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FIELD TEST UNIT TO DEVELOP SCALE CONTROL TECHNIQUES FOR BINARY CYCLE POWER PLANT

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The objective of this project is to evaluate alternative methods of controlling scale that can form on the brine side of heat exchangers used in a binary power systems.

On June 9, 1981 we completed a 30-day scaling test on a geothermal well. At present, we are correlating data from this test in order to determine exactly what was occurring during the test.

In order to evaluate scale control methods a test unit comprised of two parallel sets of steam separators and heat exchangers was constructed. The design of these exchangers duplicates the flow path of the exchangers which are being designed for a proposed 10 MW binary power plant. Each set of exchangers has 36' long passes. The first four passes are sized to condense vapor coming from the top of the steam separator and the last six passes are sized to cool the condensed vapor and brine as rejected to the separator. Heat from the condensed vapor and brine is rejected to the atmosphere through a circulating oil system and an air cooled heat exchanger. The two parallel sets of exchangers can be operated individually so that comparative testing can be carried out, thus saving valuable time and allowing us to directly observe comparative results of different scale inhibiting treatments.

The test plan envisioned that we would be able to monitor heat transfer rates and fluid flow through the exchangers. By opening the ends of the tube bundles we would be able to make a visual assessment of scaling conditions at the ends of the tubes and in the passages between the bundles. Temperature, pressure, and flow measurements were recorded hourly for all the instruments mounted on the unit. Seventeen temperature measuring points were also recorded by a strip chart recorder. Differential pressures were measured and recorded on strip charts for the flow measuring devices.

Test experience indicates that a number of minor improvements should be made to the test unit prior to proceeding with further field testing. The changes envisioned would reduce the manpower required for running the test, provide more accurate measurements and provide additional sample points.

The design of the exchange heads needs to be modified in order to provide easy access to the tube ends and provide better placement of gas vents, sampling points, cross-over pipes, thermometers, thermocouples, etc. This will greatly reduce the time required for inspection, cleaning and turn around of the unit when it is being serviced. The readings we observed on some thermocouples and thermometers lead us to believe that they were not indicating the true temperature of the stream they were supposed to be measuring. Careful repositioning of the temperature measuring points will no doubt improve the accuracy of our heat transfer measurements.

Accurate fluid flow measurements in the oil circulating loops are difficult to obtain when simple orifice plates are used as the measuring element due to the viscosity changes which occur as the oil temperatures change. We expect that with improved instrumentation, accurate fluid flow measurements will not be a problem.

Fluid flow measurements on the brine side of the exchanger were made using a head tank ahead of an orifice. We were able to calibrate these orifices during operation and we feel that they are relatively accurate.

We plan to connect temperature, flow, and pressure sensing elements to a data logger in order to record most of the test data automatically. This will reduce our manning requirements on future tests to a minimum and provide data in a convenient form. During the first test we ran heat balances at the site using a printing calculator.

Presently, we are correlating data gathered during the test and awaiting results of laboratory analysis so we can arrive at some conclusions about the scale formations which occurred.

In brief, we did experience some scaling during the 30-day test run when we ran untreated geothermal fluid through one set of heat exchangers. The second set of heat exchangers operating with Nalco 7274 (neutralizer/Hydrazinc) in the steam condensing section and Nalco 780 (sulfite) plus Nalco 7317 (scale inhibitor) in the liquid section of the heat exchanger did not scale up as rapidly. We were able to clean the exchangers, using a caustic solution + a 10% acid wash followed by a 1% caustic wash to neutralize the acid within the exchangers. Due to a number of factors we were not able to follow through on our test with corresponding chemical treatment corrections due to the time lag between our obtaining scale samples and getting laboratory reports back so as to take effective corrective action.