Title
CONTROL TECHNOLOGY FOR IN-SITU OIL SHALE RETORTS

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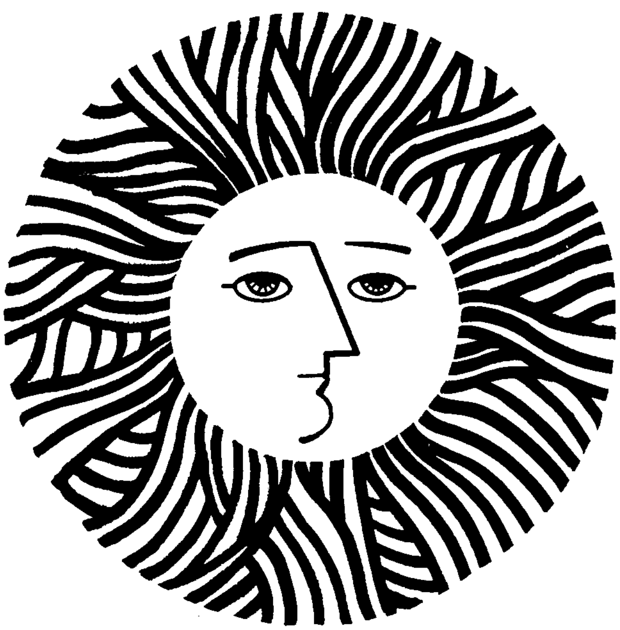

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February 13, 1980

TO: Charles Grua and Art Hartstein

FROM: Peter Persoff, Joe Ratigan, Mohsen Mehran, and Phyllis Fox

RE: January Monthly Progress Report
Control Technology for In-Situ Oil Shale Retorts
LBID-176

TASK 3. BARRIER OPTIONS

The paper, Hydraulic cement preparation from Lurgi Spent Shale, was presented by Peter Persoff at the Third Annual Oil Shale Conversion Symposium, sponsored by Laramie Energy Technology Center.

Preparation of grout and grouted core samples

A program was initiated to measure modulus, strength, and permeability on candidate grouts and simulated grouted core specimens. For economy, candidate grouting materials will be at least 90 percent on-site waste materials (Lurgi spent shale and/or lean raw shale fines); up to 10 percent will be portland cement or hydraulic cement produced from Lurgi spent shale as described in the December progress report.

In preliminary experiments, slurries with water-solid ratios (wsr) ranging from 0.7 to 1.8 were made to check for "bleeding" (settling of solids leaving a clear supernatant). Bleeding is deleterious in grouts because it leaves ungrouted voids. The maximum wsr that did not bleed was 0.8. A slurry with 97.5 percent Lurgi spent shale, 2.5 percent portland cement, and 0.8 wsr was tested for flow properties. Time of efflux from a standard grout flow cone was over 3 min (20 sec is desirable for intrusion grouting) and when injected into a packed column of -3/8 in. + 1/4 in. prewetted and flooded L-2 spent shale, it penetrated less than 6 in. under 30 psi injection pressure. These results suggest that a non-bleeding grout of only Lurgi spent shale has too high a yield value (is too thick) for effective grouting. Replacement of a portion of the spent shale with lean raw shale fines (-30 + 100 mesh) will be tried as a means to reduce the water requirement.

Grouted retort structural requirements for additional resource recovery.

Rock mechanics calculations for various modified in-situ (MIS) conceptual designs in the Tract C-a stratigraphy have been completed. The finite element program developed in December was used to determine pillar and grouted retort vertical stresses and overburden stresses and subsidence. All computer models assumed an overburden depth of 400 ft. and a retort height of 750 ft. Four models were developed with the following dimensions:

Model	Pillar Width (feet)	Retort Width (feet)	Areal Extract (%)
1	150	100	16
2	50	300	74
3	150	300	44
4	50	100	44

Retorts were assumed to be square in plan.

Emphasis was given to the evaluation of grouted retort strength and stiffness requirements. In this regard, two criteria were used to establish the requirements. First, the vertical pillar stress was limited to a constant multiple of the unconfined, uniaxial strength of the various oil shale members (both lean and rich sections) averaged over the height of the pillars. This multiple was taken as 0.2. In other words, the pillar vertical stress was limited to one fifth of the laboratory-determined strength. Second, the tensile stress in the overburden resulting from subsidence above the retorts was limited to one-fifth of the laboratory-determined tensile strength. These criteria arise because the pillars should remain intact to support the overburden and no new fractures should develop in the overburden. Any new fractures would result in different groundwater flow paths and also would decrease the ability of the overburden to resist subsidence.

In all cases examined, the overburden tensile stress requirement was more restrictive in establishing grouted retort requirements. The properties of the grouted retorts considered were as follows:

Deformation Modulus* (psi)	Uniaxial Compressive Strength (psi)
50,000	1000
250,000	1000
750,000	1000

*tangent modulus at zero strain

Additional models were evaluated without any grout in the retorts and hence, assumed to have negligible stiffness and strength.

From the model results it appears that a grouted retort with a deformation modulus of about 500,000 psi and a uniaxial strength of 1000 psi is sufficient to meet the two constraints and still allow essentially total extraction of the oil shale by the MIS concept.

Further cases were evaluated which considered partial oil shale extraction followed by grouting of the retorts and subsequent retorting of the region previously occupied by the pillars. These "secondary" retorts were assumed to not be grouted. This analysis indicated that significantly greater stiffness would be required to meet the two constraints if this "partial" grouting plan was followed.

Future efforts will concentrate on evaluation of the significance of the assumptions made in the analysis.

TASK 5. LEACHING OPTIONS

Column leaching studies described previously are continuing. The resulting data are being used to verify the leaching model described in earlier reports and to develop kinetic constants.

TASK 6. GEOHYDROLOGIC MODIFICATION OPTIONS

Last month, the computer model TRUST was used to simulate saturated flow in a homogeneous aquifer due to dewatering by a well located in the center of a block of retorts. Since it is expected that mesh size may influence the calculated drawdown, particularly near the well and at small times, a sensitivity analysis was done to determine the optimum mesh size. It was concluded that the width of the first few elements near the well should be the same order of magnitude as the well radius.

A small mesh was then designed to check the unsaturated portion of the program TRUST. The seepage face was included in the program to handle the flow of water from the interior nodes to the well when the potential in the well decreases below that of the boundary nodes.

To check the validity of the numerical scheme for saturated-unsaturated flow, model calculations are being checked against the approximate analytical solution of Kroszynski and Dagan (1975). This task is still in progress.

The next step in our modeling efforts will be the collection of all the relevant hydrologic properties of the layered system at tracts C-a and C-b in order to simulate the dewatering of the region according to some reasonable production rates. Sensitivity analyses will be performed to observe the effect of different dewatering schemes on the Piceance Creek Basin water regime.

References

Kroszynski, U. I. and G. Dagan, 1975, "Well pumping in unconfined aquifers: The influence of the unsaturated zone", Water Resources Research Vol. 11, No. 3, 479-490.

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