BOILERS FOR STEAM TURBINES (CONVENTIONAL)

Boilers for steam turbines provide high pressure and high temperature steam for the turbine for expansion. The boiler pressure & temperature have increased over the years.
The temperature is increased because it is better to have as hot a temp for the expanding fluid (coming from Carnot concept also). The limit on the temperature is the steels used in the boiler & in the turbine. Since the combustion Temperature is much higher than 1000 there would not be any problem to heat the steam to much higher temperatures other than metallurgical.

Pressure is increased for having smaller boilers. The limit is the critical pressure at the very end, however in more common small boilers the pressure is selected as a compromise for size and added complications. Higher pressures require more robust construction in every aspect, pumps, pipes, steam drums.

Boilers can be natural circulation or forced circulation. This term refers to the evaporator section of the boiler. That is the part which supplies the latent heat to the water. Most boilers in Malta are natural circulation. In this type of boiler the water is heated in the boiler and steam bubbles are formed, the mixture of water/steam is passed into a steam drum where the water & steam are separated. The water is again heated to eventually become steam, while the steam is directed to the superheater where more heat is added to bring the steam to the reqd temperature.

. Note that the steam drum is not a heat transfer module. It is more a buffer of steam & water storage and is required for the separation of the steam from the water.

The most recently built boilers in Malta are 513°C outlet steam at 90 bar. The previous boilers in Malta were 70 bar and 40 bar.

The Delimara boilers develop steam equivalent to 60 MW.

Abroad much bigger boilers in the range of 600 MW also exist.

The critical pressure of steam is 221 bar and boilers do exist which are super critical. In these boilers there is no evaporator section as such as there is no boiling transition. The water goes from water to steam directly and completely.

Refer to the Boiler diagram of Delimara.

Furnace is where the combustion takes place.
Wind box is where the fresh air is directed to the burners.
Air registers, open or close air to a particular burner depending whether the burner is off or on.

Air in the wind box, is preheated from an air heater from the flue gas (just before flue gas is passed away to the chimney)
The boiler walls are made up of finned tubes

Viewed from Above

The tubes are infact the evaporator part of the boiler. The tubes are vertical. They are filled in the bottom by means of a much bigger pipe coming from the steam drum (down comer). Water in the finned tubes is then heated by means of the radiation of the flame in the

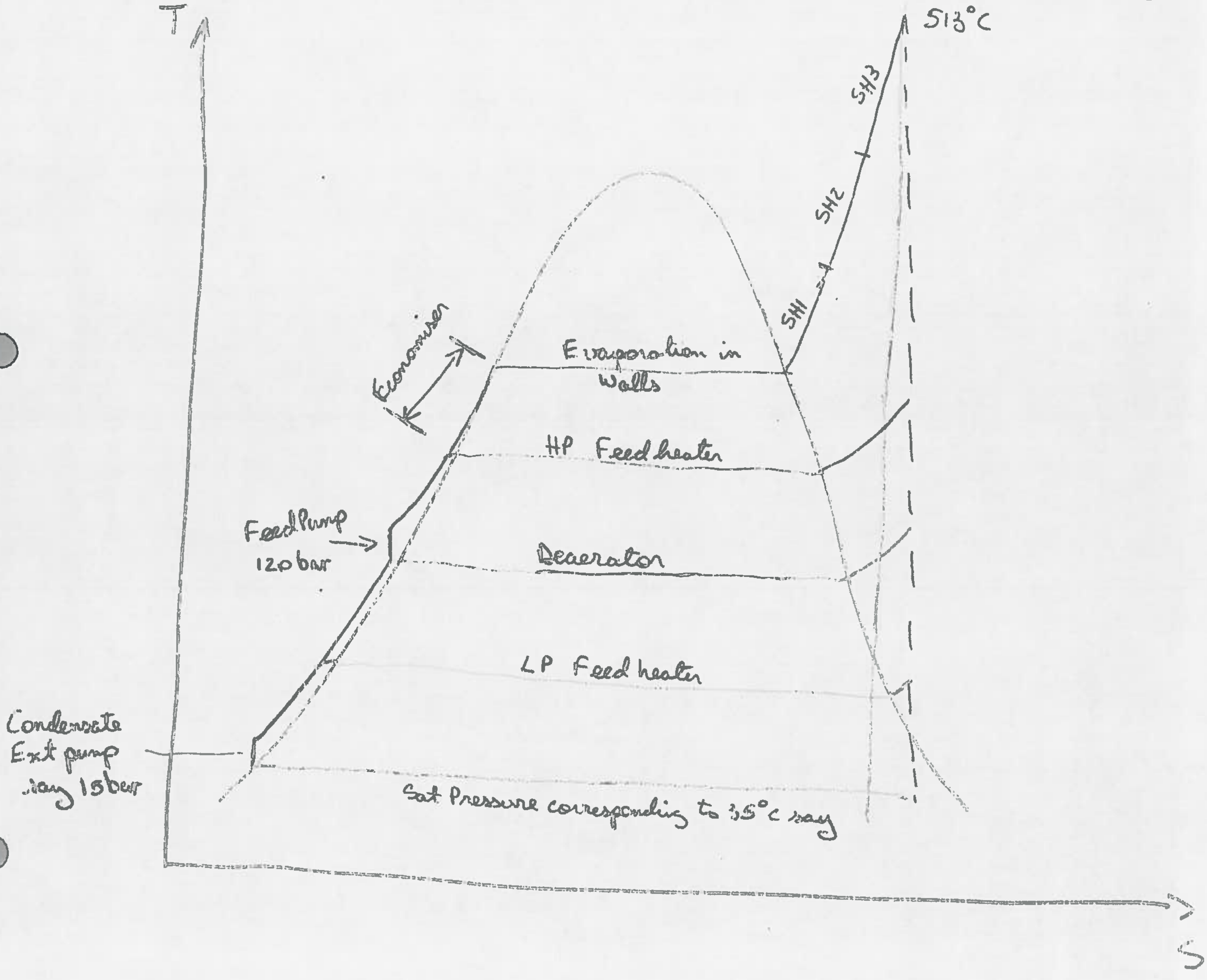
1st pass of the boiler and also to a lesser extent in the 2nd pass. As the water is heated it generates steam bubbles and hence the mixture density falls. In this way the water / steam mixture in the walls rises and overflows into the steam drum. The steam and water are separated in the steam drum. The water again goes to the downcomer to make another cycle. The mass of water that changes to steam and goes to the superheater is made up for by the economiser which fills the steam drum so that the level is maintained.

Sometimes a mud drum is incorporated in the boiler which is at the bottom of the downcomer and is mostly a water storage tank. In the steam drum or mud drum, as water is always being evaporated, there will be a build up of solids, i.e. the salts that cannot vapourise as the water does. Hence either occationally or continuously, an amount of water must be drained to control the amount of solids. This is called blow down.

The superheater is divided into 3 parts, so that in between, water is added to control the steam outlet temperature. This is called attemperation spray water injection. In this way it is possible to keep the steam outlet temperature at the rated 513°C say determined by the alloy steels irrespective of the dirt on the superheater and the % load on the boiler. Note that when dirt accumulates it reduces the heat transfer so less attemperation is done. On the other hand when the boiler is less than 100% load, the heat transfer surfaces are larger than required and hence attemperation is req^d.

The same superheater, say SH1 is divided into separate bundles to facilitate construction and cleaning.

The Economiser provides the heating of the incoming water to the saturation temp at the drum pressure. Actually the economiser does not recieve the condensate directly from the condenser say at 35°C but after the feed heaters so it is more than 200°C say.



∴ Other points mentioned

FD Fans : Forced Draught Fans
ID Fans : Induced Draught Fans.

If only FD Fans are used as at Delimara, furnace pressure is +ve.
If both FD & ID's are used the furnace pressure is -ve.
FD fans take fresh air from ambient and force it into the air heater and subsequently into wind box & furnace.

ID fans, pull air from air heater (flue gas side) and force it into the chimney.

Fuel to burners can be either coal or fuel oil. Coal need to be pulverised by mills and is then pumped into boiler as dust.
Oil is pumped by means of screw pumps. Since oil is very viscous it has to be heated continuously by electricity or steam. Furthermore the fuel oil pipes are arranged in a loop so that fuel is never stagnant in pipes.
Fuel is burnt properly by help of atomising steam which is injected on the fuel being ejected from the burner tip. In this way the fuel is atomized, i.e. made into small particles so that combustion is helped.

Boiler is hanging from above. In this way boiler heat transfer surfaces are always structurally simple, in tension, and have only heat transfer complexities! Weight is then handled by the I beams outside which are at ambient conditions ∴ no thermal problems.