Introduction

A study was made to determine desirable operating conditions for the helium gas purge system in the MSRE circulating pump. The purge stream is split in such a way as to sweep both the pump bowl containing the molten salt and the oil bath providing the pump lubrication, as shown below.

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**Fig. 1**

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\[ V = 0.1 \text{ ft}^3 \text{(incl. lines)} \]
\[ T = 150^\circ \text{F} \]
\[ T = 1200^\circ \text{F} \]
\[ P = 17 \text{ to } 50 \text{ psia} \]
\[ V = 1.9 \text{ ft}^3 \text{ (normal)} \]
It is desirable to keep the purge flows small in order to keep hot gas handling requirements to a minimum and to reduce helium consumption. The flows must be large enough, however, so that reversal of purge flow to the pump bowl or oil bath does not occur when the salt expands or contracts. The minimum gas purge flow rates for which reverse flow will not occur were determined for various operating conditions.

Results

The results are derived from rough hand calculations and from an analog computer solution of a more refined model of the system. In general, the assumptions made for both the rough model and the analog model are such that the results would be pessimistic. The expansion and contraction rates for the salt are taken as the maximum expected values (except for a dump), per A. N. Smith, MSRE memo 60-50.

Expansion of the salt due to a positive temperature excursion was estimated to be a maximum of 0.66 ft³/min. Figure 2 is a typical curve showing the results of one of the analog computer runs showing the variation in flow rates with pump bowl gas space volume changes. From this curve it can be seen that the minimum steady state flow rate into the bowl required to prevent reverse flow is about 600 std. liters/day for minimum pressure (17 psia). The required flow is a linear function of pressure; therefore a flow rate of 1800 std. liters/day would be required at 50 psia.

These minimum flow rates are based on the assumption of 0.1 ft³ volume in the oil bath, 1.9 ft³ volume in the pump bowl, and 5.6 ft³ in the holdup tank. A larger oil bath volume or a smaller combined volume of pump bowl and tank would call for a proportionate increase in the required purge flow rate. Therefore it is desirable to maintain the minimum possible oil bath volume and the maximum possible pump bowl and tank volume.

A salt expansion rate of less than the 0.66 ft³/min. rate given as maximum would cause proportionately less change in pump bowl flow rates.

The minimum allowable purge flow to the oil bath, determined from the effects of contraction of the salt, is computed using a maximum salt contraction rate of 0.66 ft³/min. It was found that the minimum allowable flow rates were approximately equal to those computed for the pump bowl purge flow rate.

The transient percentage change in system pressure from such excursions is approximately equal to the total percentage change in the combined volume of the pump bowl and the tank. This would amount to a maximum change of 3.5 psi for 17 psia normal operation. The pressure returns to normal on a time constant dependent on the steady state purge flow rates, which is typically several hours.

It should be noted that this analysis has not included the effects of diffusion flow and convection flow might have on the results.
FIG. 2

MSRE PUMP SWEET ANALOG

MAXIMUM PURGE FLOW VARIATIONS
FOR SALT EXPANSION AND CONTRACTION
SYSTEM PRESSURE = 17 PSIG

--- FLOW RATE INTO PUMP FLOW FOR
.60 FT$^3$/min SALT EXPANSION FOR
~ 1.1 min. (MAX ALLOWABLE EXPANSION)

--- FLOW RATE INTO OIL BATH FOR
.65 FT$^3$/min SALT CONTRACTION FOR
~ 2.1 min. (MAX ALLOWABLE CONTRACTION)

--- SS. FLOW = 600 STD. LITERS/DAY

Flow Rate, Grams HE/min

Time, Minutes

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