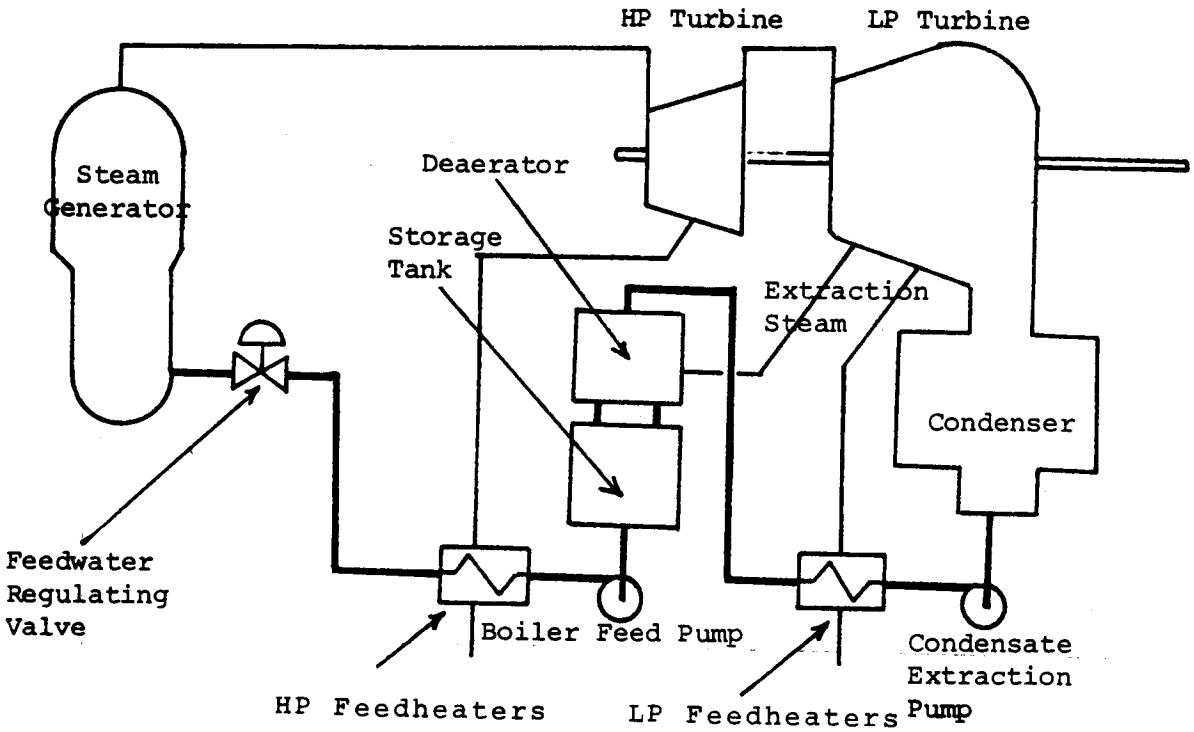
Turbine, Generator & Auxiliaries - Course 334

FEEDWATER HEATING SYSTEM - I



The Feedwater Heating System

Figure 8.1

The water which is collected in the hotwell is at a temperature of 33°C and an absolute pressure of only 5 kilopascals. Since the steam generators are at a pressure of roughly 4 megapascals, the pressure of this water must be greatly increased as it is pumped from the hotwell to the steam generator. In addition, the feedwater must be heated to approximately 175°C prior to entry to the steam generator for two reasons:

1. this greatly increases the efficiency of the steam/feedwater cycle, and

2. it lessens the thermal shock of the relatively cold feedwater entering the 250°C steam generator.

In order to increase the temperature and pressure of the feedwater, the feedheating system has two sets of pumps and a number of feedheaters. The feedheating system is generally divided into three parts:

1. a low pressure feedheating system,

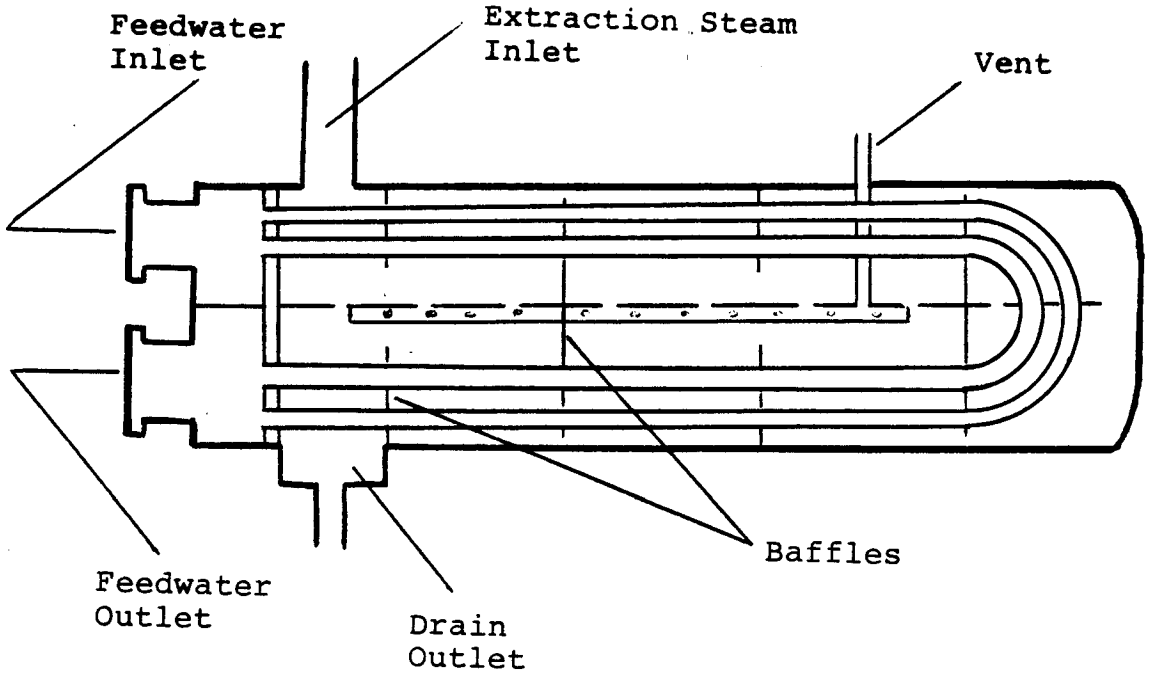
2. a deaerator and storage tank, and

3. a high pressure feedheating system.

Low Pressure Feedheating System

The water which leaves the condenser hotwell is sent to a condensate extraction pump. This pump raises the absolute pressure of the feedwater to approximately 700 to 1400 kilopascals. The low pressure feedheating system gets its name from the fact that this feedwater is still at low pressure compared to the 4000 kilopascals in the steam generator.

The steam which is used to heat the feedwater in the low pressure feedheaters is extracted from the turbine (typically the low pressure turbine) and is known as extraction steam. The extraction steam condenses in the shell of the feedheater and the water is sent back to the condenser.



Feedheater

Figure 8.2

Figure 8.2 shows a typical low pressure feedheater of the type used in most large generating stations. Feedwater flows through the tubes. This type of feedheater is known as a double pass feedheater since the feedwater passes through the heater twice in going from the inlet to the outlet. Extraction steam enters the shell of the feedheater and is condensed as it passes over the outside of the tubes.The baffles in the shell of the feedheater not only give support to the tubes but also ensure the steam flows over the entire tube heating surface. The air vent on the heater shell is connected to the condenser to remove air and other non-condensible gases from the shell of the heater. If the air was not removed, it would form an air blanket around the tubes and reduce the heat transfer.

The feedwater is typically heated in more than one low pressure feedheater and leaves the last low pressure feedheater at approximately 80°C to 100°C.

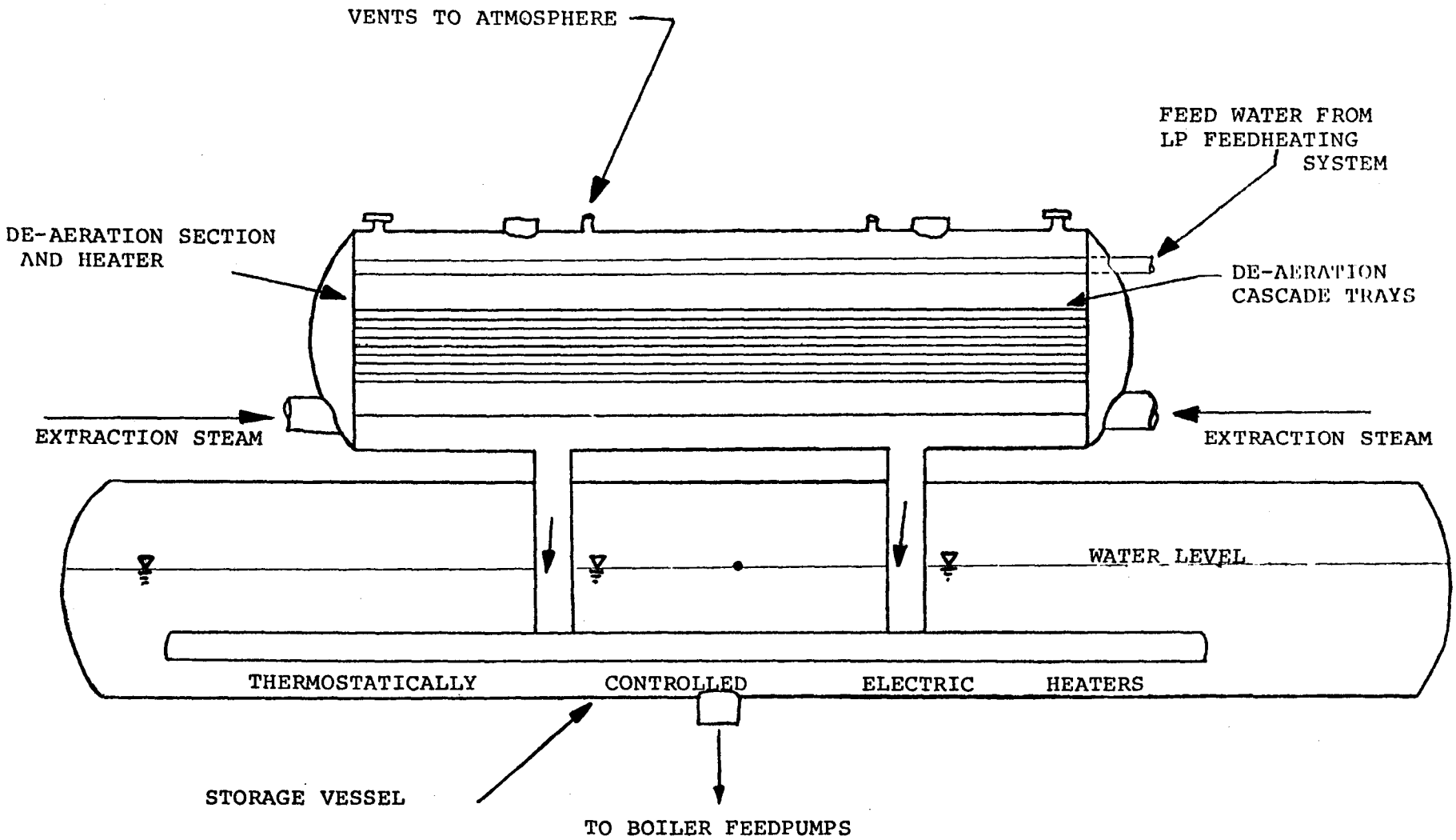
The Deaerator and Storage Tank

The deaerator, as the name implies, removes air from the feedwater. If this were not done, the corrosion rate of the metals in the high pressure feedheating system and steam generator would be significantly increased. In addition to removing air, the deaerator acts as a feedheater.

Figure 8.3 shows a typical deaerator and its associated storage tank. Extraction steam from the low pressure turbine enters the deaerator near the bottom and passes upward.The incoming feedwater enters the deaerator near the top and is sprayed downward over cascade trays. The steam condenses and in doing so, heats the feedwater. As the feedwater is heated to near the boiling point, the air is released from the water droplets. In addition, the steam passing over the water droplets "scrubs" the air off the surface of the droplets. The air is vented to atmosphere off the top of the deaerator. While the steam to the deaerator normally comes from the low pressure turbine, there is an alternate source of steam which comes directly from the main steam line. This source is used to provide necessary feedheating during unit startup and at other times when steam is shut off to the turbine and extraction steam is, therefore, unavailable.

The feedwater and condensed steam from the deaerator drain into a storage tank. This storage tank has three basic functions:

1. to maintain a positive suction head for the boiler feed pump,



Deaerator/Storage Tank

Figure 8.3

2. to hold, together with the condenser hotwell, sufficient water in storage to maintain a full load for a period of ten minutes, and

3. during shutdown and low load periods, to maintain the water in the storage tank at 125°C with electric heaters in the storage tank. This is to prevent air absorption in the water and to minimize thermal shock to the steam generators during startup. These heaters are much too small to provide adequate heating of the feedwater at high power levels when steam provides the heating.

High Pressure Feedheating System

The boiler feed pumps take a suction on the deaerator storage tank and raise the absolute pressure to between 4 and 7 megapascals. This high pressure feedwater is then sent through high pressure feedheaters. The high pressure feedheaters are identical to the low pressure feedheaters except:

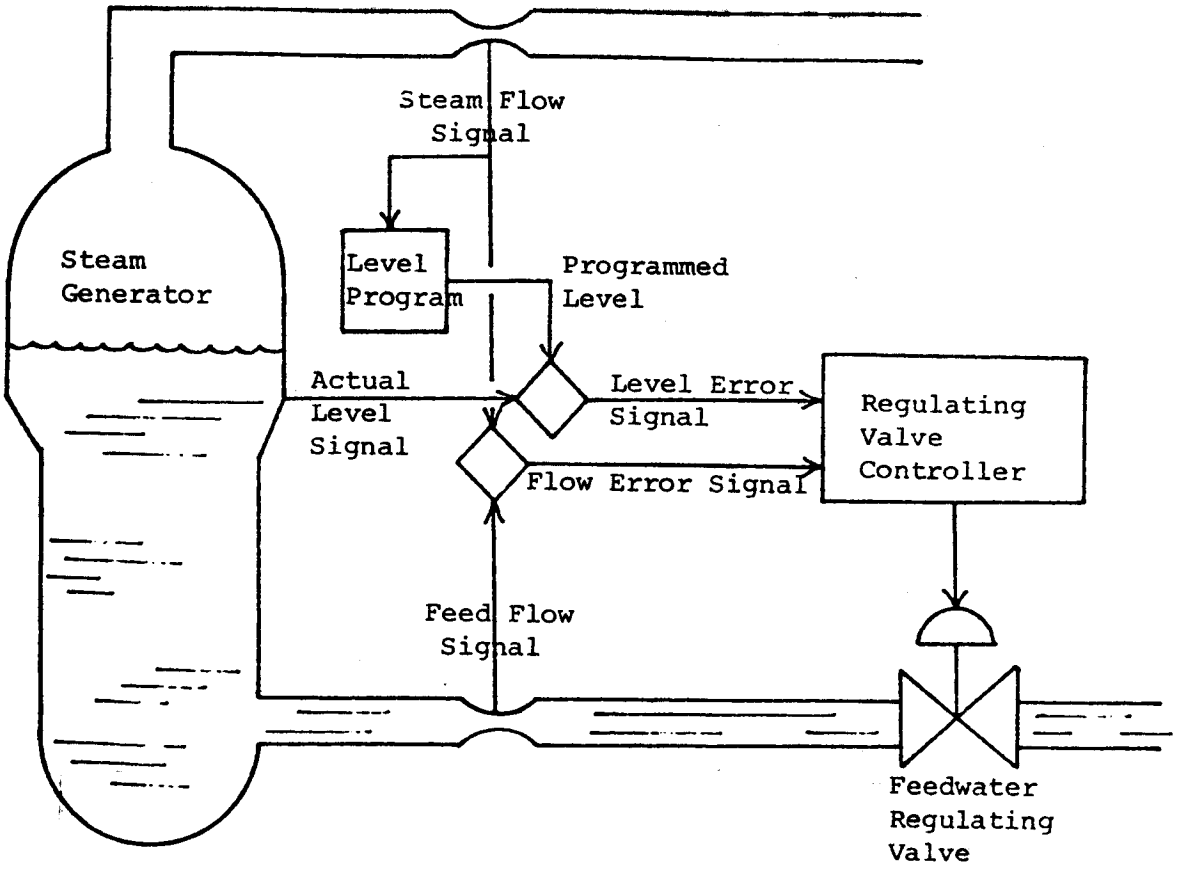
1. they are designed to operate at higher pressure and temperature,

2. the extraction steam comes from the high pressure turbine and/or moisture separator, and

3. the drains from the condensed extraction steam are pumped back to the deaerator.

Before the feedwater enters the steam generator, it passes through a feedwater regulating valve. The function of this valve is to allow sufficient feedwater to enter the steam generator to match the steam flow out and maintain the level in the steam generator. To do this, the controller for the valve compares steam flow out of the steam generator with feedwater flow into the steam generator and moves the valve to make the two equal. In addition, it compares the actual steam generator water level with a predetermined programmed level and positions the valve to make these two equal.

It is critical that water level be maintained properly. If the steam generator is either too high or too low, the cyclone separators and scrubbers in the steam generator will not operate properly. The wet steam which results could cause severe damage to the turbine blading.



Feedwater Regulating Valve Control

Figure 8.4

ASSIGNMENT

1. What is the function of the feedwater heating system?

2. What is the function of the deaerator storage tank?

3. What is the function of the low pressure feedwater heating system?

4. In a feedwater heater, why is it necessary to have a vent on the heater shell and where do the air vents go?

5. The baffles in a feedheater serve two purposes, what are they?

6. Describe how the deaerator removes dissolved gases from the feedwater.

7. How is the feedwater flow controlled to the boiler to ensure that the water level is constant?

8. What are the effects of a very high water level in the boiler?

9. Why are electric heaters fitted in the deaerator storage vessel?

10. Draw a line diagram of a feedheating system showing:

    (a) Hotwell
    (b) Condensate Extraction Pump
    (c) Feedwater Regulating Valve
    (d) Boiler Feed Pump
    (e) Deaerator
    (f) LP Feedheater
    (g) HP Feedheater
    (h) Extraction Steam Lines
    (i) Steam Generator

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