Steam and Gas Power Systems
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Module No # 02
Lecture No # 10
High Pressure Boilers (Part-1)

Hello I welcome you all in this course on steam and gas power system today we will start with the high pressure boilers.

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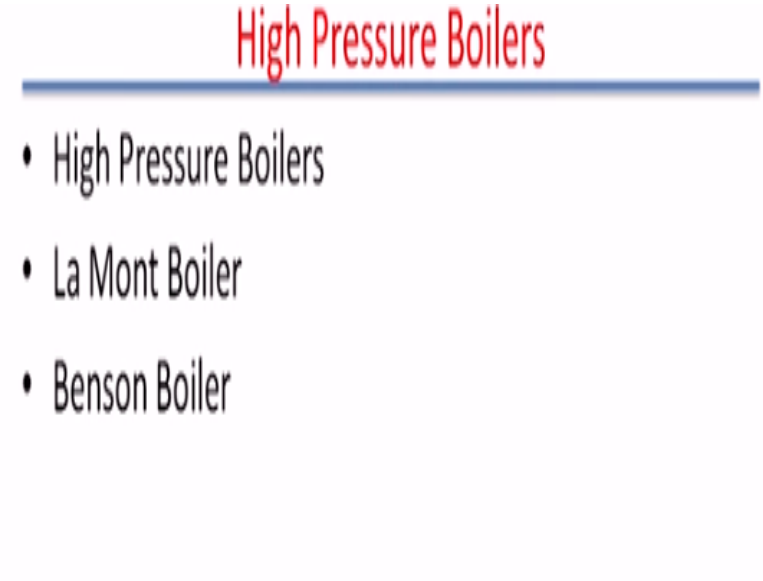

As clear from the name itself these boilers they work on high pressure and today we will discuss two high pressure boilers one is La mont boiler another is Benson boiler.

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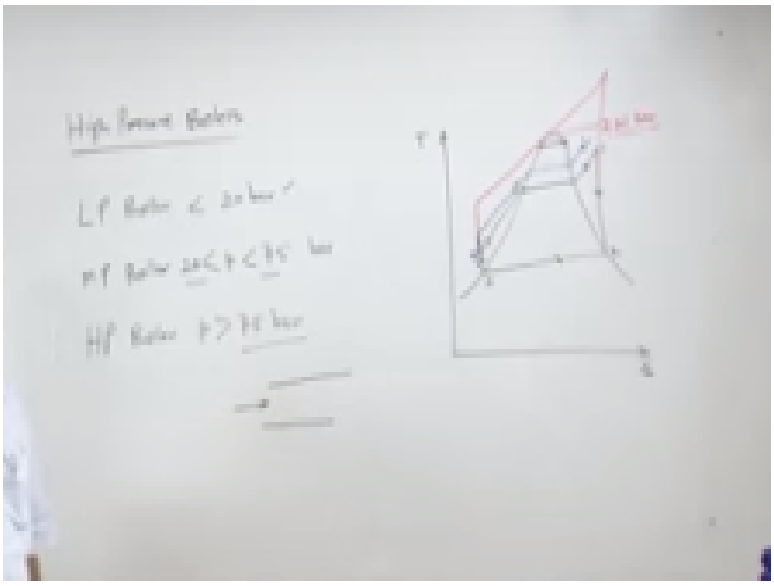

Now high pressure boilers first of all we should understand the need of the high pressure boiler. If you look at the rankine cycle this is temperature and this is entropy 1, 2, 3, 4, 5 the efficiency of the ranking cycle depends average temperature of heat radiation. If we increase the average temperature of heat radiation the efficiency of cycle will increase.

So 4, 5, 1 can be shifted to another high pressure this points will be shifted like this so we will get another temperature remaining same we will get another point one here. If we keep on increasing the pressure the situation will come we will process the critical point and we cross the critical point in that case the process will become something like this.

When the pressure in the boiler or the boiler in the operating beyond the critical then it becomes the super critical cycle and because the net temperature of heat reduction is high here that efficiency is high right. For a steam the critical pressure is approximately 221 bar. However high pressure boilers are like though this high pressure boilers do not operate to the high pressure right.

So but still they are on high pressure first of all we will decide will draw a line for high pressure boiler and low pressure boiler. So low pressure boiler where pressure is less than 20 bar as we discussed in previous lectures like Lancashire boilers previous lecture like this Lancashire boiler or Cochran boiler.

So all this boilers were having pressure less than twenty bar so they were low pressure boilers now medium pressure boilers where pressure is greater than 20 bar and less than seventy five bar. So when the pressure overs in the boilers overs in 20 bar to seventy five bar they are known as medium pressure boilers. Now the third one is high pressure boiler these boilers are going to discuss today when the pressure is greater than seventy five bar.

Such type of boilers are known high pressure boilers in high pressure boilers the water circulation is forced water circulation it means there is always a pump which circulates water in the high pressure boilers. The benefit of the high pressure boilers is suppose they are operate on a high temperature and high pressure the temperature is almost I mean uniform inside the boiler body right so that is the benefit we can because placement of grate is also.

I mean it as any constraints for the placement of grates but in high pressure boiler we have force circulation of water through the tubes we have freedom of placing the grate also in the boiler. And when we are operating in a cycle when we are operating very high pressure right in that case because the efficiency is high a steam consumption reduces for the same output for the same output if the efficiency of the cycle is high rankine cycle is high less amount of steam will be required.

So when we are using high pressure boiler they are operating on high pressure then amount of steam required for the operation of the cycle. Another advantage this is a indirect advantage of high pressure boilers because in this boilers inside the tube the velocity of the water is very high. So to some extent it prevents this scaling of the tube surface so that is indirect benefit of a using a high pressure boiler.

So we will start one by one on high pressure boilers we will start with the La mont boiler and there other advantages are also compact size same amount of heating they are compact in size portability is easy they can easily transported to one place to other place because they are very smaller in size.

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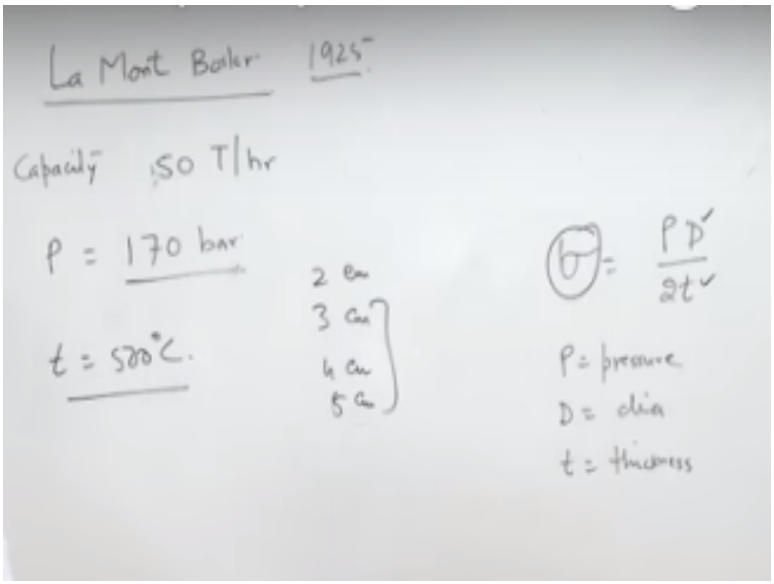

So we will start with the La Mont boiler is high pressure boiler it is clear from the name itself it was invented by LA MONT in nineteen twenty five right. The capacity the boiler capacity is important right so capacity of the boiler of this boiler is fifty tones per hour it means this boiler can give at the particular pressure the pressure also I will give you the pressure is 170 bar.

If you remember those boilers Lancashire boiler, Cochran boiler and Cornish boiler the pressure was less than 20 bar. So pressure itself has gone tenfold here right in those boiler the pressure was 15 bar 16 bar 18 bar here the pressure is 17 bar. So the design the boiler has to be robust. Because in high pressure jones especially the boiler must be able to sustain the pressure that is why most of the high pressure boiler are water tube boiler.

Because high pressure is there in the tube it is not in the flue gases that is why high pressure many of the (()) (07:40) most of the high pressure boilers are water tube boilers. Because when we are using water tubes if you remember the formula there is a stresses is PD by 2 T P is the pressure D is the diameter and T is the thickness. Suppose I want to maintain the same pressure in its shell and the tube.

Tube as much small smaller diameter so for the same stress level this is constant D by T ratio is important. If I want to have large I want to store steam in a large diameter drum thickness of the drum wall has to increase right. The moment I am reducing this D diameter then thickness we

can go for smaller or less than thickness. So that is why in a tubes are in the diameter of let us say one inch one and half inch one and quarter inch or half inch.

Diameter of the shell means one meter or two meter so you can compare the dimensions 1 inches = 2.54 centimeter so tube diameter may be let us say 3 centimeter or 4 centimeter or 5 centimeter at the most right or may be 2 centimeter but shire diameter is normally 2 to 3 diameters in that proportion thickness is we are using the same material.

So that is why high pressure boilers are normally water tube boilers so water is circulated in the tubes and tubes are surrounded by this is the basic working of this boilers we will take down one by one and the tube is surrounded by the flue gases now the same steam we can pass through the super heater flue there is a separate arrangement for the super heater.

Super heater also filled with the super gases the same pipe or through some drum or through a header it may go to some heater zone we may get superheated steam feed water can pass through the passage of flue gases then feed water heater it will take place through a economizer so all this accessories which I discuss in the previous lecture they become almost integral part of the boiler then no longer remains accessories becomes integral part of the boiler.

Because when we are operating at high temperature because here the temperature is also high temperature is 500 degree centigrade. So you can imagine we are getting steam at 170 bar pressure and 500 degrees centigrade temperature. So when we are getting steam at this high temperature the flue gas temperature shall also higher than this and the flue gases they are coming out of the boiler it is simply wastage of heat.

So our job is as engineer out job is to trap as much as possible out of this outgoing heat so in a La Mont boiler we will go for the construction of the La Mont boiler.

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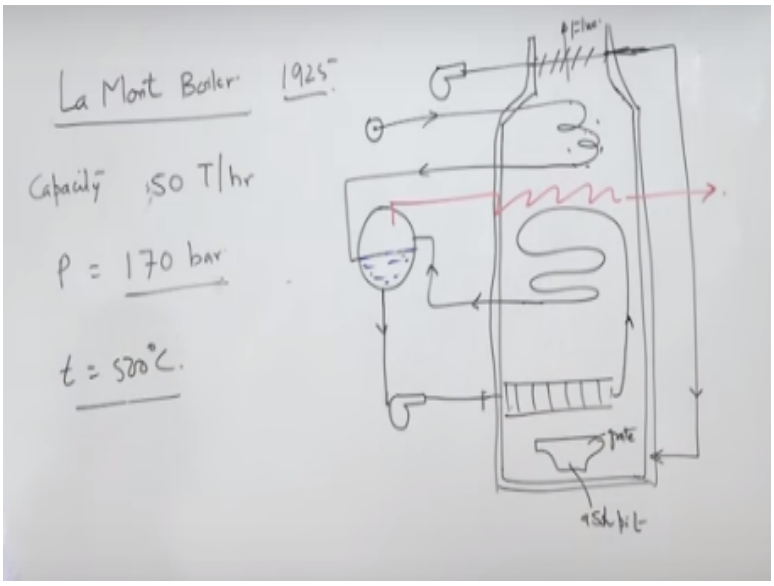

First of all it is a vertical boiler so the drum in the boiler is like this it is neck and passage for flue gases to go out from this passage flue gases leave the boiler right. Now at the bottom of the boiler the fuel is burnt and grate is provided lot of heat go out with the flue gases because I mentioned earlier the steam is generated 500 degree centigrade so definitely the heat carried away by the flue gases is relatively higher and with the help of air free heater we can tap this heat.

So air heater is fixed somewhere here and air is circulated with the help of the blower when air emerges from this side this high temperature air is sent to the grate at below there is ash pit and this is grate. So high temperature air it enters the grate to burn the fuel right. So this heat can be used can be utilized this heat taken at the air free heater can be utilized in burning the fuel. Now this boiler has a small drum also it is partially filled with water and partially filled with the steam.

Now this water partially filled water this water is circulated in the boiler for purpose of generating the steam. Now one more thing we can do to put a economizer in the boiler so the heat somewhere here so heat which is taken away by the flue gases can be tapped for heating the feed water. So an economizer is fixed so feed water supply system so feed water supply system feed pump and feed water is supplied to the so this is economizer in the boiler I will not write but I will show you this is I will indicate this is economizer.

So in the same passage were the flue gases are taken place for economizer is put which takes heat because the feed water takes heat from the flue gases and then the air which is used for burning the fuel in the grate takes heat from the flue gases. Now this water enters the this is the high pressure drum the pressure is high in this drum it is half filled in the water feed water it means upper half steam is stored and below that there is feed water.

Now this feed water goes to the boiler shell so for circulating feed water a pump is required a pump is required now this pump pushes the water in the shell and here there is a header because in the grade there is a radiant heating of there are number of tubes so there is a radiant heating of water and water is converted in the steam right.

After that after the radiant heating it goes again in goes to the same tube is again circulated through is placed in the path of flue gases. So there are two types of heating through this feed water one is radiant heating from the grate and then from the flue gases after this water is converted into the steam and steam is sent to the drum for storage and from here we can get saturated steam right.

Am explaining again the shell in the shell the flue gases are leaving from the top is air free heater is fixed in order to pre heat the air which is used for (()) (15:49) fuel in the grate and below the grate there is ash pit and economizer is also used for per heating the feed water. Water is collected here right then it from this shell the water is taken and it is circulated inside the shell first radiant heating of this tubes takes place then conductive heating of tubes takes place.

Water is converted into steam water is converted into the steam and stored in the shell now one thing is remaining super heating of the steam. So simply steam is taken out from the shell this steam is taken from the shell this is saturated steam it is once again passed to this flue gases and we get superheated steam that is it that is the working of La Mont boiler.

La Mont boiler small diameter tubes are used when we are using small diameter tubes the heat transfer is effected is quite effective. Because in that case surface to volume ratio is high if you

using this small diameter tubes. And second thing is it has got very high evaporation (()) 17:11) because there is a force circulation of water in fact we have to maintain force circulation of water in the boiler because it has very high evaporation.

Rest of the things like mountings are always there integral part of the boiler pressure indicator water level indicator this and that I have not shown that I have simply schematic show you the movement of the fluid for the working of a La Mont boiler.

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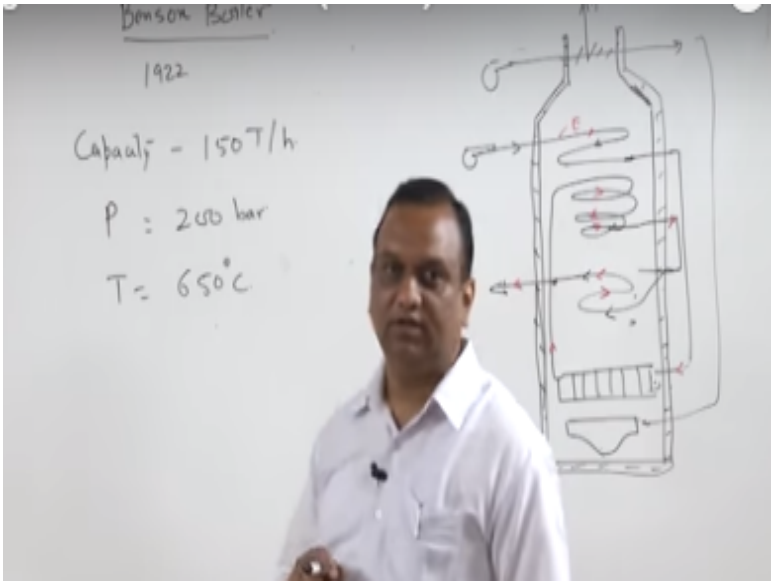

Now the next one is Benson boiler the Benson boiler was invented by MARK BENSON in year nineteen twenty two previous one was nineteen twenty five this one is nineteen twenty two. Capacity of this boiler capacity of this boiler is 150 tones per hour three times of the capacity of La Mont boiler capacity of 50 tones per hour remember. So he capacity of the boiler is one 50 tones per hour pressure is also 200 bar right.

So it is very close the critical point the pressure because in previous one La Mont boiler the pressure was only 170 bar. So in Benson boiler the pressure is 200 bar temperature is 650 degree centigrade we can go up to 650 degree centigrade. So this is I mean specification on higher side pressure is high in comparison to La Mont boiler pressure is higher the temperature is also higher.

Another thing is beauty of this boiler is within ten minutes it will go to the peak value I mean it is quick in response this boiler is very quick in response. Another characteristic of this boiler is it does not have any drum so it is a drum less boiler. In previous there was a drum in La Mont boiler there was a drum where steam was stored drum for the storage of the steam is steam was stored saturated steam was stored.

But in this boiler there is no drum so that is why it is also known as drum less boiler now if there is no drum portability automatically increases and the weight of the boiler is also reduced. Weight of the boiler is almost reduced by 20% if you are not using drum because the steam has to be stored at very high pressure. So when the steam has to be stored very high pressure definitely the design of the drum is robust design.

So its (()) (20:01) of amount 90% approximately 20% weight of the boiler so that drum is not here so approximately 20% weight of the boiler is reduced. Now mean vertical shell right. In this boiler also because you can see the temperature is further higher so lot of heat must be going with the flue gases. So air free boiler is provided in order to pre heat the flue gases and definitely this heat will come to the grate again fuel is point here.

So this pre heated air will come to the grate will facilitate the burning of the fuel to the grate now feed water. Feed water has to be heated in the economizer right and it is drum less boiler. So in single go all the operations will be done pre heating of feed water or heating in economizer heat conversion of water into the saturated steam and super heating of the steam right. So there is a single tube for feed water and the feed water passes through economizer takes because flue gases are moving in this direction.

So it takes heat from the flue gases after economizer after pre heating then radiant heating as to be done here right. So water feed water which is heated in the economizer after taking heat in the economizer it is transported to a place above the grate and their there is arrangement of the tubes parallel arrangement. So that effective radiant heating of water takes place with the help of which the fuel which is burning in the blade.

After radiant heating after radiant heating the convective heating of the water resistance so again explaining the circuit because it is the single go right feed water feed water is this is economizer. Economizer to radiant heating radiant heating to convective heating right after convective heating we can take the steam out if you want saturated steam if you do not saturated steam then again it goes to the super heater and super heating takes of the just a minute it will not go from top to bottom.

It will go from bottom to top super heating will take place and super heating steam will emerge from here right. So I hope that the circuit is the clear to you I can explain it again there is a air free heater which pre heats the air which goes to grate there is a pump. Which pumps the feed water through economizer this is economizer and after economizer it goes for the radiant heating the feed water goes for the radiant heating in near the grate or the grate in the combustion chamber right.

Here in the convection of the water into steam takes place partial conversion then after this the water is passed through a convective heater where conversion of water into the steam takes place further conversion of water into the steam takes place from here we can get the saturated steam. If you want superheated steam the again this saturated steam circulated before the flue gases and we get the superheated steam.

So the working is very simple the problem here is the problem of maintenance because it is it is the construction is not simple as it is as simple as looking in schematic. So cleaning in this boiler specially for the maintenance purpose of for the cleaning of the tube. It is not impossible but it is a difficult it is not that easy that easy but the benefit of the boiler is it is light in weight because there is no drum there is only grate in network of tubes and its shell.

Today we have covered both the boilers La Mont and Benson boilers the next class we will again covered two more high pressure boilers that is all for today thank you