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SUBJECT: Rate of Heat Removal from Fuel Reflux Condenser
HRT Report II A 15b

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RATE OF HEAT REMOVAL FROM FUEL REFLUX CONDENSER
HRT Report II A 15b

Summary

A test has been carried out to determine rates of heat removal from the fuel reflux condenser under various conditions. The maximum rate at which heat could be removed by the condenser cooling water was measured at a number of different pressures in the storage tank and reflux condenser. Results, shown in Fig. 1, indicate satisfactory performance.

Test Procedure

The storage tanks were filled to about 50% of capacity with distilled water, and steam turned on to the evaporator jackets. All non-condensibles were expelled by heating with the vent open and the cooling water off until steam came out the vent. The vent was then closed and cooling water turned on at maximum flow. Cooling water temperatures in and out were recorded to determine heat removal rate. Temperatures of the evaporator legs were used to determine pressure in the tanks. (PI-352 cannot be used when pressure is below atmospheric.) Steam pressure in the evaporator jackets was changed to change the heat input to the system.

Results

Table I below summarizes the test data. The original data are recorded on page 66 of the HRT Data Log.

Table I				
Fuel Reflux Condenser Test Data				
Run	1	2	3	4
Evaporator Steam Pressure, psig	17	41	61	80
Temperature in Evaporator Legs, °C				
lower end	82	91	99	104
upper end	84	94	101	106
Cooling Water Header Pressure, psig	52	52	52	52
Cooling Water Inlet Temperature, °C	25	25	25	25
Cooling Water Outlet Temperature, °C	50	55	59	63

MADE IN U. S. A.
10 X 10 PER INCH

Heat Removal Rate, Kw

220

200

180

160

140

120

100

80

Fig. 1

RATE OF HEAT REMOVAL
IN FUEL REFLUX CONDENSER
COOLING WATER

(With full cooling water flow
and no gas in condenser.)

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Storage Tank Pressure, psia

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8 10 12 14 16 18 20 22

0 2 4 6

4

Although there is no flowmeter in the cooling water line to the reflux condenser, it was possible to calculate the flow rate from the results of earlier tests on the cooling water system.¹ In these tests it was found that the flow rate through the reflux condenser was 22.5 gpm with a supply header pressure of 60 psig, a return header pressure of 15 psig and valve 413A wide open. Return header pressure did not vary appreciably with flow. The flow rate at the lower supply header pressure obtained during the condenser test was calculated as follows:

$$F = 22.5 \left(\frac{52 - 15}{60 - 15} \right)^{1/1.8} = 20 \text{ gpm}$$

The pressure in the storage tanks was taken to be the saturation pressure of water at the temperature observed at the upper end of the evaporator legs.

Discussion

The performance of the condenser comes close to the design calculations. The condenser was designed to remove 170 kw of heat with the tanks at atmospheric pressure and with 21.5 gpm of 100°F cooling water.² Actually about 176 kw were removed at atmospheric pressure with 20 gpm of 77°F cooling water.

The purpose of the test was to predict the maximum rate at which heat could be removed from radioactive fuel solution in the storage tanks under reactor operating conditions. The test measured only the heat going into the cooling water, so that heat losses to the cell air will be an additional means of removing heat from the radioactive solution. On the other hand, the test was run with no non-condensibles in the condenser. When the tanks contain radioactive solution, decomposition and fission product gases will be present and will reduce heat transfer rates in the condenser. These two effects tend to balance each other so that the attainable heat removal rate under reactor conditions will probably be near that found in this test.

PNH:be

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¹R. E. Brooksbank, "HRT Cooling Water System Evaluation," ORNL CF 56-4-194, April 30, 1956.

²C. L. Segaser, "Bayonet Tube Reflux Condenser for the HRT Outer Dump Tanks," ORNL CF 55-1-49, January 4, 1955.