Steam and Gas Power Systems
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Module No # 02
Lecture No # 08
Water Tube Boilers

Hello I welcome you all in this course on steam and gas power systems today we will discuss water tube boilers there are number of water tube boilers we cannot discuss all of them here.

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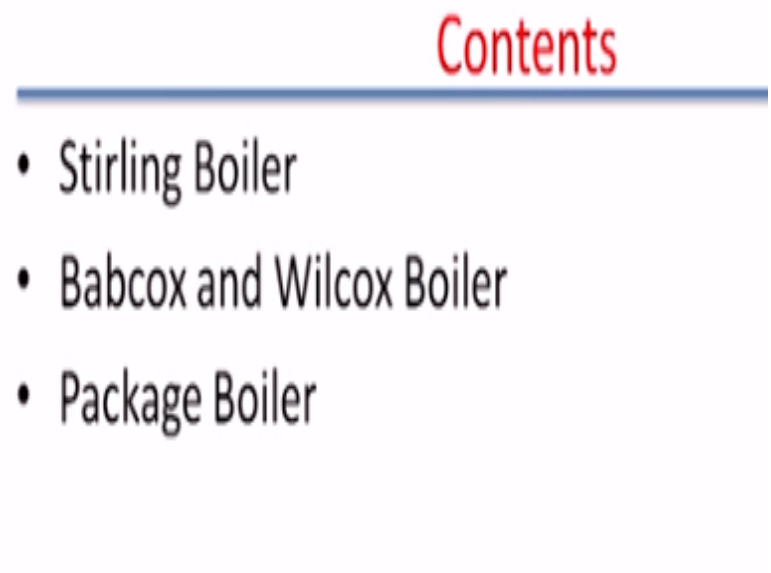

But we will take certain water tube boilers like Stirling boiler, Babcox and Wilcox boiler and Package boiler.

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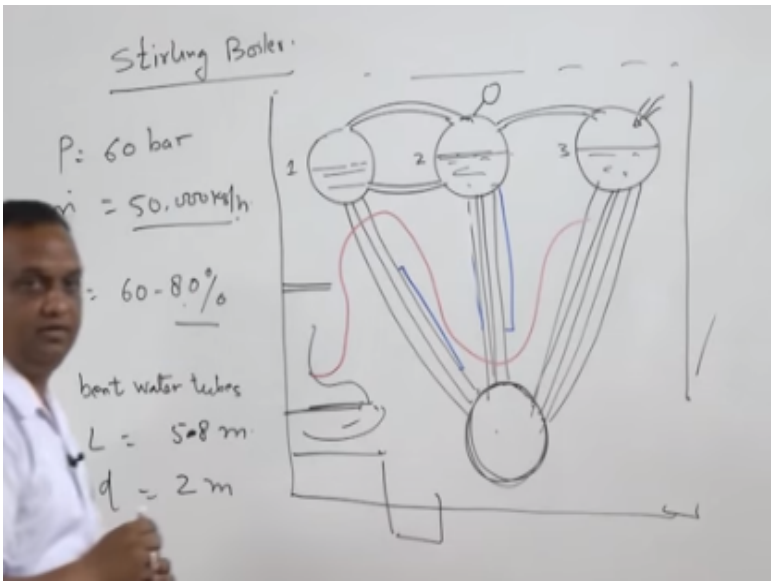

Now stirling boiler consist of number of drums right there is steam drums. So a typical boiler has three steam drums right and one is water drum or mud drum now this water drum it can have four or five wall steam drums or two or three water drum depending upon the size of the boiler or amount of this team is required because a typical stirling boiler can work up to pressure = 60 bar and steam generation rate can be 50,000 KG per hour.

It is enormous steam generation is a huge boiler efficiency of this boiler varies between 60 to 80 % and it can go up to 80 % efficiency right. So let us take a typical of three steam drum boiler and one mud drum boiler and these drums are connected with bent water tube. Now this bent water tubes they connect drums all these steel drums to the mud drum.

There is steel drum one two three and this is water drum or mud drum it is ensured that that water level in these drums. Drum one this is drum one this is drum two let us say this is drum three water level is maintained same in all the drums now how it is possible? it is possible when we put circulating tubes between these two or these two drums are interconnected they are known as circulating tubes okay.

And another type of tubes are equalizing tubes they are for equalizing the pressure so these are equalizing tubes which are connecting all these three drums and these two drums are connected by circulating tubes the feed water is provided from here there is a feed check value and feed

water is provided from here right and from here the feed water enters this water drum and the length of the drum perpendicular to this I will just to give you idea this can be approximately 5 or 5.8 to 6 meters 5.8 meters and diameter of drum is approximately two meters.

So size of the boiler is quite large these tubes are bent tubes the benefit of the bent tube is thermal stresses are not developed they will simply bend. When the expansion takes place these tubes will simply bend so thermal stresses will not be developing in these tubes. Now it is but in a housing and some provision for I will how you a diagram photograph of this.

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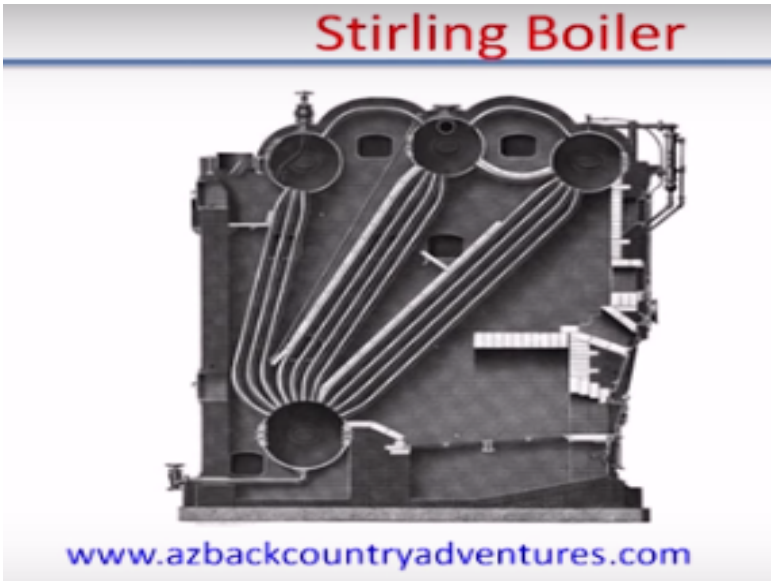

This is the arrangement is something like this is on revise side I have taken from these in this case the feed water supplied from here knowing whatever is given in the photograph feed or feed check wall is here and feed water is supplied from here right. And he fuel is burnt here in this part this is of the top is also closed fuel is burnt here in this part okay. And there is a ash pit and rest of the things are more or less same.

Fuel is burnt here and it is passed over this tubes feed water comes from here it goes down and it comes to the water chamber or mud chamber and after this water vapor when the water is converted into the vapor it starts raising and getting connected here. Now these drums they have mountings like pressure gauge water level indicator safety wall steam stuff wall to supply this steam.

Now if you want superheat this steam then simply take a steam from here in a pipe and again circulate through this space right the steam will get superheated. Similar type of arrangement is done in most of the boilers so the flue gases they get deflected right they are baffle plates. So baffle places are also shown here so flue gases coming from here they do not simply cross this. There are baffle plates baffle plates I will show you by different color they are baffle plate so flue gases they and this will come here.

So there is a baffle here and in this case the flue gases emerging from here they will enter from the top they will come down and then they leave from here. So there is a path for flue gases is maximized due to with the help of this baffle plates. Steam is collected here now the benefit of stiling boiler the major benefit is high heat steam production rate will write benefit here. The biggest advantage of this boiler is mass on steam production rate is very high as I stated earlier it can go up to 50,000 thousand KG per hour that is the one thing.

Now second thing is the pressure can also go up to 60 bar and pressure loss in entire system because it is it works from natural convection right and in fact the movement of water takes place by the principle of thermo syphon right. So the pressure drop in the boiler within the boiler is minimum that is another advantage of this boiler and this boiler permits a great flexibility of the design I mean you can ask per your requirement you can change the design also you can go for say six drum boiler and you can add here three more drums right.

Tubes they are bent tubes because they are bent tubes that is why no thermal stresses are developed in tube that is the benefit of this tube but the problem with this boiler is it is very difficult to clean this boiler because there is a network of the tubes right. So cleaning is a major problem manhole is provided on this side. So for the cleaning purpose man hole is this is a great side this side for cleaning purpose the passages are provided to clean the boiler but cleaning is a little difficult job it is large in size.

So it occupies definitely is one more steam so boiler has to be large in size this is larger in size it requires more space. Thirdly superheating is also we cannot go for very high level of

superheating with this type of boiler but this where the requirement of a steam is large this boiler is very useful. Now after stirling boiler we will take the Babcox and Wilcox boiler this is also very popular boiler.

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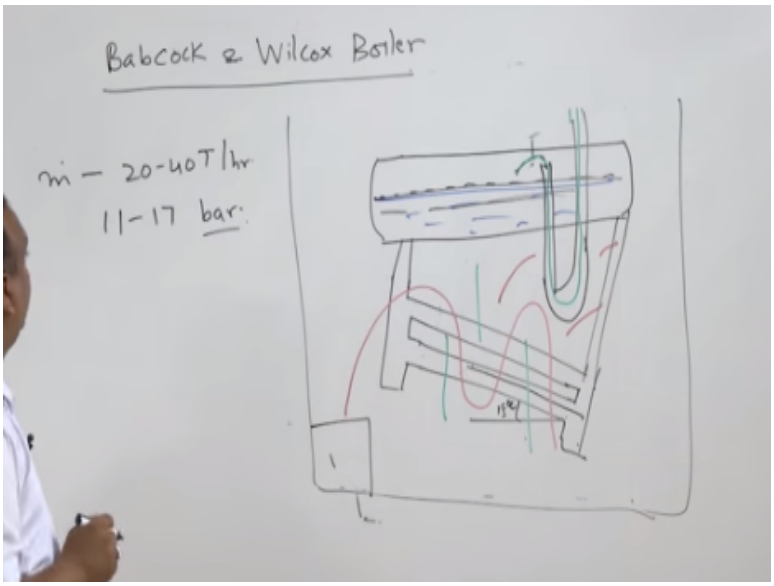

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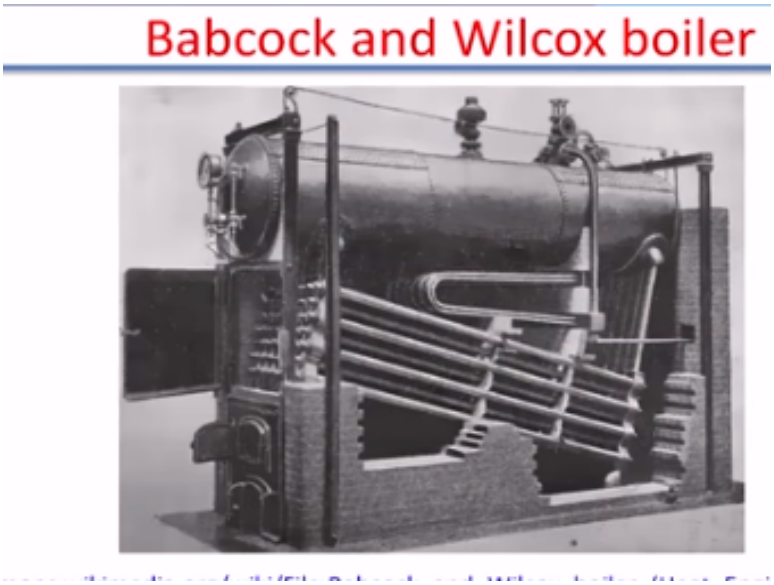

This boiler is also water tube boiler and this is boiler is also quite large in size this boiler has a horizontal shell at the top as shown here also right it has three tubes inclined at a particular angle they are water tubes and at the both end the water header is made for the circulation of water the intimation of these tubes is fifteen degree from the horizontal.

It is also house in a brickwork right water entering this in these tubes the feed water it moves in a full direction this boiler as a great most of the arrangement are same. It has a right for a fuel is burned inside and then there are vessels here also in this boiler also there is a provision of baffles. So the purpose of the providing baffles is when the flue gases the move in the overall tubes they move in a zigzag way and they cover the maximum path the heat transmission is maximum so that the actions of the boiler is improved.

Steam generated in the boiler goes to the shell and shell is as in the other case also share is partially filled with the water and partially filled with the steam. So this lower part is filled with the water and upper part is filled with the steam. Now suppose I want to have a superheated steam now in order to have a superheated steam in order to have a superheated steam the steam is trapped with the help of or we can make it right here also and just steam is just taken from the upper part of the shell.

This is re circulated in the boiler body and it is taken out so steam the saturated steam which is collected at the top of the shell it enters this tube circulated through this tube and leave from the top and this is the supply line for superheated steam and heat for superheated steam is provided by flue gases flowing inside this because the entire shell this entire space is filled with the flue gases and this part you are saying is bend tubes they are for super heating of steam right.

And the water to this tubes comes from this side so this is how the entire systems works. Now this boiler can produce 20 to 40 tones per hour of a steam at a range of 11 to 17 bar pressure right in this boiler because it also works on the natural convection the pressure loss is minimum defective tubes because a lot of space inside the shell inside the boiler housing.

So defective tubes can be easily replaced so defective tubes can be easily replaced it is supported the entire system is supported on the iron structure. So the problem because what happens when the system is supported or it is restricted by the brickwork right in that case some the structure related problems do come into the picture and that does not happen when the entire system is supported or ironing structure.

So these are the details of Wilcox boiler after that we take up a package boiler now package boiler or I mean small capacity boilers they are compact portable and they are available in wide range right wide range of steam generation and wide range of pressure now in most of the boiler in these boilers you must have seen that there is a single pass of water tube.

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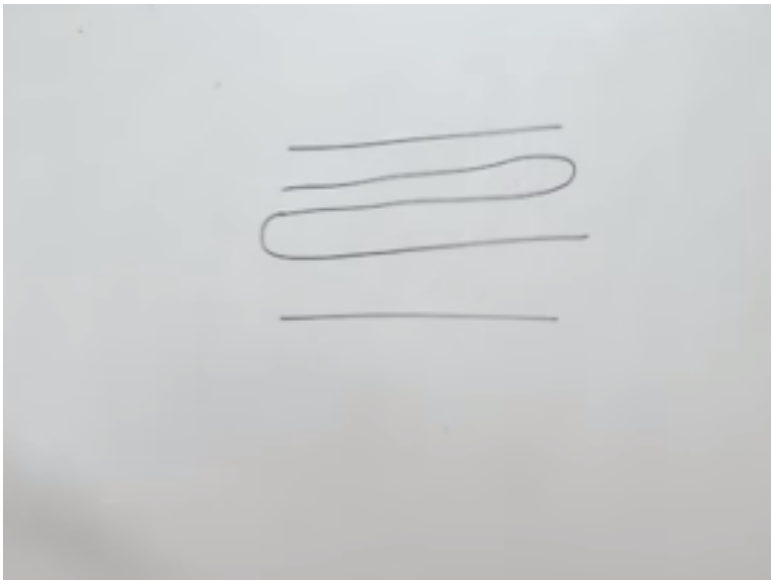

In package boiler there is a multi-pass now what we can do in a shell just water is entering from this side then it can take U turn and return to same side then again there is a U pin and then again it can take U turn and leave from this side. Now this will make the size of the this will reduce the size of the boiler so package boilers has everything inside one structure one entity it is smaller in size it is portable it is flexible.

It is flexible in the sense it has wide range of operations though you may have to purchase different boiler for different ranges but package boilers are available in wide range. Now in package boilers if you look at the arrangement of the drum and the tube.

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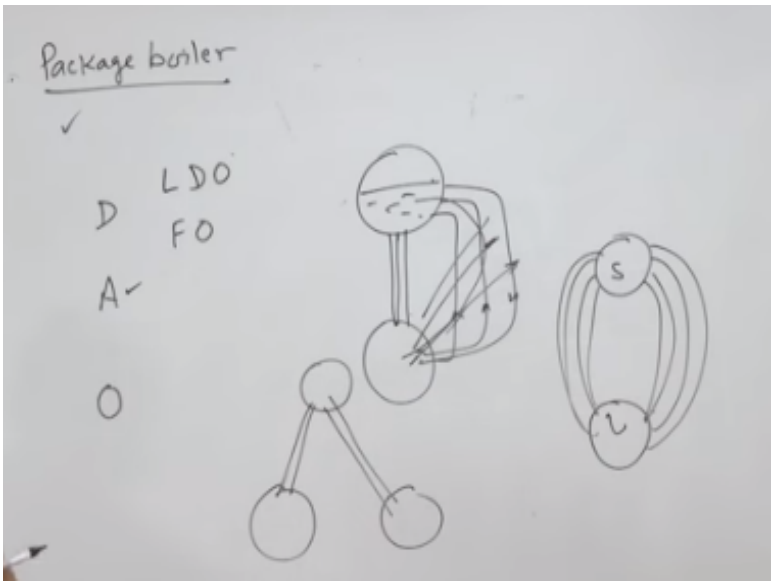

There is a D type arrangement there is A type arrangement and there is a O type arrangement. In principle there is a steam drum and there is water drum right and this steam drum is connected with the water drum and there are D types of tubes like this core tubes in which the water flows and air is sorry flue gases are blown over these tubes right and the water and the steam is the water is converted through the steam and the steam is collected in this shell.

Another type of arrangement is A type arrangement in A type arrangement there are two water drums and one is steam drum they are connected like this right. Another type of arrangement is O type arrangement O type arrangement there is steam drum and water drum and steam drum tubes are simply connected with water drum steam. So there are different configurations of steam drum and water drum connectivity in these boiler s in addition to this you can use variety of fuel for this boiler.

For this boilers package type of boilers you can use light diesel oil you will find package boilers working on furnace oil right and different type of fuels can be used for these type of boilers these boilers characteristic of these boilers is they have small combustion space and heat release rate in package type of boiler is quite large efficiency also of these boilers because they are compared boiler.

Efficiency of these boiler is also quite high so I think we have covered a wide number of boilers we have covered fire tube boilers we covered water tube boilers before we start mounting the accessories in the next class I will give you introduction of mounting accessories. So mountings are those devices which is necessary for the operation of the boiler for example safety one if boiler cannot work without safety wall.

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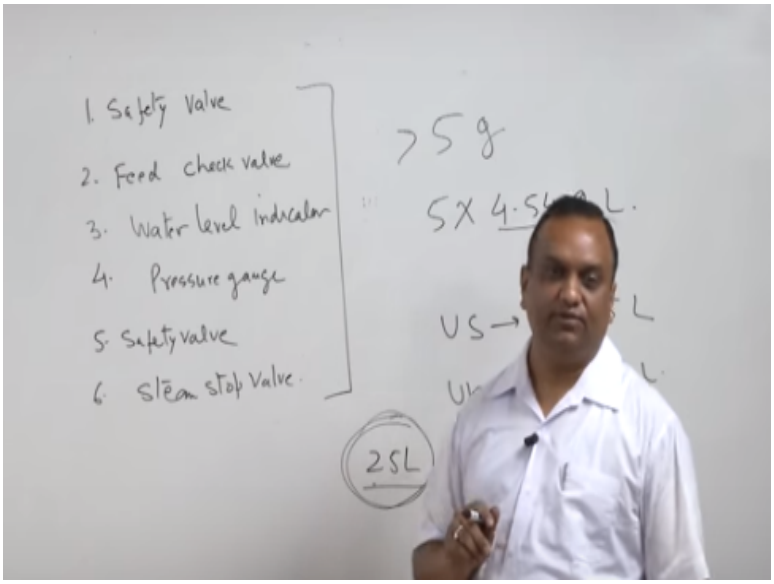

Feed check wall now feed check wall is provided with the inlet of the boiler right it is sort of the non-return wall and in feed check wall the reverse flow of water cannot take place once the water enters the boiler there is no reverse flow. Water level indicator I have discussed earlier also there is a water level indicator there is a pressure gauge they are mountings only and safety wall.

Steam Stop wall where there are certain accessories are provide in the boiler to improve the efficiency of the boiler like economizer air pre heater feed water heaters. So these are the accessories they are other certain accessories also which are necessary or which are required or which can improve the efficiency of the boiler but the mountings without mountings boilers cannot be allowed to operate now in our country there is a IBR act as per IBR any steam generating machine which is having volume more than five gallons.

5 gallons mean 5 into 4.5409 liters one gallon is four this is British gallon there are two types of gallon one is US gallon another is UK gallon or British imperial gallon. US gallon is 3.785 meters and British gallon is 4.5409 liters.

So if you take five this gallons it comes around twenty two point seven so any steam generating equipment's which has volume more than 22.7 liters. Now this limit has been increase to or it is rounded off to 25 liters it is subjected to the inspection stationary body sorry state government bodies regular inspection have to be made before operating this boilers otherwise boiler will not be allowed to operated.

If the volume is less than this and the boiler is operating very high pressure it is not covered under IBR these types of boiler are known as non IBR boilers right. For so for petty application for small applications non IVR boilers are preferred there the volume of the steam inside the boiler is less than 25 liters for a steam supplies.

Suppose there is a pipe line for supplying a steam so if the diameter of the pipe line is more than 10 inches it is again subjected to inspected in the IVR. So is a very I mean is a thick document or a large document and one has to be thorough before operating a new boiler because boilers are covered under IVR and IBR was found in nineteen twenty five because during that time there are number of accidents in boilers because not doing the proper keeping of the boilers.

So due to these accidents there were number of causalities so an act was brought this is Indian boiler regulating act regulatory act and under this act if the boilers are meeting certain requirement they are put under the inspection of stationary bodies. Now in the next class I will start with I will continue with mountings and accessories in the boilers that is all for today.