MARINE ENGINEERING

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Lecture13

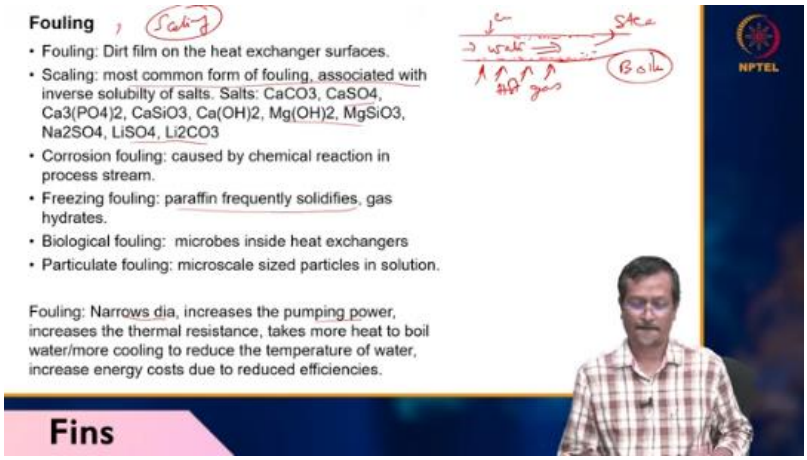
Fins

whenever you are talking about heat exchanger especially in boiler application so the some term will be coming fouling scaling okay so those terms will become fouling means a dirt film on the heat exchanger surface so I have heat exchanger let's say this is water is going through this and hot gas is there combustion gas let's say hot gas outside okay inside water flowing So if water is having certain contaminant, say contaminant may be salt, whatever water you are getting from your tap or drinking water bottle, there will be certain amount of minerals. If that mineral is there and continuously water is flowing through this one and you are boiling also, what will happen? Steam will not take the salts or contaminants.

Steam will take only the water molecule. then what will happen this salts will get deposited on the pipe surface salt or dust or debris whatever things are there if those are getting deposited your heat transfer rate will be reduced because pipe material let's say this is copper pipe material is having higher heat transfer rate okay now you have fouling or contaminant or scaling okay so those material you will have lower heat transfer rate when higher heat transfer rate pipe is there now you have another layer lower heat transfer rate so you can remember the formula for resistance concept so higher heat transfer rate lower heat transfer rate then that means your total heat transfer rate average heat transfer rate got reduced okay so if water is having contamination or the fluid is having contamination then you have to remove that contamination or salt content then you can put for your water application especially in boiler later i will discuss details about boiler flow okay uh in some cases because this is steel pipe or copper pipe lots of salt will be created because of corrosion okay that those also will be deposited on the piping surface okay so scaling most common form of fouling associated with inverse solubility of salts okay salt like calcium carbonate calcium sulfate uh calcium lithium magnesium lots of salts will be getting deposited on the surface corrosion uh caused by chemical reaction process steam and many cases if oxygen is there that also will create like some corrosion at high temperature

freezing fouling paraffin so especially in oil and gas application paraffin frequently solidifies and creates gas hydrate that will also be deposited inside piping system okay biological fouling microbes inside heat exchanger particularly fouling microscope size

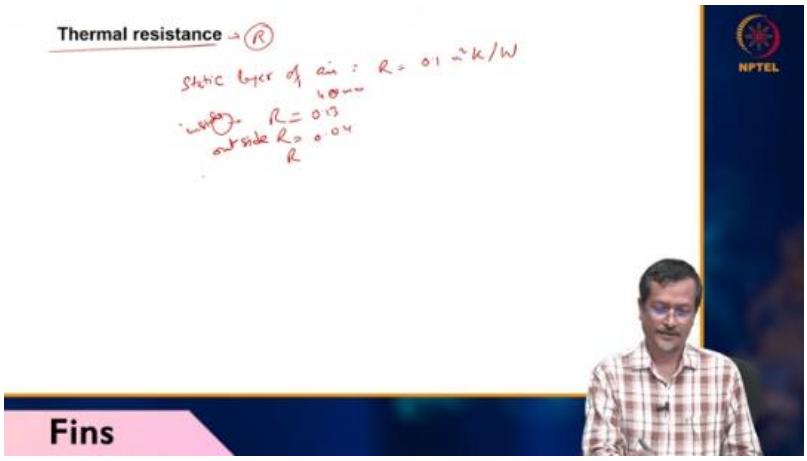
particles in solution so that also will be creating fouling so following what will be the effect it will be narrowing the piping diameter increasing pumping power means narrowing down pipe so you have already fixed pumping power and system working but you narrow down pipe narrow down pipe means lots of pressure drop will be there okay lots of pressure drop means pump must be working high okay so pumping power will be increasing so you have to give more electricity more power here okay Increasing thermal resistance, so thermal resistance increase because this fouling is having lower heat conductivity. Take more heat to boil water or more cooling. uh to reduce the temperature of water or increase energy cost due to reduced efficiency so fouling has a negative effect so whenever you are putting water or anything so you have to consider all the parameters then you can handle things smoothly because whenever you design on boiler or any system or you are using so if you are not considering all this part that can be dangerous so let's say pipe is blocked and you are creating lots of pressure pump is trying to work hard to cross this barrier pipe can burst or leakage can be there so that can be dangerous okay so if there is any restriction of howling is happening so you have to take care thermal resistance



Overall heat transfer coefficient can also be calculated by V of thermal resistance R. So we already discussed about thermal resistance like electrical analogy. So already we discussed about electrical analogy regarding thermal resistance. heat transfer between fluid and the wall is one resistance wall is self one resistance transfer between the wall and the second fluid is another thermal resistance so therefore different thermal resistance will be there fouling thin boundary layer fluid film then metal boundary layer may be another insulated

layer so different layers are there we have seen the formulation okay surface coating or layer or burnt product adds extra thermal resistance so if there is you design your system but if we are getting extra deposition or coating or anything then again resistance will be increasing some typical heat transfer resistance static layer of air of air it will have r equals 0.1 meter square k w 40 millimeter thickness okay 40 millimeter inside heat heat resistance horizontal current okay inside pipe heat resistance horizontal current horizontal flow is there then r will be 0.13 okay for air outside resistance inside

outside will be 0.04 unit will be same inside heat transfer resistance heat current from down to upward leave it fin or extended surface here I have taken some picture you you use the fin for industrial purpose for example in computer you have lots of fins actually this is metal and these are the protrusion fins okay so fins will be having same temp almost same temperature as base metal okay this is base metal and extended same metal actually continuous metal then heat transfer rate will be increased but here maybe in hostel in your hostel you have seen this type of compressor compressor for your cycle pumping, bicycle pumping. So, here heat exchanger is there. Why?



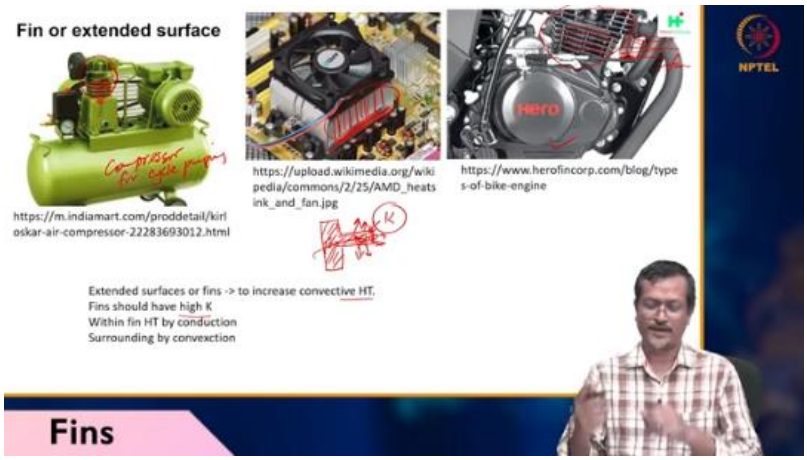
These, there will be piston cylinder arrangement. So, there air compression is happening. When air compression happening, so inside air temperature will be very high. So that high temperature, if you reduce the temperature actually, the system performance will be increasing. So that's why these fins will be there.

Fins are extended surface. Those extended surface will be reducing temperature of the cylinder. So that whole system performance will be increasing. Electrical power consumption will be lower. In computer also, if you do not reduce temperature, maybe circuitry can burn.

And in motorcycle, if you see there, there is engine actually, piston cylinder arrangement will be there and these are the fins. So those fins will be reducing temperature. and here normally when you are not driving so it will be having natural convection because there is no air blow and your engine also taking less amount of power but when you are driving engine will be taking more amount of power it will be generating more heat so that time air also will be blowing over it so it will be creating forced convection actually. So they have created the engine outside so that whenever you are driving air will be passing over the fins and will be creating a force convection and heat transfer rate will be higher and engine will be safe okay so extend the surface of fins to increase convective heat transfer coefficient fin should have higher thermal conductivity so whatever fins are there normally it will be aluminum uh aluminum iron will be lower application because aluminum have a very high heat conduction rate than iron 250 around something we have seen already

uh within fin high transfer by conduction be happening let's say i have one fin here this is my metal okay so this will be same metal normally same metal will be there both okay and this will be higher k if you if it is a very lower heat conductivity there will be no use because this temperature is 100 this whole fin must be 100 degree almost 100 or 99 up to this okay but Original metal will be 100 and fin other end is 30 degree. That means this fin will not work. So you need very high heat conductivity through this one. So that whenever heat will go outside because of convection and radiation, the heat will be flowing directly from metal to the fin quickly as soon as possible.

So that again the temperature, fixed temperature will maintain on the fin. and heat will be dissipated in the surrounding. So, temperature difference will be maintained. So, good conductive heat transfer will be maintained because del T is there, Q proportional to del T. What are the different shapes of fins? Fins are surfaces that extend from an object to increase heat transfer rate.



Fin material must be high conductive. So, fins shape can be like this. okay I'm drawing one okay so fin shape so this is my fin okay this is the width and this is fin length length cannot be very long because very long means base metal temperature and other end temperature if temperature difference is very high very long means heat will be dissipated you say this is my base metal this is my fin so 100 degree centigrade 100 100 100 100 if it is very long then heat will be dissipated all around and it when it is reaching this end this may be 30 degree so this portion may not be useful so just make smaller and make it better and if you make very long also then air flow or other fluid flowing over it

that flow also will get resistance. So, you have to make optimal shape and size fin so that airflow will not be blocked so much and heat conduction be proper, heat convection also be proper. So, you are getting benefit from conduction, convection both and not restricting the fluid flow. This is triangular fin. Another can be rectangular fin.

Rectangular fin can be like this. It will be like this. So, this is a rectangular type fin. Another can be like trapezoidal, not sharp pointed rather it will be like this. This is trapezoidal type of fin. Trapezoidal.

And there can be a parabolic shape. Parabolic shape fin will be like this. this parabolic shape and it can be cylindrical shape, pure cylindrical like this. This is cylindrical. So, many type of fin possible.

and those are being used in the industry for example very thin film rectangular type film will be there in a micro channel application micro channel where in your computer application very narrow very thin sheet you are creating and a very small space like one two three four so very small space will be there in between okay so through that some air will be passing and heat transfer rate will be higher and it will be very high conductive

normally aluminum will be there now you see the for example rectangular fin okay this is the length l and d is your thickness and a is your this length okay so ideal case will be like if t temperature a so whole temperature will be ta this is ideal case heat will be going out conduction through this fin it will be conduction from conduction from surrounding it will go by convection then another will be radiation also possible so you are trying to take benefit from all the three modes of heat transfer in ideal case temperature will be same base metal and fin okay.