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SUBJECT: Calibration of D₂O Receiver (T-2) Weigh Cell
And Thermal Level Probe, HRT-CP Experiment T-2

TO: W. D. Burch

FROM: J. D. Perret, Jr.

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15. D. F. Flynn
16. W. R. Gall
17. T. H. Gladney

32. R. W. von
33. W. H. 38
34. J. D. Perret

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CALIBRATION OF D₂O RECEIVER (T-2) WEIGH CELL AND THERMAL LEVEL PROBE HRT-CP Experiment T-2

I. Description of Equipment

The D₂O receiver (T-2) in the HRT-CP low-pressure system is the primary D₂O storage vessel for the operations of the chemical processing equipment. Referring to ORNL CF-56-3-22, "Operating Procedure for the HRT Chemical Plant," by R. B. Lindauer, it can be seen that T-2 is used in charging fuel to the hydroclone system, Step I.8.b.; preparing carrier to receive a letdown rinse from the hydroclone, Steps IV.10.g. and 14.b.; and boildown of the carriers, Step VI.4. All of these operations call for a knowledge of the contents of T-2. Since this liquid level is so important, T-2 is equipped with two separate instruments for liquid level indication. A description of these two instruments, as abstracted from a letter from R. K. Adams, follows:

- (1) "...A Baldwin-Lima-Hamilton Type SR-4 load cell of 0-200-lb range will be used as one of the level elements. This cell has an accuracy of 0.1% and will be used over the approximate range of 150-200 lb. This takes into account the weight of the water to be contained in tank T-2 and the tare weight of the tank....The total motion of the tank over the 50-lb (operating) range will be less than .002 inches.... The level signal from the weigh cell will be displayed on one pen of the panel recorder IR-T-2-12.
- (2) The thermal level probe is designed to be an auxiliary level measurement. This probe consists of a source of heat surrounded by thermocouple junctions embedded in a stainless-steel housing. The thermocouple junctions are spaced in equal increments along the length of the probe. In normal operation, the thermocouples in the portion of the probe which is immersed in the liquid will produce an electrical output which is small. The output from the thermocouples in the portion of the probe which is not immersed in the liquid will be greater. This is due to the differences in heat transfer of the probe to liquid and probe to vapor surfaces. The bottom thermocouple junction which is always immersed in the liquid is used to compensate the instrument for changes in liquid temperature....The signal output from the thermal level probe will be displayed as a proportional recording utilizing the second pen of recorder IR-T-2-12...."

Figure 1 is a sketch of the physical appearance of T-2 and connected equipment in the CP cell.

II. Purpose of the Experiment

Since T-2 liquid level is so important in the operation of the CP equipment, it is necessary to have an accurate calibration of the two liquid level measuring devices. This involves an exact measurement of the contents vs. elevation (or liquid level) in this part of the system, and an evaluation of the effects on the instrumentation of changes in ambient temperature and liquid temperature in tank T-2.

FIGURE NO. 1

III. Procedure

A. Liquid level vs. contents calibration

1. Install temporary equipment as shown in sketch, Fig. 2.
2. Fill the two 10-gal carboys with distilled water and let stand in cell until they have reached ambient cell temperature.
3. Put water into system at fill funnel until the liquid level on the manometer shows above the level of FP-7.
4. Operate FP-7 to form a plug at this freezer station.
5. Drain system and record indicated level in manometer. This is the zero point for the calibration.
6. Calibrate T-5 by carefully adding water from a graduate, recording volume added and manometer reading. Continue until manometer level is just above where line 1117 connects into T-2.
7. Drain the system.
8. Thaw freeze plug at FP-7; close T-3-2 and T-4-2.
9. Calibrate T-5 plus T-2 as in Step 6, above, to the top of T-2. Keep additions small when level approaches lines 1117 and 1127 so that volume required to fill T-3, T-4 and these lines can be read.
10. Drain the system.

The calibration of liquid volume vs. level of T-2 will then consist of the calibration in Step 9 minus the calibration in Step 6, and the volume required to fill T-3, T-4, lines 1117, and 1127.

B. Liquid level vs. instrument reading calibration

1. The weigh cell and thermal level probe (TLP) will be checked out and readied for operation by the Instrument Section (see Discussion).
2. With both instruments in operation record instrument readings as read from IR-T-2-12 and liquid level as read on the manometer as liquid is added through the fill funnel. Allow sufficient time between additions for T-2 to come to thermal equilibrium. Continue until T-2 overflows through lines 1117 and 1127. If boiling occurs in T-2 due to the heat input from the TLP, it may be impossible to calibrate the TLP below a designated minimum liquid level, and in this event the power to the TLP should not be turned on until this level has been reached in T-2.

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FIGURE NO. 2

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C. Determination of thermal effects on the reliability of the instrumentation.

1. Drain system down to ~ 50% level in T-2.
2. Permit system to cool to ambient cell temperature by cutting power to TLP; when cool return power to TLP.
3. Record manometer level and weigh cell readings.
4. Continued operation of the TLP will increase the temperature of the contents of T-2 until thermal equilibrium is reached. Operate TLP until T-2 contents reach steady state as shown by no further temperature changes, (a taped on thermometer will be sufficient for this test) noting especially if contents boil. Keep a continuous record of instrument indications and T-2 temperature.
5. Cut off power to TLP, maintain liquid level in T-2, and let T-2 cool to ambient cell temperature.
6. When T-2 has cooled to cell temperature read weigh cell signal. Continue to take weigh cell readings once an hour during the period from 2:00 p.m. to 4:00 a.m. to detect any shift in the weigh cell signal resulting from thermal contraction of piping to T-2 as the ambient cell temperature changes (a blower may be required to reduce cell ambient temperature to outside air temperature).

IV. Discussion

The power input to the TLP will have to be set at a level which will not boil the contents of T-2 when the level in T-2 is at the minimum expected operating level and the ambient cell temperature is at the maximum expected. Both of these conditions set a limit on the maximum amount of heat which can be transferred from the probe to the cell air.

The results of C.4, 5, and 6 will determine if any further calibrations are required.

V. Equipment required:

- 1 manometer, 36 in. or larger.
- 1 valve adapter
- 2 thermometers 0-100°C
- 2 10-gal carboys
- Freeze plug, FP-7, in operation.
- Thermal level probe, weigh cell and connected instrumentation in operation.
- Fittings and lines, as shown in Fig. 2.
- Valves T-3-2 and T-4-2 operable.

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J. D. Perret, Jr.
J. D. Perret, Jr.

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