MARINE ENGINEERING

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Lecture26

Boilers

Now, every time I say boiler, the definition of a boiler is a vessel in which heat is produced by combustion. So, the boiler will have a combustion chamber. The boiler will have some fuel intake and there will be burning. Fuel means you need three things to burn something. fuel plus oxygen.

combustion will be happening. Sometime we say combustion chamber. or we can say furnace. Because you are burning fuel, you are generating lots of heat, and this heat will be passed. The heat will be going to my maybe water tube system or fire tube system, and we will get lots of heat, lots of steam. this steam will be normally superheated steam.

Boiler generates steam for power generation, hot water for heating purposes. many cases hot water also required for example, room heating purpose in winter countries or you are going to colder countries where room heat is required. their boiler also can be supplying steam hot steam to room walls. room will be heated up because of this radiation. water heating purpose fuel oil heating oil tanker heating air conditioning running cargo pump turbine steam-driven machinery firefighting so many applications are there for boiler so boiler not only it is producing power for steam generation rather it is producing hot steam for many other purposes so boiler classification when you are seeing boiler so boiler there are different types of boilers are there so

We will discuss water tube and fire tube boiler, water tube and fire tube. And method of firing, there are internal firing boiler, external firing boiler is there. Circulation of water, natural circulation, forced circulation. boiler will have the natural circulation, fluid will be flowing naturally or maybe some pump will be working. you are forcing water to flow.

And pressure of steam so low-pressure system and high-pressure system also we are creating so there are different types of boilers different names also will be there we will

discuss later so first thing water tube and fire tube boiler so I have one system where water is passing through this pipe okay water passing through tube this is water tube And fire tube, fire or flue gas or smoke, is smoke tube also, instead of a fire tube, smoke goes through a tube. this is called a fire tube. they have different application.

Water tube will have larger application, fire tube will have smaller applications. And what is flue gas? Flue gas means after combustion, you give fuel, maybe coal, wood, liquid fuel like diesel, petrol, anything you can give and mix with oxygen, burn it, you get lots of heat. And after combustion, some soots and carbon particles will be going out. That is called flue gas.

It will be having lots of energy actually. that is called flue gas or sometimes they call stack gas. flue gas or stack gas after combustion you take lots of energy after that some gas will be going out from the system that is called flue gas or stack gas. here water tube and fire tube differences are there water will be inside tube and in fire tube fire or hot gas inside tube hot gas will be inside tube and outside will be water you see you have one pot and one immersion heater you may have right so electric coil will be there so outside water is there inside hot coils are there so instead of hot coil electrical coil you can have hot gas so that will be fire tube or smoke tube sometimes this is smoke tube also

steam capacity for water tube is low for high speed application, fire tube slow speed application, water tube little bit complex in design and water tube requires more floor area, fire tube requires less floor area. students should go through these differences. and there are different names also there will be different company be producing different uh boiler different types of boilers so they have given their own name like cornish boiler question and boiler locomotive lecture boiler scottish men boiler these are fire tube boilers again water tube boiler if you see starling boiler back pocket cox boiler euro boiler lemon boiler so you don't have to go through details but you should know the names of different names are there you should not say okay why I don't know anything so some maybe if you can google also you can get some more names okay but you should know that there are different types of boilers different names are there maybe fire tube or water tube then on the basis of that they will be differentiating so I'll draw one fire tube boiler so water tube boiler first water tube boiler is like this I have one drum drum will have one water inlet, from water inlet is there then, water inlet then.

flue gas will be going out through this. now I have this pipe I have another pipe it will go like this will go like this okay so steam out water inlet and flue gas out flue gas out, this is

air and fuel inlet, air plus fuel. So, to get anything burning, you need air plus fuel plus heat. if you are not giving heat, air and fuel will not burn.

For example, you have wooden chair, it is not burning, although air also there and wooden chair also can burn. You need certain amount of heat. Similarly, if I have fuel plus heat, air is not there, still it may not burn. So, all the three things will be required.

This is called fire triangle actually. If you want to get any fire, you must have fuel, oxygen, plus heat. O All the three things will be required. So, if you want to stop fire, you can break any of the arm of this triangle.

This is called fire triangle. O So, for your combustion, you actually provide all these three. Fuel, oxygen and heat and you start doing in combustion you give all the three and reaction will be occurring this is called combustion chamber or furnace combustion chamber bar okay and water will be coming through this it will be going like this it will be going like this okay

and this combustion fuel will be going like this okay and the steam you are going from the top this is called water tube boiler another called two drum boiler two drum boiler is like this i will have one drum here and i'll have another drum here and i'll have one furnace here okay and lots of pipes will be connecting to these drums okay and fuel plus air you are injecting here so lots of heat you are generating okay heat generating and this is water drum water drum this is steam drum okay so this steam will be here this is completely water one is downcomer, one is steam will be collected there. This is called water tube boiler. This is called water tube two drum boiler.

Sometime D type they say. two drum boiler this is a d type like it will be looking like d the drum is there pipes are there and furnace will be somewhere so it will be looking like almost d so this is called d type boiler so this is normally used for marine locomotives so one fire tube well fire tube boiler will be like this i have furnace flame Okay. So, fire is going like this and water is here. Okay.

And steam will be going out like this. Okay. And your flue gas. flue gas is going out. It is and water will be outside the pipe.

If water is inside pipe, this is called water tube. This is called fire tube. now boiler is producing lots of heat and you can see the flue gas is taking lots of heat now types of merchant and naval boilers. like two drum boiler, I already told D type, this is called two

drum boilers, D type, D type boiler, some will be reheat type, later we will discuss reheat means like you are getting steam.

one turbine, again you heat, again put to another turbine, then you condense it, pump it, put into boiler. this way it will work. this is reheat type. reheating here happening, reheating. We will discuss later reheating.

A forced circulation boiler will be there, forced circulation boiler. force circulation boiler is there, so water is there inside. water will be forced to circulate inside boiler, so that more mixing will be happening and more heat transfer will be happening to the water. And supercharged boiler, supercharged boiler. Supercharged boiler means combustion chamber needs lots of oxygen.

in that case, what do you do? You compress air and you give to combustion chamber. combustion efficiency will be higher and you can make a compressed system and heat transfer will be higher. So, that is called a supercharged boiler. Some are there wasted boiler.

What is the wasted boiler? Wasted boiler is like this. I have one IC engine. IC engine I will discuss later. IC engine or any other type of engine is there.

So that is producing lots of waste heat after combustion. Like if you see any truck or bus, the tailpipe will have lots of hot gas coming out, right? that heat, if you can reuse it, your system officially be increasing. that is called waste heat. That heat you are not using.

So now boiler engineers or scientists have thought, use that heat to increase water temperature. That is called waste heat boiler. So using that heat, you are boiling water. And because of... And other types are there, I already told that fire tube, water tube boiler, fire tube, water tube, D type already.

there will be A type, O type, and many other types also available. Most common and medium small size boiler D type, this is most common medium. and small size boiler you are using for marine machinery. if you are seeing the reheat cycle actually if I draw this boiler and the whole cycle Rankine cycle, boiler and first it is going to one level of turbine, then exit whatever steam you are getting, you are not sending to condenser, rather you are sending to boiler again, reheating again, again you are putting to another level of turbine, then you are putting to condenser, then pump, then boiler.

you may have several two three stages of reheating are also possible okay this is a reheat cycle it's the same thing actually here you can see natural here you can see natural circulation boiler for circulation boiler so the left side is showing this is a furnace riser heater furnace tube or riser heater heat input just wait so left side is your natural natural this is forced how it is working so you see this one drum is here okay drum one pipe is coming like this and there is no heat addition or pump working here heat addition is there but the pump is not there so what is happening you give heat input here this side okay when you give heat input it will be giving lots of steam so bubble will be formed when bubble is getting formed so bubble will be rising up okay and water density also will be down because of this heating when water density down and bubbles are going up so this other column let us say column a column b from column a water will be coming down to take that place where heat is, you are giving the heat.

Again, when fresh water coming, it is getting heat, it will create bubble. it will move up. Fresh water will be coming from A column. it will be rising in B column. this way, the circulation will be happening.

This is called natural circulation. So, you are not giving any pump or you are not forcing water to flow. But if you see this one, but if you see this one, other one, I have one pump here. you are forcing, this pump is forcing the fluid to flow further at a higher rate.

This is called force circulation. In some cases, natural circulation will be slower. So, you may not prefer. So, you want more flow quickly, you want to heating up the whole system, then pump can be working. But again, pump means you need extra energy

for pumping system. Now, you said that water will be flowing because of natural circulation or forced circulation. Now, you have combustion chamber and combustion chamber, naturally if you see this right side chula in Indian oven, you see this one hole is here. From hole, the fuel is given and hot gas is going up. Hot gases are going up.

So, when combustion happening, it is exothermic reaction happening. Exothermic. Okay. Exothermic reaction happening or combustion happening? Combustion happening inside chola.

Combustion. Okay. There, hot gases going out because when air is getting heated up, the air, because of low density, it will be moving up. When it is moving up, the high density air, it will be entering from this fuel hole, fuel plus air. high density air will be entering through this hole and again it will get heated up, it will move out.

this is a natural circulation happening. This is called a draft. This is a natural draft. You are not forcing, automatically it will take air, it will burn and hot gas will go out. But in forced draft, many cases you may have seen that when first time you are trying to burn this fuel, so many people will be taking some fan and they will be moving like this nearby this oven.

So, what will happen? You are forcing some extra air to go to the combustion area and burn it. This is called forced draft. so induced drop means you are not giving any extra energy but air automatically will go it will be heated up it will go out so in the boiler also if you are using a natural draft system so in that case or induced draft system there automatically air will be coming it will go but you want more air to go inside the combustion chamber then you use some fan or some other mechanism you give some more air to the combustion chamber and your combustion will be proper Sometimes people use the supercharged boiler.

They use compressed air to give more oxygen to the combustion chamber and the fuel will be burning quickly.