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SUBJECT: Blanket Entrainment Separator Performance
HRT Test Number IV A, 34 c, b

TO: S. E. Beall

FROM: R. Van Winkle and J. D. Flynn

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SUMMARY

The blanket entrainment separator was tested on June 19 and 20, 1956 using potassium sulfate as tracer as outlined by Burch[1]. Runs were made with solution volumes of 186 and 1860 liters in the blanket dump tanks at boil-up rates of 3.2, 4.5 and 10 pounds per minute. Using a nominal concentration of 11.9 grams of potassium per liter, the concentration of potassium in the condensate varied between 1.0 ppm and 42 ppm, giving de-entrainment factors between 284 and 11,900. Duplicate samples were not taken and very erratic results indicated that the sampling procedure was probably faulty. The entrainment test was then repeated at a nominal volume of 555 liters in the dump tank, at concentrations between 30 and 38 grams potassium per liter. In the last test, potassium concentrations less than 0.2 ppm in the condensate indicated de-entrainment factors in the range 152,000 to 191,000. (De-entrainment factor is defined as the potassium concentration in the dump tank solution divided by the concentration in the condensate).

Procedure

1. Solution Make-up. 100 pounds of chemically pure potassium sulfate (containing a calculated 44.89 pounds (20.36 kg) of potassium were dissolved in 4000 pounds of steam condensate. The calculated concentration was 10.94 grams of potassium per kilogram of solution (which corresponds to a concentration of 11.15 grams per liter). The reported concentration of a sample sent to the laboratory for analysis was 11.9 grams potassium per liter.

2. Sampling. The dump tank samples were taken from a connection installed between the pair of flanges that normally contain valve HCV-437 (see figure I); the condensate samples were taken from the temporary discharge line of the pressurizer purge pump. Condensate was returned to the system through the condenser so that the dump tank solution concentration remained constant. The holdup in Lines 219 and 223 (in the suction line of the purge pump) is about 5.5 liters and the purge pump normally delivers about 0.2 gpm. With the purge pump in operation there were four volume changes of liquid in the suction line of the purge pump during 30 minutes of operation before sampling.

[1] W. D. Burch, Blanket Entrainment Separator Performance, HRT Test IV a, Item 34 b, ORNL CF-56-2-3 (March 26, 1956).

3. Run 1, Blank Run. A dummy run was made using steam condensate instead of solution in the dump tank at boil-up rates of 3.2, 4.5 and 10 lb/min. The sample results are listed as Run 1 in Table I.

4. Run 2. 410 pounds of the make-up solution (described above) were transferred to the blanket dump tank through Line 262 and using boil-up rates of 3.2, 4.5, and 10 pounds per minute, samples were taken after 30 minutes of operation at each boil-up rate. The results are tabulated in Table I.

5. Run 3. The balance of the original 4100 pounds of solution was transferred to the blanket dump tank and Run 2 was repeated with a nominal 1860 liters of solution in the dump tank.

6. Run 4. Run 4 was performed because of the erratic results from Runs 2 and 3. The solution from Run 3 was to have been evaporated until about 1000 pounds of solution remained in the dump tank; however, because of a plugged snubber valve on the dump tank weigh cell, the weight being indicated in the dump tank remained nearly constant and the solution was evaporated to dryness. Inability to keep the temperature of the dump tank solution at the boiling point led to the discovery that the dump tank weight instrument was faulty. Upon repair of the instrument, 1250 pounds of condensate were added to the dump tank to redissolve the potassium sulfate salt and Run 4 was performed. Duplicate samples were taken and large volumes of solution were removed from the dump tank sample point to flush out holdup in the strainer pot and assure good samples.

RESULTS AND CONCLUSIONS

Complete sample results are listed in Table I. Poor sampling technique rather than entrainment appeared to be responsible for the inconsistent results in Runs 2 and 3. The results of Run 4, in which more care in sampling was exercised, indicate de-entrainment factors more in line with what are required if the blanket system is ever operated with concentrated uranyl sulfate solutions. Subsequent experience with the fuel entrainment separator during the natural uranium run supports the belief that de-entrainment factors are the order of 100,000 rather than 1000--10,000 as indicated by the original tests using tri-sodium phosphate solution[2] and Runs 2 and 3 using potassium sulfate.

[2] P. N. Haubenreich and R. Van Winkle, Efficiency of Fuel System Entrainment Separator During Normal Operation. HRT Report II A (7c)b, ORNL CF-56-5-167 (May 25, 1956).

R. Van Winkle
J. D. Flynn

RVW:JDF:mdm

Attachment

Table I. Results of Blanket Entrainment Separator Test

Run No.	Approx. Vol. Solution in Dump Tank (liters)	Boil-up Rate (lb/min)	Est. Dump Tank Conc. (g K/1)	Reported K Concentration		Dump Tank Conc. Condensate Conc.
				Dump Tank (g/1)	Condensate (ppm)	
1	364	3.2	0	<0.2 ppm	<0.2	-----
1	364	4.5	0	"	"	-----
1	364	10	0	"	"	-----
2	186	3.2	11.9	6.25	42	284
2	186	4.5	11.9	1.14	1.5	7,930
2	186	10	11.9	0.42	5.73	2,080
3	1860	3.2	11.9	0.665	10.5	1,133
3	1860	4.5	11.9	1.30	1.0	11,900
3	1860	10	11.9	0.180	1.42	8,380
4	555	3.2	-	30.5	< 0.2	152,500
4	528	4.5	-	31.5	< 0.2	157,500
4	450	10	--	38.2	< 0.2	191,000

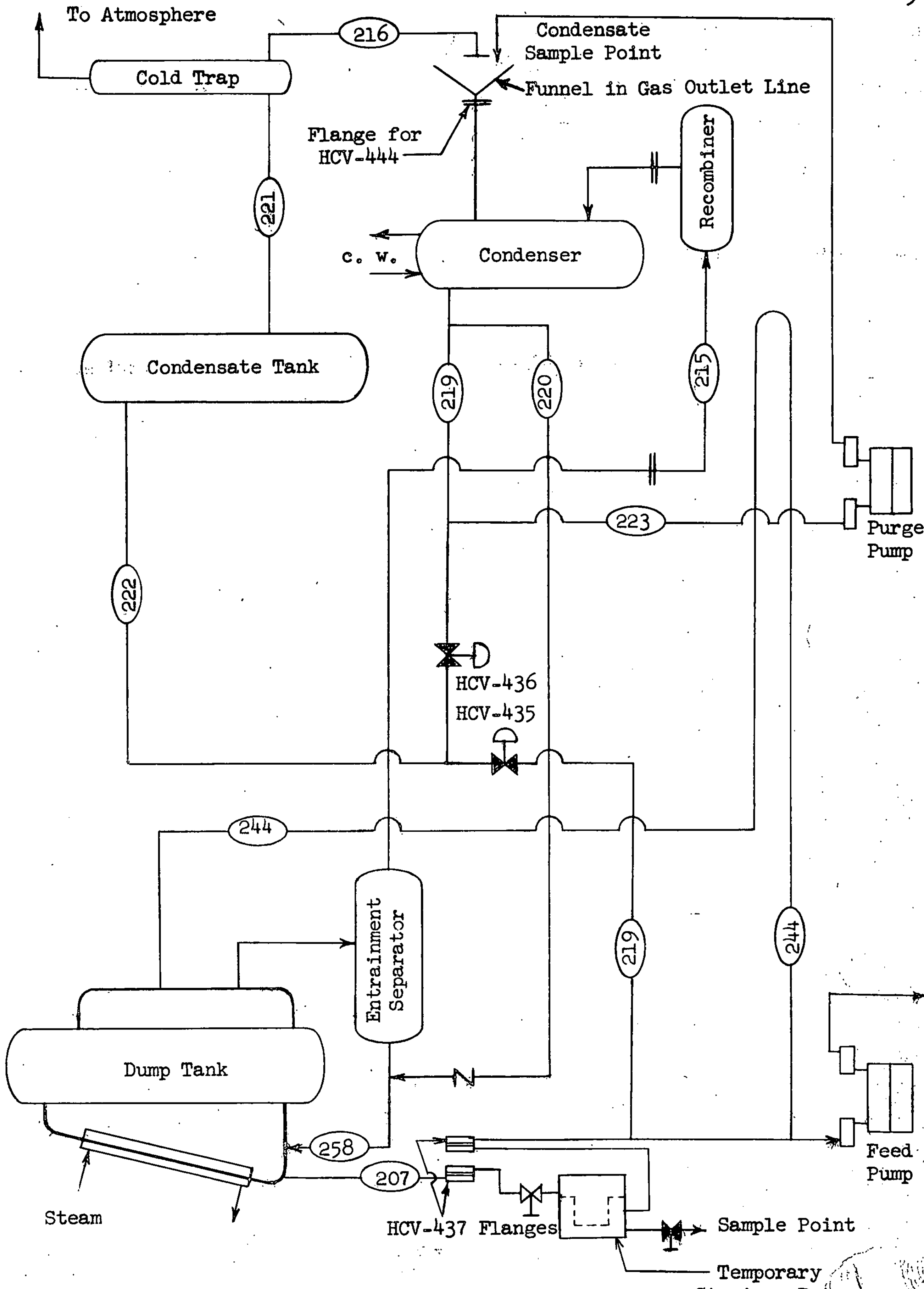

Fig. 1

FLOWSHEET - BLANKET ENTRAINMENT SEPARATOR TEST