Power Plant Engineering
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Lecture - 05
Mountings & Accessories – I

I welcome you all in this course on Power Plant Engineering. We have amply discussed in the previous lecture about the steam generators. And now we will discuss about Mounting and Accessories of steam generators.

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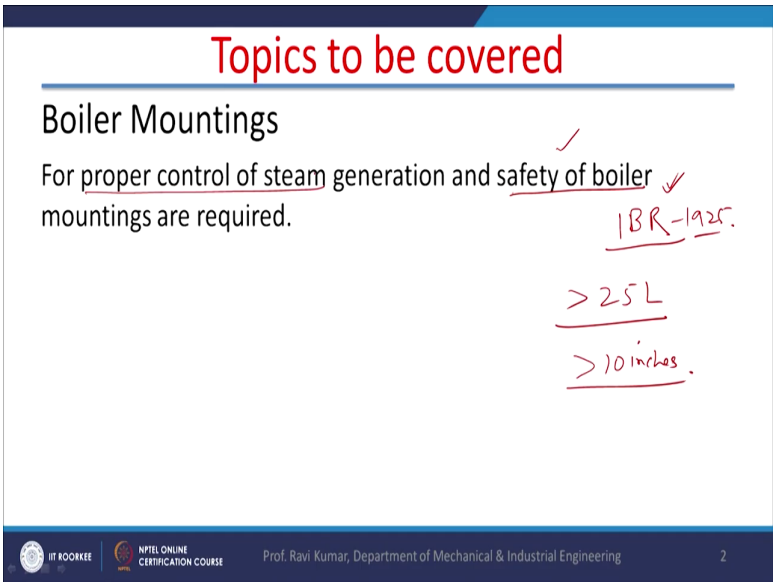

Mountings are important in a steam generator; I will give you an example for example in a car, proper control of a car or monitoring of a car steering is required, brakes are required

without them you cannot run the car right. For carrying the luggage, the carrier is required. So, these are all mountings of the car.

Similarly, in case of the boilers, mountings are required for the proper operation and safety of the boiler because safety of the boiler is very important. And in India we have an act IBR and in it was introduced in 1925 and all the boilers operating beyond a particular range. For example, the volume of the shell is more than 25 liters, it is covered under IBR; if the pressure any pressurized storage of steam is covered under IBR.

Any pipe which has diameter more than 10 inches is covered under IBR and it is tends to be I mean properly inspected before commissioning of the boilers. So, safety of the boiler is important and the same time for proper control of a steam generation mountings are they required in a boiler. So, they are necessary part or integral part of the boiler without them the boiler cannot operate.

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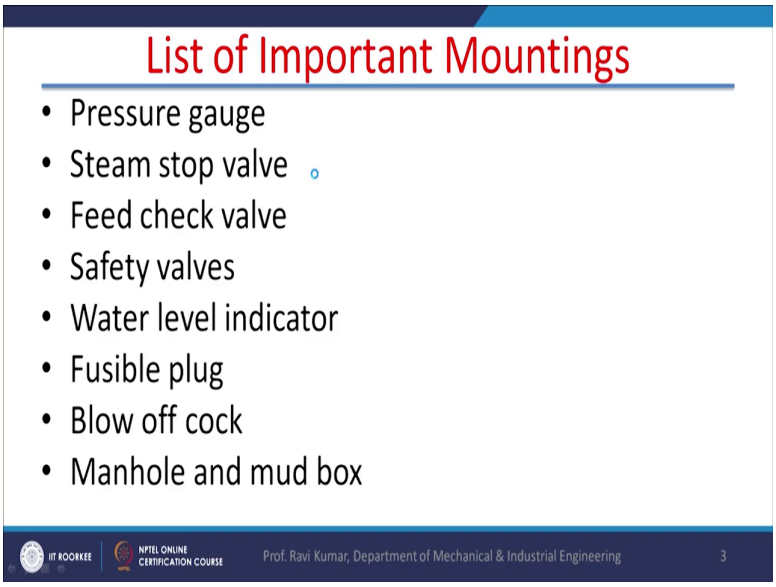

Now, there certain important mountings which are required to be there in a boiler. First is pressure gauge to measure the pressure steam stop valve, feed check valve, safety valves; there are number of safety valves I will discuss them in the during the lecture. Water level indicator fusible plug, blow off cock, manhole and mud box so, we will start with pressure gauge.

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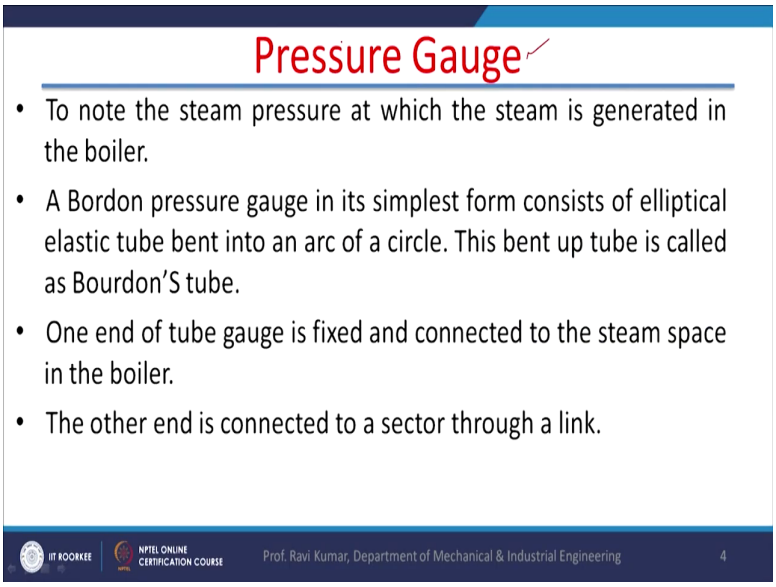

The purpose of the pressure gauge is to measure the pressure and it measures the gauge pressure. Now if we discuss about the pressure gauge pressure is pressure above the atmospheric pressure.

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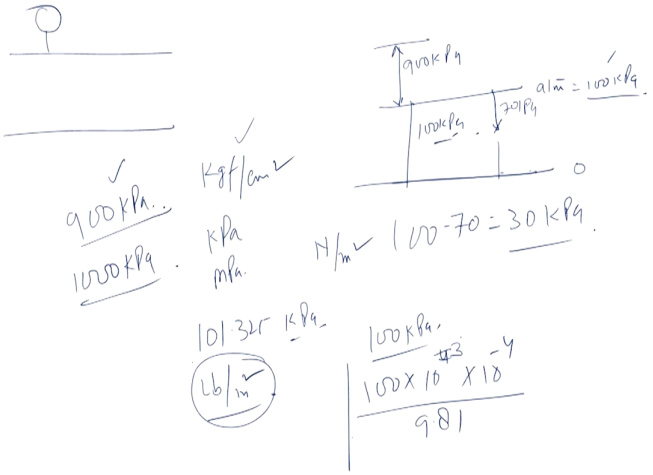

Suppose this is your 0 pressure here it is atmospheric pressure maybe let us say a 100 kilo Pascal it is 101.32 where I am taking 100 kilo Pascal. And the gauge which is mounted on the shell of the boiler, suppose this is a shell of the boiler a pressure gauge is mounted on the shell of the boiler and this pressure gauge measures the pressure above the atmospheric pressure; it does not take the absolute pressure.

Suppose a gauge is you depicting 900 kilo Pascal of pressure and so this pressure has to be added to the atmospheric pressure; this will give the absolute pressure. So, for the purpose of the calculations and design of the boiler this gauge pressure plus atmospheric pressure has to be added in order to find the absolute pressure in the boiler.

Suppose this is 0 pressure line that is pressure under absolute vacuum and gauge pressure is pressure above this atmospheric pressure it is let us say 900 kilo Pascal and this is some

pressure let us say a 100 kilo Pascal right. So, the total pressure absolute pressure in this in the shell is going to be 1000 kilo Pascal.

Now another term is vacuum; a vacuum suppose I say a vacuum of the order of 30 kilo Pascal is maintained in the shell; in a condenser a vacuum is normally n maintained inside the condenser. So, if I say a vacuum of the order of 70 kilo Pascal so, it does not mean the pressure inside the vessel is 70 kilo Pascal vacuum; means pressure below the atmospheric pressure. So, if the vacuum is 70 kilo Pascal, it means the absolute pressure is 100 minus 70 it is going to be 30 kilo Pascal right.

Now the units of the pressure measure it different you will if you go to the industry you will find different units for different pressure gauges. If you go for the old pressure gauges, the pressure is given in kilogram force per centimeter square it is an n gear system which is which we now do not follow we follow as a system in si system with pressure is expressed in terms of kilo Pascal and mega Pascal.

1 Pascal is 1 Newton per meter square right. So, 100 kilo Pascal the atmospheric pressure is 101.325 kilo Pascal ok. Now if divided by 1000 you will get mega Pascal, in some of the pressure gauges you will find that the pressure is given in pounds per square inch right; so, pounds per square inch.

So, for example, in MKS system; suppose we have pressure of 100 kilo Pascal, if we want to convert this into kilogram force per centimeter square or in MKS unit. So, this 100 kilo Pascal first it should be converted into the Pascal sorry into the Pascal so, this has to be 3 this has to be 3 per centimeter square into 10 to power minus 4 divided by 9.81; this will give us pressure in kilogram force per centimeter square.

Similarly, if this pressure is given in pounds per square each right and if you divide this by 14.5 you will get pressure in kilo Pascal's right. So, these are the conversion as a mechanical engineer you should be very comfortable with the conversion from one unit to another unit

because, if you go to the industries you will find pressure gauges; especially, in the boiler or any other industry in different units.

So, you should be comfortable, in conversing converting pressure into from one unit to another unit. Now, regarding the pressure gauges used in the boilers normally they are bourdon tube type of pressure gauges.

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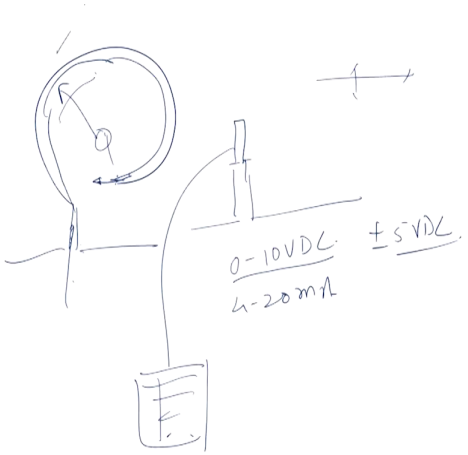

So, bourdon tube is a tube of normally elliptical cross section it is a circular tube, it is making approximately 270 degree angle. And the beauty of this tube is when you pressurize this tube there is only linear expansion, there is no swelling of the tube only there is a change in the length of the tube. And this change in the length of tube through the linkage is displayed through indicator on the dial gauge and they are calibrated right.

So, when this side of the tube is fixed in the shell when the pressure this the tube is pressurized, when the tube is pressurized the extense horizont suppose this horizontal extension of this tubes takes place. And this extension through the linkage is converted into an angular displacement and this angular displacement is shown on the dial and pressure is indicated.

So, it is an integrated without pressure gauge the boiler cannot operate. So, pressure in any case we need to know the pressure inside the vessel if the vessel is heated and it contains certain order of pressure. So, I say engineer we need to know what is the order of the pressure and that order of the pressure is displayed by the pressure gauge.

Nowadays, pressure transducers are also there. So, the function of the pressure transducer is to convert the pressure it there also mounted on the on the valve or through a tube on the boiler. And the pressure transducers they are they convert pressure into the electrical pulse.

The electrical pulse either it is in the range of 0 to 10 volt DC; it is a standard output or 4 to 20 milli amperes and this may be plus minus 5 volt DC also it depends upon the it varies from one manufacturer to another manufacture. And these signals are displayed on a display screen and they are the whole assembly is known as pressure transmitter.

We can have pressure transducers on the boilers, but it displayed type of pressure gauge in normal pressure gauge which I mentioned earlier has to be there on the boiler it is mandatory.

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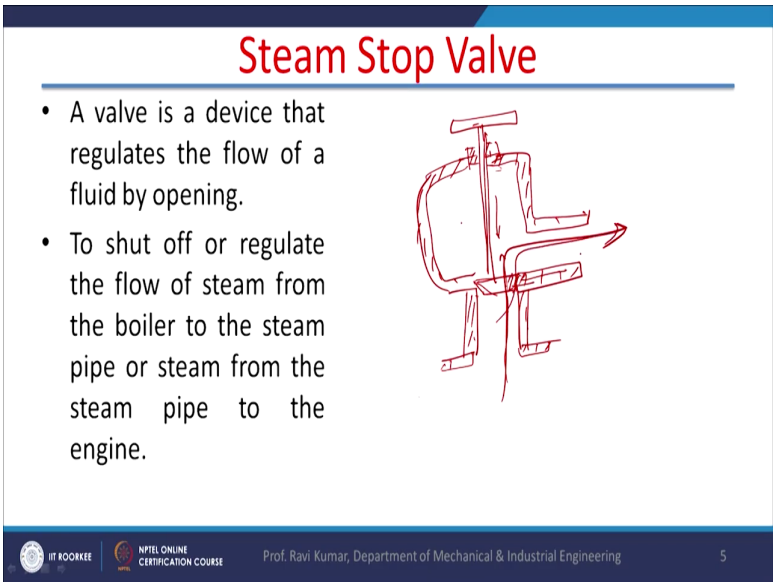

So, this will give us about the information about the pressure inside the boiler and after the pressure gauge there is a very important part or an mounting in a boiler is steam stop valve. The purpose of the steam stop valve is to supply steam; suppose in a boiler the steam is generated, now steam has to be supplied somewhere I mean in to engine or for a particular process steam is to be supplied. So, T steam is supplied through steam stop valve.

So, function of the steam stop valve to supply steam and to regulate the flow of a steam out of the boiler. So, from the steam stop valve it goes to the pipe and it is connected. So, boiler is connected to another device with the help of steam stop valve right. So, steam stop valve it has a casing suppose this is mounted on the boiler shell this is boiler shell and this is steam stop valve there is a valve here, this is we can say is the boundary and this and here there is a spindle. Just I am drawing the schematic and there is a wheel right.

So, when we turn the wheel there stuffing box and all here to in order to prevent the leak leakage of a steam. So, when we turn the wheel here is casing so, when we turn the wheel this valve is lifted; when this valve is lifted, when this valve is lifted the flow of steam takes place through T steam its just a simple a control device right.

And if we want to close the supply of the steam, we will simply turn the wheel we will turn the wheel the spindle will move in this direction and this valve will sit on the seat and the flow of a steam will be stopped. So, that is why it is called a steam stop valve. So, we can monitor the flow of the steam, at the same time we can stop the flow; because always the steam is not required; I mean initially stages of the boiler when we start the boiler initially supply of a steam is not required it takes some time right.

So, at that time the valve is closed and whenever the steam is required, this wheel is turned and the steam flows from because this valve is lifted from the seat and the steam flows through this to the supply point.

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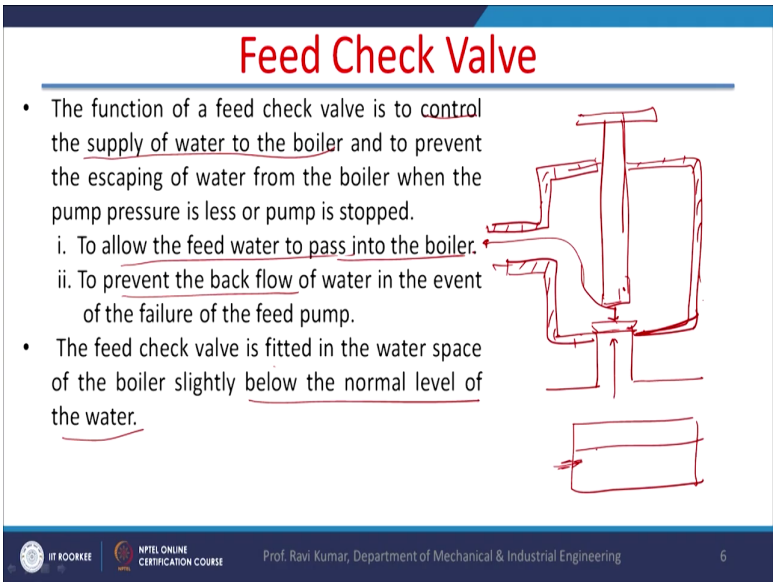

And after this there is another valve which is very important it is a feed check valve; now feed check valve if you look at the Carnot cycle.

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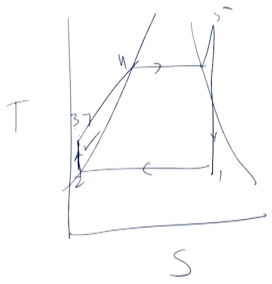

If you look at the Carnot cycle, not Carnot cycle, Rankine cycle we will let us say have some superheat also this process let us say 1, 2, 3, 4, 5. So, process 2 to 3 it is a vertical line. So, it is isentropic compression of the flute and this takes place inside the inside a pump.

Now, this pressurized fluid has to go to the boiler right. Sometimes it happens that pump does the pressure at the outlet of the pump is less than the pressure in the boiler, this may happen during the operation. So, in that case steam should not back flow to the pump. So, this arrangement is made in a feed check valve, in this valve there is a I mean it is also mounted on the boiler.

And in this boiler there is a disk, which is placed over the opening and here is the restriction and rest of the spindle is there and rest of the assembly is same. And there is let us close for it from this side and this side there is a outlet of a steam which is an outlet of a steam. So, steam

pushes this disc this disc is lifted right and sorry steam not a steam water pressurized water pressurized water, pushes this is disc and this disc is lifted and steam is sorry the pressurized water supplied to the boiler.

Suppose in case the pressure inside the boiler is higher than the pressure generated by the pump right, in that case the pressure is waiter will pressurize this disc and the disc will be closed. So, reverse flow is not possible. And the quantity of water is again controlled by this spindle; if you increase the gap between these two the more of the water of pressurize water flow into the boiler.

And the feed check valve is it just pleased before the just below the water level, it is placed just before below the water suppose there is a shell water level is up to here. So, feed check valve will be placed somewhere here to supply water in the boiler. So, it controls the supply of water to the boiler pass into the boiler to allow feed water to pass into the boiler and it prevents the backflow.

And it is fitted in the water space of the boiler slightly below the normal level of the water as I explained earlier. It is fixed slightly below the water level in the boiler.

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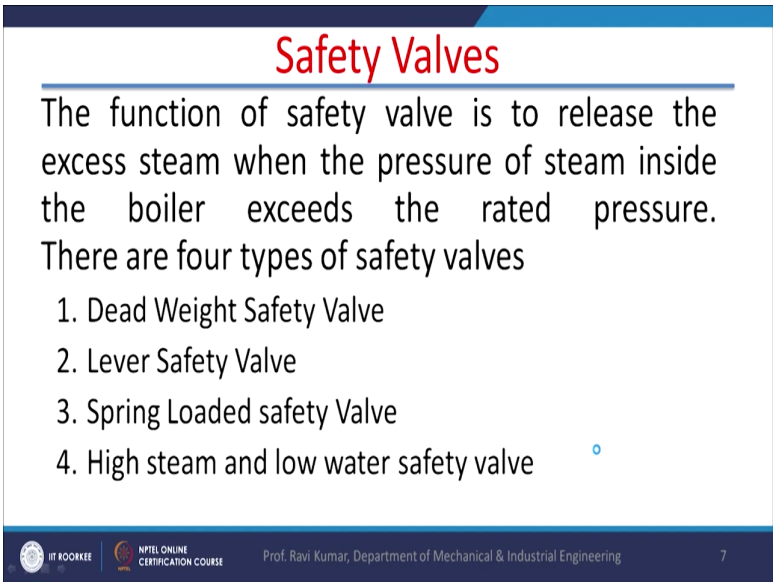

Now, safety valves safety valves are important and as per IBR every boiler should have at least 2 safety valves more are welcome, but at least 2 safety valves have to be there in a boiler they may be of the same kind and they may be of the different kind. And the purpose of safety valve as I as it is clear from the name itself to provide safety for the operation of the boiler.

So, suppose the we fix boiler pressure as let us say 50 bar so and safety bar is the safety valve is suppose safety valve will adjusted at 50 bar. So, if the pressure exceeds 50 bar, the steam will be vented off so, that pressure inside the boiler is reduced. A very good example of the safety valve you can see in the pressure cooker in day today's life. A pressure cooker has a valve when pressure exceeds certain value that is a 2 approximately 2 bar pressure 2 bar gauge pressure.

Then the deadweight it is a deadweight safety valve it is the first one the deadweight safety valve. So, safety valve is lifted and the steam is vented off. So, we will discuss these valves one by one we will start with the deadweight safety valve.

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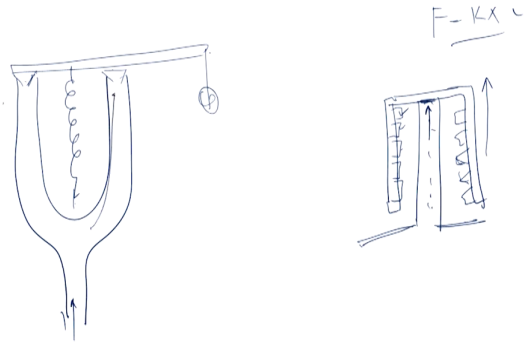

So, deadweight safety valve is very simple, suppose there is a supply of a steam and it is connected it is also mounted on the boiler shell. So, this side is filled with the steam and we have a cap right and this gap closes this opening and cap has certain weight. In actual boiler this weight can be altered, to control the range of the operating pressure of the dead weight safety valve. Suppose I want to have 80 bar I will add more weights I want to reduce the critic limiting pressure to 20 bar I will remove some of the weights.

So, this arrangement is there and it is this dead weight top type of thing it caps the opening, then it is pressurized and there is a I mean these two forces balance each other; I mean the

weight of this cap which includes the weight of these weights variable weights and this casting and it is balanced by the pressure of the steam.

So, when the pressure of the steam exceeds, this cap is lifted and the steam is vented off right. But there are certain disadvantage of this type of deadweight type of safety valves. Suppose if there are a lot of vibrations in the boiler; suppose there is a locomotive boiler if you are putting it in the locomotive boiler it may not work properly.

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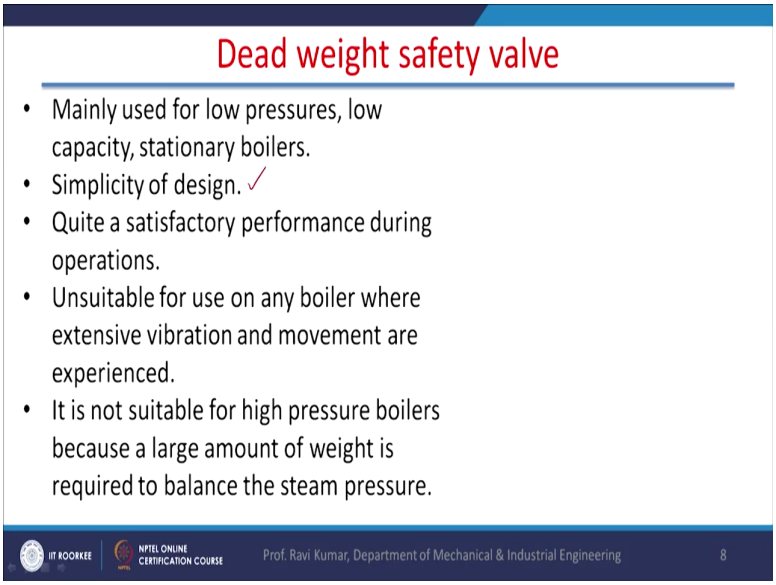

So, there are certain disadvantages also, it is a simply design and it is mainly used for low capacity low pressure boilers because if you go for the high pressure boilers more weights have to be put. So, it will become bulky and unmanageable. So, these type of safety valves are not used for high pressure boilers they are used only used for the low pressure boilers; they

are not used for the boilers were vibrations are taking place they are not used for the mobile boiler.

So, there are certain restrictions, but in number of the valve I they are very reliable I mean deadweight safety valves are very reliable they will always operate right; because they are operating on it passive technique. So, passive systems are more reliable systems. So, this is a very simple in construction, but at the same time there are certain limitations to operate this safety this safety valve.

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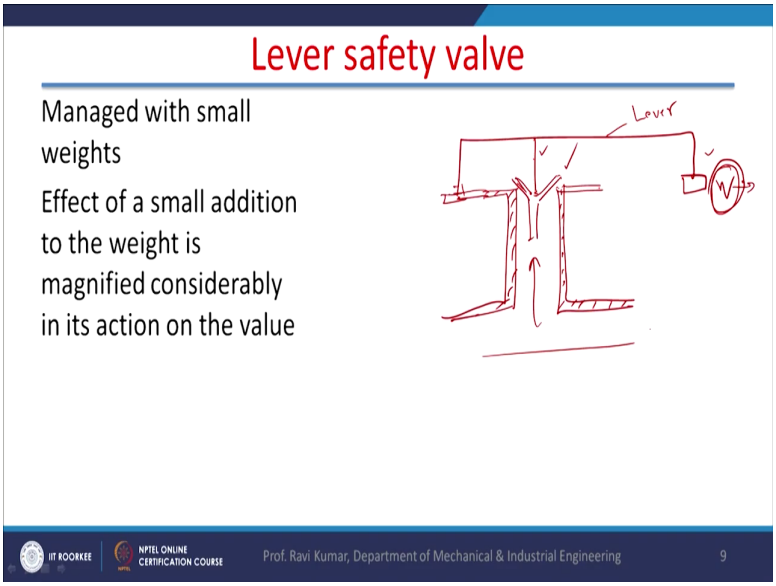

Now, another safety valve is lever safety valve. So, lever safety valve is almost like deadweight safety valve, it is suppose this is mounted on the boiler shell right and there is a lever. So, lever is and here are the weights and this lever this is a lever arm this is a lever and

this is weight w. Here it is hinged lever is hinged and its the same thing when they steam pressurizes this because now we have momentum right.

So, we can go for the smaller weights, we do not have to put large weights that is the benefit of this, but at the same time slightly slight change in weight will also change the critical pressure. I mean there is a certain advantages and there are certain disadvantages also and this type of safety valve also cannot be used for hybrid. Simply here put instead of putting weight at this position weights are put at this position and there is a lever it is hinged here right.

So, when we so here we require less mass of the weights and in the same time slight change in the mass of the weight will change the operating pressure. So, these type of valves are also not recommended for the applications where their vibrations or there is a high pressure. So, these type of safety valves are limited for low pressure boilers and static boilers where there no operation when there where there is no movement.

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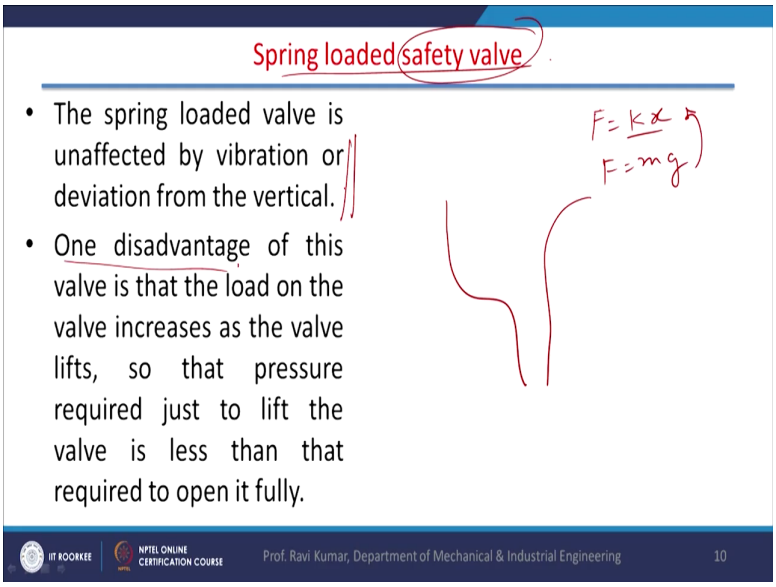

Now, this is a very popular safety valve spring loaded safety valve. So, here the action of spring is used for controlling the not controlling the flow of steam for the safety purpose. And you know that in spring F is equal to kx; if you are using weights then F is equal to mg. So, mg is replaced by kx.

So, in spring suppose there is a two arm if you take two arm spring loaded safety valve. Suppose there is a two arm spring loaded safety valve this side is connected to the boiler right in the middle there is a spring right and these openings are controlled with the help of a arm which is connected with this spring and here are some weights ok.

So, this spring will control because F is equal to kx right it is pre stress; pre stress spring or pre stretch stress not a stress stretched spring. So, when the steam is the steam pressure exceeds certain value, only then this valve will be lifted and the steam will be vented off. So,

this type of valve can be applied for the applications where there is their vibrations and their movement in the boiler, but the problem in this arrangement is when the spring is stretched the force will increase right.

So, there is a slightly I mean there is a drawback slight drawback of this valve, but is still this valve is its quite reliable and it is used many of the applications including boilers. I mean, in other applications also this valve is used and especially in the boilers this is a very favorite or the popular safety device. So, this is the one disadvantage of this boiler. But it is same time it is affected by unaffected by the vibrations and deviations from the vertical.

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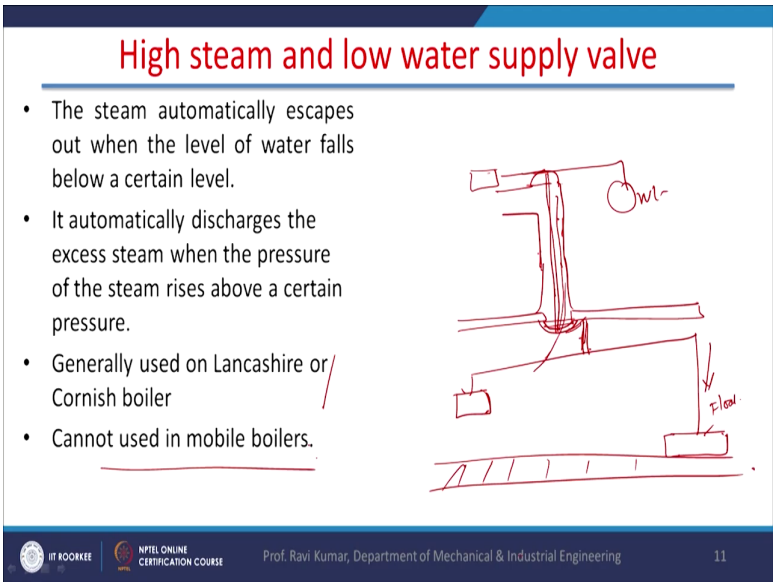

After a spring loaded valve there is a another valve which is known as high steam and low water supply valve; now this valve become operative when the water level is low. So, far we

have discussed about the safety valve we are concerned about the steam pressure. If pressure is high, the valve will went of the steam that is the basic function of the safety valve.

But in this particular safety valve, which is known as high steam and low water supply valve. In this valve if the pressure is high of course, it will went out the steam and give some water zone. And if the water supply is low that also shall be indicated by this type of valve. And suppose there is a this is the shell of the boiler right and this shell is covered by this NAND here it is not hinged.

So, there is a arm which is hind here hinged here not at this place and it consists of this side. There is a lever weight this is a lever and if weight is hanging on the lever on the one arm of the lever; another arm of the lever is having float this is float and this is boiler and this is let us say water level in the boiler right.

On this side arrangements are normal; I mean and there is an exit and there is a lever again there is a weight and the lever and there is a counterweight on this lever it is balanced from both sides there is a weight it is a counterweight and it is connected through stylus to this now what happens. Suppose the pressure is high, the pressure is high here the disc will be lifted disc will be lifted and steam will be vented off now on the other side this is connected to this.

So, if the pressure is high steam will be lifted and this will be lifted and steam will be vented off. Suppose on the other side if the water level is low, if the water level is low the float will come down it is hinged here right. So, what will happen there connected. So, this will also open this valve. So, valve is opened by two ways, either by high pressure or by the low level of the water; in that case also venting of a steam. So, steam will come out of this, but this sound will be different from the previous zone this arrangement is made in the boiler.

So, a operator can easily understand, whether the sound is due to high pressure or sound is due to low level of water. So, this type of mounting you will find usually in the Lancashire boiler or the Cornish boiler still it cannot be used in a mobile type of boiler. Another mounting is water level indicator; now water level indicator the function of the water level

indicator to show the level of the water inside the shell; because in a boiler the boiler shell is opaque right.

So, and as an operator we should know what is the level of water in the boiler for valve I have. We have already discussed that is previous one this one high steam and low water supply boiler valve. But this is a valve it will only indicate when the supply is very low, but we need to maintain certain level of water inside the shell.

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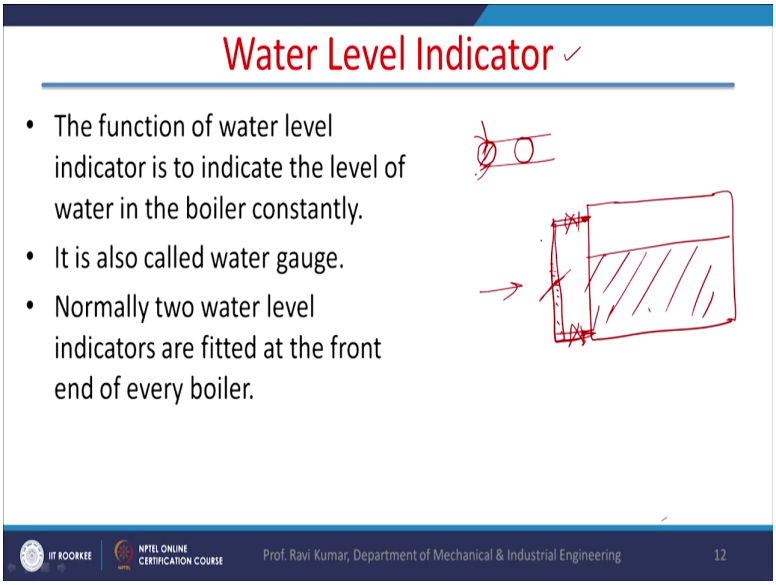

So, for this purpose if water level indicator is required and it is a very simple device, it is in a tube transparent tube which is connected suppose this is a boiler shell. And in the boiler shell the water is filled up to this level. So, a transparent tube is fixed two openings are made and the one is at the top at the bottom and a transparent tube is fixed right; from these two

openings at these two openings at the top at the bottom connecting these two openings top at the bottom.

And this tube will also indicate because fluid rely to control the level in both the spaces. So, here it will be filled it will be shown to be filled up to here. So, operator can see what is the level of water in the boiler and the boiler must have two water level indicator not one water level indicator it is mandatory to have two water level indicator in the boiler.

And the now the issue is suppose this tube breaks if this tube breaks entire steam will come out. So, this has to be prevented. So, first of all valves are provided on these arms. So, we need not I mean monitor constantly monitor the level of the water whenever we want to see the water will just simply open the valves and see the level of the water it can remain open also right.

So, normally what people do they closed these two valves and operate the water those who are experienced operators after certain time interval they will open the valves and see the water level water level in the boiler. If it is constantly opened right, if breakage takes place the steam will come out right. So, in order to prevent that a very simple arrangement is made the iron balls are filled a an iron ball is put into the tube right.

So, when there is a breakage, steam will like to steam will push this iron ball and it will block it block the passage iron ball will come here it to block the passage and the steam will not come out. And meanwhile operator will get sufficient time to close the valve. Normally, when you are seeing the water level in the shell, the differential pressure is not very high.

So, valve will not close the opening but when the breakage takes place here inside suppose inside pressure is 100 kilo Pascal or sorry 50 bar or 60 bar with very high velocity steam will try to rush out of the boiler and that will push this ball to this opening here if there is an opening and it will here there is an opening; it will close the opening and steam will not come out meanwhile the operator will get a chance to close the valves and stop the flow of the steam.

So, that is all for today. In the next class we will continue with the mountings and we will discuss some more accessories of the boilers.

Thank you very much.