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DISCLAIMER

HEAT EXCHANGER MODULE TEST

(RP1094-1)

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The heat exchanger module test is an EPRI/DOE cooperative field test of shell-and-tube heat exchangers to be performed with brine from Chevron Resources Company's Heber, California, field. Overall heat transfer coefficients will be measured with isobutane and a mixture of isobutane-isopentane as the working fluid in a simulated power cycle.

The objectives of the project are:

- *Verify the performance of state-of-the-art* heat exchangers in geothermal service;
- Verify the heat exchangers' performance heating either selected pure light hydrocarbons or selected mixtures of light hydrocarbons in the vicinity of their respective critical pressures and temperatures;
- Establish overall heat transfer coefficients that might be used for design of commercial-size geothermal power plants using the same geothermal brine and light hydrocarbon working fluids;
- Define the effects of heat exchanger cleaning techniques on subsequent heat exchanger performance;
- Establish overall condensing coefficients that might be used for design of commercial-size geothermal power plants using the same light hydrocarbon working fluids;
- To perform and investigate the above under representative field operating conditions during which the production well will be pumped.

The Lawrence Berkeley Laboratory has been assigned management responsibility for DOE's portion of the project. The mechanism for cooperation between LBL and EPRI on this project is the Project Group, consisting of one representative from EPRI and one from LBL. A project manager, reporting to the Project Group, provides the day-to-day contact with the contractor including technical direction, schedule control, and invoice review and approval.

Because it is a cooperative project and not jointly funded, the two sponsoring organizations have each assumed certain responsibilities. LBL is responsible for the system design, procurement of the hardware and analysis of the data from the tests. EPRI is responsible for the construction and operation of the test apparatus and distribution of the final report. The project manager is responsible for writing the final report.

The main emphasis will be on the primary brine/hydrocarbon heat exchangers. This heat exchanger train consists of six exchangers in series; the brine in the tubes and the hydrocarbon in the shell. Table I lists the main features of the primary heat exchangers.

Table I

PRIMARY HEAT EXCHANGER DETAILS

No. of tubes: 62
Tube length: 24 ft.
Tube size: 3/4 in. OD, 16 ga.
Tube material: carbon steel
Tube pitch: 15/16 in., triangular
Shell ID: 8 3/4 in.
Baffle spacing: 12 in.
Area per exchanger: 292 ft^2

The heat exchanger module test consists of three fluid loops: brine, hydrocarbon and cooling water. The three loops are interconnected through the primary brine/hydrocarbon heat exchanger train and the desuperheater-condenser-subcooler train. The heat load is then rejected to the atmosphere in a wet cooling tower. The high pressure (heater) portion of the hydrocarbon loop is separated from the low pressure (condenser) portion by a pressure-reducing valve simulating a turbine.

The working fluids will be heated at supercritical pressures (600 psia) and the test is designed to gain insight into the behavior and heat transfer rates of the working fluids near the critical point. In particular, the working fluid mixture of isobutane and isopentane will be studied to observe any "fractionation" or unstable flow behavior that might occur due to vaporization of the mixture components at different locations in the heat exchangers.

Data from the test will be compared with predicted values using various models, such as the film coefficients predicted by the LBL SIZEHX code. The heat exchanger manufacturer will be asked to predict the performance of his units under the test conditions and these predictions will be compared to the test data. The test data will also be compared with predictions made using available correlations and film coefficients being measured in LBL's Binary Fluid Experiment.

In order to reduce the head required from the circulating pump, the hydrocarbon will be condensed at 250 psia (200°F) during primary heat exchanger runs. The subcooler will reduce the liquid hydrocarbon temperature to 120°F entering the primary heat exchangers.

To look at condensing coefficients, the hydrocarbon flow will be reduced and the system pressure dropped to 95 psia (120°F). Tests will then be run to obtain data on the condensing coefficient versus condensate loading.

An initial series of tests with isobutane will be run, to be followed with an 80/20 mixture of isobutane and isopentane. Several 200 hour runs separated by tubeside cleanings will be made to look at the effectiveness of the cleaning method.

The schedule calls for test operation to begin in mid-September, 1978. Three months of testing has been planned. All the heat exchangers, desuperheater, condenser, subcooler, cooling tower, and hydrocarbon circulating pump are on hand. The contractor, Colley Engineers and Constructors, Gardena, California, who will design, fabricate and operate the loop, is presently working on the system design.

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