Chemical Process Utilities
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Lecture - 27
Steam Traps, Centralization, and Fuel Selection

Welcome to the lecture on steam accessories under the head of chemical process utilities. We have covered how we are generating the steam, different aspects of boilers, aspects of other assets, mountings accessories, etc. related to the boiler. We discussed the attemperator steam drums part of steam drums.

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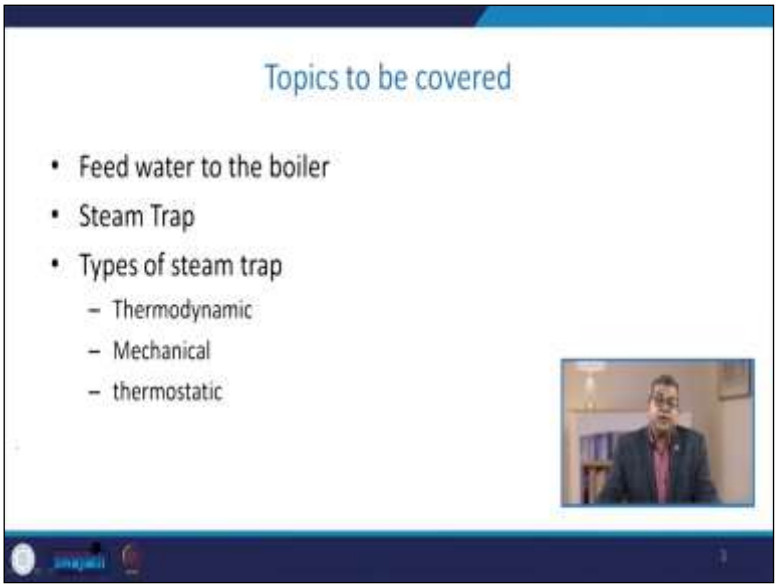

In the previous lecture, we discussed the feed water quality feed water supply of the boiler. This chapter will discuss the remaining part of this feed water supply or quality or the importance of feed water to the boiler. We will discuss the steam traps, especially regarding the different types attributed to the thermodynamic steam trap mechanical thermostatic steam traps.

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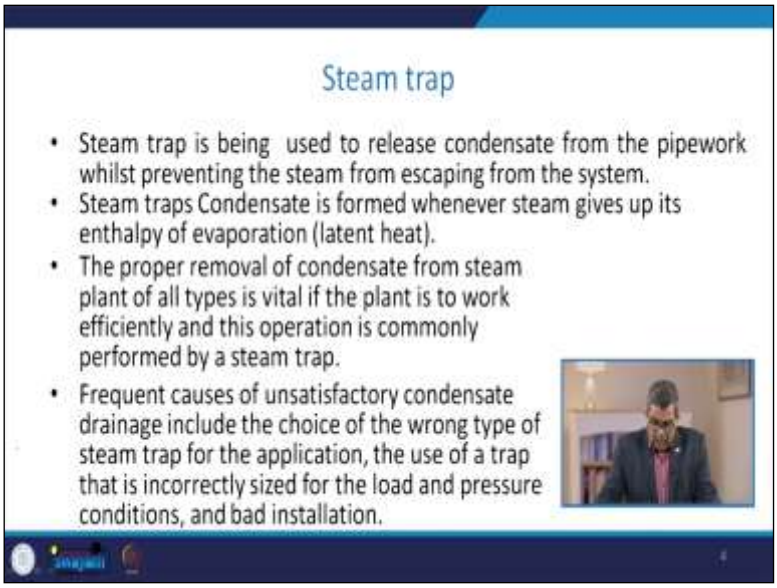

The steam traps are being used to release the condensate from the pipework while preventing the steam from escaping into the system. Steam trap condensate usually, when the condensate is formed, the steam gives up its enthalpy of evaporation called the latent heat. The proper condensate removal from the steam plant of all types is vital. If we; need to work the plant efficiently and the steam trap commonly performs this operation.

Frequent causes of unsatisfactory condensate drainage include the wrong type of steam trap for the application. The use of a trap, a steam trap that is the incorrect size of the load and pressure condition and the; bad installation, so we had discussed a lot about the steam traps then the question arises what a stream trap is. So, the steam trap is an automatic valve capable of distinguishing between the condensate and the live stream. So, separation is extremely essential.

So, the difference between condensate and steam is usually sensed in several ways. One way suggests that the string trap detects the difference with respect to the density. Another says that react to the difference with respect to the temperature, and the third is relying upon the difference in the flow characteristics. What must steam trap do? This is again a very vital question.

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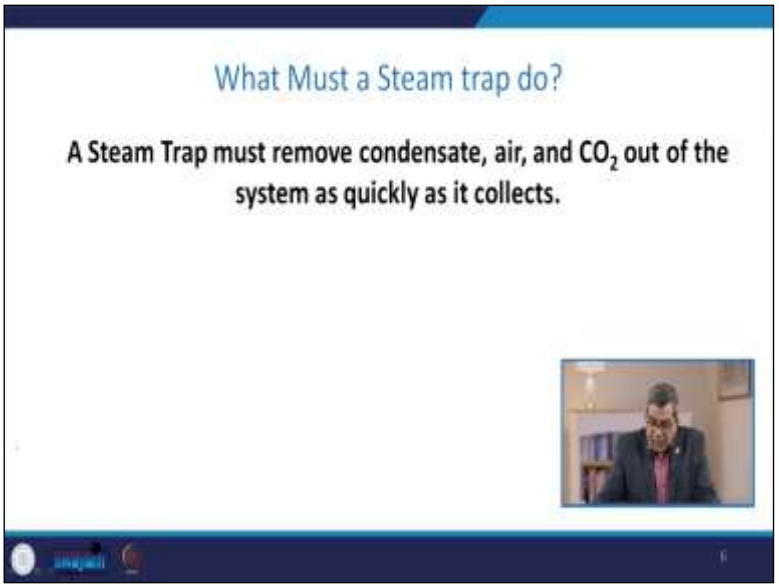

The steam trap must remove condensate air or any kind of co to interrupt from the system as quickly as it collects. There should be no term, and theoretically, there should not be any retention time.

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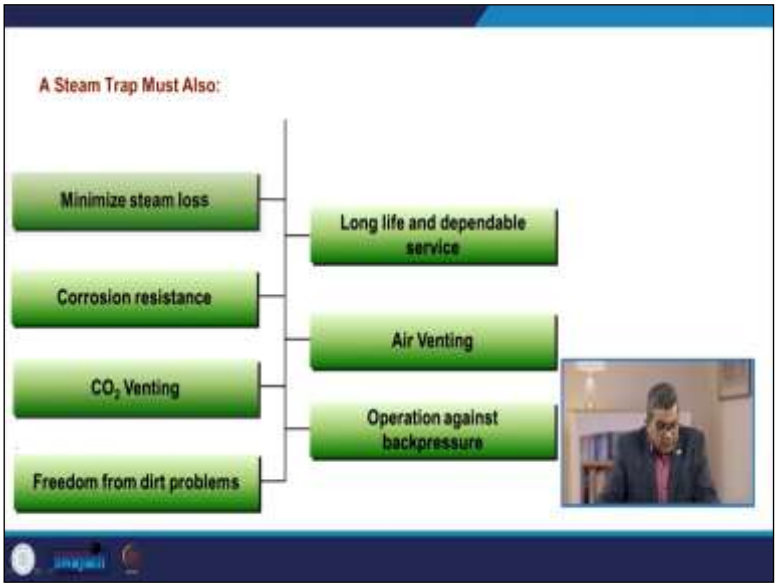

So, a steam trap must also minimize steam loss, which is again very important. It must be corrosion resistant, impart carbon dioxide venting, and impart freedom from dirt problems. All these things are essential for the long life and dependable service of the boiler steam piping network etc. Apart from this, the steam trap must also provide air venting. It must provide operation against the backpressure.

Usually, backpressure may occur because there may be a slight change in the pressure when the condensate forms. So, a back pressure may occur.

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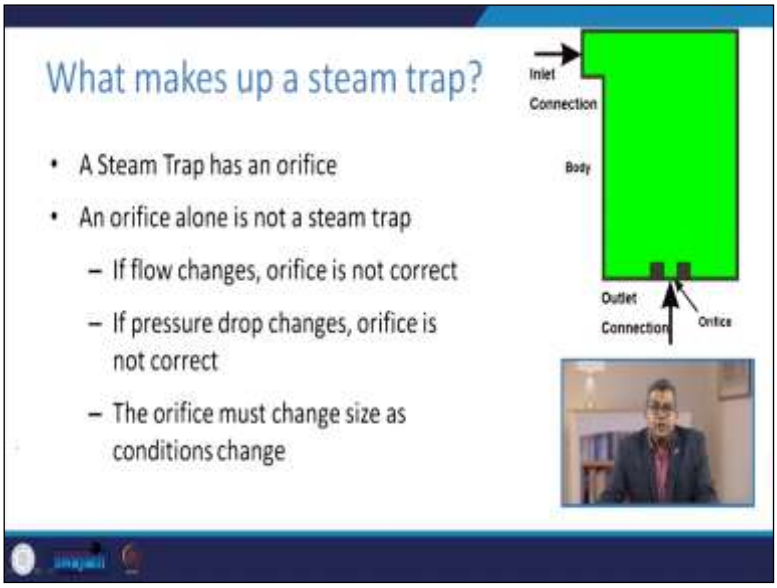

The question is, again, what makes up a steam trap. Usually, a steam trap has an orifice you can see over here, and an orifice alone is not a steam trap. If flow changes orifice is not correct if pressure drop changes or if it is not correct, if the orifice must change size as conditions changes, that is the thing. Here you can see the inlet connection, body, and outlet connection. All these are some of the rough diagrams of the steam trap.

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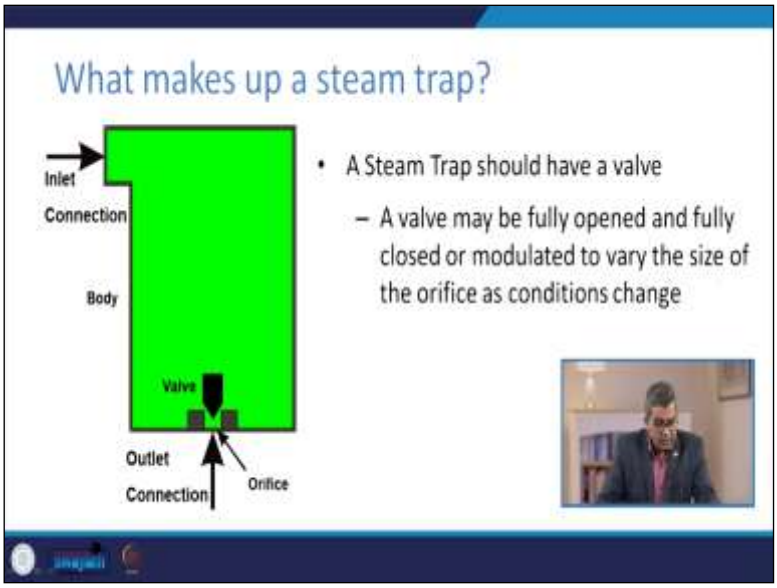

A steam trap should have a valve. A wall may be fully opened or fully closed, or modulated to vary the size of the orifice as per the condition changes. Here you see that this is the valve, and it changes as per the prevailing conditions. a stream trap should have an operator. This operator usually senses when to move the wall and supplies the power to move the wall. Traps are different in the type of wall and types of operator use.

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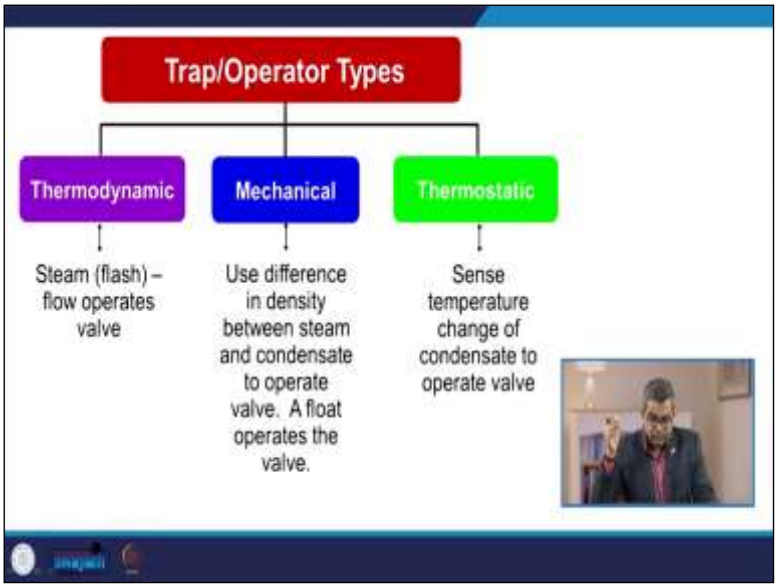

Let us talk about the different types of traps operator. Usually, when we discuss steam traps are always attributed to the different types of operators. One operator is the thermodynamic type. It is a steam (flashes) based operator where the flow operates the valves. Other one is the mechanical

type, which uses the difference in the density between the steam and condensate to operate the wall and float. The last one is the thermostatic type, which senses the condensate's temperature change to operate the valve.

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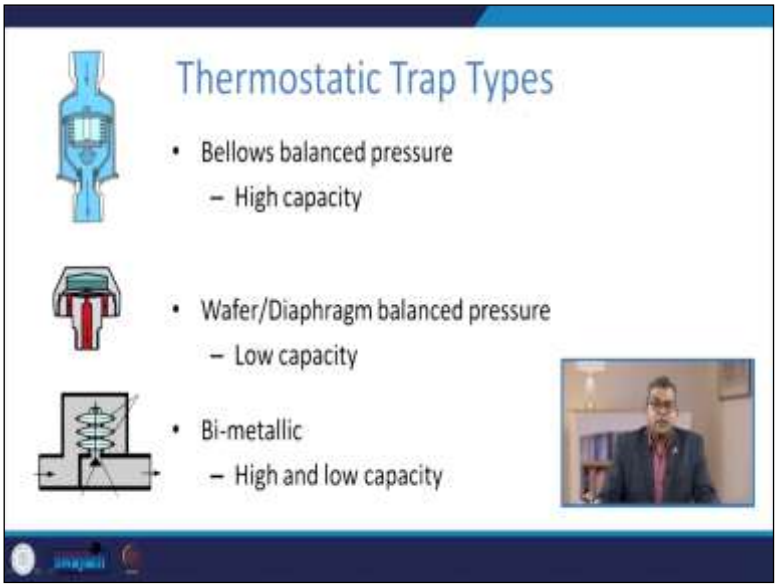

So, the thermostatic trap system is foremost when we talk about the different types of traps. Here this is again a different type of trap like bellows balance pressure are having a very high capacity like this then wafer diaphragm balanced pressure slightly lower capacity. Here you see that there are certain bimetallic types of thermostatic traps with high and low capacity in the wafer and the diaphragm. So, these are the biometrics we will discuss in due course of time.

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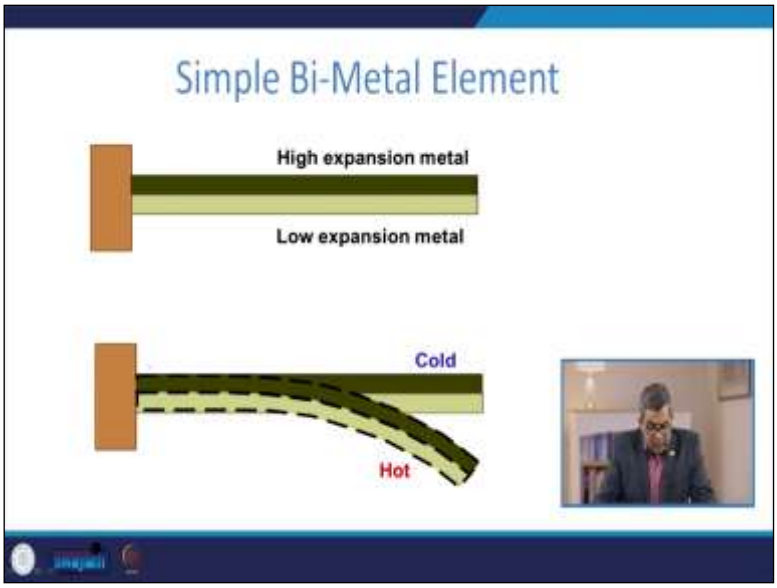

When we talk about this simple bi-metal element, two metals with different expansion aspects are infused together. Here you see that this is the high metal, the high expansion metal, and here the other infused metal is the low expansion metal. So, when any temperature change occurs, there may be slight deformation in these rods or in these operators, which can reduce the flow or change or alter the flow, and the steam trap works.

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You can see this is a more pictorial thing. Here you see that when this metal deforms, it usually closes this wall. So, it restricts the passage of either steam or water. Usually, this valve is operated through this bimetallic strip. Usually, the wall inside trap pressure holds the valve closed—this

wall toggles. Backpressure can blow trap open opening and closing temperature wide apart and must subcool deeply to prevent the steam loss. So, all these are the essential parameters for this one.

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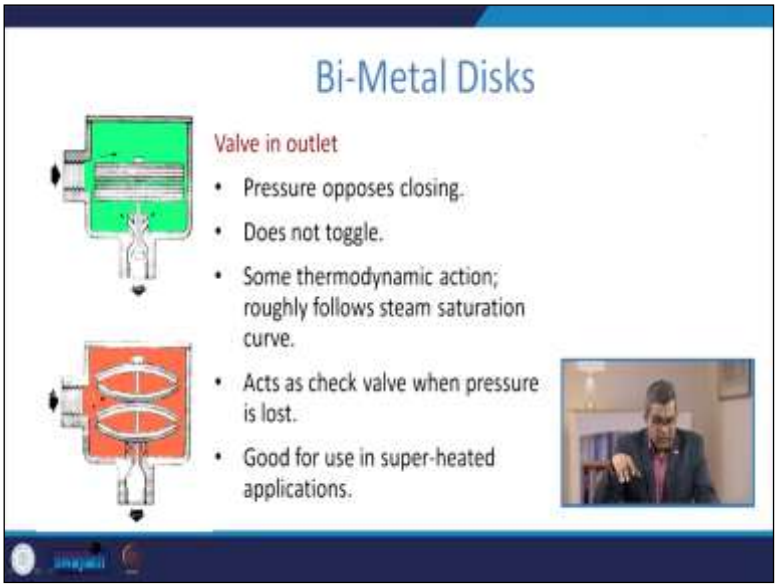

You see that there are certain bi-metal disks which used to operate here you see that these are the bimetal disc and are attributed and if a condition prevails can either form deform to this way by this way allow the passage of steam or water. So, usually, pressure opposes closing, does not toggle, some thermodynamic action roughly follows the steam saturation curve, sometimes acts as a check valve when pressure is lost and is very good for superheated application.

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Other types of steam traps are disc and seat types of systems. Here you see that this is the disc that is usually seated over here. This is the two-seat seat to seal, and this is the flat wall and seats required near perfect to the flatness of seal. So, this is the usual condition, and if any kind of deformation occurs, this may open, and the water or steam whatever can come out.

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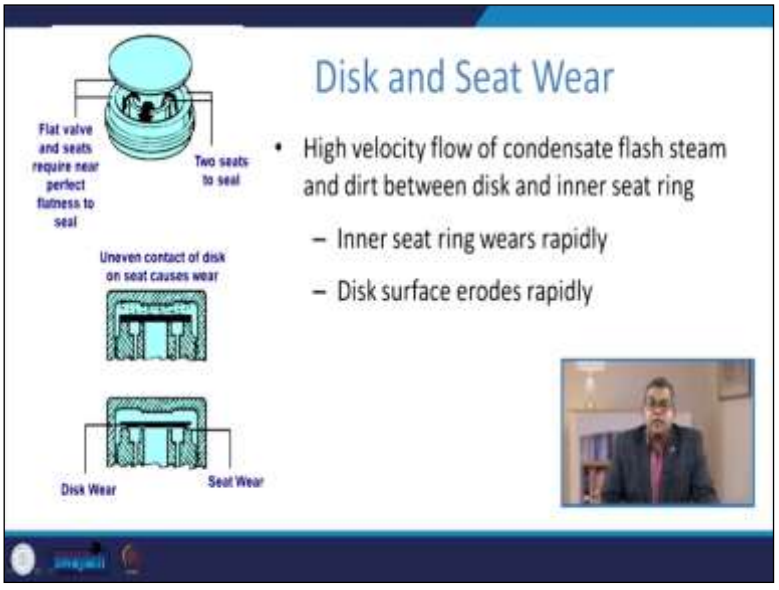

High velocity the flow of condensate to flash stream and dirt between the disc and inner seat rings sometimes it can create a problem and this inner seat this one inner seat ring wears rapidly, and disc surface erodes rapidly.

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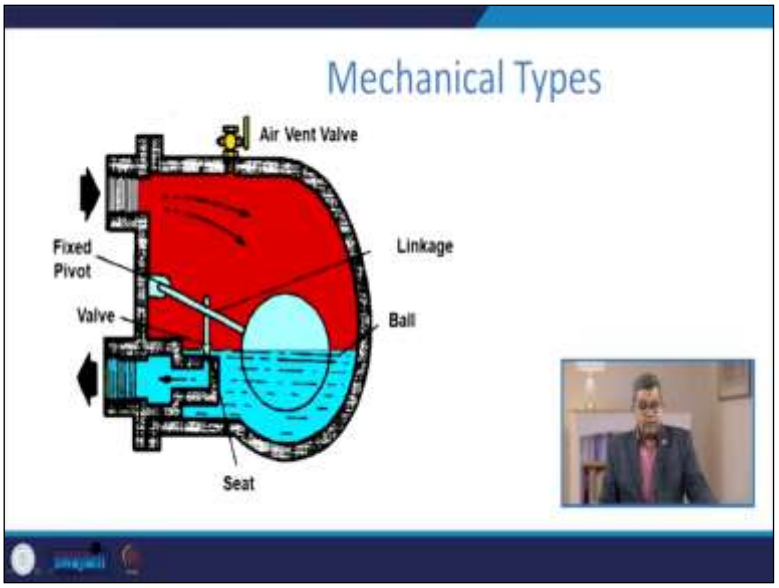

There are certain mechanical traps here you see that this is a float ball or float valve. It is closely linked with the fixed pivot, and it is attributed to the valve, and this is the air vent wall. So, if this particular, I mean the level of water goes up in the in this steam trap, then automatically this wall opens to facilitate the drainage of condensate water and to facilitate the steam entrapment.

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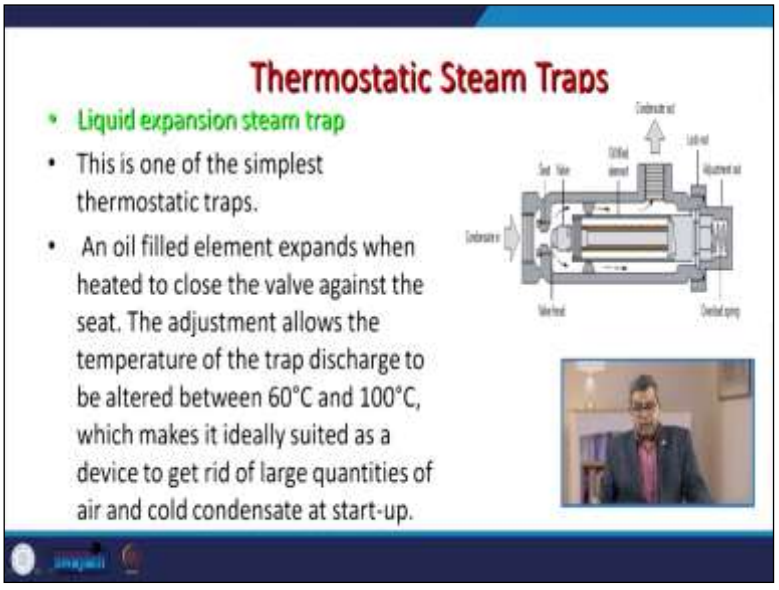

There are some thermostatic steam traps in which the liquid expansion steam trap usually is one of the simplest forms of the thermostatic trap. An oil-filled element usually expands when heated to close the wall against the seed. The adjustment allows the temperature of the trap discharge to

be altered, say between 60 to 100 degrees Celsius, which makes it ideally suited as a device to get rid of large quantities of air and cold condensate at a startup.

You see that this is the seat, and it is fitted with this wall, and this is the valve head, and here this particular thing is filled with oil, and we may have some adjustment nut through which we can adjust the desired parameters. So, if a condensate usually is so, the expansion or contraction may occur in this way, it can regulate the condensate recovery or condensate outlet within the steam system.

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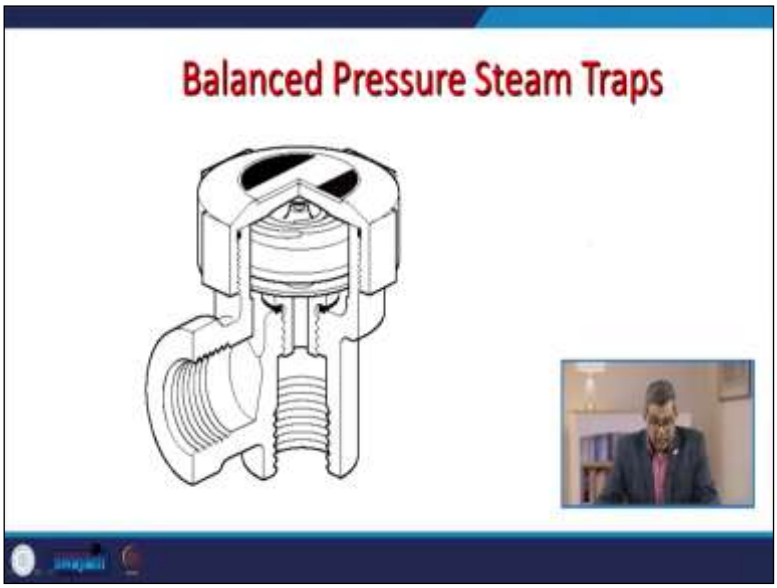

This is the balanced pressure steam trap here, and some weighted discs are there if there is a change in density. So, it may open or close just to facilitate the passage of condensate.

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Again, you see that the labyrinth type of steam trap is very common and very useful. Here these discs are attached in a graduating reducing manner, and this is the crown wheel through which you can adjust the length of these discs; and by this way, this not only imparts a hindrance to the passage. So, any kind of esteem may get condensed over time, which can allow the safe passage for the condensate out.

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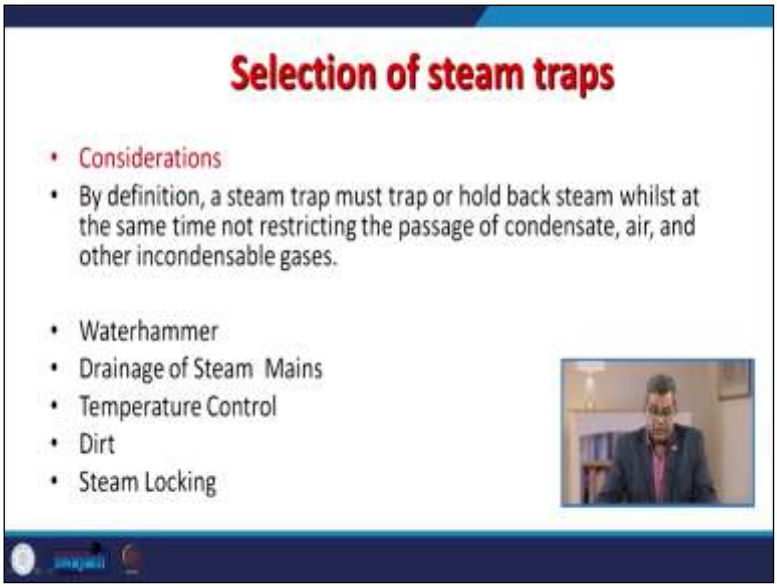

We discussed a lot of different types of steam traps. The question arises of how we can go for a proper steam trap. This is one of the fundamental questions. So, while selecting the proper steam trap, there must be certain considerations, and by definition, a steam trap must trap or hold back

steam while the same at the same time it should not restrict the passage of condensate, air, or other incondensable gases like CO_2 etc.

It should overcome the problem of water hammering. We will discuss this thing later on. It should provide the proper drainage to the steam mean it should provide the proper control, remove the dirt, and prevent the steam from locking.

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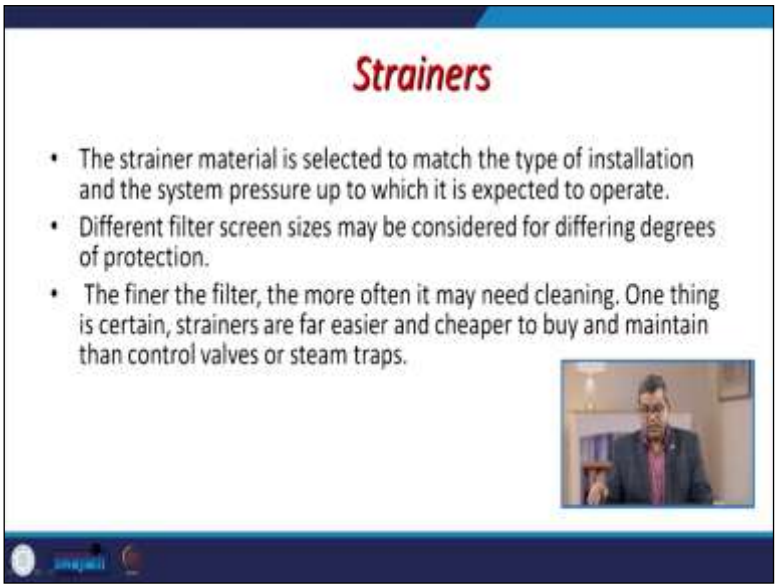

So, all these things are quite essential for the steam trap. Let us talk about strainers. The strainer material is selected to match the type of installation and the system pressure up to which it is expected to operate. We have discussed that what is the role of the strainer. Different types of filter screen sizes may be considered for different degrees of protection. The reason for the strainer is that sometimes during the passage of steam, there may be certain debris certain dirt dust may entrap within the steam line.

The role of the strainer is to entrap all those dirt, debris etc., to provide the finest purity of steam with respect to the particles. So, the finer the filter, the more often it may need to clean. This is one of the major disadvantages. So, one thing is certain: strainers are far easier and cheaper to buy and maintain the control valve or steam traps.

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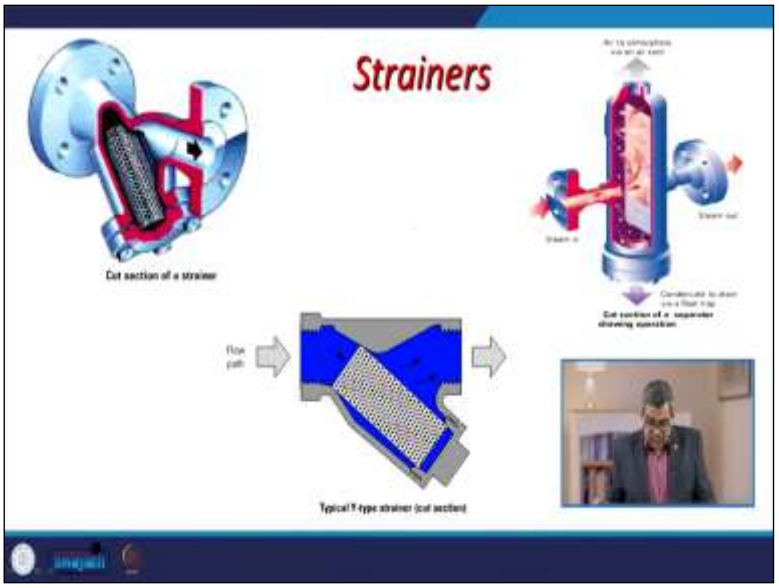

These are some of the examples of the strainers cut section of the strainer. Here it is a more pictorial view here, the steam is coming inside, and it strikes the plate that is the perforated plate, and because of the striking, some of the steam may get condensed. So, you can remove the system, and the purest form, purified, or restrained form of steam is coming out. This is the inner anatomy of the strainer. This is a flow path you can see that this is the strainer.

So, any kind of debris, dirt, etc., can be removed here, and steam may, or steam or condensate may go out. This is again the cut section of the strainer.

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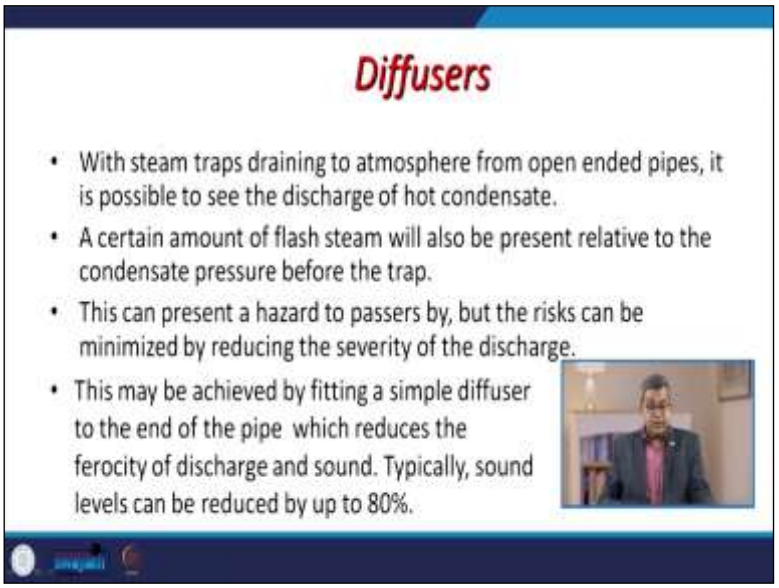

Apart from these accessories, there are certain diffusers are being used in the steam line or steam traps. With the steam trap draining into the atmosphere from an open-ended pipe, it is possible to see the discharge of hot condensate. A certain amount of flash steam will also be present relative to the condensate pressure before the trap. This can present a hazard to a passerby, but the risk can be minimized by reducing the severity of the discharge.

Sometimes this may be achieved by fitting a simple diffuser to the end of the pipe, which reduces the ferocity of discharge and sound, and typically sound level can be reduced by up to, say, 80%.

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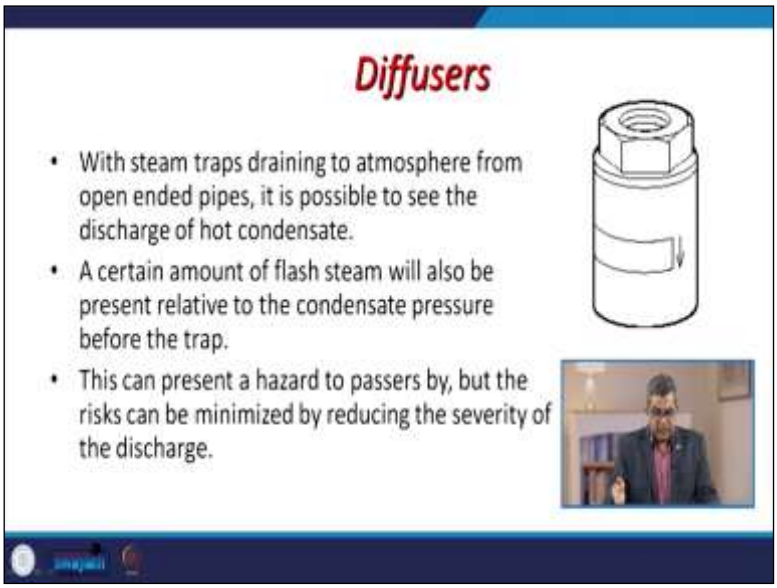

This is the typical diffuser. With the steam trap draining into the atmosphere from an open-ended pipe, it is possible to see the discharge of hot condensate. A certain amount of flash steam will also be present relative to the condensate pressure before the trap. This can be this can present a hazard to the passerby, but the risk can be minimized by reducing the severity of the discharge.

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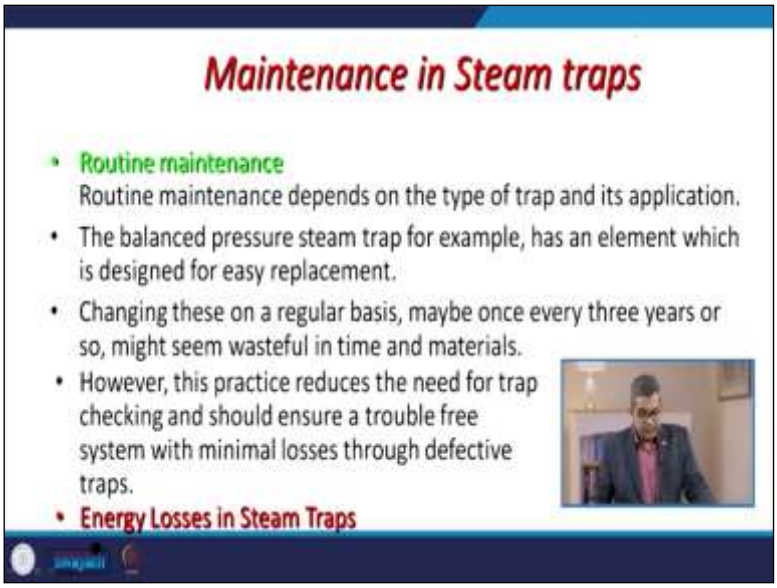

We discussed a lot with the steam traps then, obviously because they are an integral part of the steam piping or distribution network and require continuous maintenance. So, there are a couple of aspects attributed to the maintenance of steam traps; one is routine maintenance. The routine maintenance depends on the type of the trap and its application. Like balanced pressure stream trap, for example, has an element designed for easy replacement. Changing these regularly maybe once every three years or so, might seem wasteful in time and material.

However, this practice reduces the need for trap chain checking and should ensure a trouble-free system with minimum losses through defective traps. Apart from this, significant energy loss is attributed to these stream traps.

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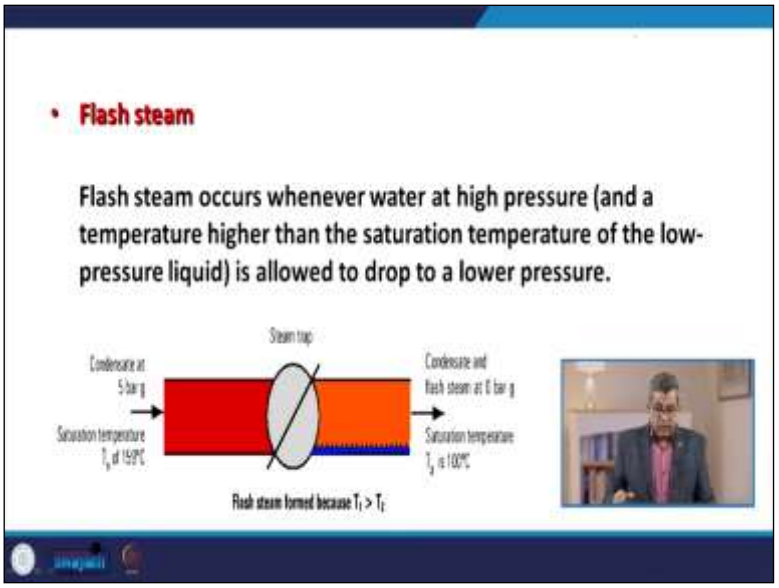

To overcome these losses, there is a flash steam concept. This flash steam occurs whenever water at high pressure and a temperature higher than the saturation temperature of the low-pressure liquid is allowed to drop to lower pressure. Here you see that condensate at 5 bar, and saturation temperature says 159 degree Celsius it is relatively higher, which is the steam trap. So, flashing occurs, and the condensate and the flash stream at 0 bar come out with a saturation temperature of 100 degrees Celsius. So, the flash stream is steam formed because this t 1 is greater than t 2.

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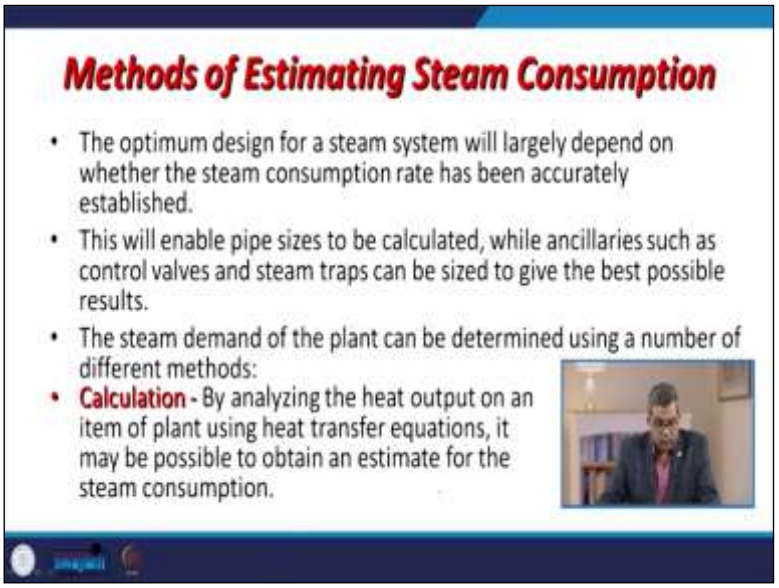

Another important point in the steam generation unit is estimating steam consumption. The optimum design for a steam system largely depends on whether the steam consumption rate has

been accurately established. So this will enable pipe size to be calculated while ancillaries like control valves or steam traps can be sized to give the best possible results. The steam demand of the plant can be determined using a number of different methods.

One way is by calculating the heat output on an item of the plant using a heat transfer equation. It may be possible to obtain an estimate for steam consumption.

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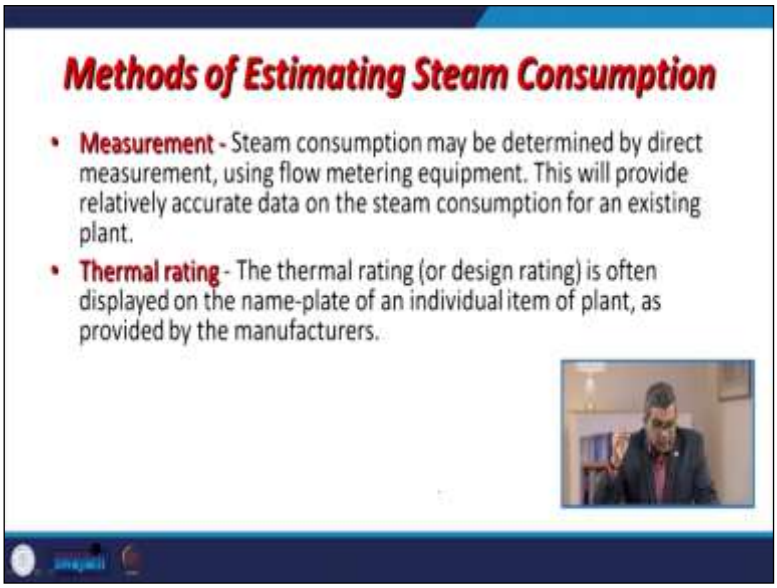

Another is the measurement steam consumption may be determined by the direct measurement using the flow metering equipment. This provides relatively accurate data on the steam consumption for an existing plant. Another way is the thermal rating. The thermal rating or design rating, sometimes referred to as a design rating, is often displayed on the master plate or a nameplate of an individual item of the plant as provided by the manufacturer. So, sometimes it is reflected as a theoretical rating.

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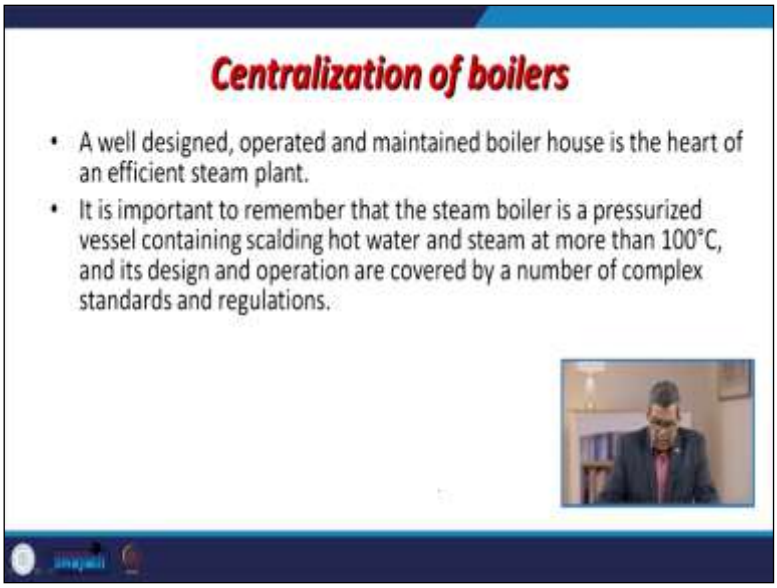

See, when we talk about the boiler and these accessories in a mounting, another concept is usually coming to the picture: the centralization of the boiler. Sometimes it is very catchy or a buzzword. The reason is that if we are having the centralization of the boilers concept, then we may have the facility to have one steam distribution network, but simultaneously it offers a variety of disadvantages related to the varying load.

So, a well-designed, operated and maintained boiler house is the heart of an efficient steam plant. It is important to remember that the steam boiler is a pressurized vessel, a pressure vessel containing scalding hot water and steam at more than 100 degrees Celsius. Its design and operation usually are covered by a number of complexities standards and regulations. When we are going for the boiler's centralization, these and especially referring to the standards.

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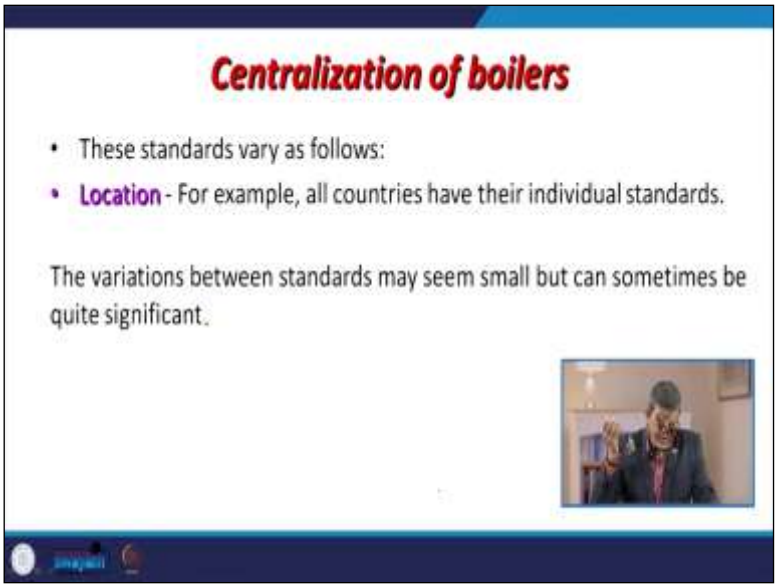

Their standards may vary based on the location we studied; all countries have their own individual standards like, the Indian context has the Indian Boiler Regulation Act etc. The variations between the standards may seem small but can sometimes be quite significant. Another thing in the boiler house is the overtime that is change of technology in response to safety.

Sometimes this is you can say very important and sometimes is a less important area. Technology change is again a very debatable part.

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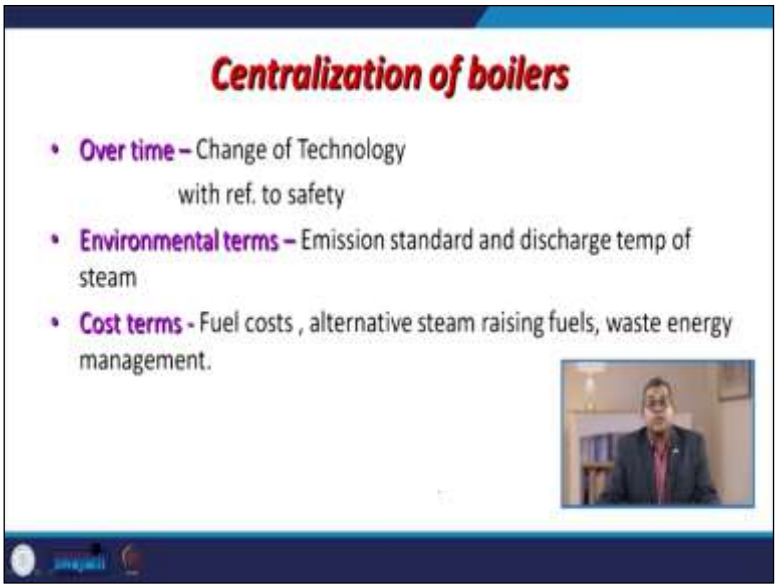

Maybe the choice of fuel may be the choice of the fluctuation may be the choice with respect to safety. So, one must look into this particular aspect. Another thing is with respect to the environmental terms, and these are attributed to the various environmental standards emission standards discharge temperature of the esteem etc. Sometimes it is attributed to the local body, and sometimes it is attributed to the central body.

Some states do offer various kinds of leverage with respect to the environmental norms, and some are very strict. So, all these conditions and even some countries are very rigorous with respect to the emission standards and usually, it all depends on the choice of the fuel and the method of firing. another aspect with respect to the cost term is the fuel cost alternative steam raising fuels waste energy management.

When we talk about fuel cost, so many things usually come into our minds. One is that is related to the availability of the fuel transportation cost calorific value. All these are the contributing factor with respect to the cost aspect. Generally, when we are talking about the centralization of the boiler when more than one boiler is required to meet the demand, it becomes economically viable to house the boiler plant in a centralized location.

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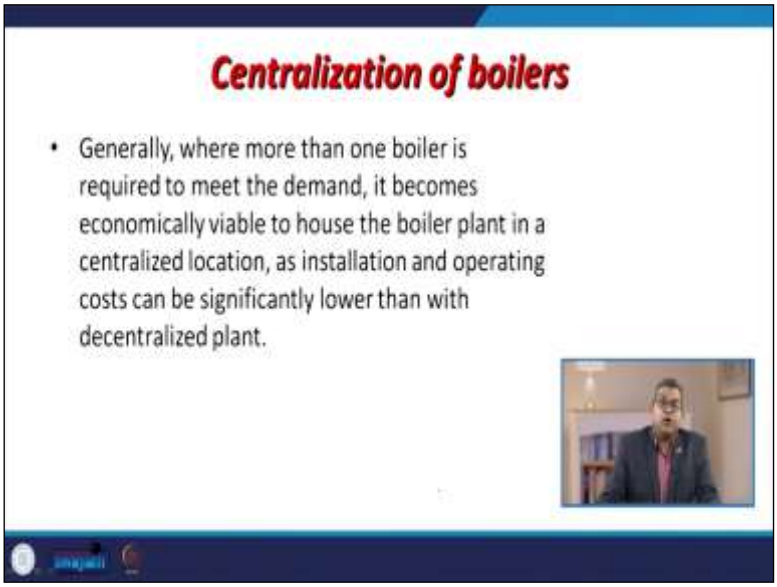

Installation and operating costs can be significantly lower than with the; decentralized plant. Centralization offers various benefits over the use of this dispersed smaller boiler that, is more choices of fuel and tariff.

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Identical boilers are frequently used in the centralized boiler rooms, reducing the inventories cost and spare cost. Heat recovery is quite easy to implement for the best return and the reduction in manual supervision. Economic size and the sizing of the boiler plant to suit the diversification in demand sometimes with the centralization of the boiler exhaust emissions are easily monitored and controlled. You may have only one stake through which you can discharge the things.

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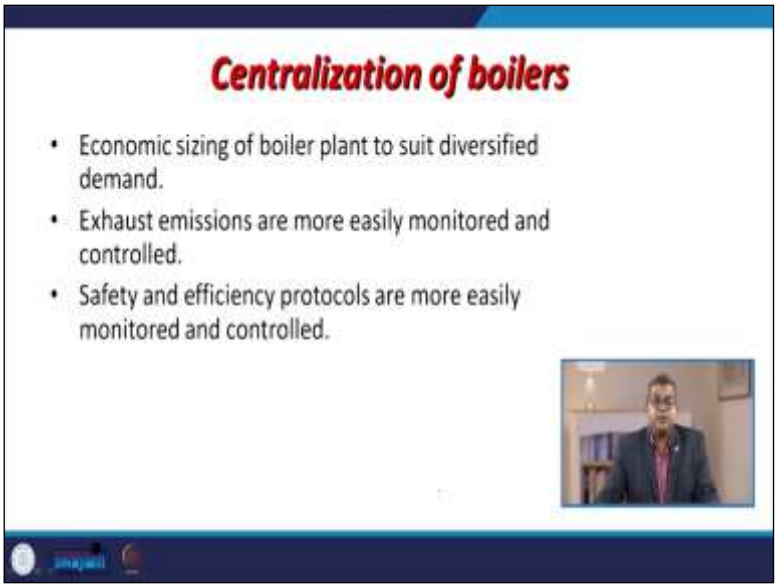

Similarly, these protocols' safety and efficiency are more easily monitored and controlled because it is centrally located. See when sometimes the fuel for the boiler is a very debatable aspect because it has a various parameters to be addressed. Usually, there are three most common types of fuels used, coal, oil, and gas. Industrial or commercial waste is sometimes used in certain boilers and the electricity for electrode boilers.

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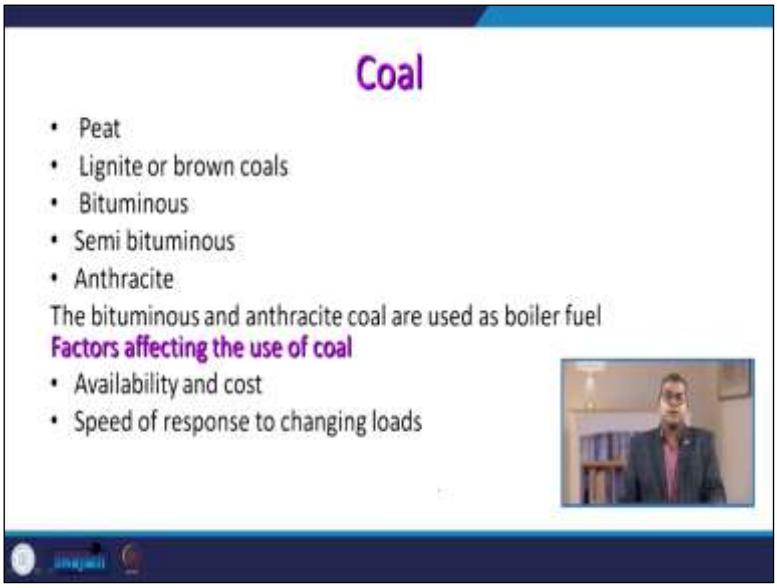

Let us briefly talk about coal. There are different types of coals in practice peat lignite or brown coal, bituminous, semi bituminous anthracite. The bituminous and anthracite coals are used for the boiler fuel. When we are using these types of fuels, there are several factors affecting the use of

coal. One is the availability in the cost because the mines are far away. So, sometimes there the transportation is attributed to various factors like political reasons sometimes the transportation lines.

And sometimes there are so many embargoes etc. The second thing is that the speed of response to the changing loads has some resonance time to combustion. So, these factors need to be addressed. Apart from these, discharges because we discussed the emission standards. So, discharges from the coal are again very important ash one is ash. This is to be removed, usually involving manual intervention.

And the reduction in the amount of steam available while de-ashing takes place. So, this is because you have to do in between. The ash must be disposed of, which itself may be very costly affair and various countries or states or different plantsare suffering with the ash disposal problem.

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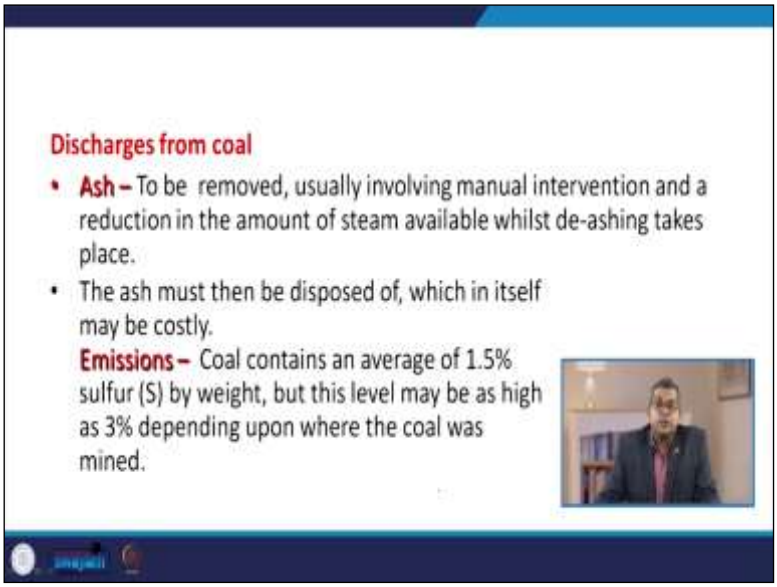

Emission usually coal contains 1.5% of sulfur by weight, but this level may be high as 3% depending upon where the coal was mined, and trust me, this creates a huge problem with respect to the environmental aspect.

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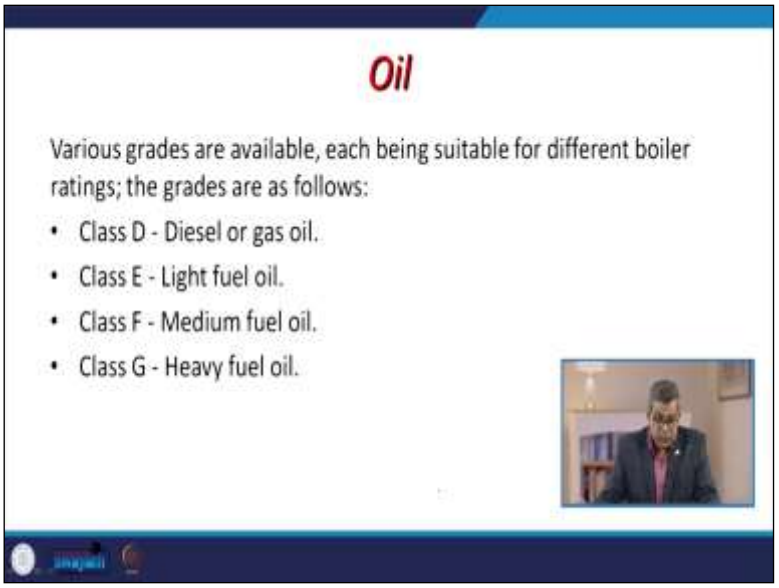

The next fuel is oil. Usually it is graded based on the requirement based on various refiners etc. So, various grades are available and suitable for different types of a boilers rating and these grades are like class D diesel or gas oil class C light fuel oil class F medium fuel wire class G heavy fuel oils, etc.

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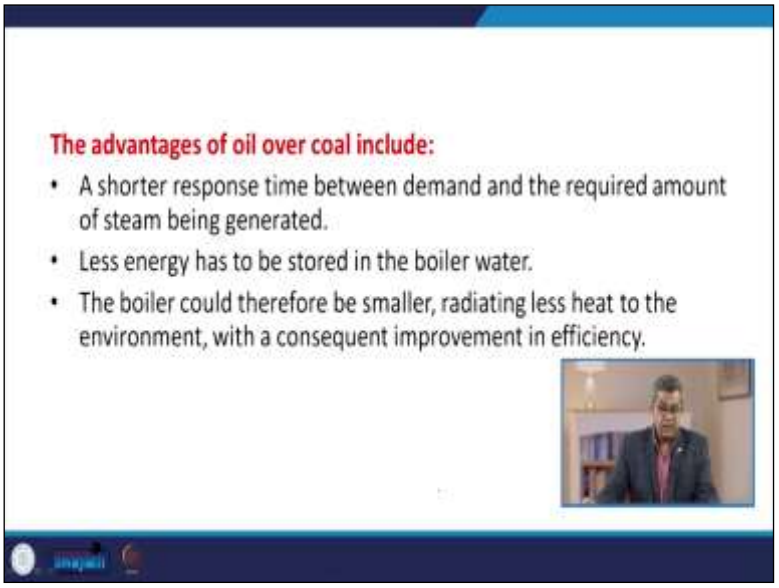

When we have the choice between oil and coal, there are certain advantages associated with oil over coal, including the shorter response time between the demand and the required amount of steam being generated. Less energy has to be stored in the boiler water because of this shorter

response time. Therefore, the boiler could be smaller, radiating less heat to the environment with the consequent improvement in efficiency.

The smaller size also means that the boiler occupied less production is space. So, again the indirect cost reduction.

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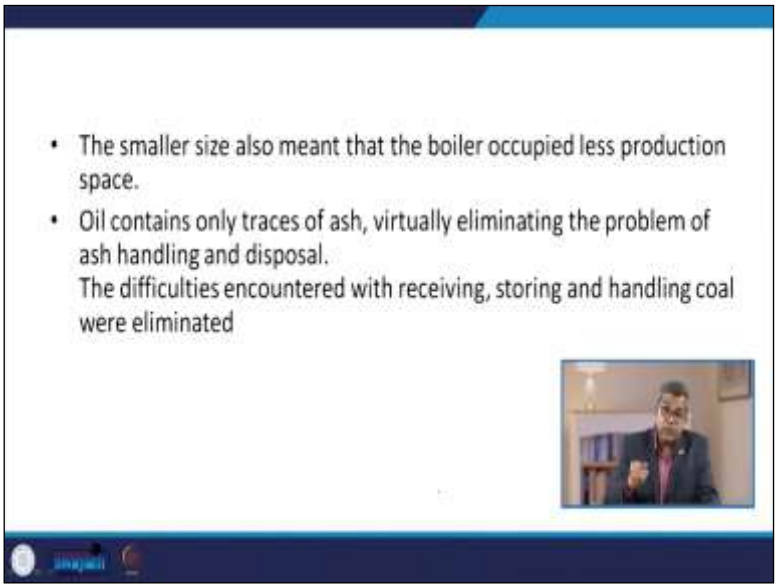

The oil contains only traces of ash and virtually eliminates the ash handling and disposal problem, which is a very burning problem. The difficulty is encountered while receiving, storing and handling coal usually it is being eliminated.

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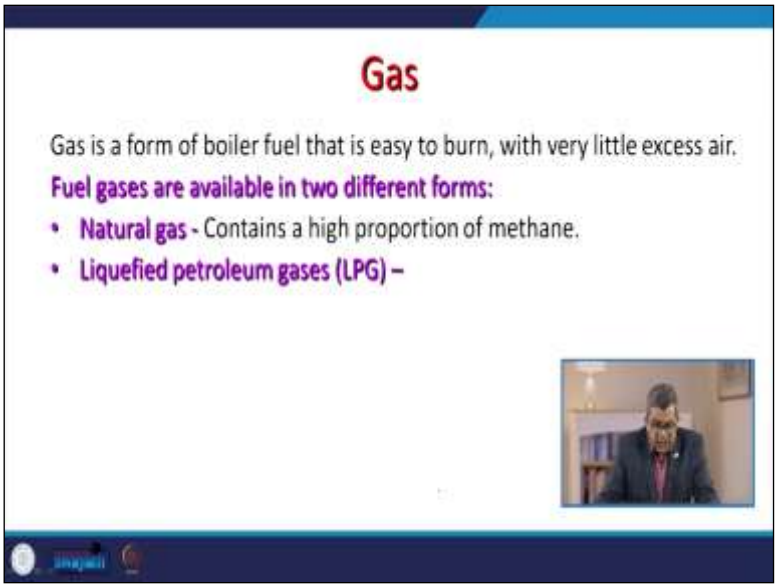

Another choice is the gas. Gas is a form of boiler fuel that is easy to burn with very little excess air. Fuel gases are available in two different forms: natural gas containing a high proportion of methane, almost 85 to 90%, and LPG, the liquefied petroleum gas.

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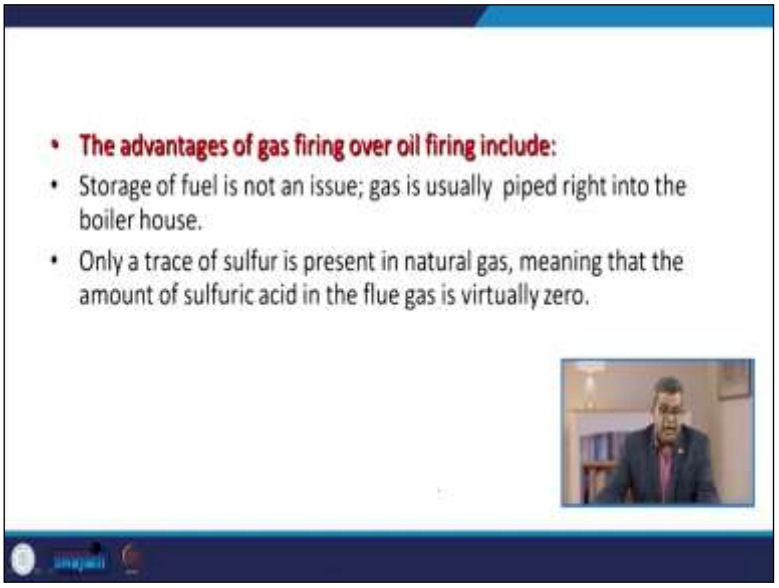

Advantages of gas firing over oil firing because we; discussed that oil is a bit superior to coal. Similarly, the gas firing has more advantages compared to the oil firing. This includes that the storage of fuel is not an issue. Gas is usually piped right into the boiler house. Only traces of sulphur are present in natural gas, meaning that the amount of sulfuric acid in the flue gases is minimal. Another choice of fuel is waste, waste as a primary fuel.

There are two aspects. One is that waste material is burnt to produce heat which is used to generate steam. The motives may include the safe and proper disposal of hazardous material.

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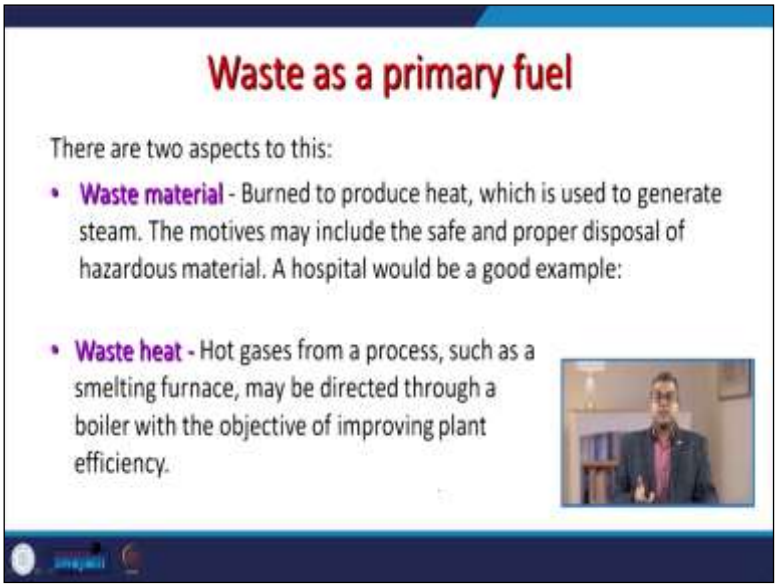

One example is hospital waste; another is the waste heat hot gases from a process like the exothermic process in a chemical reaction. Another is the smelting furnace, which may be directed through a boiler to improvise the plant efficiency. So, we discussed the different types or choices of fuel. The question arises: What should be the phenomena through which we can select the appropriate fuel.

So, the choice of fuel is again very important it will have a significant impact on the cost and the flexibility of the boiler plant. Factors that need consideration include the cost of fuel because ultimately, if the cost is on the higher side, your cost of this team would definitely be on the higher side.

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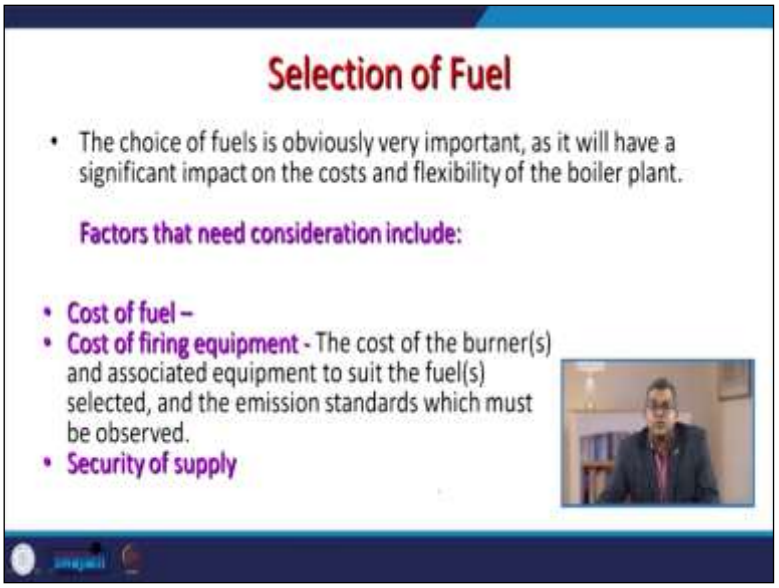

The cost of firing equipment, the cost of burners, and associated equipment to suit the fuels selected and emission is standard which must be observed. Then the security of supply sometimes the disturbance may create the problem and thereby it may adversely impact to the operation of your boiler house.

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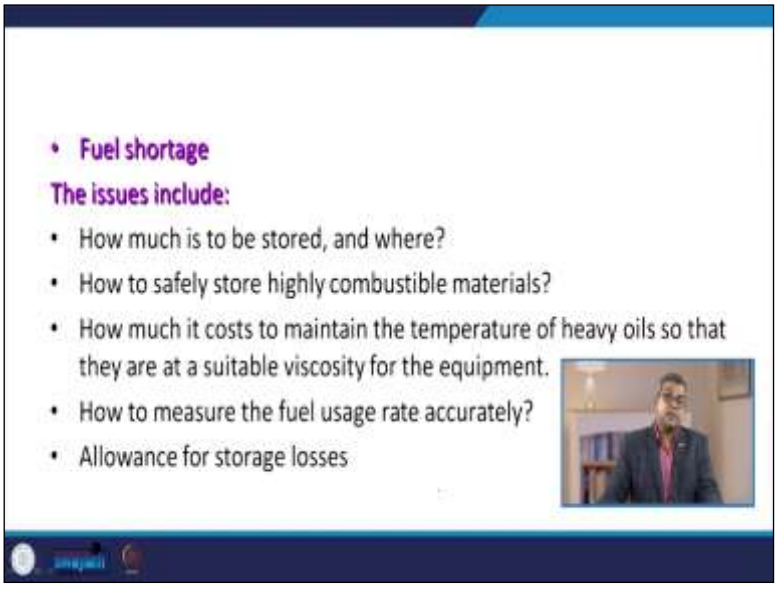

Fuel shortages again this all depends on the supply. So, these are some of the points which we need to address. There are some other issues that include how much fuel needs to be stored and where? If you are storing the oil, you need to follow the safety norms, and how much and quantities you need to store depends on the other aspect attributed to the plant.

How to safely store the highly combustible material gas and oil are especially at stake. How much does it cost to maintain the temperature of heavy oil. So, that is in a suitable viscosity of the temp equipment. Again this is a very crucial aspect because sometimes because of the cost because of the ease we used to store these oils, but during the use or during the use in the burner, it must have a proper temperature.

So, how much will it cost to maintain that particular temperature? Measuring the fuel uses rate accurately is again a very difficult task because it depends on the area factor, including the fuel purity. There are certain types of impurities associated with the fuel's improper combustion etc. Then how can we provide the allowances of various allowances for storage losses because during the storage, some sort of losses may, occur maybe leakage may be draining etc.

So, all these things are need to be addressed. while considering the boiler design the boiler manufacturer must aware about the fuel what kind of fuel to be used when designing the boiler.

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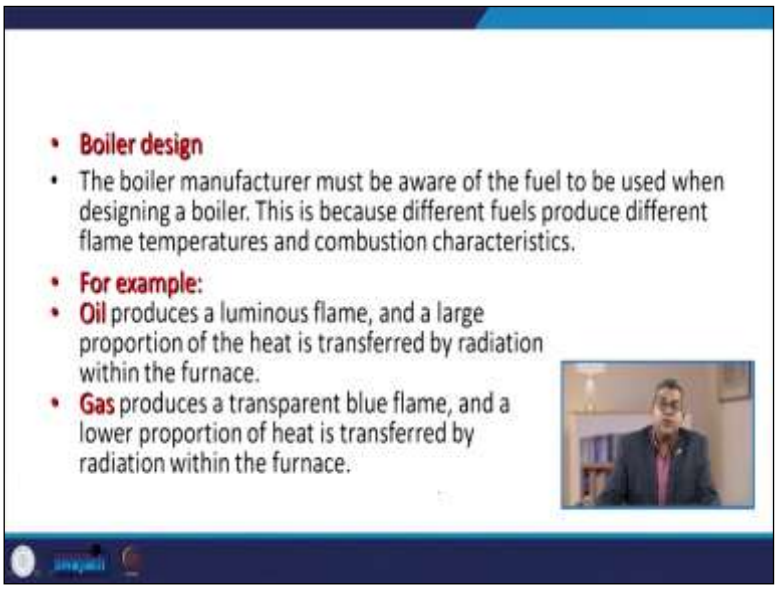

This is because a different fuel produces a different type of flame temperature and combustion characteristics. For example, oil produces luminous flame, and the radiation transfers a large proportion of the heat within the furnace. Gas produces the transparent blue flame, and the

radiation transfers a lower proportion of heat within the furnace. So, in this particular lecture, we discussed the various accessories attributed to steam generation, especially the boilers.

We discussed a lot with the steam traps, different types of steam traps, strainers etc. Similarly, we discussed the centralization of the boiler aspect. We discussed the various choices of fuel to the boiler.

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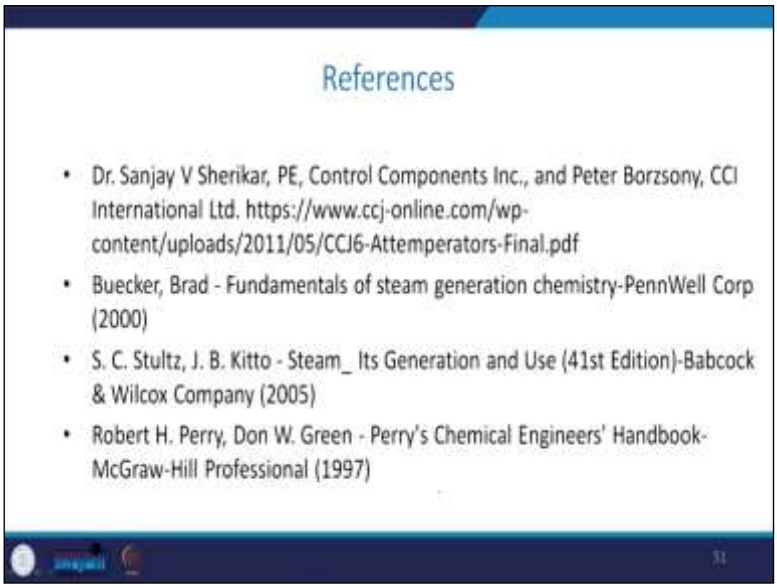

In case if you wish to go for further study we have enlisted couple of references for your convenience, thank you very much.