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BLANKET DUMP TANKS AND CONDENSATE TANKS
HRT Engineering Test Procedures No. IV 34a, b, c, and 37

Purpose of Test

The blanket dump tanks and condensate tanks provide a storage reservoir for D_2O . To maintain an accurate inventory it is necessary to know the D_2O holdup in these tanks at all times. When UO_2SO_4 is used in the blanket solution, the relative amounts of holdup in the dump tanks and condensate tanks will be a measure of the uranium concentration in the dump tanks and thus in the blanket itself.

The purposes of these tests are:

1. a. To calibrate the dump tank weigh cell and determine unweighed volumes in adjacent piping.
- b. To ascertain the total volume of the low-pressure system, excluding the outer storage tanks.
- c. To determine, if possible, the magnitude of condensate holdup in the evaporator leg jackets and in line 215.
2. To calibrate the condensate weigh system.

Dump Tank Weigh Cell Calibration

Calibration of the dump tank weigh cells is somewhat complicated by the many lines leading from the system, the solution in which may in some cases be all blanket solution or in other cases blanket solution diluted with condensate. Some of these lines, such as the dump lines, are partially weighed also.

Each line involved was examined individually for complicating factors and the observation and recommendations are listed below.

In determining the course of action to take, the accuracy of calibration desired and that actually obtainable because of the limitations imposed by the weigh cells, must be considered. It was assumed that the accuracy desired was the greatest attainable. The weigh cell specifications are $\pm 1/2$ percent of load range--in this case 5000 lb--or ± 25 lb. Some data presented by Toucey for WE-397 in which known weights were added showed the precision to be within the $1/2$ percent tolerance, but not significantly better.

Therefore, it is logical to assume that at any given time the weight of liquid in the blanket dump tanks will not be known to closer than 25 lb.

The following individual lines were examined:

1. Dump line 206 and 259--Contains about 10 liters between PdCV-252 and the dump tanks. This line will be full to the level of liquid in the dump tanks with line 259 left in or nearly completely full if 259 is removed. To insure having the significant volume filled if line 259 is removed, the system should be filled by removing PdCV-252 and making a temporary connection. If line 259 is left in, it would be more convenient to fill the system through line 245b; the O₂ addition line, and the dump line should fill automatically.
2. Feed line 207--Contains approximately 7 liters and will be full at all times. Since this line is vented at the pumps via line 244 back to the dump tanks, the line will fill automatically during calibration and no special precautions are required.
3. Condensate line 219--Contains about 4.8 liters of condensate. In filling the dump tanks with HCV-435 open and the condensate tank empty, only about 1/4 liter of H₂O will back into this line. This volume can be ignored. HCV-435 may be either open or closed.
4. Line 208, transfer to outer storage tanks--Contains about one liter, may be full or only partially full during operation. This small volume is not significant.
5. Line 244, pump suction vent--Contains about one liter. It will normally be filled to the dump tank level and will do so without special precautions during the calibration.
6. The steam jackets on the evaporator legs contain 54 liters. During normal operation, steam would occupy nearly all of this volume and the weight would be quite small. For the calibration, care should be taken to insure that these jackets are empty by draining the traps.

The volumes of the lines listed above are rough estimates probably good to approximately 25 percent. Since the dump tank weigh cell calibration will be completely empirical, and it has been shown above how to reproduce normal holdups during the calibration, the exact volume of these lines is not required.

Operation of the Weigh Cells

The weigh cells are pneumatic operated instruments which incorporate a booster pilot relay to automatically balance the applied load by air pressure which is indicated on a Hg manometer. Figure 1 is a simplified schematic of the components and air line connections. Layout of the pneumatic control panel, located on the third level of the control room is shown in Figure 2.

Fig. 1 - Weigh System

ORNL-LR-Dwg.-13240

Fig. 2

Weigh System Panel Board

Several features of the system should be noted:

1. Supply pressure to the pilot relay and tare regulator is 50 psi, and comes from the building 80 psi header, reduced by a manual filter-regulator located in back of the control board.
2. The tare load is indicated on a gauge, in effective total weight, and by a manometer as total absolute pressure minus reactor cell absolute pressure. Note that by venting the top of the tare manometer and the top of the tare regulator control diaphragm to the reactor cell, the instrument is made completely independent of cell pressure.
3. The weigh cell functions equally well over a wide range of tare loads, both actual loads and effective loads applied by air pressure. For HRT use, the tare load pressure will be initially set so that the weigh indicator on the main control board will indicate zero when the tanks are empty. The panel gauge indicates zero with an applied pressure of 5 psi with WE-495. Therefore, with the dump tanks empty, the tare pressure will be set so that the live manometer indicates 5 psi or 10.4" Hg and the actual tare pressure noted on the tare manometer. Thereafter when an accurate measurement is desired, with liquid in the tanks, the tare pressure will be regulated to this previously established value.
4. Only single manometers are provided for the tare loads and live loads of the four weigh cells. Two one-inlet, four outlet air valves, located on the weigh cell panel board are used to switch the manometers to the separate weight cells. The individual weight indicators on the main panel function at all times.

Accuracy of Calibration Scales

The scales used in the calibration procedure should be accurate to + 1 pound. If the accuracy is not known, it should be checked prior to the calibration, either against scales of known accuracy or standard weights.

Blanket Dump Tank Weigh Cell Calibration Procedure

- _____ 1. To fill the dump tanks with water use the drain line of the strainer pot which has been installed in the place of the blanket feed block valve, HCV-437.
- _____ 2. Open the valve substituting for HCV-437 in the suction line.
- _____ 3. The system should be thoroughly drained by breaking line 208 below HCV-439 and line 209 at the feed pumps. After draining reconnect the pump line, close HCV-437, and apply air pressure to the dump line to blow out any traces of water that does not drain (requires at least 6-8 psi).

- _____ 4. Make certain the system is vented by opening TCV-787 or TCV-788 beyond the cold traps and a valve in the off-gas line to the atmosphere, e.g., HV-729.
- _____ 5. Re-open substitute HCV-437.
- _____ 6. Drain the evaporator leg steam jackets by removing the plugs in the bottom of the traps on the 1st control-room level. Special steps may be required to vent the steam supply lines to permit draining.
- _____ 7. Check the weigh cell suspension mounting system:
 - a. Check lock nuts on U-bolts, mounting bolts, etc.
 - b. Remove temporary tacks and chocks.
 - c. Inspect weigh beam pivots and knife edges.
 - d. Lower beam onto knife edges.
- _____ 8. Place pneumatic system in operation as outlined above.
 - a. Set supply pressure at 50 psi.
 - b. Regulate tare load until the output of the live manometer is exactly 10.4" Hg.

Record: tare load _____ lb.

tare manometer _____ inches Hg
- _____ 9. Add water to the system in 50-lb batches for the first 200 lbs, then in 200-lb batches until a total of 5000 lb has been added. Record data in the following table. The tare manometer should be checked prior to each reading and returned to the figure recorded above if required. Read the manometer to at least +0.05 inches.
- _____ 10. Plot the data; determine an equation of the type

$$\text{Wt. in tanks} = \text{Manometer reading} \times \text{Scale factor} + \text{Constant}$$
 using some standard means such as the method of least squares. Determine average deviation for the calibration data.

Determination of Total Low-Pressure System Volume

It is desired to know the total volume of the system bounded by the purge pump, the feed pump and valves 238, 239, 245, 439, 938, 252, 787, and 788. Because of the many places in this system in which air may be trapped unless special precautions are taken, it appears that the simplest method to determine the volume is to evacuate the system and vent the vacuum with H_2O , measuring the weight added.

Lb H ₂ O Added	Live Manometer	Panel Indicator	Indicated Wgt.*	Deviation
0	10.4	0		
50				
100				
150				
200				
400				
600				
800				
1000				
1200				
1400				
1600				
1800				
2000				
2200				
2400				
2600				
2800				
3000				
3200				
3400				
3600				
3800				
4000				
4200				
4400				
4600				
4800				
5000				

*Weight calculated from manometer reading and calibration curve or equation developed from the data.

Procedure

- _____ 1. The water addition system used in the calibration procedure may be used here.
- _____ 2. Connect a vacuum pump to the system by installing a temporary tee adapter and block valve in the flanges which normally contain HCV-444 in Line 216.
- _____ 3. Blank the feed pump and purge pump suction flanges, or else freeze a plug in their suction lines.
- _____ 4. Check that the following valves are closed:
 - a. HCV-238 - Manual switch
 - b. LCV-245 - Close manually
 - c. HCV-239 - Should be closed
 - d. HCV-938 - Manual switch
 - e. HCV-439 - Manual switch
 - f. TCV-787-788 - Manual switches
- _____ 5. To permit better access between various parts of the system, open the following valves:
 - a. HCV-437
 - b. HCV-435
 - c. HCV-436
- _____ 6. Pull vacuum on the system down to 1 mm Hg if possible. Close valves and determine if system is tight by letting stand at least 30 minutes. Record pressure obtained _____.
- _____ 7. Vent vacuum by admitting H_2O , weighing all H_2O added and carefully preventing any air inleakage. Record weights added in table below and system pressure after each 400-lb addition.

Water Added	Pressure	Water Added	Pressure
0		4000	
400		4400	
800		4800	
1200		5200	
1600		5600	
2000		6000	
2400		6400	
2800		_____	
3200		_____	
3600		_____	Atmospheric

Condensate Holdup During Normal Operation

To ascertain if holdup of condensate in any unweighed lines was significant, the following lines were examined:

1. Line 219 will hold up about 5.7 liters of H_2O above HCV-435 during normal operation that will not be weighed.
2. Line 222 will hold about 3 liters, only a small fraction of which will be weighed. This line will be filled during calibration.
3. Line 220 will hold up about one liter, a portion of which may be weighed as part of the dump tank system.
4. The evaporator jackets, as explained previously, would hold about 54 liters if full of H_2O . Of course, normally the volume will be largely filled with condensing steam. While an elaborate scheme could be devised to determine the weight held up, the small holdup does not warrant the time involved. It is estimated that the holdup, which will be weighed by the dump tank weigh cells is less than 10 pounds.
5. Line 215 will contain some condensate due to heat losses to the cell air. However, the maximum rate of condensation is less than 5 lb/hr so an insignificant quantity will be retained in this line.
6. The total system filled with steam at atmospheric pressure would contain only 4 lb of steam. Consequently, the effect of vapor may be ignored.

Taking into consideration the holdups listed, the weight of D_2O condensate in the system during normal operation that will not be weighed during the calibration is approximately 16 lb. This quantity should be added to the condensate tank indicated weight, and thus included in the condensate tank calibration curve.

The procedure outlined for the dump tank calibration will result in filling all lines normally full of fuel, so the calibration requires no corrections.

Condensate Tank Calibration Procedure

- _____ 1. Remove HCV-436 and connect a temporary line from this point to the drum on the calibration scales. H_2O will be added to the condensate tank through line 222.
- _____ 2. Close HCV-435.
- _____ 3. Vent the system by opening TCV-787 and HV-729.
- _____ 4. Check the weigh cell mounting system as outlined for the dump tank system.

5. Place pneumatic system of WE-497 in operation.

a. Supply pressure is 50 psi.

b. Regulate tare load until output to the live manometer is exactly 6.12 inches of mercury.

Record: tare load _____ lb.

tare manometer _____ inches Hg

6. Add water to the system in 20-lb batches initially until a total of 100 lb has been added, then in 50-lb batches. Record data in the following table. The tare manometer must be checked prior to each reading and returned to the above figure if required.

lbs H ₂ O Added	Live Manometer	Panel Indicator	Indicated Weight*	Deviation
20				
40				
60				
80				
100				
150				
200				
250				
300				
350				
400				
420				
440				
460				
480				
500				

* Weight calculated from manometer reading and calibration curve or equation developed from the data.

7. Plot the data; determine equation for the data and average deviation of the calibration data in gallons.

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