Reactor, Boiler & Auxiliaries - Course 233

# HEAT TRANSPORT $D_2O$ COLLECTION

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## I. PURPOSE OF SYSTEM

The main purpose of the HT $D_2O$ collection system is to collect, by gravity drainage, normal leakage from HT equipment collection points via a closed piping system. The system also pumps the collection $D_2O$ back to the HT system.

As with the moderator $D_2O$ collection system, this system will minimize leakage to plant atmosphere. This is especially important for HT equipment as there are many more leak off collection points than in the moderator system. Also the higher pressure of the HT system and some of its auxiliary systems will result in more leakage than in the low pressure moderator system.

## II. SYSTEM DESCRIPTION

Typical collection points will be from:

### 1. Pumps

The collection points will typically be from:

pumps seals

pump intergasket cavities

pump drain/vent lines

The pumps involved will be:

(a) main HT pumps

(b) HT pressurizing pumps

(c) HT shutdown cooling pumps.

### 2. Heat Exchangers

The collection points will typically be from:

heat exchanger drain/vent lines

heat exchanger intergasket leak off lines.

The heat exchangers involved will be:

(a) shutdown cooling HX

(b) emergency (back up) HT pump gland cooler

(c) bleed cooler

(d) bleed condenser

(e) main boilers

3. Valves

The valves with leak off collection points (from stem seal packing or, occasionally, double gasket cavities on flanges) will typically be:

(a) HT main system isolating valves (if used)

(b) feed and bleed system isolating and control valves

(c) HT shutdown cooling system isolating valves

(d) HT system pressure relief valves

A typical HT $D_2O$ collection system is shown in Figure 1. The collection points drain into the HT $D_2O$ collection tank which is usually situated at a low level in the reactor building to facilitate good gravity drainage.

## III. OPERATING FEATURES

During normal operation the leakage points will provide typically enough leakage to fill the collection tank every few hours. Increases in the collection rate will usually indicate deterioration in some particular pump/HX/valve leak off point. Flow gauges on the collection lines will enable the particular leak off line to be traced.

As many of the collection points are collecting hot HT $D_2O$ leakage, the collected $D_2O$ has to be cooled in the collection tank. Cooling is provided by immersed tubes circulating recirculated water. This is a potential source of HT $D_2O$ collection downgrading if a leak occurs in these tubes. Hot $D_2O$ vapour from the collection tank is also cooled in a vent condenser, as shown in Figure 1, and condensed $D_2O$ drained back into the collection tank. The vent condenser is also a potential source of $D_2O$ downgrading.

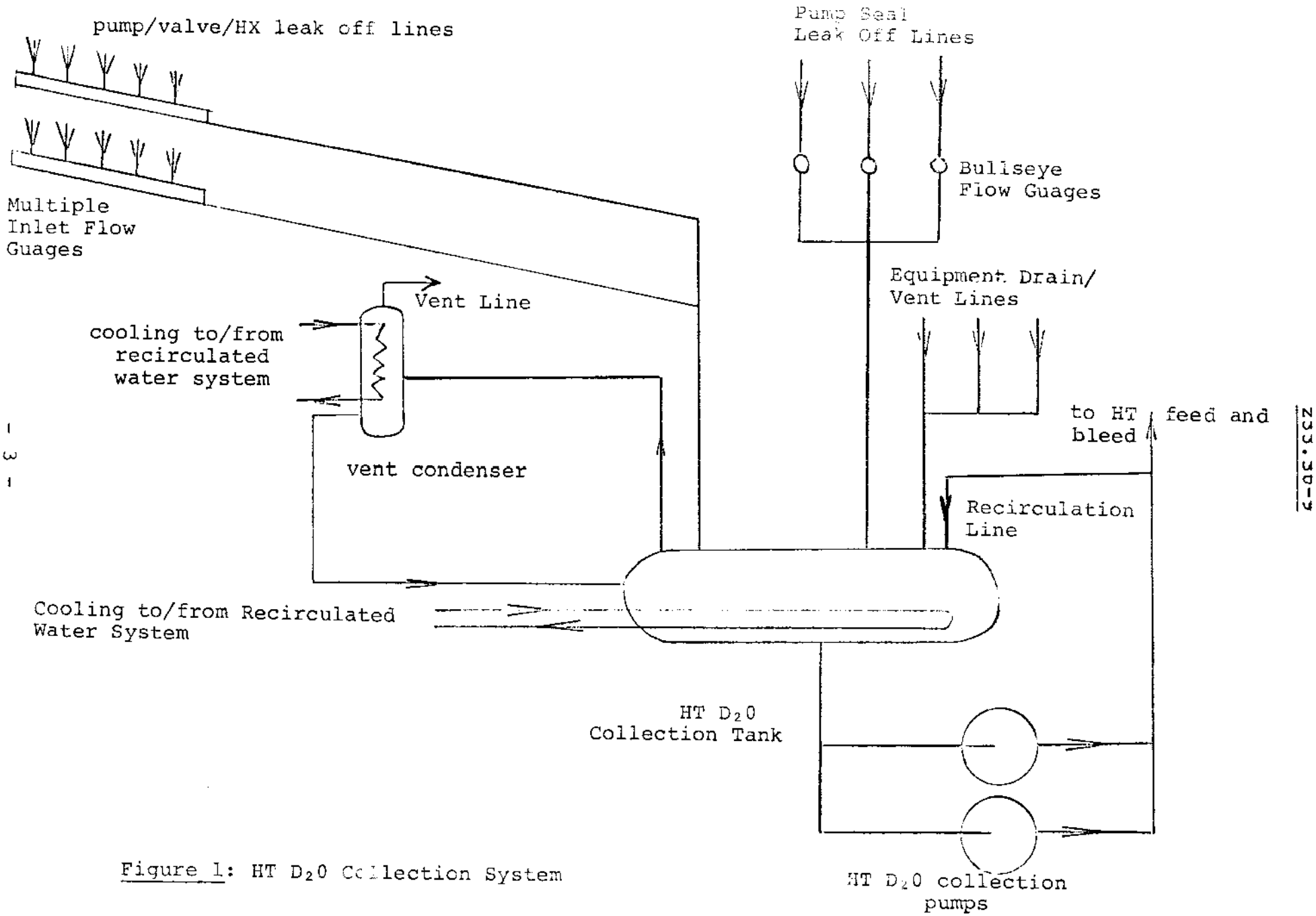


Figure 1: HT $D_2O$ Collection System

When the collection tank is almost full, a high level alarm will come in and the tank $D_2O$ should then be recirculated using the $D_2O$ collection pump to provide good mixing, enabling a representative sample to be obtained at the heat transport $D_2O$ sample station. Usually the system is provided with 2 x 100% collection pumps for higher reliability due to the more rapid collection rates in this system compared to the moderator collection.

The $D_2O$ is checked for the various parameters discussed in the $D_2O$ sampling system. Of most importance, however, is the isotopic. The isotopic of the returns is usually specified to be within 0.1% of the current unit isotopic before it can be returned, after authorization by the control room operator, to the HT feed and bleed system. The return point is usually the bleed filter inlet (ie, the purification system inlet).

The isotopic of the returns is not as important as far as reactivity is concerned as that of the moderator returns. For the HT $D_2O$ the reactivity will change by about 0.05 mk for each 0.1% change in the bulk HT isotopic. As a specific example, the pumping back to the main system of one collection tank full of $H_2O$ would result in a downgrading of about 0.13%.

If a HT collection sample is not satisfactory it is pumped to drums ready for chemical clean-up and/or upgrading.

## ASSIGNMENTS

1. What are the types of HT system equipment which have leak off points to the HT $D_2O$ collection system? For your own plant confirm that the specific equipment mentioned in the text has leak off points.

2. What is the most important check, which should be done before the HT $D_2O$ collection tank is pumped out? Can you think of any circumstances where this may not be done?

3. Why is a helium cover gas not usually designed for this system.

4. Calculate the resulting isotopic of the HT $D_2O$ if the contents of the HT $D_2O$ collection tank are completely pumped back into the HT in the following cases (A calculator is necessary to do this accurately.)

   (a) HT collection isotopic is 99.00%

   (b) HT collection isotopic is 98.90%

   (c) HT collection isotopic is 97.00%

   (d) HT collection tank is full of $H_2O$

   State the immediate and long term consequence of (a), (b), (c) and (d).

   Assume:

   (i) initial HT system isotopic is 99.00%

   (ii) total HT system mass is 160 Mg

   (iii) mass of water in a full collection tank is 200 kg.

5. In your own station find out

   (a) how often the HT $D_2O$ collection tank is normally pumped out

   (b) how often an isotopic check of the collection tank $D_2O$ is made

   (c) which equipment has the largest normal leak rate

   (d) any ways in which $H_2O$ may get into the collection system.

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