MARINE ENGINEERING

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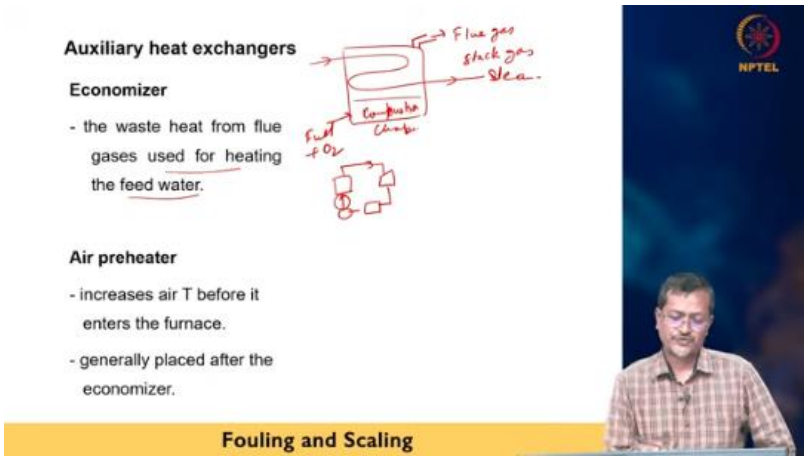
Lecture27

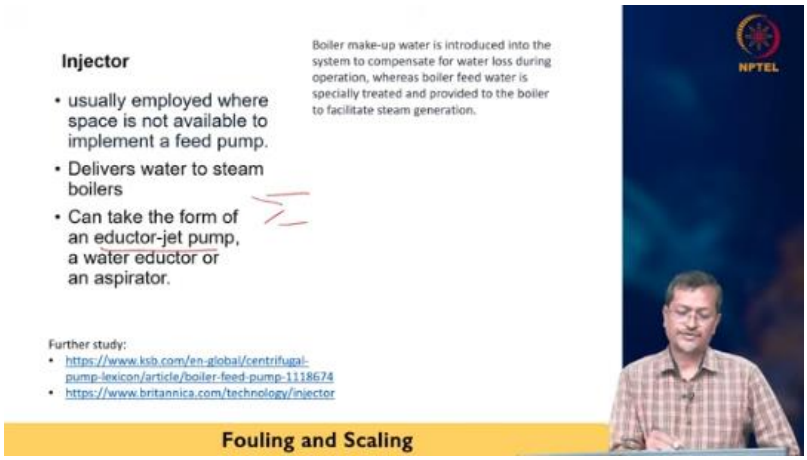
Fouling and Scaling

Now, you got boiler, so boiler will have one combustion chamber, combustion chamber. Now, you are giving fuel plus oxygen and you have maybe your water pipe will be there, water will be getting heated up and is going out, steam out, maybe water tube. and your flue gas will be going out so what is happening your flue gas will have lots of heat so what you can do you can use that heat okay for that scientist thoughtless use one economizer means like boiler you have okay boiler sending hot steam to turbine then condenser then pump then boiler so palm when sending fluid to boiler so the temperature will be lower normally they thought let's use this exhaust gas or flue gas or stack gas flue gas or stack gas use heat from flue gas or strike gas and increase the feed water temperature okay the waste heat from flue gas used to heat the feed water okay then you're using some of the waste heat To increase water temperature your boiler performance should be increasing this is called an auxiliary heat exchanger so economizer is an is heat exchanger okay another is an air preheater so you are taking lots of air air contains a very low amount of oxygen and the majority will be a nitrogen

Now, whenever air is delivered to your combustion chamber, the air temperature is very low and combustion chamber temperature is high. That means you are increasing air temperature first, then you are burning the fuel. Now, can you increase the air temperature so that your combustion efficiency will increase? So, again you use flue gas and increase the air temperature and increase system efficiency. So, increase air temperature before it enters the furnace, generally placed after the economizer.

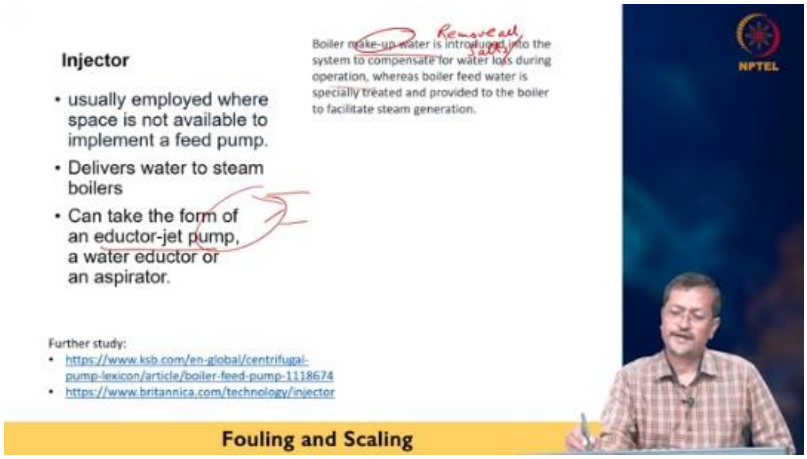


economizer and air preheater both are helping to increase boiler efficiency and it is taking heat from your flue gas or exhaust gas that will not be used normally. A boiler injector, an injector I have already discussed, is usually employed where space is not available to implement a feed pump. very compact application, your injector delivers water to a steam boiler, and can take the form of an eductor jet pump. eductor jet pump or jet pump, whatever I explained already, that is nozzle type thing. that same thing actually.



They have different name, water jet pump, water eductor, aspirator, there is a different name is there. Using that one, feed water can be injected. here two terms will be coming boiler makeup water sometime the term will be coming so makeup water actually not feed water boiler makeup water is introduced into the system to compensate water loss during operation so whole system is running boiler turbine condenser pump if there is a leakage so there will be some water shortage and boiler will have fixed amount of water if you have less amount of water then the whole system will not develop required pressure okay so you have to maintain that much of water so for that what you do you give some makeup water every time okay and that makeup water will be compensating your loss and makeup

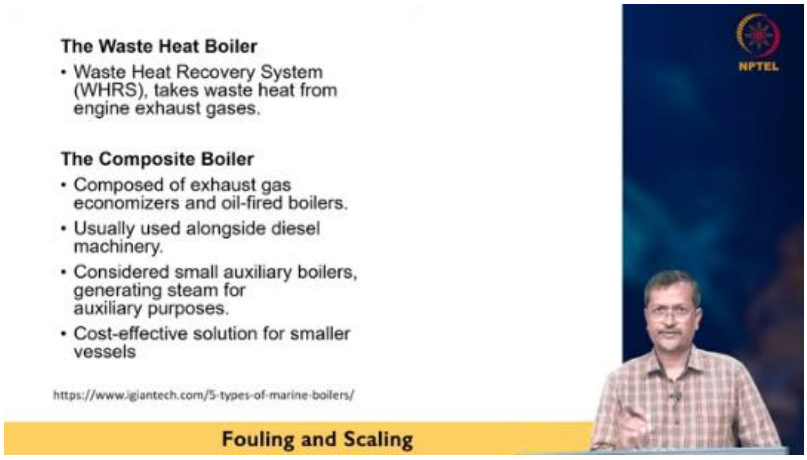
water means see what i cannot give you have to remove all the salts okay remove all salts debris and debris then you inject into the boiler because if you are giving water with salt or some other debris that will get deposited in the boiler pipes so later stage you create a problem so whenever the makeup water is getting fed into the boiler the water must be distilled properly

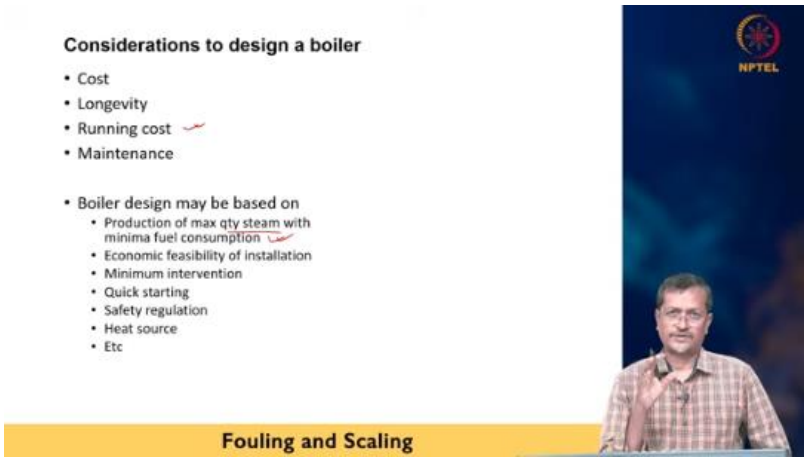


whenever the boiler is there so boilers have lots of fittings so boiler must have pressure gauge because it is pressure it is pressure vessel so pressure vessel means because of certain reason let's say there is any blockage and you are giving lots of heat and pressure is going going shooting up okay so in that case that can be dangerous so you must have a pressure gauge to sense how much pressure you are developing okay so junction stop valve must be there feed check valve how much flow your fluid we are giving that check valve must be there blow of cock will be there manhole and mud hole will be there so the cleaning operation can be proper and many other mountings will be there water level indicator how much water is there inside boiler we have to check uh safety valve must be there preventing excessive pressure buildup if there is too much pressure getting built up so safety valve will be like you have pressure cooker you have seen like household cookings right so there will be one extra safety valve so their boiler also will have some extra safety valve to prevent excessive pressure buildup and busting combined height steam and low water safety valve protects against high steam pressure and low water level in a boiler okay so feasible plug also be there prevent overheating so an explosion what why overheating will be there let's say boiler because of certain reason your sensor not working and overheating started so this fusible plug will be melted and it will be making safe and many cases let's say water level got down and you are giving heat but there is nothing to take heat from the boiler so again that will be a problem so all the systems like sensors pressure gauge flow meter flow sensors all the system must be working properly and you have to observe okay

then system will be safe So, whenever you are designing boiler, you have to consider the cost, longevity, how long it will be running, running cost, you should not have too much maintenance also.

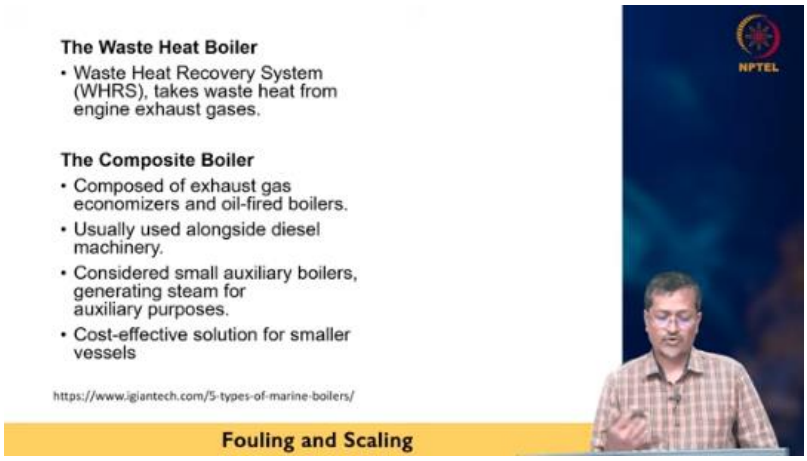
And boiler design may be based on the production of a maximum quantity of steam, how much steam you are producing with minimum fuel consumption. performance is very important, the economic feasibility of installation, minimum intervention, quick starting, safety regulation, heat source, many other reasons also possible before designing or installing a boiler marine boilers so there will be main propulsion boiler it's a very big ships they can have a steam turbine system so it provide it will provide steam to the propulsion systems and a mainly d type boiler will be there and auxiliary boiler also may be d type any type water tube boiler like babcock wheel talks and other type of boiler also used for marine applications Waste heat boiler, I already explained that if there is any waste heat from other engines, ice engine, any other engine, so there also you can use boiler. You can heat water, then hot water or steam you can transfer to other places.





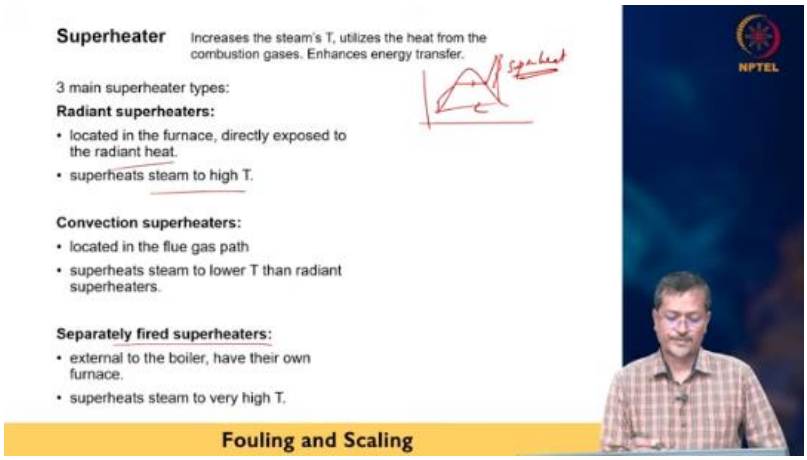
So, there will be some composite boiler, composite of exhaust, gas, economizer, oil fired boiler, usually used alongside the diesel machinery. So, that is why this is called composite. So, you are using exhaust gas. Again, you have another fuel system. Consider small auxiliary boilers generating steam for auxiliary purposes.

Cost-effective solution for smaller vessels. Superheater. So increase the steam temperature to use the heat from a combustion gas. Enhance energy transfer. So I already told that saturation steam we are not using for turbine.

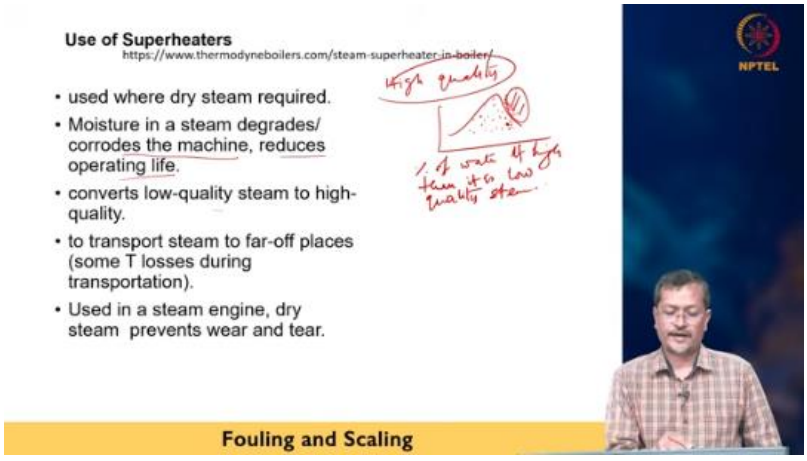


You have to superheat. This is a superheated zone. So, you have to create this superheat, then you put a turbine and you run the system. Three main superheater types is there, radiant type superheater located in the furnace. Inside furnace it will be there, directly exposed to the radiant heat, superheat steam to a high temperature, convection superheater and separately fired superheater.

Separately fired superheater, it will be giving very high temperature, but convective superheater, it is little bit lower temperature will be there. So, use a superheated, superheated, it will be giving dry steam, dry, wet, actually high quality steam when you say high quality. So, high quality steam means like I have a vapor envelope, my steam should be outside this envelope, superheated zone. If something is inside, so quality low. amount of percent of steam in steam.



percent of water, if high, then it is low quality steam, low quality. So, let us say I do not have any water content in steam, let us say purely superheated zone, I am getting the steam. there is very high quality steam, but if I using steam here means some water content also there because i told inside there will be water content also there water plus steam mixture so this will low quality steam so our target should be to produce high quality steam so that we very much beneficial for turbine so moisture in a steam degrades corrodes machines reduces operating life converse low quality steam to high quality steam in separating your super heater And many cases, you have to transport steam from one place to another place.



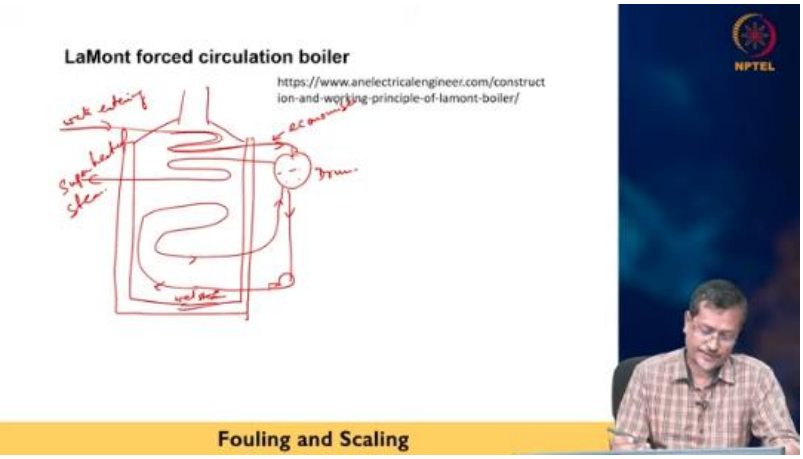
In that case, instead of forming liquid, you create superheat so that steam will not form liquid or it will not get deposited. only steam you can transfer. Using a steam engine, dry steam prevents wear and tear. Steam engine, we will discuss later. Larmont force circulation boiler.

So, I will draw one boiler. You can see this one. How does it look like? Larmont force circulation boiler. So, first what will be coming?

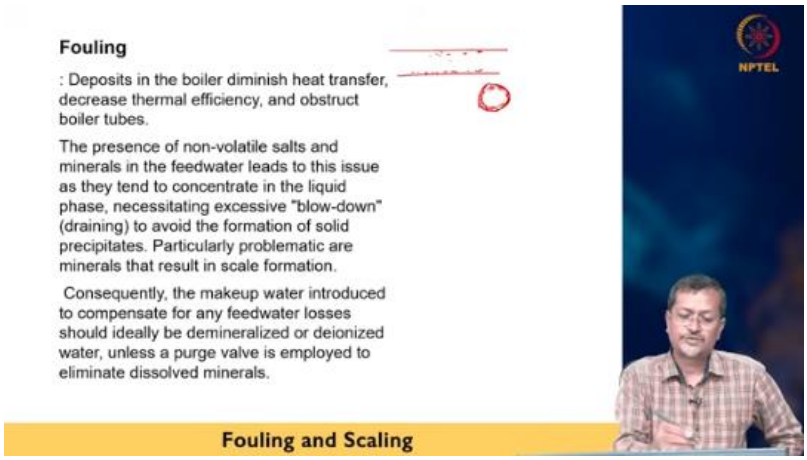
One pump is here. From drum is here. superheated from drum some fluid is coming to pump pump to furnace wait a steam okay wait a steam is going like this it is going like this again it coming to this drum now from drum again you take steam you pass through this furnace again and you are getting superheated steam. First, you get steam done then again next level whatever steam you are getting you pass through furnace again so that will create superheat.

to get superheat some you have to put the pipe or whatever saturated steam you got inside your furnace again so that you can get more high quality steam or dry steam or superheated steam. And water will be entering here, water entering here. water will be going like this, it is going to your drum, this is economizer. inlet water is coming from economizer, economizer is here.

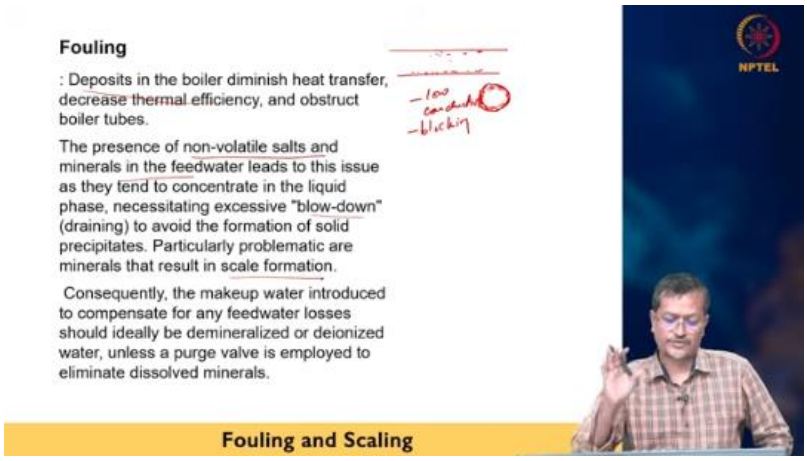
Flue gas will give some heat to feed water. that is called economizer. This is called force circulation, force circulation it is written there Lamont force circulation boiler. So, whenever I already told that boiler feed water or that make-up water must be purified clean properly so when you are cleaning no salt no debris nothing should be there it will be pure h2o okay so fouling deposits in the boiler diminishes heat transfer so if you have lots of salts or debris so it will be deposited inside the tube so finally this tube will be getting blocked when it is getting blocked your fluid flow can be stopped another thing is that



this metal, the pipe metal or tube metal will have high heat conductivity. Now, you have a deposition. So, deposited material will have low heat conductivity. So, deposited material will have low thermal conductivity. So, low conductivity will be there.



Again, it will be blocking path. so whatever extra fluid extra water you are giving that must be properly clean the presence of non-volatile salt and minerals in feed water leads to this issue as they tend to concentrate in the liquid phase they sit excessive blow down or draining to avoid the formation of solid participation particularly problematic are minerals that result in scale formation. So, inside pipe there will be scale formation, there will be strong, almost metallic thing, but heat transfer rate will be lower, it will be blocking. So, that is a negative thing.



Consider the make-up water introduced to compensate of any feed water losses should ideally be demineralized or deionized, this make-up water. another term is coming scaling that is called fouling scaling is that lots of salts will get deposited like calcium salt magnesium silicon iron aluminum if there in in the water then it will be deposited in the heat transfer surface okay it will be very strong salt will be deposited hindering heat transfer, causing hotspots. Calcium, magnesium, and salt, along with elevated silicon related to water alkalinity are primary scale contributors. Scale consisting of carbonates, bicarbonates, and sulfates develop gradually and impede heat transfer efficiency.

Carbonate deposits identified by effectiveness in acid form dense scales with large Silicone is deposited in a hard, light, coloured scale resistant to hydrochloric acid solubility. Regular maintenance is crucial to avoid all these issues.