V. 2 (2), P. 1602-1612(1970).

DESCRIPTORS- AMORPHOUS SILICA; CHEMICAL COMPOSITION; CHEMICAL REACTIONS; COLLOIDAL SILICA; CORROSION; CORROSION INHIBITORS; CORROSION RESISTANT ALLOYS; GEOTHERMAL FLUIDS; IRON OXIDES; MEASURING METHODS; PH DEPENDENCE; PIPELINES; SCALE COMPOSITION; SCALING; SILICA MINERALS; SILICA SOLUBILITY; SILICATES; TIME DEPENDENCE; REYKJAVIK; ICELAND.

208

MARSHALL 57
BRINE TREATMENT/CORROSION

TITLE- CORROSION BY LOW-PRESSURE GEOTHERMAL STEAM.

AUTHOR- MARSHALL, T.;HUGILL, A.J. [DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH, WELLINGTON (NEW ZEALAND). DOMINION LAB.].

REFERENCE- CORROSION, V. 13, P. 329T-337T(MAY 1957).

DESCRIPTORS- CHEMICAL COMPOSITION; CORROSION; CORROSION RESISTANT ALLOYS; EXPERIMENTAL RESULTS; MEASURING METHODS; FLOW RATE; GEOTHERMAL FLUIDS; STRESS CORROSION; WAIRAKEI GEOTHERMAL FIELD; NEW ZEALAND.

209

MARSHALL 73
BRINE TREATMENT/CORROSION

TITLE- CORROSION CONTROL IN GEOTHERMAL SYSTEMS.

AUTHOR- MARSHALL, T.;BRAITHWAITE, W.R. [DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH (NEW ZEALAND). CHEMISTRY DIV.].

REFERENCE- GEOTHERMAL ENERGY, P. 151-160 (EARTH SCIENCES, 12)(1973).

DESCRIPTORS- CHEMICAL COMPOSITION; COOLING TOWERS; CORROSION; CORROSION PROTECTION; CORROSION RESISTANT ALLOYS; EROSION; GEOTHERMAL BRINES; GEOTHERMAL POWER PLANTS; PIPELINES; PITTING CORROSION; STRESS CORROSION; SURFACE EQUIPMENT; TURBINES.

210

AKIBA 70
BRINE TREATMENT/SCALING
BRINE TREATMENT/CORROSION

TITLE- MECHANICAL FEATURES OF A GEOTHERMAL PLANT.

AUTHOR- AKIBA, M. [TOKYO SHIBAURA ELECTRIC CO., LTD., (JAPAN). TURBINE ENGNG. DEPT.].

REFERENCE- GEOTHERMICS, SPECIAL ISSUE 2, V. 2 (2), P. 1521-1529(1970).

DESCRIPTORS- CHEMICAL COMPOSITION; CORROSION; GEOTHERMAL POWER PLANTS; SCALE COMPOSITION; SCALING; STRESS CORROSION; SURFACE EQUIPMENT; TURBINE BLADES; TURBINES; MATSUKAWA GEOTHERMAL FIELD; CERRO PRIETO GEOTHERMAL FIELD; GEYSERS GEOTHERMAL FIELD; JAPAN.

211

ANDERSON 70
BRINE TREATMENT/SCALING
BRINE TREATMENT/CORROSION

TITLE- A VAPOR TURBINE GEOTHERMAL POWER PLANT.

AUTHOR- ANDERSON, J.H. [CONSULTING ENGINEER, YORK, PA. (USA)].

REFERENCE- GEOTHERMICS, SPECIAL ISSUE 2, V. 2 (2), P. 1530-1532(1970).

DESCRIPTORS- GEOTHERMAL POWER PLANTS: BINARY FLUID SYSTEMS; TURBINES; MODERATE TEMPERATURE; ELEVATED TEMPERATURE.

212

KOGA 70
BRINE TREATMENT/SCALING
BRINE TREATMENT/CORROSION

TITLE- GEOCHEMISTRY OF THE WATERS DISCHARGED FROM DRILLHOLES IN THE OTAKE AND HATCHOBARU AREAS.

AUTHOR- KOGA, A. [KYUSHU UNIV., BEPPU (JAPAN). INSTITUTE OF BALNEOLOGY].

REFERENCE- GEOTHERMICS, SPECIAL ISSUE 2, V. 2 (2), P. 1422-1425(1970).

DESCRIPTORS- GEOCHEMISTRY; CHEMICAL COMPOSITION; GEOTHERMAL BRINES; DEEP WELLS; OTAKE GEOTHERMAL FIELD; HATCHOBARU GEOTHERMAL FIELD; JAPAN.

213

MASHIKO 70
BRINE TREATMENT/SCALING
BRINE TREATMENT/CORROSION

TITLE- NEW SUPPLY SYSTEMS OF THERMAL WATERS TO A WIDE AREA IN JAPAN.

AUTHOR- MASHIKO, Y. [HOT SPRING RESEARCH INSTITUTE (JAPAN)].

HIRANO, Y. [SOCIETY OF ENGINEERS FOR MINERAL SPRINGS (JAPAN)].

REFERENCE- GEOTHERMICS, SPECIAL ISSUE 2, V. 2 (2), P. 1592-1595(1970).

DESCRIPTORS- GEOTHERMAL FLUIDS; MODERATE TEMPERATURE; CASE HISTORIES; PIPELINES; CORROSION; SCALING; CALCITE; JAPAN.

214

SHCHERBAKOV 70
BRINE TREATMENT/SCALING
BRINE TREATMENT/SPENT FLUID DISPOSAL

TITLE- THERMAL WATERS AS A SOURCE FOR EXTRACTION OF CHEMICALS.

AUTHOR- SHCHERBAKOV, A.V. [AN SSSR, MOSCOW. GEOLOGICHESKIJ INST.].

DVOROV, V.I. [AN SSSR, MOSCOW. INST. GEOLOGII RUDNYKH MESTOROZHDENII, PETROGRAFII, MINERALOGII I GEOKHIMII].

REFERENCE- GEOTHERMICS, SPECIAL ISSUE 2, V. 2 (2), P. 1636-1639(1970).

DESCRIPTORS- GEOTHERMAL BRINES; GEOLOGY; CHEMICAL COMPOSITION; MINERAL RECOVERY; USSR.

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WERNER 70
BRINE TREATMENT/SCALING
BRINE TREATMENT/SPENT FLUID DISPOSAL

TITLE- CONTRIBUTIONS TO THE MINERAL EXTRACTION FROM SUPERSATURATED GEOTHERMAL BRINES, SALTON SEA AREA, CALIFORNIA.

AUTHOR- WERNER, H.H.

REFERENCE- GEOTHERMICS, SPECIAL ISSUE 2, V. 2 (2), P. 1651-1655(1970).

DESCRIPTORS- GEOTHERMAL BRINES; CHEMICAL COMPOSITION; MINERAL RECOVERY; SCALE COMPOSITION; SALTON SEA.

216

HANCK 76
BRINE TREATMENT/CORROSION

TITLE- CORROSION STUDIES AT THE GEYSERS POWER PLANT. ABSTRACT NO. 106.

AUTHOR- HANCK, J.A.;NEKOKSA, G.:FRIEDRICH, S.J. [PACIFIC GAS AND ELECTRIC CO., SAN RAMON, CALIF. (USA). DEPT. OF ENGINEERING RESEARCH].

REFERENCE- EXTENDED ABSTRACTS, 150TH SOCIETY MEETING, VOL. 76-2. THE ELECTROCHEMICAL SOCIETY, INC., PRINCETON, N.J., 1976, P. 297-299.

DESCRIPTORS- GEOTHERMAL POWER PLANTS; PITTING CORROSION; CORROSION; CORROSION RESISTANT ALLOYS; CORROSION MONITORING; MEASURING INSTRUMENTS; MEASURING METHODS; EXPERIMENTAL RESULTS; HYDROGEN SULFIDES; CREVICE CORROSION; EROSION; GEYSERS GEOTHERMAL FIELD.

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RHODES 76
BRINE TREATMENT/CORROSION

TITLE- CORROSION MECHANISMS OF CARBON STEEL IN AQUEOUS H2S SOLUTIONS. ABSTRACT NO. 107.

AUTHOR- RHODES, P.R. [SHELL DEVELOPMENT CO., HOUSTON, TEX. (USA)].

REFERENCE- EXTENDED ABSTRACTS, 150TH SOCIETY MEETING, VOL. 76-2. THE ELECTROCHEMICAL SOCIETY, INC., PRINCETON, N.J., 1976, P. 300-302.

DESCRIPTORS- HYDROGEN SULFIDES; CORROSION; MEASURING METHODS; EXPERIMENTAL RESULTS; PH VALUE.

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CRAMER 76
BRINE TREATMENT/CORROSION

TITLE- THE EFFECT OF DISSOLVED GASES ON THE CORROSION OF METALS IN GEOTHERMAL BRINES. ABSTRACT NO. 108.

AUTHOR- CRAMER, S.D. [BUREAU OF MINES, COLLEGE PARK, MD. (USA). COLLEGE PARK METALLURGY RESEARCH CENTER].

REFERENCE- EXTENDED ABSTRACTS, 150TH SOCIETY MEETING, VOL. 76-2. THE ELECTROCHEMICAL

SOCIETY, INC., PRINCETON, N.J., 1976, P.
303-304.

DESCRIPTORS- CORROSION; GEOTHERMAL BRINES; MEASURING METHODS; EXPERIMENTAL RESULTS; PH VALUE; CHEMICAL COMPOSITION; CREVICE CORROSION; STRESS CORROSION; EAST MESA KGRA; SALTON SEA GEOTHERMAL FIELD.

219

SHANNON 76B
BRINE TREATMENT/CORROSION

TITLE- THE ROLE OF CHEMICAL COMPONENTS IN GEOTHERMAL BRINES ON THE CORROSION OF METALS. ABSTRACT NO. 109.

AUTHOR- SHANNON, D.W. (BATTELLE PACIFIC NORTHWEST LABS., RICHLAND, WASH. (USA)).

REFERENCE- EXTENDED ABSTRACTS, 150TH SOCIETY MEETING, VOL. 76-2. THE ELECTROCHEMICAL SOCIETY, INC., PRINCETON, N.J., 1976, P. 305-306.

DESCRIPTORS- CHEMICAL COMPOSITION; CHEMICAL REACTIONS; GEOTHERMAL BRINES; CORROSION; CORROSION RESISTANT ALLOYS; MEASURING METHODS; EXPERIMENTAL RESULTS; HYDROGEN SULFIDES; PH VALUE; MODERATE TEMPERATURE; ELEVATED TEMPERATURE.

220

POSEY 76
BRINE TREATMENT/CORROSION

TITLE- ELECTROCHEMICAL ASPECTS OF CORROSION OF IRON AND STEELS IN SYNTHETIC BRINES. ABSTRACT NO. 110.

AUTHOR- POSEY, F.A.;PALKO, A.A. (OAK RIDGE NATIONAL LAB., TENN. (USA). CHEMISTRY DIV.).

REFERENCE- EXTENDED ABSTRACTS, 150TH SOCIETY MEETING, VOL. 76-2. THE ELECTROCHEMICAL SOCIETY, INC., PRINCETON, N.J., 1976, P. 307-308.

DESCRIPTORS- ELECTROCHEMICAL CORROSION; GEOTHERMAL BRINES; BRINES; CORROSION; CORROSION RESISTANT ALLOYS; MEASURING METHODS; EXPERIMENTAL RESULTS; CARBONATES; CHLORIDES; SULFIDES; PH VALUE; MODERATE TEMPERATURE; ELEVATED TEMPERATURE; PITTING CORROSION; SCALING.

221

DOWNS 76B
BRINE TREATMENT/CORROSION
BRINE TREATMENT/SCALING

TITLE- EXPERIMENTAL EVALUATION OF THE GEOCHEMISTRY OF GEOTHERMAL SYSTEMS.

AUTHOR- DOWNS, W.F.;BARNES, H.L. [PENNSYLVANIA STATE UNIV., UNIVERSITY PARK (USA). DEPT. OF GEOSCIENCES].

REFERENCE- EXTENDED ABSTRACTS, 150TH SOCIETY MEETING, VOL. 76-2. THE ELECTROCHEMICAL SOCIETY, INC., PRINCETON, N.J., 1976, ABSTRACT NO. 111, P. 309-310.

DESCRIPTORS- GEOTHERMAL SYSTEMS; GEOCHEMISTRY; EXPERIMENTAL MODELS; DYNAMIC SYSTEMS; BRINES; GEOTHERMAL FLUIDS; ROCKS; ROCK-FLUID INTERACTIONS; MINERALS; SOLUBILITY; SILICA MINERALS; SCALING; PRECIPITATION; SILICA CHEMISTRY; QUARTZ; CHEMICAL REACTION KINETICS; HEAT EXCHANGERS; LASL.

222

LIU 76
BRINE TREATMENT/CORROSION
BRINE TREATMENT/SCALING

TITLE- VAPOR PRESSURE LOWERING OF A SYNTHETIC GEOTHERMAL BRINE AT ELEVATED TEMPERATURES.

AUTHOR- LIU, C.T. [WESTINGHOUSE RESEARCH LABS., PITTSBURGH, PA. (USA)].

REFERENCE- EXTENDED ABSTRACTS, 150TH SOCIETY MEETING, VOL. 76-2. THE ELECTROCHEMICAL SOCIETY, INC., PRINCETON, N.J., 1976, ABSTRACT NO. 112, P. 311-312.

DESCRIPTORS- THERMODYNAMIC PROPERTIES; GEOTHERMAL BRINES; VAPOR PRESSURE; OSMOTIC COEFFICIENT; TEMPERATURE DEPENDENCE; MODERATE TEMPERATURE; ELEVATED TEMPERATURE; CONCENTRATION DEPENDENCE; SODIUM CHLORIDES; EXPERIMENTAL RESULTS.

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CRAMER 76B
BRINE TREATMENT/CORROSION
BRINE TREATMENT/SCALING

TITLE- THE THERMODYNAMICS OF GASES DISSOLVED IN BRINES.

AUTHOR- CRAMER, S.D. [BUREAU OF MINES, COLLEGE PARK, MD. (USA). COLLEGE PARK METALLURGY RESEARCH CENTER].

REFERENCE- EXTENDED ABSTRACTS, 150TH SOCIETY MEETING, VOL. 76-2. THE ELECTROCHEMICAL SOCIETY, INC., PRINCETON, N.J., 1976, ABSTRACT NO. 113, P. 313-314.

DESCRIPTORS- THERMODYNAMICS; DISSOLVED GASES; GEOTHERMAL BRINES; OXYGEN; CARBON DIOXIDE; METHANE; SOLUBILITY; TEMPERATURE DEPENDENCE; MODERATE TEMPERATURE; ELEVATED TEMPERATURE; CONCENTRATION DEPENDENCE; ENTROPY; ENTHALPY; SALTING-OUT EFFECT; SCALING; CORROSION; EXPERIMENTAL RESULTS.

224

STAEHLE 76
BRINE TREATMENT/CORROSION

TITLE- EFFECTS OF HYDROGEN SULFIDE ENVIRONMENTS ON THE PERFORMANCE OF MATERIALS.

AUTHOR- STAEHLE, R.W.;AGRAWAL, A.K. [OHIO STATE UNIV., COLUMBUS (USA). DEPT. OF METALLURGICAL ENGINEERING].

REFERENCE- EXTENDED ABSTRACTS, 150TH SOCIETY MEETING, VOL. 76-2. THE ELECTROCHEMICAL SOCIETY, INC., PRINCETON, N.J., 1976, ABSTRACT NO. 114, P. 315.

DESCRIPTORS- HYDROGEN SULFIDES; MATERIALS TESTING; CORROSION RESISTANT ALLOYS; CORROSION; STRESS CORROSION; POLARIZATION STUDIES.

225

HEHEMANN 76
BRINE TREATMENT/CORROSION

TITLE- HYDROGEN SULPHIDE STRESS CORROSION CRACKING IN MATERIALS FOR GEOTHERMAL POWER.

AUTHOR- HEHEMANN, R.F.;TROIANO, A.R. (CASE WESTERN RESERVE UNIV., CLEVELAND, OHIO (USA). DIV. OF METALLURGY AND MATERIALS SCIENCE).

REFERENCE- EXTENDED ABSTRACTS, 150TH SOCIETY MEETING, VOL. 76-2. THE ELECTROCHEMICAL SOCIETY, INC., PRINCETON, N.J., 1976, ABSTRACT NO. 115, P. 316-317.

DESCRIPTORS- MATERIALS TESTING; CORROSION RESISTANT ALLOYS; HYDROGEN SULFIDES; CORROSION; STRESS CORROSION; YIELD STRENGTH; GEOTHERMAL POWER PLANTS; EXPERIMENTAL RESULTS.

226

ISAACS 76
BRINE TREATMENT/CORROSION

TITLE- THE INITIATION AND GROWTH OF LOCALIZED CORROSION ON STAINLESS STEELS IN CHLORIDE SOLUTIONS.

AUTHOR- ISAACS, H.S.;VYAS, B. (BROOKHAVEN NATIONAL LAB., UPTON, N.Y. (USA)).

REFERENCE- EXTENDED ABSTRACTS, 150TH SOCIETY MEETING, VOL. 76-2. THE ELECTROCHEMICAL SOCIETY, INC., PRINCETON, N.J., 1976, ABSTRACT NO. 116, P. 318-319.

DESCRIPTORS- CHLORIDES; CORROSION; CORROSION RESISTANT ALLOYS; PITTING CORROSION; STAINLESS STEELS; COATINGS; CREVICE CORROSION; POLARIZATION STUDIES; CONCENTRATION DEPENDENCE.

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PESSALL 76
BRINE TREATMENT/CORROSION

TITLE- THE CORROSION RESISTANCE OF NICKEL-BASED ALLOYS UNDER STRESS IN HIGH TEMPERATURE, HIGH CHLORIDE ENVIRONMENTS.

AUTHOR- PESSALL, N.;LIU, C.T. [WESTINGHOUSE RESEARCH LABS., PITTSBURGH, PA. (USA)].

REFERENCE- EXTENDED ABSTRACTS, 150TH SOCIETY MEETING, VOL. 76-2. THE ELECTROCHEMICAL SOCIETY, INC., PRINCETON, N.J., 1976, ABSTRACT NO. 117, P. 320-321.

DESCRIPTORS- CORROSION RESISTANT ALLOYS; TEMPERATURE DEPENDENCE; MODERATE TEMPERATURE; ELEVATED TEMPERATURE; CONCENTRATION DEPENDENCE; AQUEOUS SOLUTIONS; CHLORIDES; MAGNESIUM CHLORIDES; SODIUM CHLORIDES; SEAWATER; PH DEPENDENCE; TIME DEPENDENCE; PITTING CORROSION; STRESS CORROSION; NICKEL; EXPERIMENTAL RESULTS.

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RECHT 76
BRINE TREATMENT/CORROSION

TITLE- EVALUATION OF CORROSION IN A GEOTHERMAL WELL LINER.

AUTHOR- RECHT, H.L.;FARD, A.J.;LEE, W.T.;SPRINGER, T.H. [ATOMICS INTERNATIONAL DIV., CANOGA PARK, CALIF. (USA)].

REFERENCE- EXTENDED ABSTRACTS, 150TH SOCIETY MEETING, VOL. 76-2. THE ELECTROCHEMICAL SOCIETY, INC., PRINCETON, N.J., 1976, ABSTRACT NO. 118, P. 322-323.

DESCRIPTORS- CORROSION; GEOTHERMAL WELLS; WELL CASINGS; GEOTHERMAL FLUIDS; DISSOLVED SOLIDS; WELL LOGGING; ELEVATED TEMPERATURE; METALLOGRAPHY; METALS; PIPELINES; PITTING CORROSION; CORROSION RESISTANT ALLOYS; EXPERIMENTAL RESULTS.

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GOLDBERG 76
BRINE TREATMENT/SCALING
BRINE TREATMENT/CORROSION

TITLE- PITTING CORROSION AND SCALING OF PLAIN CARBON STEEL EXPOSED TO GEOTHERMAL BRINE.

AUTHOR- GOLDBERG, A.;OWEN, L.B. [CALIFORNIA UNIV., LIVERMORE (USA). LAWRENCE LIVERMORE LAB.].

REFERENCE- EXTENDED ABSTRACTS, 150TH SOCIETY MEETING, VOL. 76-2. THE ELECTROCHEMICAL SOCIETY, INC., PRINCETON, N.J., 1976, ABSTRACT NO. 119, P. 324-325.

DESCRIPTORS- CORROSION; PITTING CORROSION; SCALING; WELL CASINGS; CARBON STEELS; SALTON SEA GEOTHERMAL FIELD; GEOTHERMAL BRINES; CHLORIDES; SULFIDES; SILICA MINERALS; STRESS CORROSION; CREVICE CORROSION; AMORPHOUS SILICA; PIPELINES; EXPERIMENTAL RESULTS.

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TONEY 76
BRINE TREATMENT/SCALING
BRINE TREATMENT/CORROSION

TITLE- METALLURGICAL EVALUATION OF MATERIALS FOR GEOTHERMAL POWER PLANT APPLICATIONS.

AUTHOR- TONEY, S.;COHEN, M. [GENERAL ELECTRIC CO., LYNN, MASS. (USA). MEDIUM STEAM TURBINE DEPT.].

CRON, C.J. [UNION OIL CO., BREA, CALIF. (USA). UNION OIL RESEARCH CENTER].

REFERENCE- EXTENDED ABSTRACTS, 150TH SOCIETY MEETING, VOL. 76-2. THE ELECTROCHEMICAL SOCIETY, INC., PRINCETON, N.J., 1976, ABSTRACT NO. 119A, P. 326-327.

DESCRIPTORS- MATERIALS TESTING; GEOTHERMAL POWER PLANTS; CORROSION RESISTANT ALLOYS; CORROSION; STRESS CORROSION; TURBINES; HEAT EXCHANGERS; NEW MEXICO; GEOTHERMAL FLUIDS; NATURAL STEAM; TIME DEPENDENCE; FATIGUE; AMORPHOUS SILICA;

231

ROSENFELD 75
BRINE TREATMENT/CORROSION

TITLE- CORROSION AND METAL PROTECTION.

AUTHOR- ROSENFELD, I.L. (ED.) [AN SSSR, MOSCOW. INST. FIZICHESKOJ KHIMII].

REFERENCE- CORROSION AND METAL PROTECTION. INDIAN NATIONAL SCIENTIFIC DOCUMENTATION CENTRE, NEW DELHI, 1975, 378 P.. TRANSLATION OF "KORROZIYA I ZASHCHITA METALLOV", MOSKVA, 1970, TRANSLATED FROM RUSSIAN.

DESCRIPTORS- CORROSION; CORROSION INHIBITORS; CORROSION PROTECTION; CORROSION RESISTANT ALLOYS; PITTING CORROSION; STRESS CORROSION; METALS; STAINLESS STEELS; ELECTROCHEMICAL CORROSION; ELECTROLYTES; SEAWATER; SULFURIC ACID; NITRIC ACID; HYDROCHLORIC ACID; HYDROGEN SULFIDES; OIL WELLS; DRILL PIPES; COATINGS; POLYMER COATINGS.

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KUKACKA 74
BRINE TREATMENT/SCALING
BRINE TREATMENT/CORROSION

TITLE- POLYMER-CONCRETE COMPOSITES FOR ENERGY RELATED SYSTEMS. PROGRESS REPORT NO. 1, APRIL-JUNE 1974.

AUTHOR- KUKACKA, L.E.;AUSKERN, A.;FONTANA, J. [BROOKHAVEN NATIONAL LAB., UPTON, N.Y. (USA). DEPT. OF APPLIED SCIENCE].

REFERENCE- POLYMER-CONCRETE COMPOSITES FOR ENERGY RELATED SYSTEMS. PROGRESS REPORT NO. 1, APRIL-JUNE 1974. BNL 19152, BROOKHAVEN NATIONAL LAB., UPTON, N.Y., 1974, INFORMAL REPORT, 8 P..

DESCRIPTORS- COOLING TOWERS; GEOTHERMAL BRINES; WELL CEMENTING; MATERIALS TESTING; SALTON SEA GEOTHERMAL FIELD; COATINGS; GEYSERS; GEOTHERMAL POWER PLANTS; POLYMER-CONCRETE MATERIALS; GEOTHERMAL WELLS; HIGH TEMPERATURE; DESALTING PLANTS; WASTE PROCESSING; PIPELINES.

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KUKACKA 74B
BRINE TREATMENT/SCALING
BRINE TREATMENT/CORROSION

TITLE- POLYMER-CONCRETE COMPOSITES FOR ENERGY RELATED SYSTEMS. PROGRESS REPORT NO. 2, JULY-SEPTEMBER 1974.

AUTHOR- KUKACKA, L.E.;AUSKERN. A.;FONTANA, J. (BROOKHAVEN NATIONAL LAB., UPTON, N.Y. (USA). DEPT. OF APPLIED SCIENCE).

REFERENCE- POLYMER-CONCRETE COMPOSITES FOR ENERGY RELATED SYSTEMS. PROGRESS REPORT NO. 2, JULY-SEPTEMBER 1974. BNL 19324, BROOKHAVEN NATIONAL LAB., UPTON, N.Y., 1974, INFORMAL REPORT, 7 P..

DESCRIPTORS- ELEVATED TEMPERATURE; EXPERIMENTAL RESULTS; GEOTHERMAL BRINES; GEOTHERMAL POWER PLANTS; GEOTHERMAL WELLS; MATERIALS TESTING; MECHANICAL PROPERTIES; OIL WELLS; PIPELINES; POLYMERIZATION; WASTE PROCESSING; WELL CEMENTING; POLYMER-CONCRETE MATERIALS; AUTOCLAVES.

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KUKACKA 74C
BRINE TREATMENT/SCALING
BRINE TREATMENT/CORROSION

TITLE- POLYMER-CONCRETE COMPOSITES FOR ENERGY RELATED SYSTEMS. PROGRESS REPORT NO. 3, OCTOBER-DECEMBER 1974.

AUTHOR- KUKACKA, L.E.;AUSKERN. A.;FONTANA, J. (BROOKHAVEN NATIONAL LAB., UPTON, N.Y. (USA). DEPT. OF APPLIED SCIENCE).

REFERENCE- POLYMER-CONCRETE COMPOSITES FOR ENERGY RELATED SYSTEMS. PROGRESS REPORT NO. 3, OCTOBER-DECEMBER 1974. BNL 19746, BROOKHAVEN NATIONAL LAB., UPTON, N.Y., 1974, 16 P..

DESCRIPTORS- ELEVATED TEMPERATURE; EXPERIMENTAL RESULTS; GEOTHERMAL BRINES; GEOTHERMAL POWER PLANTS; GEOTHERMAL WELLS; HIGH TEMPERATURE; MECHANICAL PROPERTIES; OIL WELLS; PIPELINES; TIME DEPENDENCE; WASTE PROCESSING; WELL

CASINGS; WELL CEMENTING; POLYMER-CONCRETE
MATERIALS; AUTOCLAVES; GEYSERS GEOTHERMAL
FIELD; THERMAL ANALYSIS.

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KUKACKA 75
BRINE TREATMENT/SCALING
BRINE TREATMENT/CORROSION

TITLE- POLYMER-CONCRETE COMPOSITES FOR ENERGY RELATED SYSTEMS. PROGRESS REPORT NO. 4, JANUARY-MARCH 1975.

AUTHOR- KUKACKA, L.E.;AUSKERN, A.;FONTANA, J. [BROOKHAVEN NATIONAL LAB., UPTON, N.Y. (USA). DEPT. OF APPLIED SCIENCE].

REFERENCE- POLYMER-CONCRETE COMPOSITES FOR ENERGY RELATED SYSTEMS. PROGRESS REPORT NO. 4, JANUARY-MARCH 1975. BNL 19970, BROOKHAVEN NATIONAL LAB., UPTON, N.Y., 1975, 15 P..

DESCRIPTORS- BRINES; DATA; ECONOMICS; ELEVATED TEMPERATURE; EXPERIMENTAL RESULTS; FIELD STUDIES; GEOTHERMAL FIELDS; GEOTHERMAL POWER PLANTS; GEOTHERMAL WELLS; HIGH TEMPERATURE; MATERIALS TESTING; MECHANICAL PROPERTIES; NATURAL STEAM; POLYMERIZATION; TIME DEPENDENCE; WASTE DISPOSAL; WASTE MANAGEMENT; WASTE PROCESSING; WELL CASINGS; WELL CEMENTING; POLYMER-CONCRETE MATERIALS; AUTOCLAVES; GEYSERS GEOTHERMAL FIELD; NEW MEXICO; THERMAL ANALYSIS.

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KUKACKA 75B
BRINE TREATMENT/SCALING
BRINE TREATMENT/CORROSION

TITLE- POLYMER-CONCRETE COMPOSITES FOR ENERGY RELATED SYSTEMS. PROGRESS REPORT NO. 5, APRIL-JUNE 1975.

AUTHOR- KUKACKA, L.E.;AUSKERN, A.;FONTANA, J. [BROOKHAVEN NATIONAL LAB., UPTON, N.Y. (USA). DEPT. OF APPLIED SCIENCE].

REFERENCE- POLYMER-CONCRETE COMPOSITES FOR ENERGY RELATED SYSTEMS. PROGRESS REPORT NO. 5,

APRIL-JUNE 1975. BNL 20336, BROOKHAVEN NATIONAL LAB., UPTON, N.Y., 1975, 13 P..

DESCRIPTORS- ELEVATED TEMPERATURE; EXPERIMENTAL RESULTS; FIELD STUDIES; GEOTHERMAL BRINES; GEOTHERMAL POWER PLANTS; GEOTHERMAL WELLS; MATERIALS TESTING; MECHANICAL PROPERTIES; NATURAL STEAM; OIL WELLS; PIPELINES; POLYMERIZATION; TIME DEPENDENCE; WASTE MANAGEMENT; WASTE PROCESSING; WELL CASINGS; WELL CEMENTING; POLYMER-CONCRETE MATERIALS; GEYSERS GEOTHERMAL FIELD; NEW MEXICO; AUTOCLAVES; THERMAL ANALYSIS.

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KUKACKA 75C
BRINE TREATMENT/SCALING
BRINE TREATMENT/CORROSION

TITLE- CONCRETE-POLYMER MATERIALS FOR GEOTHERMAL APPLICATIONS. PROGRESS REPORT NO. 6, JULY-SEPTEMBER 1975.

AUTHOR- KUKACKA, L.E.;AUSKERN, A.;FONTANA, J. (BROOKHAVEN NATIONAL LAB., UPTON, N.Y. (USA)., DEPT. OF APPLIED SCIENCE).

REFERENCE- CONCRETE-POLYMER MATERIALS FOR GEOTHERMAL APPLICATIONS. PROGRESS REPORT NO. 6, JULY-SEPTEMBER 1975. BNL 20571, BROOKHAVEN NATIONAL LAB., UPTON, N.Y., 1975, INFORMAL REPORT, 15 P..

DESCRIPTORS- COATINGS; CORROSION RESISTANT ALLOYS; DATA; ELEVATED TEMPERATURE; EXPERIMENTAL RESULTS; FIELD STUDIES; GEOTHERMAL BRINES; GEOTHERMAL ENERGY; GEOTHERMAL POWER PLANTS; MATERIALS TESTING; MECHANICAL PROPERTIES; NATURAL STEAM; PERMEABILITY; PIPELINES; POLYMERIZATION; TIME DEPENDENCE; WELL CASINGS; WELL CEMENTING; EAST MESA KGRA; KLAMATH FALLS KGRA; RAFT RIVER KGRA; POLYMER-CONCRETE MATERIALS; NEW MEXICO; IMPERIAL VALLEY; THERMAL ANALYSIS; POLYMERS; IMPERIAL VALLEY; AUTOCLAVES; GEYSERS GEOTHERMAL FIELD.

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KUKACKA 75D
BRINE TREATMENT/SCALING
BRINE TREATMENT/CORROSION

TITLE- CONCRETE-POLYMER MATERIALS FOR GEOTHERMAL APPLICATIONS. PROGRESS REPORT NO. 7, OCTOBER-DECEMBER 1975.

AUTHOR- KUKACKA, L.E.;FONTANA, J.;HORN, W.;AMARO, J. [BROOKHAVEN NATIONAL LAB., UPTON, N.Y. (USA). DEPT. OF APPLIED SCIENCE].

REFERENCE- CONCRETE-POLYMER MATERIALS FOR GEOTHERMAL APPLICATIONS. PROGRESS REPORT NO. 7, OCTOBER-DECEMBER 1975. BNL 20865, BROOKHAVEN NATIONAL LAB., UPTON, N.Y., 1975, INFORMAL REPORT, 22 P..

DESCRIPTORS- COATINGS; CORROSION; ELEVATED TEMPERATURE; EXPERIMENTAL RESULTS; FIELD STUDIES; GEOTHERMAL FLUIDS; GEOTHERMAL POWER PLANTS; GEOTHERMAL WELLS; MATERIALS TESTING; MECHANICAL PROPERTIES; PERMEABILITY; PH ADJUSTMENT; PIPELINES; SCALING; SCALING CONTROL; WELL CASINGS; WELL CEMENTING; POLYMER-CONCRETE MATERIALS; THERMAL ANALYSIS; POLYMERS; GEYSERS GEOTHERMAL FIELD; AUTOCLAVES; NEW MEXICO; KLAMATH FALLS KGRA; EAST MESA KGRA; RAFT RIVER KGRA.

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KUKACKA 76
BRINE TREATMENT/SCALING
BRINE TREATMENT/CORROSION

TITLE- CONCRETE-POLYMER MATERIALS FOR GEOTHERMAL APPLICATIONS. PROGRESS REPORT NO. 8, JANUARY-MARCH 1976.

AUTHOR- KUKACKA, L.E.;FONTANA, J.;HORN, W.;AMARO, J. [BROOKHAVEN NATIONAL LAB., UPTON, N.Y. (USA). DEPT. OF APPLIED SCIENCE].

REFERENCE- CONCRETE-POLYMER MATERIALS FOR GEOTHERMAL APPLICATIONS. PROGRESS REPORT NO. 8, JANUARY-MARCH 1976. BNL 21244, BROOKHAVEN NATIONAL LAB., UPTON, N.Y., 1976, INFORMAL REPORT, 18 P..

DESCRIPTORS- CORROSION; CORROSION RESISTANT ALLOYS; ECONOMICS; ELECTROCHEMICAL CORROSION; ELEVATED TEMPERATURE; FIELD STUDIES; GEOTHERMAL FLUIDS; GEOTHERMAL POWER PLANTS; GEOTHERMAL SYSTEMS; MATERIALS TESTING; MECHANICAL PROPERTIES; NATURAL STEAM; PH ADJUSTMENT; POLYMERIZATION;

SCALING; WELL CASINGS; WELL CEMENTING; POLYMER-CONCRETE MATERIALS; POLYMERS; THERMAL ANALYSIS; GEYSERS GEOTHERMAL FIELD; IMPERIAL VALLEY; KLAMATH FALLS KGRA; RAFT RIVER KGRA.

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KUKACKA 76B
BRINE TREATMENT/SCALING
BRINE TREATMENT/CORROSION

TITLE- CONCRETE-POLYMER MATERIALS FOR GEOTHERMAL APPLICATIONS. PROGRESS REPORT NO. 9, APRIL-JUNE 1976.

AUTHOR- KUKACKA, L.E.;FONTANA, J.;HORN, W.;AMARO, J. [BROOKHAVEN NATIONAL LAB., UPTON, N.Y. (USA). DEPT. OF APPLIED SCIENCE].

REFERENCE- CONCRETE-POLYMER MATERIALS FOR GEOTHERMAL APPLICATIONS. PROGRESS REPORT NO. 9, APRIL-JUNE 1976. BNL 21665, BROOKHAVEN NATIONAL LAB., UPTON, N.Y., 1976, INFORMAL REPORT, 20 P..

DESCRIPTORS- COATINGS; CORROSION; ELEVATED TEMPERATURE; EXPERIMENTAL RESULTS; FIELD STUDIES; GEOTHERMAL FLUIDS; GEOTHERMAL POWER PLANTS; GEOTHERMAL SYSTEMS; MECHANICAL PROPERTIES; SCALING; WELL CEMENTING; POLYMER-CONCRETE MATERIALS; AUTOCLAVES; GEYSERS GEOTHERMAL FIELD; NEW MEXICO; KLAMATH FALLS KGRA; RAFT RIVER KGRA; NILAND.

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ARNORSSON 70
BRINE TREATMENT/SCALING
BRINE TREATMENT/CORROSION

TITLE- UNDERGROUND TEMPERATURES IN HYDROTHERMAL AREAS IN ICELAND AS DEDUCED FROM THE SILICA CONTENT OF THE THERMAL WATER.

AUTHOR- ARNORSSON, S. [IMPERIAL COLLEGE, LONDON (UK). APPLIED GEOCHEMISTRY RESEARCH GROUP].

REFERENCE- GEOTHERMICS, SPECIAL ISSUE 2, V. 2 (1), P. 536-541(1970).

DESCRIPTORS- ELEVATED TEMPERATURE; GEOTHERMAL FIELDS; SILICA MINERALS; SOLUBILITY; CHEMICAL

EQUILIBRIUM: CHALCEDONY; QUARTZ; PRECIPITATION; MEASURING METHODS; EXPERIMENTAL RESULTS; DEEP WELLS; ICELAND.

242

DOMINCO 70
BRINE TREATMENT/SCALING
BRINE TREATMENT/CORROSION

TITLE- THE GEOCHEMISTRY OF THE KIZILDERE GEOTHERMAL FIELD, IN THE FRAMEWORK OF THE SARAYKOY-DENIZLI GEOTHERMAL AREA.

AUTHOR- DOMINCO, E. [U.N. GEOTHERMAL ENERGY SURVEY OF WESTERN ANATOLIA, ANKARA (TURKEY)].

SAMILGIL, E. [MTA INSTITUTE, ANKARA

REFERENCE- GEOTHERMICS, SPECIAL ISSUE 2, V. 2 (1), P. 553-560(1970).

DESCRIPTORS- GEOCHEMISTRY; GEOTHERMAL FLUIDS; GEOTHERMAL RESERVOIRS; RESERVOIR PROPERTIES; MODERATE TEMPERATURE; HYDROLOGY; CHEMICAL EQUILIBRIUM; CALCITE; CHEMICAL ANALYSIS; MEASURING METHODS; EXPERIMENTAL RESULTS; DEEP WELLS; KIZILDERE GEOTHERMAL FIELD; TURKEY.

243

ELLIS 70
BRINE TREATMENT/SCALING
BRINE TREATMENT/CORROSION

TITLE- QUANTITATIVE INTERPRETATION OF CHEMICAL CHARACTERISTICS OF HYDROTHERMAL SYSTEMS.

AUTHOR- ELLIS, A.J. [DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH, PETONE (NEW ZEALAND). CHEMISTRY DIV.].

REFERENCE- GEOTHERMICS, SPECIAL ISSUE 2, V. 2 (1), P. 516-528(1970).

DESCRIPTORS- CHEMICAL EQUILIBRIUM; CHEMICAL REACTIONS; CHEMICAL COMPOSITION; CONCENTRATION DEPENDENCE; ELEVATED TEMPERATURE; GEOCHEMISTRY; PH VALUE; GEOTHERMAL FLUIDS; DEEP WELLS; TEMPERATURE DEPENDENCE; CALCITE; PRECIPITATION; SALINITY; SULFIDES.

244

HAYASHIDA 70
BRINE TREATMENT/SCALING
BRINE TREATMENT/CORROSION

TITLE- DEVELOPMENT OF OTAKE GEOTHERMAL FIELD.

AUTHOR- HAYASHIDA, T.;EZIMA, Y. [KYUSHU ELECTRIC POWER CO., INC., FUKUOKA (JAPAN). RESEARCH DIVISION].

REFERENCE- GEOTHERMICS, SPECIAL ISSUE 2, V. 2 (1), P. 208-220(1970).

DESCRIPTORS- GEOTHERMAL FIELDS; GEOTHERMAL POWER PLANTS; GEOTHERMAL RESERVOIRS; RESERVOIR PROPERTIES; GEOLOGY; GEOCHEMISTRY; DEEP WELLS; WELL CASINGS; WELL DESIGN; WELL INTERFERENCE; SEISMOLOGY; SCALE COMPOSITION; DESCALING; CHEMICAL COMPOSITION; DISSOLVED GASES; FLOW RATE; OTAKE GEOTHERMAL FIELD; JAPAN.

245

LINDAL 70
BRINE TREATMENT/SCALING
BRINE TREATMENT/CORROSION

TITLE- THE PRODUCTION OF CHEMICALS FROM BRINE AND SEAWATER USING GEOTHERMAL ENERGY.

AUTHOR- LINDAL, B. [CONSULTING ENGINEER, REYKJAVIK (ICELAND)].

REFERENCE- GEOTHERMICS, SPECIAL ISSUE 2, V. 2 (1), P. 910-917(1970).

DESCRIPTORS- MINERAL RECOVERY; GEOTHERMAL BRINES; SEAWATER; GEOTHERMAL ENERGY; REYKJANES GEOTHERMAL FIELD; ICELAND; CHEMICAL COMPOSITION; CHEMICAL REACTIONS; ECONOMICS.

246

SMITH 70
BRINE TREATMENT/SCALING
BRINE TREATMENT/CORROSION

TITLE- GEOTHERMAL DEVELOPMENT IN NEW ZEALAND.

AUTHOR- SMITH, J.H. (MINISTRY OF WORKS, WELLINGTON (NEW ZEALAND)).

REFERENCE- GEOTHERMICS, SPECIAL ISSUE 2, V. 2 (1), P. 232-247(1970).

DESCRIPTORS- GEOTHERMAL WELLS; GEOTHERMAL FIELDS; GEOLOGY; DEEP WELLS; ELEVATED TEMPERATURE; CASE HISTORIES; TEMPERATURE LOGGING; WELL COMPLETION; WELL HEAD PRESSURE; SCALING; DESCALING; REAMING; SILICA MINERALS; CALCITE; NGAWHA GEOTHERMAL FIELD; ORAKEIKORATO GEOTHERMAL FIELD; REPOROA GEOTHERMAL FIELD; ROTOKAWA GEOTHERMAL FIELD; TAUHARA GEOTHERMAL FIELD; TEKOPIA GEOTHERMAL FIELD; BROADLANDS GEOTHERMAL FIELD; NEW ZEALAND.

247

WAHL 75
BRINE TREATMENT/SCALING

TITLE- SCALE DEPOSITION AND CONTROL RESEARCH FOR GEOTHERMAL UTILIZATION. THE ABOVE ARTICLE HAS ALSO APPEARED IN (1) PROC.--2ND U.N. SYMP. ON THE DEV. AND USE OF GEOTHERMAL RESOURCES, SAN FRANCISCO, CALIF., MAY 20-28, 1975, AND (2) PROC.--WORKSHOP ON MATERIALS PROBLEMS ASSOCIATED WITH THE DEV. OF GEOTHERMAL ENERGY SYSTEMS, EL CENTRO, CALIF., MAY 16, 1975.

AUTHOR- WAHL, E.;YEN, I.K. (GARRETT RESEARCH AND DEVELOPMENT CO., INC., LA VERNE, CALIF. (USA)).

REFERENCE- SCALE DEPOSITION AND CONTROL RESEARCH FOR GEOTHERMAL UTILIZATION. GRD 75-050, GARRETT RESEARCH AND DEVELOPMENT CO., LA VERNE, CALIF., MAY 1975, 15 P..

DESCRIPTORS- AMORPHOUS SCALE; BRINES; CALCITE; CHEMICAL COMPOSITION; CHEMICAL EQUILIBRIUM; CHEMICAL REACTION KINETICS; EXPERIMENTAL RESULTS; GEOTHERMAL BRINES; MATHEMATICAL MODELS; MEASURING METHODS; PH VALUE; PRESSURE DEPENDENCE; SCALE COMPOSITION; DESCALING; SCALING; SILICA MINERALS; SILICATES; TEMPERATURE DEPENDENCE; TIME DEPENDENCE; EAST MESA KGRA.

248

WONG 70
BRINE TREATMENT/SCALING
BRINE TREATMENT/CORROSION

TITLE- GEOTHERMAL ENERGY AND DESALINATION--PARTNERS IN PROGRESS.

AUTHOR- WONG, C.M. [OFFICE OF SALINE WATER, WASHINGTON, D.C. (USA)].

REFERENCE- GEOTHERMICS, SPECIAL ISSUE 2, V. 2 (1), P. 892-89[illegible](1970).

DESCRIPTORS- CALCITE; BRINE TREATMENT; DESALINATION; ELEVATED TEMPERATURE; GEOTHERMAL ENERGY; MINERAL RECOVERY; SCALING; IMPERIAL VALLEY.

249

ARMSTEAD 70
BRINE TREATMENT/SCALING
BRINE TREATMENT/CORROSION

TITLE- UTILIZATION OF STEAM AND HIGH ENTHALPY WATER (FOR ELECTRIC POWER GENERATION AND OTHER PURPOSES).

AUTHOR- ARMSTEAD, H.C.H.

REFERENCE- SPECIAL ISSUE 2, V. 1, P. 106-111(1970).

DESCRIPTORS- BINARY FLUID SYSTEMS; BRINE TREATMENT; CORROSION; DISSOLVED GASES; GEOTHERMAL ENERGY; GEOTHERMAL POWER PLANTS; HYDROGEN SULFIDES; POLLUTION; REVIEWS; DESCALING; SCALING CONTROL; TURBINES.

250

AXTMANN 76B
BRINE TREATMENT/SCALING

TITLE- CHEMICAL ASPECTS OF THE ENVIRONMENTAL IMPACT OF GEOTHERMAL POWER.

AUTHOR- AXTMANN, R.C. [PRINCETON UNIV., N.J. (USA). DEPT. OF CHEMICAL ENGINEERING AND CENTER FOR ENVIRONMENTAL STUDIES].

REFERENCE- PROCEEDINGS--SECOND UNITED NATIONS SYMPOSIUM ON THE DEVELOPMENT AND USE OF GEOTHERMAL RESOURCES. CALIFORNIA UNIV., LAWRENCE BERKELEY LAB., BERKELEY, CALIF., 1976, V. 2, P. 1323-1327.

DESCRIPTORS- CHEMICAL COMPOSITION; CORROSION; DISSOLVED GASES; ELEMENTS; TRACE AMOUNTS; ENVIRONMENTAL EFFECTS; GEOTHERMAL FLUIDS; GEOTHERMAL POWER PLANTS; HYDROGEN SULFIDES; INJECTION WELLS; POLLUTION; POLYMERIZATION; REVIEWS; SILICA MINERALS.

251

BRADBURY 70
BRINE TREATMENT/SCALING
BRINE TREATMENT/CORROSION

TITLE- THE ECONOMICS OF GEOTHERMAL POWER.

AUTHOR- BRADBURY, J.J.C. [UNITED NATIONS, NEW YORK, N.Y. (USA). ENERGY SECTION, RESOURCES AND TRANSPORT DIV.].

REFERENCE- SPECIAL ISSUE 2, V. 1, P. 122-131(1970).

DESCRIPTORS- BINARY FLUID SYSTEMS; ECONOMICS; GEOTHERMAL POWER PLANTS; PIPELINES; POLLUTION; REVIEWS; WELL DRILLING.

252

FACCA 70
BRINE TREATMENT/SCALING
BRINE TREATMENT/CORROSION

TITLE- THE STATUS OF WORLD GEOTHERMAL DEVELOPMENT.

AUTHOR- FACCA, G.

REFERENCE- SPECIAL ISSUE 2, V. 1, P. 8-23(1970).

DESCRIPTORS- BINARY FLUID SYSTEMS; ECONOMICS; GEOTHERMAL POWER PLANTS; REVIEWS.

253

JAMES 70
BRINE TREATMENT/SCALING
BRINE TREATMENT/CORROSION

TITLE- COLLECTION AND TRANSMISSION OF GEOTHERMAL FLUIDS.

AUTHOR- JAMES, R. [DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH, TAUPO (NEW ZEALAND)].

REFERENCE- SPECIAL ISSUE 2, V. 1, P. 99-105(1970).

DESCRIPTORS- CHEMICAL COMPOSITION; BRINE TREATMENT; CORROSION; CORROSION PROTECTION; DISSOLVED GASES; EXPERIMENTAL RESULTS; FLOW RATE; GEOTHERMAL FLUIDS; GEOTHERMAL WELLS; HYDROGEN SULFIDES; PIPELINES; REVIEWS; SAFETY; DESCALING; SCALING; SILICA MINERALS; TURBINES; WELL DESIGN.

254

WHITE 70
BRINE TREATMENT/SCALING
BRINE TREATMENT/CORROSION

TITLE- GEOCHEMISTRY APPLIED TO THE DISCOVERY, EVALUATION, AND EXPLOITATION OF GEOTHERMAL ENERGY RESOURCES.

AUTHOR- WHITE, D.E. [GEOLOGICAL SURVEY, MENLO PARK, CALIF. (USA)].

REFERENCE- SPECIAL ISSUE 2, V. 1, P. 58-80(1970).

DESCRIPTORS- AMORPHOUS SILICA; CALCITE; CHEMICAL COMPOSITION; CHLORIDES; ELEVATED TEMPERATURE; GEOCHEMISTRY; GEOTHERMAL FLUIDS; GEOTHERMAL RESERVOIRS; HEAT FLOW; INJECTION WELLS; IRON OXIDES; MINERAL RECOVERY; PH VALUE; PIPELINES; PRECIPITATION; RESERVOIR PROPERTIES; REVIEWS; ROCK-FLUID INTERACTIONS; SALINITY; SILICA MINERALS; WELL INTERFERENCE.

255

BARNES 76
BRINE TREATMENT/SCALING

TITLE- CHEMISTRY OF SILICA SCALE FORMATION.

AUTHOR- BARNES, H.L.;RIMSTIDT, J.C. [PENNSYLVANIA STATE UNIV., UNIVERSITY PARK (USA). DEPT. OF GEOSCIENCES].

HALL, B.A. (ED.)

REFERENCE- SECOND WORKSHOP ON MATERIALS PROBLEMS ASSOCIATED WITH THE DEVELOPMENT OF GEOTHERMAL ENERGY SYSTEMS. PROCEEDINGS OF THE WORKSHOP HELD MAY 16-18, 1975 AT EL CENTRO, CALIFORNIA. GEOTHERMAL RESOURCES COUNCIL, DAVIS, CALIF., 1976, P. 1-13.

DESCRIPTORS- AMORPHOUS SILICA; CARBONATES; CHEMICAL EQUILIBRIUM; CHEMICAL REACTION KINETICS; CHEMICAL REACTIONS; CONCENTRATION DEPENDENCE; CRISTOBALITE; DISPOSAL FORMATIONS; ELEVATED TEMPERATURE; EXPERIMENTAL RESULTS; FOULING; GEOTHERMAL POWER PLANTS; GEOTHERMAL RESERVOIRS; MEASURING METHODS; MODERATE TEMPERATURE; PH VALUE; PIPELINES; PLUGGING; PRECIPITATION; QUARTZ; SALINITY; SCALING; SCALING CONTROL; SILICA MINERALS; SILICA CHEMISTRY; SILICA SOLUBILITY; SOLUBILITY; TEMPERATURE DEPENDENCE.

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BISHOP 76
BRINE TREATMENT/SCALING

TITLE- GEOTHERMAL TEST BY SAN DIEGO GAS AND ELECTRIC CO..

AUTHOR- BISHOP, H.K. [SAN DIEGO GAS AND ELECTRIC CO., CALIF. (USA)].

HALL, B.A. (ED.)

REFERENCE- SECOND WORKSHOP ON MATERIALS PROBLEMS ASSOCIATED WITH THE DEVELOPMENT OF GEOTHERMAL ENERGY SYSTEMS. PROCEEDINGS OF THE WORKSHOP HELD MAY 16-18, 1975 AT EL CENTRO, CALIFORNIA. GEOTHERMAL RESOURCES COUNCIL, DAVIS, CALIF., 1976, P. 13-67.

DESCRIPTORS- BINARY FLUID SYSTEMS; CHEMICAL COMPOSITION; CORROSION; DISSOLVED GASES; DISSOLVED SOLIDS; ELEVATED TEMPERATURE; EXPERIMENTAL RESULTS; FLOW RATE; GEOTHERMAL BRINES; GEOTHERMAL POWER PLANTS; GEOTHERMAL WELLS; HEAT EXCHANGERS; MODERATE PRESSURE; PITTING CORROSION; RESERVOIR PROPERTIES; SCALING; SCALING CONTROL; SCRUBBERS; SILICA MINERALS; IMPERIAL VALLEY; NILAND; HEBER GEOTHERMAL FIELD.

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BISHOP 76B
BRINE TREATMENT/CORROSION

TITLE- WORKSHOP ON CORROSION.

AUTHOR- BISHOP, H.K. [SAN DIEGO GAS AND ELECTRIC CO., CALIF. (USA)].

HALL, B.A. (ED.)

REFERENCE- SECOND WORKSHOP ON MATERIALS PROBLEMS ASSOCIATED WITH THE DEVELOPMENT OF GEOTHERMAL ENERGY SYSTEMS. PROCEEDINGS OF THE WORKSHOP HELD MAY 16-18, 1975 AT EL CENTRO, CALIFORNIA. GEOTHERMAL RESOURCES COUNCIL, DAVIS, CALIF., 1976, P. 123-125.

DESCRIPTORS- CHEMICAL REACTIONS; CORROSION; CORROSION RESISTANT ALLOYS; GEOTHERMAL BRINES.

258

DODD 76
BRINE TREATMENT/CORROSION

TITLE- CORROSION STUDIES IN THE GEYSERS GEOTHERMAL STEAM POWER PLANT.

AUTHOR- DODD, F.J.; HAM, W.C. [PACIFIC GAS AND ELECTRIC CO.].

HALL, B.A. (ED.)

REFERENCE- SECOND WORKSHOP ON MATERIALS PROBLEMS ASSOCIATED WITH THE DEVELOPMENT OF GEOTHERMAL ENERGY SYSTEMS. PROCEEDINGS OF THE WORKSHOP HELD MAY 16-18, 1975 AT EL CENTRO, CALIFORNIA. GEOTHERMAL RESOURCES COUNCIL, DAVIS, CALIF., 1976, P. 87-99.

DESCRIPTORS- CHEMICAL COMPOSITION; PH ADJUSTMENT; CORROSION; CORROSION RESISTANT ALLOYS; GEOTHERMAL POWER PLANTS; HYDROGEN SULFIDES; MEASURING METHODS; PITTING CORROSION; STAINLESS STEELS; GEYSERS GEOTHERMAL FIELD.

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MANON 76
BRINE TREATMENT/CORROSION

TITLE- CORROSION PROBLEMS AT THE CERRO PRIETO GEOTHERMAL PROJECT.

AUTHOR- MANON, A.M. [COMISION FEDERAL DE ELECTRICIDAD, RESIDENCIA DE ESTUDIOS GEOTERMICOS, MEXICALI B. CFA.(MEXICO)].

HALL, B.A. (ED.)

REFERENCE- SECOND WORKSHOP ON MATERIALS PROBLEMS ASSOCIATED WITH THE DEVELOPMENT OF GEOTHERMAL ENERGY SYSTEMS. PROCEEDINGS OF THE WORKSHOP HELD MAY 16-18, 1975 AT EL CENTRO, CALIFORNIA. GEOTHERMAL RESOURCES COUNCIL, DAVIS, CALIF., 1976, P. 69-85.

DESCRIPTORS- BACTERIA; CHEMICAL COMPOSITION; CHLORIDES; CORROSION; CORROSION RESISTANT ALLOYS; ELECTROCHEMICAL CORROSION; ELEVATED TEMPERATURE; EROSION; EXPERIMENTAL RESULTS; FLOW RATE; GEOTHERMAL POWER PLANTS; HEAT EXCHANGERS; HYDROGEN SULFIDES; MEASURING METHODS; MODERATE PRESSURE; MODERATE TEMPERATURE; NOZZLES; PH VALUE; PITTING CORROSION; STRESS CORROSION; TURBINE BLADES; TURBINES; WELL CASINGS; CERRO PRIETO GEOTHERMAL FIELD.

260

MAURER 76
BRINE TREATMENT/CORROSION

TITLE- NEW AUSTENITIC AND FERRITIC STAINLESS STEELS FOR GEOTHERMAL APPLICATIONS.

AUTHOR- MAURER, J.R. [ALLEGHENY LUDLUM STEEL CORP., BRACKENRIDGE, PA. (USA). RESEARCH CENTER].

HALL, B.A. (ED.)

REFERENCE- SECOND WORKSHOP ON MATERIALS PROBLEMS ASSOCIATED WITH THE DEVELOPMENT OF GEOTHERMAL ENERGY SYSTEMS. PROCEEDINGS OF THE WORKSHOP HELD MAY 16-18, 1975 AT EL CENTRO, CALIFORNIA. GEOTHERMAL RESOURCES COUNCIL, DAVIS, CALIF., 1976, P. 105-119.

DESCRIPTORS- CHLORIDES; CORROSION RESISTANT ALLOYS; CREVICE CORROSION; DESALTING PLANTS; ELECTROCHEMICAL CORROSION; EXPERIMENTAL

RESULTS; GEOTHERMAL POWER PLANTS; MEASURING METHODS: PITTING CORROSION; STAINLESS STEELS; STRESS CORROSION; TEMPERATURE DEPENDENCE.

261

MAURER 76B
BRINE TREATMENT/CORROSION

TITLE- WORKSHOP ON METALS FABRICATION.

AUTHOR- MAURER, J.R. [ALLEGHENY LUDLUM STEEL CORP., BRACKENRIDGE, PA. (USA). RESEARCH CENTER].

HALL, B.A. (ED.)

REFERENCE- SECOND WORKSHOP ON MATERIALS PROBLEMS ASSOCIATED WITH THE DEVELOPMENT OF GEOTHERMAL ENERGY SYSTEMS. PROCEEDINGS OF THE WORKSHOP HELD MAY 16-18, 1975 AT EL CENTRO, CALIFORNIA. GEOTHERMAL RESOURCES COUNCIL, DAVIS, CALIF., 1976, P. 133-136.

DESCRIPTORS- GEOTHERMAL POWER PLANTS; MATERIALS TESTING.

262

NEEDHAM 76B
BRINE TREATMENT/CORROSION

TITLE- MATERIALS RESEARCH AND DEVELOPMENT PROGRAM FOR GEOTHERMAL ENVIRONMENTS.

AUTHOR- NEEDHAM, P.B., JR. [BUREAU OF MINES, COLLEGE PARK, MD. (USA). COLLEGE PARK METALLURGY RESEARCH CENTER].

HALL, B.A. (ED.)

REFERENCE- SECOND WORKSHOP ON MATERIALS PROBLEMS ASSOCIATED WITH THE DEVELOPMENT OF GEOTHERMAL ENERGY SYSTEMS. PROCEEDINGS OF THE WORKSHOP HELD MAY 16-18, 1975 AT EL CENTRO, CALIFORNIA. GEOTHERMAL RESOURCES COUNCIL, DAVIS, CALIF., 1976, P. 45-62.

DESCRIPTORS- BRINES; CARBONATES; CHEMICAL ANALYSIS; CORROSION; CORROSION RESISTANT ALLOYS; CREVICE CORROSION; DESALTING PLANTS; DISSOLVED GASES; ELEVATED TEMPERATURE; FIELD STUDIES; GEOTHERMAL BRINES; GEOTHERMAL POWER PLANTS; GEOTHERMAL

WELLS; PITTING CORROSION; SCALE COMPOSITION; SCALING; SOLUBILITY; STRESS CORROSION; TEMPERATURE DEPENDENCE; SALTON SEA GEOTHERMAL FIELD; EAST MESA KGRA.

263

WAHL 76
BRINE TREATMENT/SCALING

TITLE- WORKSHOP ON SCALING.

AUTHOR- WAHL, E.F. [OCCIDENTAL RESEARCH CORP., LA VERNE, CALIF. (USA)].

HALL, B.A. (ED.)

REFERENCE- SECOND WORKSHOP ON MATERIALS PROBLEMS ASSOCIATED WITH THE DEVELOPMENT OF GEOTHERMAL ENERGY SYSTEMS. PROCEEDINGS OF THE WORKSHOP HELD MAY 16-18, 1975 AT EL CENTRO, CALIFORNIA. GEOTHERMAL RESOURCES COUNCIL, DAVIS, CALIF., 1976, P. 127-132.

DESCRIPTORS- FIELD STUDIES; GEOTHERMAL BRINES; MEASURING METHODS; SCALING; SCALING CONTROL.

264

WILSON 76C
BRINE TREATMENT/CORROSION

TITLE- PRODUCTION, FABRICATION AND USE OF TITANIUM.

AUTHOR- WILSON, D.H. [REACTIVE METALS, INC., NILES, OHIO (USA)].

HALL, B.A. (ED.)

REFERENCE- SECOND WORKSHOP ON MATERIALS PROBLEMS ASSOCIATED WITH THE DEVELOPMENT OF GEOTHERMAL ENERGY SYSTEMS. PROCEEDINGS OF THE WORKSHOP HELD MAY 16-18, 1975 AT EL CENTRO, CALIFORNIA. GEOTHERMAL RESOURCES COUNCIL, DAVIS, CALIF., 1976, P. 101-104.

DESCRIPTORS- CORROSION; CORROSION RESISTANT ALLOYS.

265

AUSTIN 76
BRINE TREATMENT/SCALING
BRINE TREATMENT/CORROSION

TITLE- PROSPECTS FOR ADVANCES IN ENERGY CONVERSION TECHNOLOGIES FOR GEOTHERMAL ENERGY DEVELOPMENT.

AUTHOR- AUSTIN, A.L. [CALIFORNIA UNIV., LIVERMORE (USA). LAWRENCE LIVERMORE LAB.].

REFERENCE- PROCEEDINGS--SECOND UNITED NATIONS SYMPOSIUM ON THE DEVELOPMENT AND USE OF GEOTHERMAL RESOURCES. CALIFORNIA UNIV., LAWRENCE BERKELEY LAB., BERKELEY, CALIF., 1976, V. 3, P. 1925-1935.

DESCRIPTORS- BINARY FLUID SYSTEMS; ECONOMICS; ELEVATED TEMPERATURE; FLASHING; FLOW RATE; GEOTHERMAL BRINES; GEOTHERMAL FIELDS; GEOTHERMAL POWER PLANTS; MODERATE PRESSURE; NOZZLES; SURFACE EQUIPMENT; THERMODYNAMIC PROPERTIES; TOTAL FLOW SYSTEM; TURBINES.

266

DODD 76B
BRINE TREATMENT/CORROSION

TITLE- MATERIAL AND CORROSION TESTING AT THE GEYSERS GEOTHERMAL POWER PLANT.

AUTHOR- DODD, F.J.;JOHNSON, A.E.;HAM, W.C. [PACIFIC GAS AND ELECTRIC CO., SAN RAMON, CALIF. (USA). DEPT. OF ENGINEERING RESEARCH].

REFERENCE- PROCEEDINGS--SECOND UNITED NATIONS SYMPOSIUM ON THE DEVELOPMENT AND USE OF GEOTHERMAL RESOURCES. CALIFORNIA UNIV., LAWRENCE BERKELEY LAB., BERKELEY, CALIF., 1976, V. 3, P. 1959-1963.

DESCRIPTORS- CHEMICAL COMPOSITION; PH ADJUSTMENT; CORROSION; CORROSION RESISTANT ALLOYS; CREVICE CORROSION; DISSOLVED GASES; EXPERIMENTAL RESULTS; FIELD STUDIES; FLOW RATE; GEOTHERMAL BRINES; GEOTHERMAL POWER PLANTS; HYDROGEN SULFIDES; PITTING CORROSION; STAINLESS STEELS; TURBINE BLADES; GEYSERS GEOTHERMAL FIELD.

267

FERNELIUS 76
BRINE TREATMENT/SCALING
BRINE TREATMENT/SPENT FLUID DISPOSAL

TITLE- PRODUCTION OF FRESH WATER BY DESALTING GEOTHERMAL BRINES--A PILOT DESALTING PROGRAM AT THE EAST MESA GEOTHERMAL FIELD, IMPERIAL VALLEY, CALIFORNIA.

AUTHOR- FERNELIUS, W.A. [BUREAU OF RECLAMATION, BOULDER CITY, NEV. (USA)].

REFERENCE- PROCEEDINGS--SECOND UNITED NATIONS SYMPOSIUM ON THE DEVELOPMENT AND USE OF GEOTHERMAL RESOURCES. CALIFORNIA UNIV., LAWRENCE BERKELEY LAB., BERKELEY, CALIF., 1976, V. 3, P. 2201-2208.

DESCRIPTORS- CHEMICAL ANALYSIS; CHEMICAL COMPOSITION; DESALTING PLANTS; DISSOLVED GASES; DISSOLVED SOLIDS; ELEVATED TEMPERATURE; FEASIBILITY STUDIES; FLASHING; FLOW RATE; GEOTHERMAL BRINES; GEOTHERMAL WELLS; INJECTION WELLS; PIPELINES; EAST MESA KGRA.

268

HANCK 76B
BRINE TREATMENT/CORROSION

TITLE- CORROSION RATE MONITORING AT THE GEYSERS GEOTHERMAL POWER PLANT.

AUTHOR- HANCK, J.A.;NEKOKSA, G. [PACIFIC GAS AND ELECTRIC CO., SAN RAMON, CALIF. (USA). DEPT. OF ENGINEERING RESEARCH].

REFERENCE- PROCEEDINGS--SECOND UNITED NATIONS SYMPOSIUM ON THE DEVELOPMENT AND USE OF GEOTHERMAL RESOURCES. CALIFORNIA UNIV., LAWRENCE BERKELEY LAB., BERKELEY, CALIF., 1976, V.3, P. 1979-1984.

DESCRIPTORS- CATHODIC DEPOLARIZATION; CHEMICAL ANALYSIS; CORROSION; CORROSION MONITORING; CORROSION RESISTANT ALLOYS; CREVICE CORROSION; ELECTROCHEMICAL CORROSION; ELEVATED TEMPERATURE; EROSION; FIELD STUDIES; FLOW RATE; GEOTHERMAL BRINES; GEOTHERMAL POWER PLANTS; HYDROGEN SULFIDES; MEASURING INSTRUMENTS;

MEASURING METHODS; MODERATE PRESSURE; PH VALUE; PITTING CORROSION; STAINLESS STEELS; GEYSERS GEOTHERMAL FIELD.

269

LOMBARD 76
BRINE TREATMENT/SCALING

TITLE- SAN DIEGO GAS AND ELECTRIC COMPANY'S PIONEERING GEOTHERMAL TEST WORK IN THE IMPERIAL VALLEY OF SOUTHERN CALIFORNIA, USA.

AUTHOR- LOMBARD, G.L.;NUGENT, J.M. [SAN DIEGO GAS AND ELECTRIC CO., CALIF. (USA)].

REFERENCE- PROCEEDINGS--SECOND UNITED NATIONS SYMPOSIUM ON THE DEVELOPMENT AND USE OF GEOTHERMAL RESOURCES. CALIFORNIA UNIV., LAWRENCE BERKELEY LAB., BERKELEY, CALIF., 1976, V. 3, P. 2037-2043.

DESCRIPTORS- BINARY FLUID SYSTEMS; CORROSION RESISTANT ALLOYS; DISSOLVED GASES; DISSOLVED SOLIDS; ELEVATED TEMPERATURE; EXPERIMENTAL RESULTS; FIELD STUDIES; FLOW RATE; GEOTHERMAL BRINES; HEAT EXCHANGERS; MODERATE PRESSURE; PIPELINES; SALINITY; SCALE COMPOSITION; DESCALING; SCALING; SCRUBBERS; NILAND.

270

LORENSEN 76
BRINE TREATMENT/SCALING
BRINE TREATMENT/CORROSION

TITLE- POLYMERIC AND COMPOSITE MATERIALS FOR USE IN SYSTEMS UTILIZING HOT, FLOWING GEOTHERMAL BRINE.

AUTHOR- LORENSEN, L.E.;WALKUP, C.M.;MONES, E.T. [CALIFORNIA UNIV., LIVERMORE (USA). LAWRENCE LIVERMORE LAB.].

REFERENCE- PROCEEDINGS--SECOND UNITED NATIONS SYMPOSIUM ON THE DEVELOPMENT AND USE OF GEOTHERMAL RESOURCES. CALIFORNIA UNIV., LAWRENCE BERKELEY LAB., BERKELEY, CALIF., 1976, V. 3, P. 1725-1731.

DESCRIPTORS- ELEVATED TEMPERATURE; EROSION; EXPERIMENTAL RESULTS; FIELD STUDIES; GEOTHERMAL BRINES; MATERIALS TESTING; NOZZLES; SCALING; STAINLESS STEELS; TOTAL FLOW SYSTEM.

271

MATHIAS 76
BRINE TREATMENT/SCALING
BRINE TREATMENT/SPENT FLUID DISPOSAL

TITLE- THE MESA GEOTHERMAL FIELD--A PRELIMINARY EVALUATION OF FIVE GEOTHERMAL WELLS.

AUTHOR- MATHIAS, K.E. [BUREAU OF RECLAMATION, BOULDER CITY, NEV. (USA)].

REFERENCE- PROCEEDINGS--SECOND UNITED NATIONS SYMPOSIUM ON THE DEVELOPMENT AND USE OF GEOTHERMAL RESOURCES. CALIFORNIA UNIV., LAWRENCE BERKELEY LAB., BERKELEY, CALIF., 1976, V. 3, P. 1741-1747.

DESCRIPTORS- CHEMICAL COMPOSITION; BRINE TREATMENT; DESALTING PLANTS; ELEVATED TEMPERATURE; FLOW RATE; GEOTHERMAL FIELDS; GEOTHERMAL WELLS; INJECTION WELLS; MEASURING INSTRUMENTS; MODERATE PRESSURE; MONITORING; PRESSURE DECLINE; SCALING; WELL CASINGS; WELL COMPLETION; EAST MESA KGRA.

272

TOLIVIA 76
BRINE TREATMENT/CORROSION

TITLE- CORROSION OF TURBINE MATERIALS IN GEOTHERMAL STEAM ENVIRONMENT IN CERRO PRIETO, MEXICO.

AUTHOR- TOLIVIA, E.M. [FEDERAL ELECTRICITY COMMISSION, MEXICO, D.F. (MEXICO)].

HOASHI, J.;MIYAZAKI, M. [TOKYO SHIBAURA ELECTRIC CO., LTD., YOKOHAMA (JAPAN)].

REFERENCE- PROCEEDINGS--SECOND UNITED NATIONS SYMPOSIUM ON THE DEVELOPMENT AND USE OF GEOTHERMAL RESOURCES. CALIFORNIA UNIV., LAWRENCE BERKELEY LAB., BERKELEY, CALIF., 1976, V. 3, P. 1815-1820.

DESCRIPTORS- CHEMICAL COMPOSITION; CORROSION; CORROSION RESISTANT ALLOYS; CREVICE CORROSION; ELEVATED TEMPERATURE; EROSION; FIELD STUDIES; FLOW RATE; GEOTHERMAL BRINES; GEOTHERMAL POWER PLANTS; MATERIALS TESTING; MEASURING METHODS; MODERATE PRESSURE; PITTING CORROSION; STAINLESS STEELS; STRESS CORROSION; TIME DEPENDENCE; TURBINES; CERRO PRIETO GEOTHERMAL FIELD.

273

VIDES 76
BRINE TREATMENT/SPENT FLUID DISPOSAL

TITLE- RECENT STUDIES OF THE AHUACHAPAN GEOTHERMAL FIELD.

AUTHOR- VIDES, A. [CONSULTORA TECNICA S.A., SAN SALVADOR (EL SALVADOR)].

REFERENCE- PROCEEDINGS--SECOND UNITED NATIONS SYMPOSIUM ON THE DEVELOPMENT AND USE OF GEOTHERMAL RESOURCES. CALIFORNIA UNIV., LAWRENCE BERKELEY LAB., BERKELEY, CALIF., 1976, V. 3, P. 1851-1854.

DESCRIPTORS- CHEMICAL COMPOSITION; DEEP WELLS; FLOW RATE; GEOCHEMISTRY; GEOLOGY; GEOTHERMAL FIELDS; GEOTHERMAL RESERVOIRS; GEOTHERMAL WELLS; INJECTION WELLS; MODERATE PRESSURE; MODERATE TEMPERATURE; RESERVOIR PROPERTIES; WASTE DISPOSAL; WASTE WATER; WELL CASINGS; WELL CHARACTERISTICS; AHUACHAPAN GEOTHERMAL FIELD.

274

YASUTAKE 76
BRINE TREATMENT/SCALING
BRINE TREATMENT/CORROSION

TITLE- RESULTS AND IMPROVEMENTS OF WATER TREATMENT IN THE COOLING WATER SYSTEM OF OTAKE GEOTHERMAL POWER PLANT.

AUTHOR- YASUTAKE, H. [KYUSHU ELECTRIC POWER CO., INC., OITA (JAPAN). OTAKE GEOTHERMAL POWER PLANT].

HIRASHIMA, M. [KYUSHU ELECTRIC POWER CO., INC.,FUKUOKA (JAPAN). RESEARCH DEPT.].

REFERENCE- PROCEEDINGS--SECOND UNITED NATIONS SYMPOSIUM ON THE DEVELOPMENT AND USE OF GEOTHERMAL RESOURCES. CALIFORNIA UNIV., LAWRENCE BERKELEY LAB., BERKELEY, CALIF., 1976, V. 3, P. 1871-1877.

DESCRIPTORS- CHEMICAL ANALYSIS; CHEMICAL REACTIONS; BRINE TREATMENT; COOLING TOWERS; CORROSION; CORROSION PROTECTION; CORROSION INHIBITORS; CORROSION RESISTANT ALLOYS; CREVICE CORROSION; DISSOLVED GASES; EROSION; GEOTHERMAL POWER PLANTS; HYDROGEN SULFIDES; MATERIALS TESTING; PH VALUE; SCALE COMPOSITION; SCALING; OTAKE GEOTHERMAL FIELD.

275

BARNES 75
BRINE TREATMENT/SCALING
BRINE TREATMENT/CORROSION

TITLE- CORROSION AND SCALING.

AUTHOR- BARNES, H.L. [PENNSYLVANIA STATE UNIV., UNIVERSITY PARK, PA. (USA). DEPT. OF GEOSCIENCES].

HALL, B.A. (ED.)

REFERENCE- MATERIALS PROBLEMS ASSOCIATED WITH THE DEVELOPMENT OF GEOTHERMAL ENERGY RESOURCES. GEOTHERMAL RESOURCES COUNCIL, DAVIS, CALIF., MAY 1975, P. 29-31.

DESCRIPTORS- AMORPHOUS SILICA; CHLORIDES; CORROSION; CORROSION RESISTANT ALLOYS; GEOTHERMAL BRINES; HIGH PRESSURE; HIGH TEMPERATURE; HYDROGEN SULFIDES; IONIC STRENGTH; MATERIALS TESTING; PH ADJUSTMENT; PH VALUE; QUARTZ; SCALING; SILICA MINERALS; SOLUBILITY; STAINLESS STEELS; STRESS CORROSION; SULFIDES; TEMPERATURE DEPENDENCE.

276

BERTHELOT 75
BRINE TREATMENT/SCALING
BRINE TREATMENT/CORROSION

TITLE- SALTON SEA GEOTHERMAL FIELD.

AUTHOR- BERTHELOT, B.W. [PHILLIPS PETROLEUM CO., DEL MAR, CALIF. (USA)].

HALL, B.A. (ED.)

REFERENCE- MATERIALS PROBLEMS ASSOCIATED WITH THE DEVELOPMENT OF GEOTHERMAL ENERGY RESOURCES. GEOTHERMAL RESOURCES COUNCIL, DAVIS, CALIF., MAY 1975, P. 12-13.

DESCRIPTORS- AMORPHOUS SILICA; BRINE TREATMENT; CORROSION RESISTANT ALLOYS; ELEVATED TEMPERATURE; GEOTHERMAL BRINES; GEOTHERMAL FIELDS; MATERIALS TESTING; MODERATE PRESSURE; PH ADJUSTMENT; PH VALUE; QUARTZ; SCALE COMPOSITION; DESCALING; SCALING; SILICA MINERALS; SOLUBILITY; WELL CASINGS; SALTON SEA GEOTHERMAL FIELD.

277

BISHOP 75
BRINE TREATMENT/SCALING
BRINE TREATMENT/CORROSION

TITLE- SALTON SEA GEOTHERMAL FIELD.

AUTHOR- BISHOP, H.K. [SAN DIEGO GAS AND ELECTRIC CO., CALIF. (USA)].

HALL, B.A. (ED.)

REFERENCE- MATERIALS PROBLEMS ASSOCIATED WITH THE DEVELOPMENT OF GEOTHERMAL ENERGY RESOURCES. GEOTHERMAL RESOURCES COUNCIL, DAVIS, CALIF., MAY 1975, P. 14-15.

DESCRIPTORS- BINARY FLUID SYSTEMS; BRINE TREATMENT; CORROSION; DISSOLVED GASES; ELEVATED TEMPERATURE; FIELD STUDIES; FLOW RATE; GEOTHERMAL BRINES; HEAT EXCHANGERS; HYDROGEN SULFIDES; INJECTION WELLS; MODERATE PRESSURE; PH ADJUSTMENT; PIPELINES; REAMING; SALINITY; SCALE COMPOSITION; DESCALING; SCALING; SILICA MINERALS; STAINLESS STEELS; SALTON SEA GEOTHERMAL FIELD.

278

CRAMER 75
BRINE TREATMENT/SCALING
BRINE TREATMENT/CORROSION

TITLE- CORROSION AND SCALING.

AUTHOR- CRAMER, S.D.;CARTER, J.P.;NEEDHAM, P.B., JR.
[BUREAU OF MINES, COLLEGE PARK, MD. (USA).
COLLEGE PARK METALLURGY RESEARCH CENTER].

HALL, B.A. (ED.)

REFERENCE- MATERIALS PROBLEMS ASSOCIATED WITH THE
DEVELOPMENT OF GEOTHERMAL ENERGY RESOURCES.
GEOTHERMAL RESOURCES COUNCIL, DAVIS, CALIF.,
MAY 1975, P. 20-28.

DESCRIPTORS- CORROSION; CORROSION RESISTANT ALLOYS;
CREVICE CORROSION; DISSOLVED GASES; DISSOLVED
SOLIDS; ELEVATED TEMPERATURE; GEOTHERMAL
BRINES; MATERIALS TESTING; MODERATE PRESSURE;
PH VALUE; PITTING CORROSION; SALTING-OUT
EFFECT; SCALING; SOLUBILITY; STAINLESS STEELS;
STRESS CORROSION; TEMPERATURE DEPENDENCE;

279

HUTCHINSON 75
BRINE TREATMENT/SCALING
BRINE TREATMENT/CORROSION

TITLE- MATERIALS AND EQUIPMENT.

AUTHOR- HUTCHINSON, A.J.L. [BEN HOLT CO., PASADENA,
CALIF. (USA)].

HALL, B.A. (ED.)

REFERENCE- MATERIALS PROBLEMS ASSOCIATED WITH THE
DEVELOPMENT OF GEOTHERMAL ENERGY RESOURCES.
GEOTHERMAL RESOURCES COUNCIL, DAVIS, CALIF.,
MAY 1975, P. 36.

DESCRIPTORS- FLASHING; FLOW RATE; GEOTHERMAL BRINES;
GEOTHERMAL FIELDS; MATERIALS TESTING; MODERATE
PRESSURE; PIPELINES; SALTING-OUT EFFECT;
SCALING; SCRUBBERS; SILICA MINERALS; SILICA
SOLUBILITY; NILAND.

280

KUWADA 75
BRINE TREATMENT/SCALING
BRINE TREATMENT/CORROSION

TITLE- KIZILDERE (TURKEY) GEOTHERMAL FIELD.

AUTHOR- KUWADA, J.T. [ROGERS ENGINEERING CO., INC., SAN FRANCISCO, CALIF. (USA)].

HALL, B.A. (ED.)

REFERENCE- MATERIALS PROBLEMS ASSOCIATED WITH THE DEVELOPMENT OF GEOTHERMAL ENERGY RESOURCES. GEOTHERMAL RESOURCES COUNCIL, DAVIS, CALIF., MAY 1975, P. 18-19.

DESCRIPTORS- CALCITE; CARBONATES; CORROSION; DISSOLVED SOLIDS; ELEVATED TEMPERATURE; FIELD STUDIES; FLOW RATE; GEOTHERMAL BRINES; GEOTHERMAL FIELDS; GEOTHERMAL WELLS; HEAT EXCHANGERS; HEAT TRANSFER; PRECIPITATION; REAMING; SCALING; STAINLESS STEELS; STRESS CORROSION; KIZILDERE GEOTHERMAL FIELD; TURKEY.

281

MARSH 75B
BRINE TREATMENT/SCALING
BRINE TREATMENT/CORROSION

TITLE- SALTON SEA GEOTHERMAL FIELD.

AUTHOR- MARSH, G.A. [UNION OIL CO. OF CALIF., BREA (USA). RESEARCH CENTER].

HALL, B.A. (ED.)

REFERENCE- MATERIALS PROBLEMS ASSOCIATED WITH THE DEVELOPMENT OF GEOTHERMAL ENERGY RESOURCES. GEOTHERMAL RESOURCES COUNCIL, DAVIS, CALIF., MAY 1975, P. 10-11.

DESCRIPTORS- AMORPHOUS SILICA; CHLORIDES; CORROSION; CORROSION RESISTANT ALLOYS; ELEVATED TEMPERATURE; GEOTHERMAL BRINES; GEOTHERMAL WELLS; IRON OXIDES; MATERIALS TESTING; MODERATE PRESSURE; PITTING CORROSION; SCALING; TEMPERATURE DEPENDENCE; SALTON SEA GEOTHERMAL FIELD.

282

REEC 75
BRINE TREATMENT/SCALING
BRINE TREATMENT/CORROSION

TITLE- SALTON SEA GEOTHERMAL FIELD.

AUTHOR- REED, M.J. [GEOLOGICAL SURVEY, MENLO PARK, CALIF. (USA)].
HALL, B.A. (ED.)

REFERENCE- MATERIALS PROBLEMS ASSOCIATED WITH THE DEVELOPMENT OF GEOTHERMAL ENERGY RESOURCES. GEOTHERMAL RESOURCES COUNCIL, DAVIS, CALIF., MAY 1975, P. 8-9.

DESCRIPTORS- AMORPHOUS SILICA; CHEMICAL REACTION KINETICS; CHLORIDES; CORROSION; CORROSION RESISTANT ALLOYS; CREVICE CORROSION; DISSOLVED SOLIDS; ELEVATED TEMPERATURE; FLOW RATE; GEOTHERMAL BRINES; GEOTHERMAL FIELDS; SCALING; SILICA MINERALS; SILICA SOLUBILITY; SULFIDES; SALTON SEA GEOTHERMAL FIELD.

283

REED 75B
BRINE TREATMENT/SCALING
BRINE TREATMENT/CORROSION

TITLE- CORROSION AND SCALING.

AUTHOR- REED, M.J. [GEOLOGICAL SURVEY, MENLO PARK, CALIF. (USA)].

HALL, B.A. (ED.)

REFERENCE- MATERIALS PROBLEMS ASSOCIATED WITH THE DEVELOPMENT OF GEOTHERMAL ENERGY RESOURCES. GEOTHERMAL RESOURCES COUNCIL, DAVIS, CALIF., MAY 1975, P. 32-33.

DESCRIPTORS- CALCITE; BRINE TREATMENT; CHLORIDES; DISSOLVED SOLIDS; ELEVATED TEMPERATURE; GEOTHERMAL BRINES; GEOTHERMAL FIELDS; MEASURING INSTRUMENTS; PH ADJUSTMENT; REAMING; SCALING CONTROL; SILICA MINERALS; CERRO PRIETO GEOTHERMAL FIELD.

284

SCHREMP 75
BRINE TREATMENT/SCALING
BRINE TREATMENT/CORROSION

TITLE- HEBER GEOTHERMAL FIELD.

AUTHOR- SCHREMP, F.W. [CHEVRON OIL FIELD RESEARCH CO., LA HABRA, CALIF. (USA)].

HALL, B.A. (ED.)

REFERENCE- MATERIALS PROBLEMS ASSOCIATED WITH THE DEVELOPMENT OF GEOTHERMAL ENERGY RESOURCES. GEOTHERMAL RESOURCES COUNCIL, DAVIS, CALIF., MAY 1975, P. 16-17.

DESCRIPTORS- CARBONATES; BRINE TREATMENT; CORROSION; DISSOLVED SOLIDS; ELEVATED TEMPERATURE; GEOTHERMAL BRINES; GEOTHERMAL FIELDS; GEOTHERMAL WELLS; HEAT EXCHANGERS; INJECTION WELLS; MATERIALS TESTING; MEASURING INSTRUMENTS; PITTING CORROSION; SCALING; SULFIDES; HEEBER GEOTHERMAL FIELD.

285

SNODGRASS 75
BRINE TREATMENT/SCALING
BRINE TREATMENT/CORROSION

TITLE- MATERIALS AND EQUIPMENT.

AUTHOR- SNODGRASS, J.S. [REYNOLDS METALS CO., RICHMOND, VA. (USA)].

ANDERSON, D.B. [INTERNATIONAL NICKEL CO., INC., NEW YORK (USA)].

HODGE, F.G. [CABOT CORP., KOKOMO, INC. (USA). STELLITE [IV.].

KOMP, M.E. [UNITED STATES STEEL CORP., MONROEVILLE, PA. (USA). APPLIED RESEARCH LAB.].

FRANSON, I. [AIRCO VACUUM METALS, LEETSDALE, PA. (USA)].

HALL, B.A. (ED.)

REFERENCE- MATERIALS PROBLEMS ASSOCIATED WITH THE DEVELOPMENT OF GEOTHERMAL ENERGY RESOURCES.

GEOTHERMAL RESOURCES COUNCIL, DAVIS, CALIF., MAY 1975, P. 34-35.

DESCRIPTORS- CHLORIDES; CORROSION; CORROSION RESISTANT ALLOYS; GEOTHERMAL BRINES; PITTING CORROSION; SCALING; STAINLESS STEELS; STRESS CORROSION.

286

VETTER 76B
BRINE TREATMENT/SCALING

TITLE- OILFIELD SCALE - CAN WE HANDLE IT .

AUTHOR- VETTER, O.J. (CONSULTANT, LAGUNA BEACH, CALIF. (USA)).

REFERENCE- J. PET. TECHNOL., V. 28, P. 1402-1408(DEC 1976).

DESCRIPTORS- ACIDIZATION; BARIUM SULFATES; CALCITE; CALCIUM SULFATES; CARBONATES; CHEMICAL COMPATIBILITY; BRINE TREATMENT; CONCENTRATION DEPENDENCE; TEMPERATURE DEPENDENCE; ELEVATED TEMPERATURE; OILFIELD BRINES; PH DEPENDENCE; PRECIPITATION; PRESSURE DEPENDENCE; REAMING; DESCALING; SCALING; SCALING CONTROL; SOLUBILITY.

287

HATCH 70
BRINE TREATMENT/SCALING

TITLE- SCALE CONTROL IN HIGH TEMPERATURE DISTILLATION UTILIZING FLUIDIZED BED HEAT EXCHANGERS.

AUTHOR- HATCH, L.P.;WETH, G.G. (BROOKHAVEN NATIONAL LAB., UPTON, N.Y. (USA)).

REFERENCE- OFFICE OF SALINE WATER, WASHINGTON, D.C., JUL 1970, 61 P..

DESCRIPTORS- SCALING CONTROL; FLUIDIZED BED HEAT EXCHANGER; ELEVATED TEMPERATURE; HEAT TRANSFER COEFFICIENT; MEASURING METHODS; EXPERIMENTAL RESULTS; EROSION; HEAT EXCHANGERS; DESALINATION; CALCIUM SULFATES; PRECIPITATION.

288

BUSH 73
BRINE TREATMENT/CORROSION

TITLE- CONTROLLING CORROSION IN PETROLEUM DRILLING AND IN PACKER FLUIDS.

AUTHOR- BUSH, H.E. [NATIONAL LEAD CO., HOUSTON, TEX. (USA). BAROID DIV.].

NATHAN, C.C. (ED.) [BETZ LABS., INC., PHILADELPHIA, PA. (USA)].

REFERENCE- CORROSION INHIBITORS. NATIONAL ASSOCIATION OF CORROSION ENGINEERS, HOUSTON, TEX., 1973, P. 102-113.

DESCRIPTORS- CORROSION PROTECTION; OIL DRILLING; PETROLEUM INDUSTRY; DRILLING FLUIDS; DRILL STRINGS; CORROSION INHIBITORS; OXYGEN CORROSION.

289

DUNLOP 73
BRINE TREATMENT/CORROSION

TITLE- CORROSION INHIBITION IN SECONDARY RECOVERY.

AUTHOR- DUNLOP, A.K. [SHELL DEVELOPMENT CO., HOUSTON, TEX. (USA)].

NATHAN, C.C. (ED.) [BETZ LABS., INC., PHILADELPHIA, PA. (USA)].

REFERENCE- CORROSION INHIBITORS. NATIONAL ASSOCIATION OF CORROSION ENGINEERS, HOUSTON, TEX., 1973, P. 76-88.

DESCRIPTORS- CORROSION PROTECTION; OXYGEN SCAVENGING; CORROSION INHIBITORS; OIL WELLS; ENHANCED RECOVERY; OXYGEN CORROSION.

290

GARDNER 73
BRINE TREATMENT/CORROSION

TITLE- INHIBITORS IN ACID SYSTEMS.

AUTHOR- GARDNER, G. [CORROSION SPECIALIST, ELKINS, PA. (USA)].

NATHAN, C.C. (ED.) [BETZ LABS., INC., PHILADELPHIA, PA. (USA)].

REFERENCE- CORROSION INHIBITORS. NATIONAL ASSOCIATION OF CORROSION ENGINEERS, HOUSTON, TEX., 1973, P. 156-172.

DESCRIPTORS- CORROSION PROTECTION; CORROSION INHIBITORS; ACIDIZATION.

291

HAMNER 73
BRINE TREATMENT/CORROSION

TITLE- SCOPE AND IMPORTANCE OF INHIBITOR TECHNOLOGY.

AUTHOR- HAMNER, N.E. [NATIONAL ASSOCIATION OF CORROSION ENGINEERS, HOUSTON, TEX. (USA)].

NATHAN, C.C. (ED.) [BETZ LABS., INC., PHILADELPHIA, PA. (USA)].

REFERENCE- CORROSION INHIBITORS. NATIONAL ASSOCIATION OF CORROSION ENGINEERS, HOUSTON, TEX., 1973, P. 1-6.

DESCRIPTORS- CORROSION PROTECTION; CORROSION INHIBITORS; METALS; ALLOYS.

292

HAMNER 73B
BRINE TREATMENT/CORROSION

TITLE- INHIBITORS IN ORGANIC COATINGS.

AUTHOR- HAMNER, N.E. [NATIONAL ASSOCIATION OF CORROSION ENGINEERS, HOUSTON, TEX. (USA)].

NATHAN, C.C. (ED.) [BETZ LABS., INC., PHILADELPHIA, PA. (USA)].

REFERENCE- CORROSION INHIBITORS. NATIONAL ASSOCIATION OF CORROSION ENGINEERS, HOUSTON, TEX., 1973, P. 190-195.

DESCRIPTORS- CORROSION PROTECTION; CORROSION INHIBITORS; SURFACE COATING; ADDITIVES; ORGANIC COMPOUNDS.

293

HAMNER 73C
BRINE TREATMENT/CORROSION

TITLE- APPLICATIONS OF INHIBITORS IN MISCELLANEOUS ENVIRONMENTS.

AUTHOR- HAMNER, N.E. [NATIONAL ASSOCIATION OF CORROSION ENGINEERS, HOUSTON, TEX. (USA)].

NATHAN, C.C. (ED.) [BETZ LABS., INC., PHILADELPHIA, PA. (USA)].

REFERENCE- CORROSION INHIBITORS. NATIONAL ASSOCIATION OF CORROSION ENGINEERS, HOUSTON, TEX., 1973, P. 251-266.

DESCRIPTORS- CORROSION PROTECTION; CORROSION INHIBITORS.

294

HATCH 73
BRINE TREATMENT/CORROSION

TITLE- INHIBITORS FOR POTABLE WATER.

AUTHOR- HATCH, G.B. [CALGON CORP., PITTSBURGH, PA. (USA)].

NATHAN, C.C. (ED.) [BETZ LABS., INC., PHILADELPHIA, PA. (USA)].

REFERENCE- CORROSION INHIBITORS. NATIONAL ASSOCIATION OF CORROSION ENGINEERS, HOUSTON, TEX., 1973, P. 114-125.

DESCRIPTORS- CORROSION PROTECTION; CORROSION INHIBITORS; DRINKING WATER; WATER POLLUTION.

295

HATCH 73B
BRINE TREATMENT/CORROSION

TITLE- INHIBITION OF COOLING WATER.

AUTHOR- HATCH, G.B. [CALGON CORP., PITTSBURGH, PA. (USA)].

NATHAN, C.C. (ED.) [BETZ LABS., INC., PHILADELPHIA, PA. (USA)].

REFERENCE- CORROSION INHIBITORS. NATIONAL ASSOCIATION OF CORROSION ENGINEERS, HOUSTON, TEX., 1973, P. 126-147.

DESCRIPTORS- CORROSION PROTECTION; CORROSION INHIBOTORS; COOLING SYSTEMS.

296

KNAACK 73
BRINE TREATMENT/CORROSION

TITLE- INHIBITORS FOR TEMPORARY PROTECTION.

AUTHOR- KNAACK, D.F.;BROOKS, D. [E.F. HOUGHTON CO., PHILADELPHIA, PA. (USA)].

NATHAN, C.C. (ED.) [BETZ LABS., INC., PHILADELPHIA, PA. (USA)].

REFERENCE- CORROSION INHIBITORS. NATIONAL ASSOCIATION OF CORROSION ENGINEERS, HOUSTON, TEX., 1973, P. 220-227.

DESCRIPTORS- CORROSION PROTECTION; CORROSION INHIBITORS; COATINGS; PAINTS.

297

METCALF 73
BRINE TREATMENT/CORROSION

TITLE- INHIBITION AND CORROSION CONTROL PRACTICES FOR BOILER WATERS.

AUTHOR- METCALF, J.H. [BETZ LABS., TREVOSE, PA. (USA)].

NATHAN, C.C. (ED.) [BETZ LABS., INC., PHILADELPHIA, PA. (USA)].

REFERENCE- CORROSION INHIBITORS. NATIONAL ASSOCIATION OF CORROSION ENGINEERS, HOUSTON, TEX., 1973, P. 196-219.

DESCRIPTORS- CORROSION PROTECTION; CORROSION INHIBITORS; BOILERS.

298

NATHAN 73C
BRINE TREATMENT/CORROSION

TITLE- CONTROL OF INTERNAL CORROSION OF PIPELINES CARRYING CRUDE OIL.

AUTHOR- NATHAN, C.C. (ED.) [BETZ LABS., INC., PHILADELPHIA, PA. (USA)].

REFERENCE- CORROSION INHIBITORS. NATIONAL ASSOCIATION OF CORROSION ENGINEERS, HOUSTON, TEX., 1973, P. 95.

DESCRIPTORS- CORROSION PROTECTION; PIPELINES.

299

NATHAN 73
BRINE TREATMENT/CORROSION

TITLE- CORROSION INHIBITORS IN REFINERIES AND PETROCHEMICAL PLANTS--PART 1.

AUTHOR- NATHAN, C.C. (ED.) [BETZ LABS., INC., PHILADELPHIA, PA. (USA)].

REFERENCE- CORROSION INHIBITORS. NATIONAL ASSOCIATION OF CORROSION ENGINEERS, HOUSTON, TEX., 1973, P. 42-54.

DESCRIPTORS- CORROSION PROTECTION; CORROSION INHIBITORS; PETROLEUM INDUSTRY.

300

NATHAN 73B
BRINE TREATMENT/CORROSION

TITLE- CORROSION INHIBITORS IN REFINERIES AND PETROCHEMICAL PLANTS, PART 2--CONTROL OF FOULING.

AUTHOR- NATHAN, C.C. (ED.) [BETZ LABS., INC., PHILADELPHIA, PA. (USA)].

REFERENCE- CORROSION INHIBITORS. NATIONAL ASSOCIATION OF CORROSION ENGINEERS, HOUSTON, TEX., 1973, P. 55-60.

DESCRIPTORS- CORROSION PROTECTION; CORROSION INHIBITORS; FOULING; PETROLEUM INDUSTRY.

301

NESTLE 73
BRINE TREATMENT/CORROSION

TITLE- CORROSION INHIBITORS IN PETROLEUM PRODUCTION PRIMARY RECOVERY.

AUTHOR- NESTLE, A. [TEXACO RESEARCH LABS., HOUSTON, TEX. (USA). PRODUCTION CHEMISTRY GROUP].

NATHAN, C.C. (ED.) [BETZ LABS., INC., PHILADELPHIA, PA. (USA)].

REFERENCE- CORROSION INHIBITORS. NATIONAL ASSOCIATION OF CORROSION ENGINEERS, HOUSTON, TEX., 1973, P. 61-75.

DESCRIPTORS- CORROSION PROTECTION; CORROSION INHIBITORS; PETROLEUM INDUSTRY; OIL WELLS.

302

OAKES 73
BRINE TREATMENT/CORROSION

TITLE- INHIBITORS IN DESALINATION SYSTEMS.

AUTHOR- OAKES, B.D. [DOW CHEMICAL CO., FREEPORT, TEX. (USA)].

NATHAN, C.C. (ED.) [BETZ LABS., INC., PHILADELPHIA, PA. (USA)].

REFERENCE- CORROSION INHIBITORS. NATIONAL ASSOCIATION OF CORROSION ENGINEERS, HOUSTON, TEX., 1973, P. 148-155.

DESCRIPTORS- CORROSION PROTECTION; CORROSION INHIBITORS; DESALINATION.

303

PARKER 73
BRINE TREATMENT/CORROSION

TITLE- CONTROL OF INTERNAL CORROSION OF PIPELINES CARRYING REFINED PETROLEUM PRODUCTS.

AUTHOR- PARKER, I.M. [PLANTATION PIPE LINE CO., ATLANTA, GA. (USA)].

NATHAN, C.C. (ED.) [BETZ LABS., INC., PHILADELPHIA, PA. (USA)].

REFERENCE- CORROSION INHIBITORS. NATIONAL ASSOCIATION OF CORROSION ENGINEERS, HOUSTON, TEX., 1973, P. 89-94.

DESCRIPTORS- CORROSION PROTECTION; CORROSION INHIBITORS; PETROLEUM INDUSTRY; PIPELINES.

304

ROEBUCK 73
BRINE TREATMENT/CORROSION

TITLE- INHIBITION OF ALUMINUM.

AUTHOR- ROEBUCK, A.H. [FULLERTON, CALIF. (USA)].

NATHAN, C.C. (ED.) [BETZ LABS., INC., PHILADELPHIA, PA. (USA)].

REFERENCE- CORROSION INHIBITORS. NATIONAL ASSOCIATION OF CORROSION ENGINEERS, HOUSTON, TEX., 1973, P. 240-244.

DESCRIPTORS- CORROSION PROTECTION; CORROSION INHIBITORS; ALUMINUM; ALLOYS.

305

ROEBUCK 73B
BRINE TREATMENT/CORROSION

TITLE- INHIBITION OF CORROSION FROM CAUSTIC ATTACK.

AUTHOR- ROEBUCK, A.H. [FULLERTON, CALIF. (USA)].

NATHAN, C.C. (ED.) [BETZ LABS., INC., PHILADELPHIA, PA. (USA)].

REFERENCE- CORROSION INHIBITORS. NATIONAL ASSOCIATION OF CORROSION ENGINEERS, HOUSTON, TEX., 1973, P. 245-250.

DESCRIPTORS- CORROSION PROTECTION; CORROSION INHIBITORS; ALLOYS.

306

SCHASCHL 73
BRINE TREATMENT/CORROSION

TITLE- METHODS FOR EVALUATION AND TESTING OF CORROSION INHIBITORS.

AUTHOR- SCHASCHL, E. [UNION OIL OF CALIF., BREA (USA). RESEARCH CENTER].

REFERENCE- CORROSION INHIBITORS. NATIONAL ASSOCIATION OF CORROSION ENGINEERS, HOUSTON, TEX., 1973, P. 28-41.

DESCRIPTORS- CORROSION PROTECTION; CORROSION INHIBITORS.

307

SHARPLEY 73
BRINE TREATMENT/CORROSION

TITLE- MICROBIOLOGICAL CORROSION AND ITS CONTROL.

AUTHOR- SHARPLEY, J.M. [VIRGINIA COMMONWEALTH UNIVERSITY, FREDERICKSBURG (USA)].

NATHAN, C.C. (ED.) [BETZ LABS., INC., PHILADELPHIA, PA. (USA)].

REFERENCE- CORROSION INHIBITORS. NATIONAL ASSOCIATION OF CORROSION ENGINEERS, HOUSTON, TEX., 1973, P. 228-235.

DESCRIPTORS- CORROSION PROTECTION; MICROORGANISMS; BIOLOGICAL FOULING.

308

EARLOUGHER 57
BRINE TREATMENT/SCALING

TITLE- SEQUESTERING AGENTS FOR PREVENTION OF SCALE DEPOSITION IN OIL WELLS.

AUTHOR- EARLOUGHER, R.C. [EARLOUGHER ENGINEERING, TULSA, OKLA. (USA)].

LOVE, W.W. [DOWELL, INC., TULSA, OKLA.

REFERENCE- J. PET. TECHNOL., P. 17-20(APR 1957).

DESCRIPTORS- SCALING; SCALING CONTROL; OIL WELLS; INJECTION WELLS; SEQUESTERING AGENTS;

309

HAUSLER 74
BRINE TREATMENT/CORROSION

TITLE- PROCESS CORROSION AND CORROSION INHIBITORS IN THE PETROLEUM INDUSTRY.

AUTHOR- HAUSLER, R.H.;STANSKY, C.A.;NEVINS, A.J. [UNIV. OIL PROD. CO., DES PLAINES, ILL. (USA)].

REFERENCE- NACE, INTERNATIONAL CORROSION FORUM. NACE, HOUSTON, TEX., 1974, 40 P..

DESCRIPTORS- CORROSION PROTECTION; CORROSION INHIBITORS; PETROLEUM INDUSTRY.

310

VETTER 72
BRINE TREATMENT/SCALING

TITLE- AN EVALUATION OF SCALE INHIBITORS.

AUTHOR- VETTER, O.J. [UNION OIL CO. OF CALIFORNIA (USA)].

REFERENCE- J. PET. TECHNOL., P. 997-1006(AUG 1972).

DESCRIPTORS- SCALING; SCALING CONTROL; INHIBITORS; PRECIPITATION; OIL WELLS; LABORATORY STUDIES; CRYSTALLIZATION; KINETICS; TEMPERATURE DEPENDENCE; CHEMICAL COMPATIBILITY; FIGURES; TABLES.

311

PETTUS 74
BRINE TREATMENT/CORROSION

TITLE- WATER SOLUBLE CORROSION INHIBITORS--A DIFFERENT APPROACH TO INTERNAL PIPELINE CORROSION CONTROL.

AUTHOR- PETTUS, P.L.;STRICKLAND, L.N. [BAROID DIV., N L IND. INC., HOUSTON, TEX. (USA)].

REFERENCE- NACE, INTERNATIONAL CORROSION FORUM. NACE, HOUSTON, TEX, 1974, 11 P..

DESCRIPTORS- CORROSION PROTECTION; CORROSION INHIBITORS; PIPELINES; PETROLEUM INDUSTRY.

312

MATHIAS 74
BRINE TREATMENT/SCALING

TITLE- PRELIMINARY RESULTS OF GEOTHERMAL WELLS. MESA 6-1 AND MESA 6-2 EAST MESA KGRA, IMPERIAL VALLEY, CALIFORNIA.

AUTHOR- MATHIAS, K.E. [BUREAU OF RECLAMATION, BOULDER CITY, NEV. (USA)].

REFERENCE- GEOTHERMAL ENERGY, V. 2 (6), P. 8-17(JUN 1974).

DESCRIPTORS- EAST MESA KGRA; CALIFORNIA; GEOTHERMAL WELLS; HEAT FLOW; GEOPHYSICAL SURVEYS; SCALING; CHEMICAL ANALYSIS; PIPELINES; BRINE TREATMENT.

313

MILLER 76
BRINE TREATMENT/CORROSION

TITLE- CORROSION ENGINEERING IN THE UTILIZATION OF THE RAFT RIVER GEOTHERMAL RESOURCE.

AUTHOR- MILLER, R.L. [AEROJET NUCLEAR CO., IDAHO FALLS, IDAHO (USA)].

REFERENCE- CORROSION ENGINEERING IN THE UTILIZATION OF THE RAFT RIVER GEOTHERMAL RESOURCE. ANCR-1342, IDAHO NATIONAL ENGINEERING LABORATORY, IDAHO FALLS, IDAHO, AUG 1976, 80

DESCRIPTORS- CORROSION; RAFT RIVER KGRA; GEOTHERMAL BRINES; CORROSION PROTECTION; CORROSION RESISTANT ALLOYS; PITTING CORROSION; STRESS CORROSION; ELECTROCHEMICAL CORROSION; CREVICE CORROSION; EROSION.

314

UHLIG 71
BRINE TREATMENT/CORROSION

TITLE- CORROSION AND CORROSION CONTROL. AN INTRODUCTION TO CORROSION SCIENCE AND ENGINEERING.

AUTHOR- UHLIG, H.H. [MASSACHUSETTS INST. OF TECH., CAMBRIDGE (USA). DEPT. OF METALLURGY].

REFERENCE- CORROSION AND CORROSION CONTROL. AN INTRODUCTION TO CORROSION SCIENCE AND ENGINEERING. 2ND ED., JOHN WILEY AND SONS, INC., NEW YORK, 1971, 419 P..

DESCRIPTORS- CORROSION; CORROSION PROTECTION; IRON; STEELS; STRESS CORROSION; PITTING CORROSION; COATINGS; OXYGEN CORROSION; CORROSION INHIBITORS; CORROSION RESISTANT ALLOYS; ELECTROCHEMICAL CORROSION; AQUEOUS SOLUTIONS; POLARIZATION STUDIES.

315

DEBOER 77
BRINE TREATMENT/SCALING

TITLE- INFLUENCE OF SEED CRYSTALS ON THE PRECIPITATION OF CALCITE AND ARAGONITE.

AUTHOR- DEBOER, R.B. [KONINKLIJKE SHELL, RIJSWIJK (NETHERLANDS). EXPLORATIE EN PRODUKTIE LABORATORIUM].

REFERENCE- AM. J. SCI., V. 277 (1), P. 38-60(JAN 1977).

DESCRIPTORS- CRYSTAL SEEDING; CALCITE; PRECIPITATION; EXPERIMENTAL RESULTS.

316

SCHROEDER 76
BRINE TREATMENT/SCALING

TITLE- MODELING THE TEMPERATURE-DEPENDENT SCALE ACCUMULATION FROM GEOTHERMAL BRINE.

AUTHOR- SCHROEDER, R.C. [CALIFORNIA UNIV., BERKELEY (USA). LAWRENCE BERKELEY LAB.].

REFERENCE- MODELING THE TEMPERATURE-DEPENDENT SCALE ACCUMULATION FROM GEOTHERMAL BRINE. UCRL-52149, LAWRENCE LIVERMORE LABORATORY, LIVERMORE, CALIF., 1976, 16 P..

DESCRIPTORS- SCALING; SILICA MINERALS; TEMPERATURE DEPENDENCE; GEOTHERMAL BRINES; MATHEMATICAL MODELS.

317

GAUPP 74
BRINE TREATMENT/CORROSION
BRINE TREATMENT/SCALING

TITLE- CORROSION AND SCALE CONTROL.

AUTHOR- GAUPP, R.H.;NYGREN, J.A. [DREW CHEMICAL CORP. (USA)].

REFERENCE- IND. WATER ENG., P. 18-20(MAY-JUNE 1974).

DESCRIPTORS- CORROSION PROTECTION; SCALING CONTROL; CORROSION INHIBITORS.

318

GELOSA 76
BRINE TREATMENT/CORROSION
BRINE TREATMENT/SCALING

TITLE- WATER TREATMENT PROGRAMS FOR STEAM GENERATING SYSTEMS.

AUTHOR- GELOSA, L.R.;ANDRADE, R.C. [DREW CHEMICAL CORP. (USA)].

REFERENCE- IND. WATER ENG., P. 18-22(APR-MAY 1976).

DESCRIPTORS- SCALING; CORROSION; BOILERS; CORROSION INHIBITORS; OXYGEN CORROSION; WATER TREATMENTS; ADDITIVES.

319

RIGGS 73
BRINE TREATMENT/CORROSION

TITLE- THEORETICAL ASPECTS OF CORROSION INHIBITORS AND INHIBITION.

AUTHOR- RIGGS, O.L., JR. [KERR-MCGEE CORP., OKLAHOMA CITY, OKLA. (USA)].

NATHAN, C.C. (ED.) [BETZ LABS., INC., PHILADELPHIA, PA. (USA)].

REFERENCE- CORROSION INHIBITORS. NATIONAL ASSOCIATION OF CORROSION ENGINEERS, HOUSTON, TEX., 1973, P. 7-27.

DESCRIPTORS- CORROSION PROTECTION; CORROSION INHIBITORS; CHEMICAL REACTIONS; ELECTROCHEMISTRY; THEORETICAL TREATMENTS; FREE ENERGY.

320

WATKINS 76
BRINE TREATMENT/CORROSION

TITLE- CORROSION TESTING OF HIGHLY ALLOYED MATERIALS FOR DEEP, SOUR GAS WELL ENVIRONMENTS.

AUTHOR- WATKINS, M. [EXXON PRODUCTION RESEARCH CO. (USA)].

GREER, J.B. [EXXON CO. (USA)].

REFERENCE- J. PET. TECHNOL., P. 698-704(JUN 1976).

DESCRIPTORS- CORROSION; CORROSION RESISTANT ALLOYS; NATURAL GAS WELLS; EXPERIMENTAL RESULTS; PITTING CORROSION; STRESS CORROSION; TABLES; FIGURES.

321

ELLIS 63
BRINE TREATMENT/SCALING

TITLE- THE SOLUBILITY OF CALCITE IN SODIUM CHLORIDE SOLUTIONS AT HIGH TEMPERATURES.

AUTHOR- ELLIS, A.J. [DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH, WELLINGTON (NEW ZEALAND). DOMINION LABORATORY].

REFERENCE- AM. J. SCI., V. 261, P. 259-267(MAR 1963).

DESCRIPTORS- CALCITE; SOLUBILITY; SODIUM CHLORIDES; TEMPERATURE DEPENDENCE; HIGH TEMPERATURE; EXPERIMENTAL RESULTS; HYDROTHERMAL SYSTEMS; GRAPHS; TABLES.

322

FOURNIER 73
BRINE TREATMENT/SCALING

TITLE- SILICA IN THERMAL WATERS--LABORATORY AND FIELD INVESTIGATION.

AUTHOR- FOURNIER, R.O. [GEOLOGICAL SURVEY, MENLO PARK, CALIF. (USA)].

REFERENCE- PROCEEDINGS OF SYMPOSIUM ON HYDROGEOCHEMISTRY AND BIOGEOCHEMISTRY. VOLUME I - HYDROGEOCHEMISTRY. THE CLARKE COMPANY, WASHINGTON, D.C., 1973, P. 122-139.

DESCRIPTORS- SILICA MINERALS; QUARTZ; SOLUBILITY; PH DEPENDENCE; HYDROTHERMAL SYSTEMS; EXPERIMENTAL RESULTS; FIELD STUDIES; GEOTHERMOMETRY; POLYMERIZATION; TABLES; FIGURES.

323

ROGERS 55
BRINE TREATMENT/CORROSION

TITLE- CORROSION EFFECTS OF HYDROGEN SULFIDE AND CARBON DIOXIDE IN OIL PRODUCTION.

AUTHOR- ROGERS, W.F.;ROWE, J.A., JR. [GULF OIL CORP., HOUSTON, TEX. (USA). HOUSTON PRODUCTION DIVISION CHEMICAL LAB.].

REFERENCE- PROCEEDINGS--FOURTH WORLD PETROLEUM CONGRESS, SECTION II. GULF OIL CORPORATION, HOUSTON, TEX., 1955, PAPER 3, SECTION II/G, P. 479-499.

DESCRIPTORS- CORROSION; HYDROGEN SULFIDES; CARBON DIOXIDE; OIL WELLS; OILFIELD BRINES; EXPERIMENTAL RESULTS; TABLES; FIGURES.

324

LYON 74
BRINE TREATMENT/CORROSION
BRINE TREATMENT/SCALING

TITLE- A RECOMMENDED RESEARCH PROGRAM IN GEOTHERMAL CHEMISTRY.

AUTHOR- LYON, R.N. [OAK RIDGE NATIONAL LAB., TENN. (USA)].

KOLSTAD, G.A. [USAEC DIVISION OF PHYSICAL RESEARCH, WASHINGTON, D.C. (USA)].

REFERENCE- A RECOMMENDED RESEARCH PROGRAM IN GEOTHERMAL CHEMISTRY. WASH-1344, ATOMIC ENERGY COMMISSION, WASHINGTON, D.C., OCT 1974, 48 P..

DESCRIPTORS- SCALING; CORROSION; RESEARCH PROGRAMS; GEOTHERMAL SYSTEMS; GEOTHERMAL FLUIDS; THERMODYNAMIC PROPERTIES; MINERALS; METALS; KINETICS; ROCK-FLUID INTERACTIONS; MATHEMATICAL MODELS.

325

KERN 75
BRINE TREATMENT/SCALING

TITLE- CONTINOUS TUBE CLEANING IMPROVES PERFORMANCE OF CONDENSERS AND HEAT EXCHANGERS.

AUTHOR- KERN, W.I. [AMERTAP CORP., MINEOLA, N.Y. (USA)].

REFERENCE- CHEM. ENG., V. 82 (22), P. 139-144(1975).

DESCRIPTORS- SCALING; STEAM CONDENSERS; HEAT EXCHANGERS; TURBINES; SCALING CONTROL.

326

COPSON 51
BRINE TREATMENT/CORROSION

TITLE- LITERATURE SURVEY ON CORROSION IN NEUTRAL UNAERATED OIL WELL BRINES.

AUTHOR- COPSON, H.R. [INTERNATIONAL NICKEL CO., BAYONNE, N.J. (USA). RESEARCH LAB.].

REFERENCE- CORROSION, V. 7, P. 123-127(APR 1951).

DESCRIPTORS- CORROSION; OILFIELD BRINES; REVIEWS; CORROSION INHIBITORS.

327

BELTEKY 75
BRINE TREATMENT/SCALING

TITLE- PROBLEMS RELATED TO OPERATING THERMAL WELLS SUBJECT TO SCALING IN HUNGARY.

AUTHOR- BELTEKY, L. [RESEARCH INST. FOR THE DEVELOPMENT OF WATER RESOURCES, BUDAPEST (HUNGARY)].

REFERENCE- GEOTHERMICS, V. 4 (1-4), P. 57-65(1975).

DESCRIPTORS- SCALING; GEOTHERMAL WELLS; HUNGARY; SCALE COMPOSITION; SCALING CONTROL; DESCALING; GEOTHERMAL BRINES; ACIDIZATION; FIGURES; TABLES.

328

SAKAI 76
BRINE TREATMENT/CORROSION

TITLE- CORROSION BEHAVIOR OF STEELS IN GEOTHERMAL STEAM POWER PLANT.

AUTHOR- SAKAI, J.;KANEZASHI, M.;MATSUSHIMA, I. [NIPPON KOKAN K.K., KAWASAKI, KANAGAWA. TECHNICAL RESEARCH CENTER].

REFERENCE- TRANS. IRON STEEL INST. JPN., V. 16 (12), P. 688-694(1976).

DESCRIPTORS- CORROSION; ALLOYS; STEELS; NATURAL STEAM; GEOTHERMAL POWER PLANTS; EXPERIMENTAL RESULTS; TABLES; FIGURES.

329

TSKHVIRASHVILI 72
BRINE TREATMENT/CORROSION

TITLE- ON CORROSION OF METALS IN GEOTHERMAL POWER PLANTS.

AUTHOR- TSKHVIRASHVILI, D.;VARDIGORELI, O. [GEORGIAN INST. OF ENERGY, TBILISI (USSR)].

ACOLSIN, P. [NATIONAL HEAT ENGINEERING INST., MOSCOW (USSR)].

REFERENCE- GEOTHERMICS, V. 1 (3), P. 113-118(1972).

DESCRIPTORS- CORROSION; CORROSION PROTECTION; METALS; GEOTHERMAL POWER PLANTS; GEOTHERMAL

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FLUIDS; CHEMICAL ANALYSIS; EXPERIMENTAL RESULTS; GRAPHS; TABLES.

330

GOLDBERG 76B
BRINE TREATMENT/CORROSION

TITLE- GEOTHERMAL MATERIALS STUDIES. METALLURGY DIVISION QUARTERLY REPORT--APRIL-JUNE 1976.

AUTHOR- GOLDBERG, A.;JOHNSON, J.M.;GARRISON, R.E.;OWEN, L.B.;DECOURSEY, H.;HARRAR, J.E.;SHROYER, R.B. (CALIFORNIA UNIV., LIVERMORE (USA). LAWRENCE LIVERMORE LAB.).

REFERENCE- GEOTHERMAL MATERIALS STUDIES. METALLURGY DIVISION QUARTERLY REPORT--APRIL-JUNE 1976. UCID-17261-76-2, CALIFORNIA UNIV., LAWRENCE LIVERMORE LAB., LIVERMORE, CALIF., 1976, 26 P..

DESCRIPTORS- HYDROTHERMAL SYSTEMS; MATERIALS TESTING; COATINGS; TOTAL FLOW SYSTEM; STRESS CORROSION; EROSION; CORROSION; PITTING CORROSION; ELECTROCHEMICAL CORROSION; NOZZLES; TABLES; FIGURES.

331

POSEY 76B
BRINE TREATMENT/CORROSION

TITLE- CORROSIVITY OF GEOTHERMAL BRINES. PROGRESS REPORT FOR PERIOD ENDING JUNE 1976.

AUTHOR- POSEY, F.A.;PALKO, A.A. (OAK RIDGE NATIONAL LAB., TENN. (USA). CHEMISTRY DIVISION).

REFERENCE- CORROSIVITY OF GEOTHERMAL BRINES. PROGRESS REPORT FOR PERIOD ENDING JUNE 1976. ORNL/TM-5488, OAK RIDGE NATIONAL LABORATORY, OAK RIDGE, TENN., DEC 1976, 33 P..

DESCRIPTORS- GEOTHERMAL BRINES; CORROSION; CORROSIVE EFFECTS; STEELS; ELECTROCHEMICAL CORROSION; PITTING CORROSION; EXPERIMENTAL RESULTS; LABORATORY EQUIPMENT; GRAPHS; FIGURES.

332

BOHLMANN 76B
BRINE TREATMENT/SCALING

TITLE- PRECIPITATION AND SCALING IN DYNAMIC GEOTHERMAL SYSTEMS.

AUTHOR- BOHLMANN, E.G.;SHOR, A.J.;BERLINSKI, P. [OAK RIDGE NATIONAL LAB., TENN. (USA). CHEMISTRY DIVISION].

REFERENCE- PRECIPITATION AND SCALING IN DYNAMIC GEOTHERMAL SYSTEMS. ORNL/TM-5649, OAK RIDGE NATIONAL LABORATORY, OAK RIDGE, TENN., OCT 1976, 48 P..

DESCRIPTORS- PRECIPITATION; SCALING; GEOTHERMAL SYSTEMS; DYNAMIC SYSTEMS; EXPERIMENTAL RESULTS; LABORATORY EQUIPMENT; HEAT EXCHANGERS; SILICA MINERALS; GRAPHS; FIGURES.

333

MC DOWELL 76
BRINE TREATMENT/SCALING
BRINE TREATMENT/CORROSION

TITLE- SCRUBBING OF CHLORIDES IN CARRY-OVER WATER FROM GEOTHERMAL WELL SEPARATORS.

AUTHOR- MC DOWELL, G.C. [DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH, C/MOW, TAUPO (NEW ZEALAND)].

REFERENCE- PROCEEDINGS--SECOND UNITED NATIONS SYMPOSIUM ON THE DEVELOPMENT AND USE OF GEOTHERMAL RESOURCES. LAWRENCE BERKELEY LAB., UNIV. OF CALIFORNIA, BERKELEY, CALIF., 1976, V. 3, P. 1737-1740.

DESCRIPTORS- GEOTHERMAL WELLS; WAIRAKEI GEOTHERMAL FIELD; GEOTHERMAL FLUIDS; CHLORIDES; SCRUBBING; STEAM SEPARATORS.

334

GRECO 62
BRINE TREATMENT/CORROSION

TITLE- CORROSION OF IRON IN AN H2S-CO2-H2O SYSTEM.

AUTHOR- GRECO, E.C.;WRIGHT, W.B. [UNITED GAS CORP., SHREVEPORT, LA. (USA). RESEARCH DEPT.].

REFERENCE- CORROSION, V. 18, P. 119-124(1962).

DESCRIPTORS- CORROSION: IRON; HYDROGEN SULFIDES; CARBON DIOXIDE; STEELS; EXPERIMENTAL RESULTS; LABORATORY EQUIPMENT; STRESS CORROSION; DYNAMIC SYSTEMS.

335

POLIZO 74

TITLE- CORROSIVITY OF GEOTHERMAL WATERS. (IN RUSSIAN). KORRGZIONNAYA AGRESSIVNOSCH GEOTERMALNCI VODY.

AUTHOR- POLIZO, G.D. [ODESSA POLITEKHNICHESKIJ INST. (USSR)].

KURISHKO, V.A.

REFERENCE- IZV. VYSSH. UCHEBN. ZAVED., ENERG., NO. 8, P. 96-100(1974).

DESCRIPTORS- GEOTHERMAL BRINES; CORROSION; FIELD STUDIES; STEELS; ALLOYS; NORTH SIVASH GEOTHERMAL FIELD; USSR.

336

CLEARY 70
BRINE TREATMENT/SPENT FLUID DISPOSAL

TITLE- SOME CONSIDERATIONS IN UNDERGROUND WASTEWATER DISPOSAL.

AUTHOR- CLEARY, E.J. [OHIO RIVER VALLEY WATER SANITATION COMMISSION (USA)].

WARNER, D.L. [MISSOURI UNIV. (USA). DEPT. OF GEOLOGICAL ENG.].

REFERENCE- J. AM. WATER WORKS ASSOC., V. 62 (8), P. 489-498(1970).

DESCRIPTORS- WASTE WATER; UNDERGROUND DISPOSAL; DEEP WELLS; LEGAL ASPECTS; OHIO.

337

C'NEAL 75
BRINE TREATMENT/CORROSION

TITLE- CORROSION INHIBITING SYNERGISM BY TRIAZOLES IN AQUEOUS MULTIMETAL SYSTEMS.

AUTHOR- O'NEAL, C., JR.;BORGER, R.N. [SHERWIN WILLIAMS CHEMICALS (USA)].

REFERENCE- SOC. PET. ENG. J., PAPER NO. SPE 5310, P. 161-165(1975).

DESCRIPTORS- CORROSION PROTECTION; CORROSION INHIBITORS; METALS; COOLING SYSTEMS; ORGANIC COMPOUNDS; LABORATORY STUDIES; EXPERIMENTAL RESULTS.

338

WOOD 55
BRINE TREATMENT/CORROSION

TITLE- SOME EXPERIENCES WITH SODIUM SILICATE AS A CORROSION INHIBITOR IN INDUSTRIAL COOLING WATERS.

AUTHOR- WOOD, J.W.;BEECHER, J.S.;LAURENCE, P.S. [E.F. DREW AND CO., INC., NEW YORK (USA). POWER CHEMICALS DIV.].

REFERENCE- CORROSION, V. 13, P. 41-46(1957).

DESCRIPTORS- CORROSION PROTECTION; COOLING SYSTEMS; CORROSION INHIBITORS; SILICATES; STEELS; PH DEPENDENCE; TEMPERATURE DEPENDENCE; EXPERIMENTAL RESULTS; GRAPHS.

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ENVIRON. SCI. TECH. 68
BRINE TREATMENT/SPENT FLUID DISPOSAL

TITLE- DEEP WELL INJECTION IS EFFECTIVE FOR WASTE DISPOSAL.

AUTHOR- ENVIRONMENTAL SCIENCE AND TECHNOLOGY.

REFERENCE- ENVIRON. SCI. TECHNOL., V. 2 (6), P. 406-410(1968).

DESCRIPTORS- WASTE DISPOSAL; INJECTION WELLS; DISPOSAL FORMATIONS; WELL PLUGGING; DEEP WELLS; OHIO; CASE HISTORIES; ECONOMICS; LEGAL ASPECTS; LIQUID WASTES; ROCKY MOUNTAINS; COLORADO; POLLUTION LAWS.

340

VETTER 70
BRINE TREATMENT/SCALING

TITLE- PREDICTION OF DEPOSITION OF CALCIUM SULFATE SCALE UNDER DOWN-HOLE CONDITIONS.

AUTHOR- VETTER, O.J.G.;PHILLIPS, R.C. [UNION OIL CO. OF CALIFORNIA (USA)].

REFERENCE- J. PET. TECHNOL., P. 1299-1308(OCT 1970).

DESCRIPTORS- SCALING; CALCIUM SULFATES; OIL WELLS; SODIUM CHLORIDES; ANHYDRITE; OILFIELD BRINES; INHIBITORS; THERMODYNAMICS; GRAPHS; TABLES.

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CUONG 76
BRINE TREATMENT/SCALING

TITLE- SCALING CHARACTERISTICS IN THE GEOTHERMAL LOOP EXPERIMENTAL FACILITY AT NILAND, CALIFORNIA.

AUTHOR- QUONG, R.

REFERENCE- SCALING CHARACTERISTICS IN THE GEOTHERMAL LOOP EXPERIMENTAL FACILITY AT NILAND, CALIFORNIA. UCRL-52162, LAWRENCE LIVERMORE LABORATORY, LIVERMORE, CALIF., 1976, P. 1-33.

DESCRIPTORS- SCALING; GEOTHERMAL ENERGY; PILOT PLANTS; TEST FACILITIES; NILAND; BINARY FLUID SYSTEMS; GEOTHERMAL WELLS; GEOTHERMAL BRINES; CHEMICAL COMPOSITION; SCALING CONTROL; FIGURES; TABLES.

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MILLER 77
BRINE TREATMENT/SCALING

TITLE- THE USE OF GEOCHEMICAL-EQUILIBRIUM COMPUTER CALCULATIONS TO ESTIMATE PRECIPITATION FROM GEOTHERMAL BRINES.

AUTHOR- MILLER, D.G.;PIWINSKII, A.J.;YAMAUCHI, R.

REFERENCE- THE USE OF GEOCHEMICAL-EQUILIBRIUM COMPUTER CALCULATIONS TO ESTIMATE PRECIPITATION FROM GEOTHERMAL BRINES. UCRL-52197, LAWRENCE LIVERMORE LABORATORY, LIVERMORE, CALIF., 1977, P. 1-35.

DESCRIPTORS- PRECIPITATION; SCALING; GEOTHERMAL BRINES; CHEMICAL COMPOSITION; SALTON SEA GEOTHERMAL FIELD; COMPUTER CALCULATIONS; GEOCHEMISTRY; CHEMICAL EQUILIBRIUM; THERMODYNAMICS; CHLORIDES; SILICA MINERALS; SULFIDES; SOLUBILITY; TEMPERATURE DEPENDENCE; CORROSION; CHEMICAL EQUILIBRIUM CODES; GRAPHS; TABLES.

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POSEY 76C
BRINE TREATMENT/CORROSION

TITLE- CORROSIVITY OF GEOTHERMAL BRINES. PROGRESS REPORT FOR PERIOD ENDING DECEMBER 1976.

AUTHOR- POSEY, F.A.;PALKO, A.A.;BACARELLA, A.L. [OAK RIDGE NATIONAL LAB., TENN. (USA). CHEMISTRY DIVISION].

REFERENCE- CORROSIVITY OF GEOTHERMAL BRINES. PROGRESS REPORT FOR PERIOD ENDING DECEMBER 1976. ORNL/TM-5863, OAK RIDGE NATIONAL LABORATORY, OAK RIDGE, TENN., APR 1977, 23 P..

DESCRIPTORS- GEOTHERMAL BRINES; CORROSION; CORROSIVE EFFECTS; STEELS; TEMPERATURE DEPENDENCE; PH DEPENDENCE; POLARIZATION STUDIES; EXPERIMENTAL EQUIPMENT; LABORATORY STUDIES; GRAPHS.

344

BETZ 40
BRINE TREATMENT/SCALING

TITLE- REMOVAL OF SILICA FROM WATER BY COLD PROCESS.

AUTHOR- BETZ, L.D.;NOLL. C.A.;MAGUIRE, J.J. [W.H. AND L.D. BETZ., PHILADELPHIA, PENN. (USA)].

REFERENCE- IND. ENG. CHEM., V. 32, P. 1320-1323(OCT 1940).

DESCRIPTORS- SILICA MINERALS; DESCALING; BOILERS; PH DEPENDENCE; TEMPERATURE DEPENDENCE; ALUMINUM HYDROXIDES; LABORATORY STUDIES.

345

BETZ 40B
BRINE TREATMENT/SCALING

TITLE- REMOVAL OF SILICA FROM WATER BY HOT PROCESS.

AUTHOR- BETZ, L.D.;NOLL, C.A.;MAGUIRE, J.J. [W.H. AND L.D. BETZ, PHILADELPHIA, PENN. (USA)].

REFERENCE- IND, ENG. CHEM., V. 32, P. 1323-1329(OCT 1940).

DESCRIPTORS- SILICA MINERALS; DESCALING; BOILERS; MAGNESIUM INORGANIC COMPOUNDS; TEMPERATURE DEPENDENCE; PH DEPENDENCE; LABORATORY STUDIES.

346

LEHRMAN 52
BRINE TREATMENT/CORROSION
BRINE TREATMENT/SCALING

TITLE- ACTION OF SODIUM SILICATE AS A CORROSION INHIBITOR IN WATER PIPING.

AUTHOR- LEHRMAN, L. [CITY COLL., NEW YORK (USA)].

SHULDENER, H.L. [WATER SERVICE LABS., NEW YORK (USA)].

REFERENCE- IND. ENG. CHEM., V. 44 (8), P. 1765-1769(AUG 1952).

DESCRIPTORS- CORROSION; CORROSION INHIBITORS; SODIUM SILICATES; PIPES; LABORATORY STUDIES; EXPERIMENTAL RESULTS; ZINC INORGANIC COMPOUNDS; CORROSION PROTECTION.

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MIDKIFF 76
BRINE TREATMENT/SCALING

TITLE- AMORPHOUS SILICA SCALE IN COOLING WATERS.

AUTHOR- MIDKIFF, W.S. [LOS ALAMOS SCIENTIFIC LAB., N. MEX. (USA)].

FOYT, H.P. [WATER TREATMENT SPECIALIST].

REFERENCE- AMORPHOUS SILICA SCALE IN COOLING WATERS. LA-UR-75-2313, LOS ALAMOS SCIENTIFIC LAB., LOS ALAMOS, N. MEX., 1976, 22 P..

DESCRIPTORS- SILICA MINERALS; AMORPHOUS STATE; COOLING TOWERS; DESCALING; SCALING CONTROL; WATER TREATMENTS; CORROSION INHIBITORS; CHELATING AGENTS; FIGURES; X-RAY DIFFRACTION.

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PYE 47
BRINE TREATMENT/CORROSION

TITLE- CHEMICAL FIXATION OF OXYGEN.

AUTHOR- PYE, D.J. [DOW CHEMICAL CO., PITTSBURG, CALIF. (USA). GREAT WESTERN DIVISION].

REFERENCE- J. AM. WATER WORKS ASSOC., V. 39, P. 1121-1127(1947).

DESCRIPTORS- CORROSION; CORROSION PROTECTION; OXYGEN CORROSION; STEELS; CORROSION INHIBITORS.