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SUBJECT: Modifications to Underflow Pot and Cooling System

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In recent months the design of the underflow retention tank and its associated cooling system has undergone considerable modification - enough so that much of the information contained in CF 55-6-93 (Operation of Cooling System for Underflow Retention Tank) is outmoded. In this report the current design information on the underflow pot and its temperature regulating system is summarized.

Three major changes have been made in the design of the underflow pot system. First, the hydroclone has been made integral with the underflow pot. Second, it has been found that the annular construction of the underflow pot is unnecessary; the thermal currents within the pot will be great enough to dissipate the radioactive heat. Third, blower limitations have forced the use of once-through air for heating and cooling purposes. These changes have resulted in a greatly simplified underflow pot design, a beefed-up heater design and altered performance curves.

The function of the underflow pot in the chemical processing system remains the same - the temporary storage of the concentrated wastes separated from the reactor solution by the hydroclone. The shape of the underflow pot has altered considerably, however. Unit Operations experiments have shown that the transfer of heat within the pot is not the problem it was first thought to be. With this limitation on design removed, the pot can be made shorter in length and bigger in diameter, up to a diameter limit of 6 inches (maintained for reasons of criticality). Heat is still added to or removed from the underflow pot by circulating air past the pot; the temperature of the pot is still regulated by controlling the temperature of the circulating air. Also, as before, any escape of radioactive solution from the chemical processing cell by way of the air lines (via a leak in the underflow pot) is prevented by circulating the air through a number of tubes spaced along the side of the pot instead of directly past the surface of the underflow pot. These tubes are cast in aluminum billets and strapped to the underflow pot. A sketch of the underflow pot is shown in Figure I.

The air blower that will be used has a capacity of 250 #/hr of air at 6 psi head. Enough area on the underflow pot is available for heat transfer so that at this air flow rate it is necessary to keep the inlet air at a high temperature in order to avoid having a large temperature gradient along the underflow pot. The exact air temperature that is necessary will have to be determined by experience during actual operation of the system. Normal operating conditions should not be far from those shown in the following sketch, however.

Figure I
Underflow Retention Tank

At the end of the process cycle the air system will be used to cool the underflow pot and its contents to below 200°F. This will be done by shutting off the heater and blowing outside air through the system. The sensible heat to be removed from the underflow pot and solution is calculated to be 18,700 BTU; the fission heat that must also be removed decreases through the cooling cycle from the maximum of 2790 BTU/hr to about 2400 BTU/hr. The cooling time has not been recalculated since the previous report, since the value calculated at that time was a mere 2 hours and the subsequent design changes would only tend to shorten it. The curve of pot temperature vs. cooling time shown in Figure II is taken from the previous report.

Fresh uranium solution will be charged to the reactor before each processing run by feeding the solution to the underflow pot, heating the pot and contents to 300°C, and sending reactor solution to the underflow pot to displace the feed solution. The air system will be used to supply the necessary heat. The heater will supply 700°F air which, after some loss of heat to the surroundings, will reach the underflow pot at 638°F. Over a period of some 4 hours the underflow pot will be heated to operating temperature. Figures III & IV show the temperatures and heat loads that are predicted for the heating operation.

A sketch of the air heater is shown in Figure V. A series arrangement of 4 3400 watt combustion furnaces will be used to heat air flowing in a 2½ inch sch. 5 pipe. The arrangement of 2 furnaces on each level was used because of space limitations.

Some design calculations were made for a regenerator which would considerably reduce the heater requirements by using the exit gas stream to heat the inlet stream before sending it to the heater. The conclusion was reached that a regenerator is feasible but not economical on an installation of this size.

Should a rupture occur in the high pressure equipment in the chemical processing cell and should this rupture be violent enough to shatter equipment, the air lines may well provide a path for the escape of radioactive solution from the cell as soon as the cell pressure rises above atmospheric pressure. To guard against this possibility a valve has been put in each air line just outside the cell. These valves will be automatic and controlled by the pressure inside the cell. Thus, as the cell pressure rises after a major break in the high pressure equipment, the valves will automatically close and seal the escaped activity within the cell.

Herman Weeren
H. O. Weeren

HOW/jb

5

UNDERFLOW POT
TEMPERATURE (°F)

600
500
400
300
200
100
0

FIGURE II
UNDERFLOW POT TEMPERATURE
THROUGHOUT COOLING CYCLE

COOLING TIME (HOURS)

2

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6

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7

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Figure V
Air Heater

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