MARINE ENGINEERING

By

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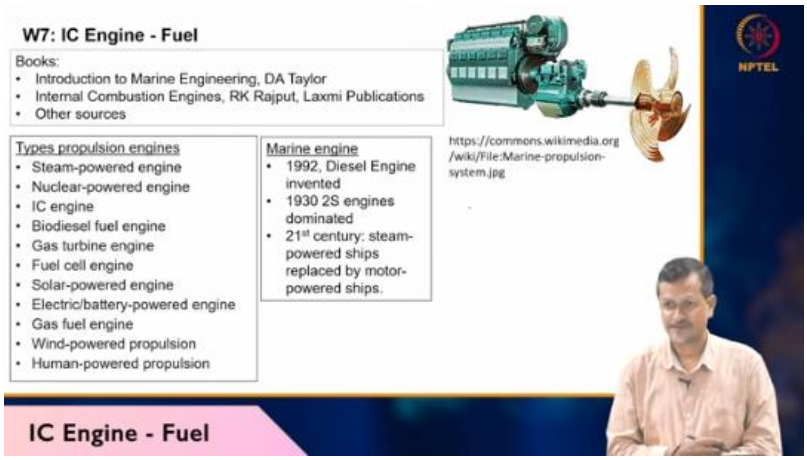
Lecture42

IC Engine - Fuel

okay good morning everybody today's lecture is a continuation of IC engine so first part you have seen this different strokes cycles different calculations the second part of this week will be discussing more on theoretical aspect of fuel fuel properties lubrication properties again a cooling system engine cooling system how to cool because temperature will be going beyond 2000 degree centigrade but your melting point of piston in cylinder or piston or piston ring will be 1200 800 degree centigrade so at high temperature it should not get melted so you should remove the heat from the system as soon as it is getting generated now the heat source will be fuel so how to burn the fuel you need oxygen and mixture of fuel and one fire source or compression ignition temperature you have to reach then fuel will be burning you will get lots of energy so that energy will be the fuel generated energy will be used for your power production or you will get torque from that from torque will be supplying power through this shaft you can see the picture okay this is your engine okay there will be gearing mechanism why gear will be required because gear will be reducing your speed okay so normal ice engine speed will be more than 200 degree 200 rpm now propeller speed will be less than 200 okay so you have to reduce the speed so for that purpose you should have one gear mechanism so the gear mechanism will be here and this is shaft shaft will be connected to your propeller



Okay, and the topic basically I have taken from D.A. Teller book or R.K. Rajput book. So, now whenever you are talking about marine engine, so marine engine, there will be steam powered engine, I will discuss in week 4 and 5. 5 I think then nuclear power engine I will discuss later IC engine we are discussing biodiesel fuel also there recent engines are there with biodiesel or alcohol based diesel engines also will be there or biofuel engine those are also IC engine actually so instead of diesel or petrol you are putting some percentage of alcohol or other hydrocarbon based fuel alcohol also having carbon as a content so whenever you are talking about fuel like

Fossil fuel. So those are having actually carbon content. So carbon will be reacting with oxygen. It will be creating carbon dioxide. It is exothermic reaction.

It will be producing lots of heat. So that heat is required. Gas turbine engine we will discuss later. Fuel cell engine we will not discuss but we will see if we have time then we can discuss something. Solar power engine also there.

Electric power, battery power these are recent engine people are developing. uh gas fuel so instead of liquid fuel gas fuel engine also possible wind power already you know uh this is older engines human powder wind power engines okay uh so basically we'll discuss in this course steam power cycle nuclear ice engine and gas turbine these cycles okay so some discussion we can have related to solar or electricity based system but later we'll see marine engineering uh marine engine if you see in nine Diesel engine I think 1892 diesel engine got invented and 1930s two stroke engine dominated. Later four stroke engine dominated. Then finally what happened steam power shifts replaced by motor power shift.

Motor power shift means like more on IC engine based system or electric power now which is coming electric or solar power. So gradually the transformation is happening. Initially it

was like human powered or wind powered. Then IC engine came up, coal powered or internal combustion engine powered. Then slowly turbine came up or reciprocating engine came up.

then diesel engine, petrol engine then recently steam ships are being replaced by your combustion, ice engines or gas turbine engine or nuclear powered engine nuclear powered engine also having limitation because of reactive nature so basically warships and other ships they will be using nuclear power but gas turbine engine also very common for big ships heavy machineries So crude oil formation to refineries to your engine. Okay. So crude oil formation. So you know that thousands of millions of years ago, lots of algae, flora, fauna, all these things got deposited and those got transformed into fuel.

Okay. It become coal or petroleum. Okay. So coal and fired engines already almost replaced okay so but still some relevance will be there in heritage train or somewhere only limited use is there for coal fired engine but petroleum or yeah so coal may have steam engine also okay but petroleum you get initially you got crude oil

So crude oil, whenever you are drilling a hole or well bore, you are getting crude oil or gas plus oil plus sand. All these components you will get. You drill a hole from earth's surface, well bore will be getting crude oil, natural gas. This is not oil, water. I should write water.

gas water sand all this mixture thing will come but these things you cannot put into your engine why your engine will not take water okay uh any well bore in this lifetime whenever you drill a hole you see oil and gas is there maybe nearby uh under this id campus okay you drill a hole you get oil and gas okay so more water you will get actually your target is to produce oil or gas but finally you will be producing more water actually okay water is more available okay so then but water is not economical for your case water will not give heating value you have to dispose dispose is difficult because water feed is containing oil particle okay crude oil particle or hydrocarbon particle then disposing will be one big challenge okay so when you are going for disposing that means you have to remove all this oil particle when you are removing that is also take it will take money Because lots of technology you have to use to remove all this hydrocarbon particle from water. So this is not giving money rather it is wasting your money. So our target is to produce oil and gas not water.

But you cannot avoid it. Then you have got oil and gas and water and sand. You have to separate on the surface. So oil well bore. to you are getting on surface okay from wellbore oil and gas you got on surface the surface separator system will be there so what is the

purpose of separator separator will be separating oil gas water sand okay there are different mechanism to separate oil gas separate again

water you got separately now water you have to remove all the hydrocarbons then you can dispose you can dispose randomly not possible there will be certain government regulations you have to follow that you have to drill another hole you have to inject there okay so there are different mechanism to dispose water sand also will have same issue when you are producing oil and gas sand also will come so disposing sand also a challenging job because it will have hydrocarbon so hydrocarbon coated sand some noise hydrocarbon coated sand disposing is very difficult so again you have to separate the hydrocarbons then dispose now gas so gas lightweight life is beautiful you are getting gas fine but gas will contain hydrogen sulfide carbon dioxide water moisture content So whenever gas you are burning, let's say Indian gas at your home, so that will not contain H2S, CO2 or water. That means you have to remove those contents. Natural gas you are getting from wellbore and you remove these harmful gases, hydrogen sulfide, carbon dioxide and water.

Then you can use the gas. And oil, whatever oil you are getting, that oil may contain H2O, small amount of H2O also not allowed. may contain some mud or sand okay sand or mud may be contained so you have to remove those things after that you can use okay so then you separated you got separated oil oil is not having mud water or sand now some salt content also may be there salt content some heavy metal salt may be there so that also you have to remove so after removal that you got crude oil crude oil is very thick actually so after removal or everything you got thick crude oil what do you mean by thick thickness high viscosity actually so water is viscosity one but oil viscosity will be twenty hundred one lakh one million also possible some crude oil will have properties such that it will not flow normally like grease, toothpaste that much of thick so very thick fluid, high viscosity now you have ice engine, ice engine injector or carburetor whatever is there this thick fluid will not flow through this then you have to do something so that it will be flowing into the engine again this thick fluid may contain still sulphur content, some amount of sulphur

If somehow the sulfur is there, sulfur will be reacting at high temperature with oxygen. So it will contain S plus O2, SO2. And another form will be there, SO3 also. So I am not balancing this one. You can do balance.

So sulfur dioxide, sulfur trioxide also will be produced. Now you have water content. If that thick crude oil is having certain amount of water, then what will happen? H2O plus SO2. or SO3, it will form H2SO4, H2SO3.

Okay, so H2SO4, H2SO3 is an acid. Acid will be reacting with metal. Okay, so sulfur dioxide is there in atmosphere. It will be harmful, very much harmful. If it is having beyond certain limit, then people can die also.

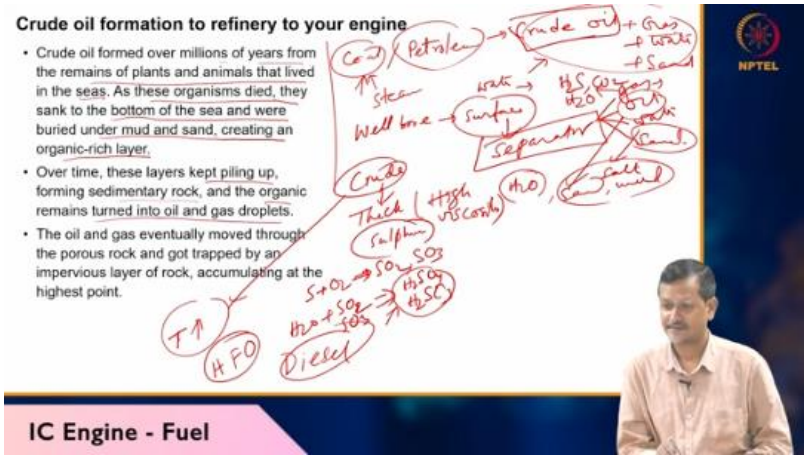
If you are smelling sulfur dioxide directly as H2S. hydro sulfide you can die okay if you have acid acid also it's very much dangerous if you concentrated hydro sulfuric acid or sulfurous acid is there it is also very much dangerous another way it is dangerous it will be corroding all the metal part okay so it is harmful for environment harmful for your machinery also so if you have any sulfur content have to remove carbon dioxide may not be so much harmful but it is not giving any heating value and again it is acidic gas so you have to remove the acidic gas acid gas means the gas reacting with water it will be forming acid carbonic acid will be formed okay so you have to remove carbon dioxide h2s water also have to remove because water is not giving heating value later i will discuss why water is important when you are calculating heating value of fuel will be giving lower calorific value okay later we'll discuss so whenever you are getting crude oil from wellborn you have to remove all the particle then finally you get a thick fluid crude oil it is having very less amount of sorry water sulfur dioxide uh hydrogen sulfide all these things okay now that thick fluid also you cannot put into your cylinder then what you have to maybe you have to increase temperature and you have to change viscosity okay so this crude oil increased temperature so whenever temperature is increased viscosity will be down viscosity low means again it will be flowing okay so flowing means then you can inject through injector port to your cylinder it can be burned like diesel fuel okay so this is the story of whole crude oil from wellbore you are getting for your engine so normal petrol or diesel this is highly purified or refined

fluid for your ice engine you are running for your bus truck bike car but this crude uh they call heavy fuel hfo okay heavy fuel so heavy fuel oil so heavy fuel will have more viscosity and sometime many many agency they are saying these are very harmful also because very very thick that's why some sulfur content and other content will be there So combustion may not be proper and it will be producing harmful gases. So many agencies they are saying okay don't use heavy fuel. But it is cheaper because from refinery you do not need to refine properly. So some thick fluid some other content also there you can use for your engine.

Okay normally this will be used for diesel engine. Okay this is for diesel engine. Over time, crude oil formed over millions of years from the remains of plants and animals that lived in the seas. These organisms died, they sank in the bottom of the sea, were buried under

the mud and sand, creating an organic rich layer. Over time, this layer kept piling up, forming sedimentary rock, and organic remains turned into oil and gas.

droplets the oil and gas eventually moved through a porous rock and got trapped by an impervious layer of rock accumulating the highest point so if you want to know more about this how this is getting formed then you have to go through we give it another document okay this is not our within our syllabus that's why i'm not going into details fine so marine engine you may have guessed okay this may be your engine so just i got this information from ashok leyland website okay this is their engine specification for marine ships okay so you can see so four inline cylinder is there number of cylinder so one cylinder is here and four inline cylinder inline cylinder means one cylinder is here another cylinder just wait I was drawing like this you can remember this is your crank shaft crank shaft previous lecture we discussed already this is your cylinder again this is your cylinder this is your cylinder and one more cylinder will be there okay so these are bearings these are bearings these are bearings these are bearings okay so one common crankshaft and four cylinders connected so one crankshaft is there one cylinder two cylinder three cylinder four cylinder okay four cylinders connected with series so this is called inline cylinder okay



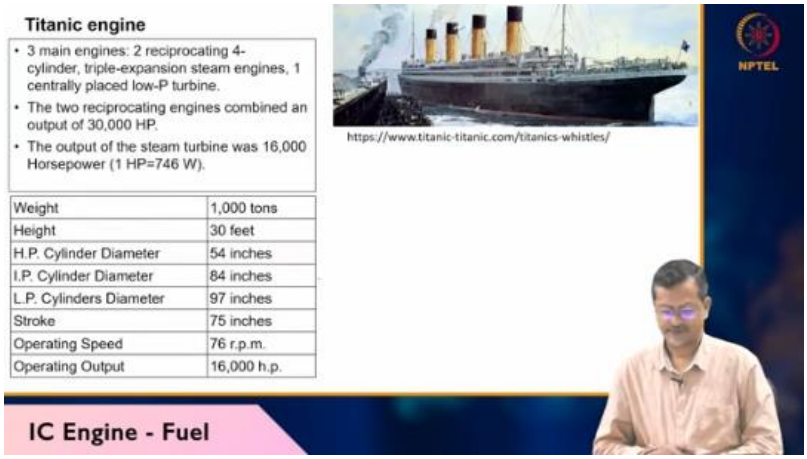
and some other type of cylinder already we discussed i think you remember this cylinder is here cylinder is here cylinder is here radial cylinder we discussed okay so this is not radial type this is inline type in one that one direction all the cylinders should be there okay and shaft is common this is crank shaft okay i have written already these are the bearings okay rated power in kilowatt 41 kilowatt 2000 rpm you can see rpm is very high 2000 right and 28 so you can guess rpm range 2020 2800 okay so displacement uh four liter displacement the piston displacement okay four liter it will take so so big engine and bore into stroke bore means this is stroke length saline stroke length BDC to TDC you can

remember and bore miss diameter 104 millimeter and 118 millimeter okay flywheel also there you can see this okay and maximum torque 250 Newton meter for 1800 rpm and torque and rpm if you multiply then you will get in you will get power actually This is torque, this is N, then power equals T into omega. So you can get power there.

So fuel injection type, mechanical inline pump is there. So this is first diesel engine, so inline pump is there. So naturally aspirated, we will discuss later. Naturally aspirated means how breathing or cooling is happening. Okay, coolant type, seawater coolant is used.

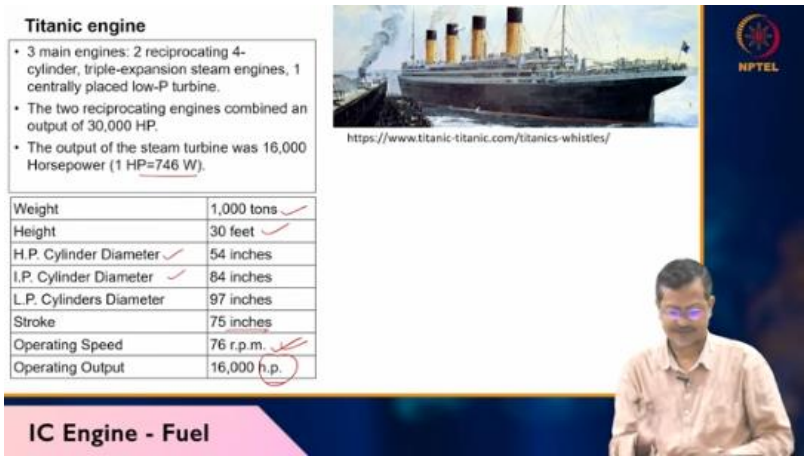
Okay, we will discuss later when we will discuss about cooling, engine cooling. And okay, marine engine size is there. Gear box also they are using, DMT something. So, it is their notation. Gear ratio 2 is to 1, 3.32 is to 1.

Okay, so they are reducing speed to half. okay marine diesel engine you can see marine diesel engine assemble the hydraulic gearbox they're using okay and application main propulsion engine for small craft or auxiliary applications okay coolant type 10 liter cooling fluid volume is required and starting system electric starting you say 12 volt dc starting system is there so spark plug will be there so 12 volt dc you have to supply charging uh alternator time is generator okay 12 volt 36 amp so power equals p into v you can calculate uh v into i okay uh engine drive it to without gaussian ticket okay so you got the idea of one engine how big it can be and what are the different parameters will be okay now just i took some example engine this titanic engine already is very much familiar to you weight was 1000 kg height 30 feet you see this high pressure cylinder low pressure cylinder so different types of cylinders were there so initially we got steam it was steam engine so usually you got steam so steam it will go to high pressure engine then same steam you are pushing to another cylinder another cylinder so pressure is going



Every time it is going lower, lower, lower. So you have multiple cylinders actually. So that is engine, steam engine. I will discuss later in other chapter. 75 inches stroke.

Stroke means TDC to BDC the distance. 75 inches. 75 means 5 feet, 6 feet. It is almost my height I think. operating speed 76 rpm okay this is propeller speed most probably operating output 1600 hp so this conversion also you should remember horsepower means like 746 watt okay this conversion sometime i'll be giving horsepower data sometime i'll be in kilowatt data so you have to convert from here and there okay



So, another example I am giving here. Icon of the sea. This is a new ship, cruise ship. The design is very large actually. You can see 3286 passengers will be there.

So many bars, lounges, swimming pools. Very big ship actually. The ship was constructed Royal Caribbean. They will be using LNG. Liquidified Natural Gas.

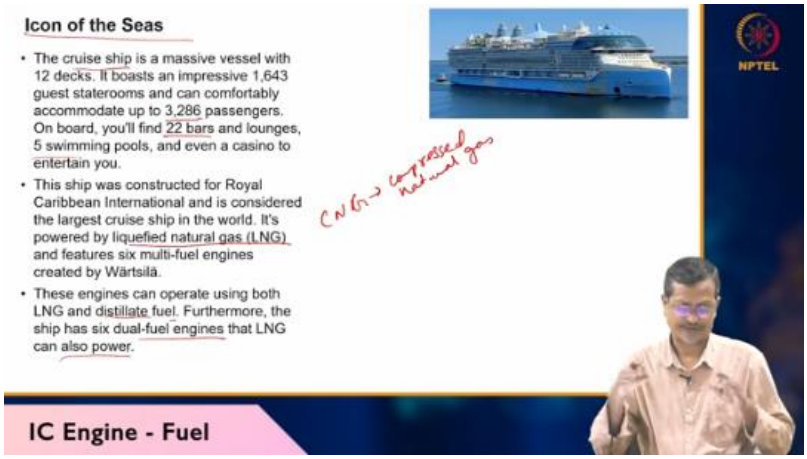
Liquidified Natural Gas and CNG. This is compressed natural gas. Okay. LNG means you created liquid. CNG means you do not create liquid actually.

It is compressed. Okay. So your Indian cylinder at home in India, they are supplying compressed natural gas CNG. Right. These engines can be operated using both LNG and distilled fuel.

Distilled fuel means like heavy fuel. Furthermore, the ship has six dual fuel engine that LNG can be also powered. So this is a dual fuel engine. So big, so heavy. So this engine will not be powering only for propelling.

It will be giving power for everything. Like so many bus, so many passengers. For everything it will be producing power. One engine it will be producing power for

everything. Like whatever water purification is there, your engine comfort like air conditioning system will be there, engine cleaning system will be there.



So all water production, electricity requirement, everything will be produced by one engine.