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SUBJECT: OBSERVED PERFORMANCE OF THE FUEL SAMPLE COOLER

TO: S. E. Beall

FROM: R. Van Winkle and R. R. Wiethaup

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OBSERVED PERFORMANCE OF THE FUEL SAMPLE COOLER

Summary

Measurements of flow rate through the fuel high-pressure system sampler indicate that the average flow rate is about 0.29 gpm (145 lb/hr) plus or minus 50%, which affords an adequate purge of from 12 to 36 volumes through the sample line if the full fifteen minutes of purging is allowed before isolating the sample.

The fuel sample cooler was found to have adequate capacity to reduce the temperature of the fuel solution from about 275°C to about 70°C, using pre-heated cooling water at 70°C. Uncertainties in temperature measurements make it impossible to estimate an "observed" over-all heat transfer coefficient.

Method

In sampling the high-pressure systems, the lines and isolation chamber are purged for fifteen minutes in order to obtain a representative sample. Flow rate was estimated by measuring the inlet and outlet temperatures of the fuel stream and the cooling water stream, the flow rate of the cooling water and calculating the fuel flow rate from the heat balance. The data and results are summarized in the attached table. The data were taken on seven different occasions when fuel high-pressure system samples were being taken, between the dates March 19, 1957 and March 25, 1957.

Discussion

In the operation of the fuel sample cooler it was intended to maintain the fuel outlet temperature (from the fuel sample cooler) in the

range 70-100°C to avoid possible peroxide precipitation. By using cooling water heated to 70°C minimum, it was practically guaranteed that the fuel solution could not be cooled below 70°C. Yet according to the results, the fuel solution was cooled to a temperature below that of the inlet cooling water, which was kept above 70°C in four out of the seven cases reported. This discrepancy could be caused by two things: (1) cooling of the water as it passed from the header in the control area (where its temperature is measured with an industrial thermometer) to the fuel sample cooler; and/or (2) errors in temperature measurement of both the fuel solution and the water. The error in measuring the difference in fuel outlet temperature and cooling water inlet temperature could be as much as 6°C. The loss in cooling water temperature in passing from the control area to the sample cooler has not been estimated but could hardly exceed three or four degrees centigrade. These considerations lead to an estimated error of plus or minus 50% in the calculated fuel solution flow rate.

There are 50 feet of 1/4-in. schedule 80 pipe (whose volume is about 0.70 liters) between the fuel high-pressure system and the sampler. Using the extreme limits of the estimated flow rates through the sampler (0.15 to 0.45 gpm) in the 15 minutes allowed for purging the lines, between 12 and 36 volumes of fuel solution pass through before the sample is isolated. This appears to be an adequate volume of purge to assure a representative sample.

Using the method of calculating the over-all heat transfer coefficient that was used in the design of the fuel sample cooler,¹ the

¹R. Van Winkle, Design Criteria for HRT Sample Line Coolers, ORNL-CF-55-1-29, (Jan. 5, 1955).

over-all coefficient under the conditions of Test 1 was calculated to be 338 Btu/hr-ft²-°F. Because of the unrealistic negative temperature difference (at the cold end of the sample cooler (coolant warmer than the hot stream) the actual temperature data could not be used to calculate an "observed" over-all heat transfer coefficient; however, using two different "estimated" log mean temperature differences, obtained by assuming cold end temperature differences of 1°F and 5°F, and the hot end temperature difference of 328°F, as reported, estimated "observed" over-all coefficients of 274 and 377 Btu/hr-ft²-°F would be obtained.

Conclusions and Recommendations

- (1) During the normal sampling operation, the flow rates used are sufficient to assure adequate flushing of the long sample lines.
- (2) The temperature data obtained are too poor to be used for calculating an "observed" over-all heat transfer coefficient, but not so bad that reasonable estimates of fuel solution flow rates could not be made.
- (3) The fuel sample line cooling water ought to be heated to 75°C at the header rather than 70°C as presently specified.
- (4) The fuel sample cooler appears to have ample capacity to reduce the fuel solution temperature to the desired temperature range.

R. Van Winkle

RVW:be
Attachment - 1 Table - "Fuel Sample Flow"

FUEL SAMPLE FLOW

Test No.	1	2	3	4	5	6	7
Temperatures, °C							
Water in	71	74	59	58	68	72	71
Water out	93	93	90	85	87	96	97
Fuel in	275	275	275	274	273	275	277
Fuel out	68	69	58	55	64	68	68
Flows, gpm							
Water	2.56	2.56	2.51	2.65	2.54	2.56	2.56
Fuel	0.28	0.24	0.36	0.33	0.24	0.30	0.26

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