**MARINE ENGINEERING**

**By**

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**Lecture45**

## Fuel Oil properties

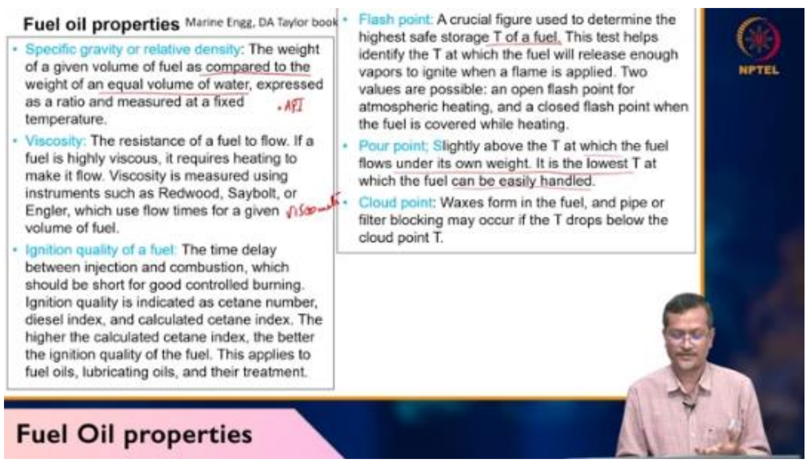
fuel oil property. specific sorry, whenever talking about fuel oil, fuel oil there will be viscosity, there will be specific gravity, there will be ignition quality, there will be pour point, cloud point, flash point. these definitions you should know, again amount of hydrocarbon and other properties also required, but basic physical definitions also you should know. specific gravity, the weight of a given volume of fuel as compared to the weight of equal volume of water, the ratio is called specific gravity or relative density.

sometime we specify this one with degree API. Viscosity, the resistance of fluid flow, fuel to flow, any fluid flowing, if high viscosity means flow rate will be lower. If a fuel is highly viscous, you require heating to make it flow. So, many time HFO or HFO fluid, heavy fluid you are using, so in that case you may have to increase temperature so that your viscosity will be reduced and it will be flowing inside the cylinder. Viscosity measured using instruments such as Redwood, Seabolt or other viscometers which use flow time for given volume of fuel.

Ignition quality, the time delay between injection and combustion is called ignition quality. This is a flash point, a crucial figure used to determine the highest safe storage temperature of fuel. If flash point is lower, so at lower temperature it is giving lots of vapour, so in that case that will be dangerous because the vapour will be mixing with air and it will be creating combustible mixture. So, that will be, if there you get any small fire source that will be, that will be complete disaster. slightly above the temperature at which the fuel flows under its own weight.

It is the lowest temperature at which the fuel can be easily handled. So let us say you are moving with ship from Chennai to Alaska. So Alaska temperature will be very low. So, in that case what will happen if you do not consider the pour point may be your fuel will be frozen or may be some wax particle and other particle will be settled down and some liquid will be on the top and other particle will be settled down or it will create hazy mass. So, that injecting that fuel inside the cylinder will be problem.

So, you have to Whenever you are using certain fuel and you are traveling from one country or one geographic location to another geographic location, so in that case you have to see whether it is having proper flash point, proper power point, proper cloud point, all these things you have to consider. So, let us say from you purchase certain fluid and in Chennai it is giving higher because temperature is higher.  it is giving more vapour, fuel vapour. the fuel vapour will be mixing with air and your weight loss of fuel will be there and again it will be a dangerous situation if it is going into the atmosphere.




LCV, HCV, Sulphur. LCV means lower calorific value, HCV means higher calorific value. calorific and higher calorific value, so LCB, higher calorific value means HCB. The carbon residue forming property of a fuel is measured using the Conradson's method. So, sulphur content, S means sulphur, sulphur content is important as it causes engine wear.

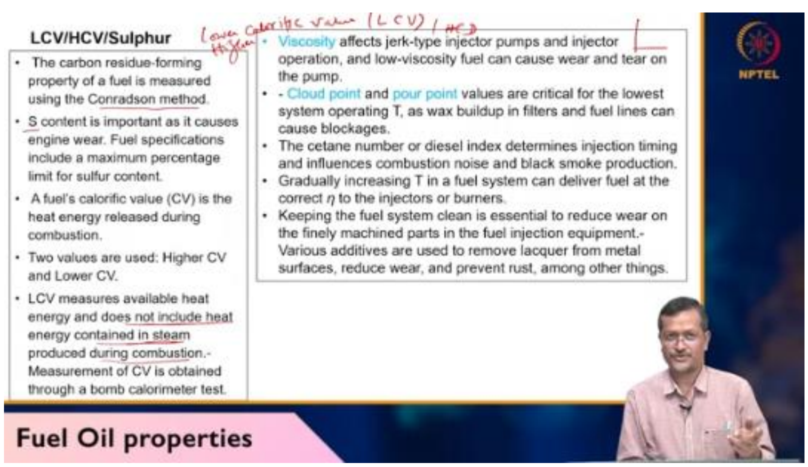
Considering sulphur content is important as it causes engine wear, fuel specification include a maximum percentage of sulphur content. A fuel calorific value is the heating value or how much heat is getting released from a fuel after combustion. Two values are used normally the terms you should remember higher calorific value, lower calorific value. Lower calorific value means Lower LCV measures available heat energy and does not include heat energy contained in the steam produced during combustion.

So, fuel can have water particle a certain amount, certain percentage. Now, you are burning the fuel. What will happen? Water will be getting latent heat and sensible heat and after combustion that heat actually it will not give you any value. Water will take that heat with it.

So, if you have higher amount of water content that means water will be taking lots of latent heat and it will go away with your exhaust gas. So, if you have a fuel with lower amount of water or H2O vapor, so your life is better. So, LCV measure available heat energy does not include heat energy containing steam produced during combustion process. So, whenever you are calculating your how much energy you are getting from a fuel, you have to use lower calorific value means higher calorific value means total amount of heat which include water vapor taking heat also. Now, if you remove total heat you have got minus the water vapor taking heat, so that much heat actually your usable heat.

So, that heat is called lower calorific value. So, that heat you can use for your calculations. Viscosity, viscosity after affects jug type injector pump and injector operation. So, viscosity is very much important.

It is temperature dependent also. If you increase temperature, viscosity will be down. So, and if you are changing temperature, so in that case viscose will change and your system can fail also or engine can stop working because it is not flowing into the engine.  in that case maybe you have to increase temperature before putting into the cylinder. Oil treatment, oil treatment is essential for both fuel oil and lubricating oil before they can be used for engine.

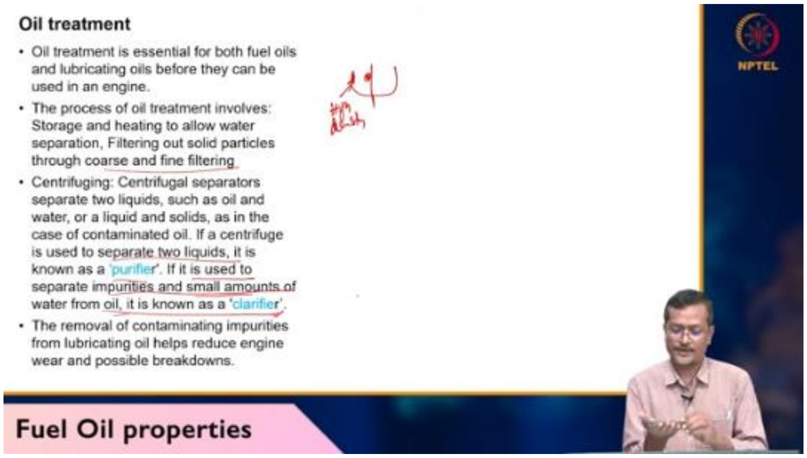



The process of oil treatment involves storage and heating to allow water separation, filtering out solid particles through coarse and fine filtering. Centrifuging action also you have to do. Centrifugal force, let us say if you take certain amount of fluid and if you roll it at a very high speed, because of high speed, different density fluid particle will be creating different layer. For example, there will be one layer, there will be high density. near the center of this axis low density fluid will be getting accumulated.

So, in that way you can separate the impurities from oil or petrol or diesel or grease or toothpaste sorry petrol or diesel or your lubricating oil. If centrifuge is used for separate two liquids it is known as purifier. If it is used to separate impurities and small amount of water from oil, it is known as clarifier. So, you see the difference between purifier and clarifier. Impurity is small amount of water also, so that is called clarifier.

To remove contaminants impurities from lubricating oil helps reduce engine wear and possible breakdown. So, lubricating oil purpose is to increase smoothness when one rotating surface is there or sliding surface is there. So, if they are getting very much high friction, so what happens? In that case, he puts some lubricating oil, so it will be moving smoothly. So, it will be reducing wear and tear.

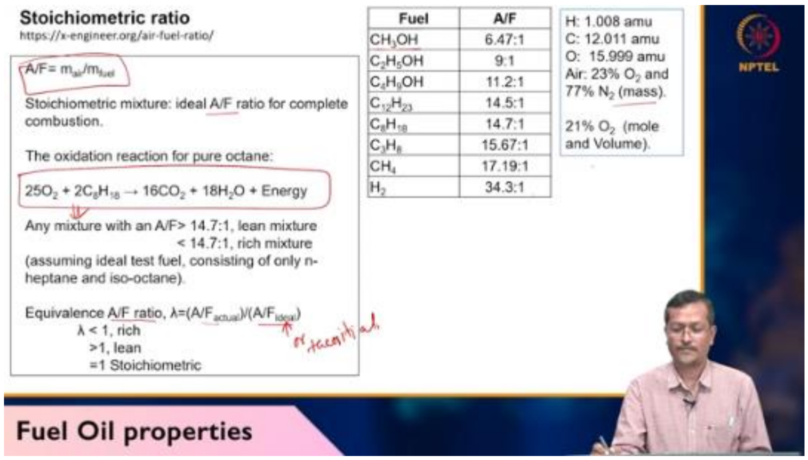
But if you have some contaminant, let us say some sand particle always there. So, sand particle when one surface is sliding over other or rolling, so that solid particle will be rubbing any of the surface or both surfaces. in that case, wear and tear will be more and your system can fail quickly. Fuel when burning in combustion chamber, some terms are used. One term is called stoichiometric ratio.




So, the ratio is defined as the mass of air divided by mass of fuel. This is mass ratio. Stoichiometric mixture, ideal air-fuel ratio for complete combustion. The oxidation reaction, you can see C8H18. We will use this.

Normally, this is common fuel for petrol engine. For this one, your air-fuel ratio 14.7 is to 1 or stoichiometric ratio actually. If you have more fuel or more air or less air, then your stoichiometric ratio will change. Equivalence ratio, air-fuel ratio, air-fuel actual divided by air-fuel ideal or theoretical, ideal or theoretical. So, lambda less than 1 is rich mixture, lambda more than 1 is lean mixture and lambda is 1, it is called stoichiometric ratio and some fuel will have different stoichiometric ratio based on their molecular weight.

You can see this CH3OH, it is having 6.47 air-fuel ratio, hydrogen is having 34.3. And whenever you are calculating for air-fuel ratio, you need to know this molecular mass. So, hydrogen is having 1.808 atomic mass unit, carbon 12, oxygen 15, 16. Air 23 point, 23 percent oxygen, 70 percent hydrogen by mass is there. But if I consider mole, then 21 percent mole is there in air, oxygen.




stoichiometric air-fuel ratio.  here you see this figure power and this is air fuel ratio. air fuel ratio when this curve is fuel consumption curve, fuel consumption this is called power curve. For gasoline engine, for example, it is given lambda is 1 for this line, lambda equals 1 and for right side, lambda equals actual airflow ratio 14.7 is to 1. But right side of this lambda equals 1, this is value, for example, it is given like 15.4 is to 1 and lambda equals 1.05, this is a by f. But left side here is given like 12.6 is to 1, a by f airfield ratio, lambda equals 0.86 and maximum power you are getting here.

But here base fuel economy, what happens if you have little bit higher amount of air, So, your fuel will be completely, it will be burning completely and it will be giving maximum power and your fuel economy will be better. But if you have less amount of air, so in that case what happens? You will get maximum power but your air consumption is low. So, maybe some pollutant gas, carbon dioxide, other gas will be produced.

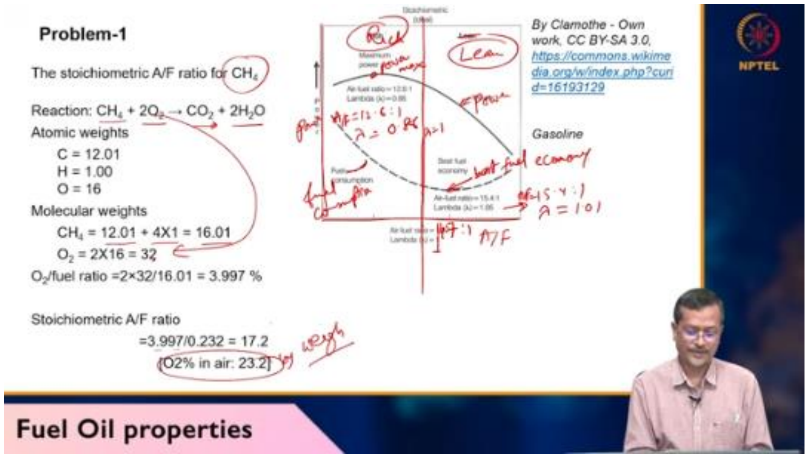
okay so your tendency will be to give some small amount of extra air so that combustion will be proper if your economy economy will be proper but when this maximum power scenario comes let's say one bike is designed for two person and three or four student riding okay uh on a bike so in that case you need maximum power but your engine volume cylinder volume is same and you are having instead of two person you are four person riding on the bike okay so bike will be requiring more power so in that case what you do you get more fuel so some fuel will be unburned from tailpipe some petrol smoke you can see white smoke will be coming and it may be making noise also so in that case you are getting less amount of air you are getting more amount of fuel so some will be un unburnt but it will give you maximum power okay but if uh economy so many cars and vehicles they they will be marking this economy zone economy zone means their little bit extra air will be there inside the cylinder and combustion will be proper. So, that time fuel economy will be better. But overloading engine or some other condition you create where you need maximum power there you have to give more fuel, air will be lower.

So, more fuel is there that is called rich mixture. Less fuel is there is called lean mixture. Okay, so this vertical line is there at the center, left side is rich mixture, right side is lean mixture. Rich mixture will have power higher, air amount will be lower, but pollution will be more. But lean mixture, it feel going to be better, power will be little bit lower, but your environmental issues will be less.

Let us assume one fuel, methane. So, methane will be reacting with oxygen, it will be producing carbon dioxide plus water. So, atomic weight of C is 12.1, hydrogen 1, oxygen 16. So, molecular weight of methane 12.1 into 4 hydrogen, 4 into 1, so 16. oxygen 2 oxygens oxygen is used.

So, we are getting 32 molecular weight. So, oxygen by fuel ratio this is not air fuel this is oxygen by fuel ratio. So, 2 into 32 is 2 oxygen molecule is there and fuel molecular weight 16. So, total you are getting 3.997 or 4 percent. Stoichiometric ratio air fuel ratio

3.97 divided by 23.2. 23.2 is coming from that oxygen is there in 23.2 by weight percentage. So, air-fuel ratio is coming 17.2. So, each fuel have their own air-fuel ratio. So, here this figure C8H18, this fuel is having 14.7.




This is basically petrol engine. So another problem, equivalence ratio lambda equals 0.7 for ethane combustion. Calculate percent of excess. Ethane means C2H6. So C2H6, if you react to oxygen, then 2C2H6 will be equal to 7O2, 4CO2, 6CO2.

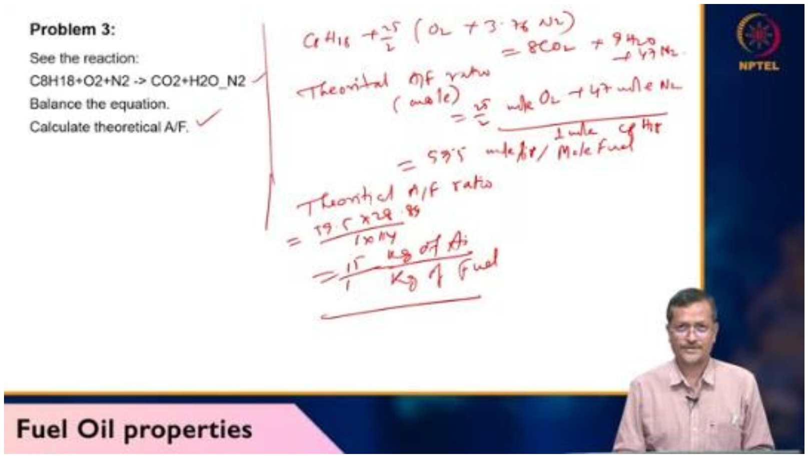
So oxygen fuel ratio, oxygen here you can see 7. And fuel is 2, so ratio is 7.2. My weight is 7 into 16, 2 into 30. 16 means oxygen molecular weight and 30 means C2H6 equals 12 into 2 plus 6 into 1. So, 24 into 30.

So, you are getting the ratio 28 by 15. Strychometric ratio, theoretical 28 by 15 to 100. So, you are getting 8.11. So, air-fuel ratio actual by air-fuel ratio theoretical. So, you are getting lambda.

So, if you solve this one, finally you are getting excess air is 30%. So, another problem we can see C8H18 again oxygen nitrogen first you have to balance the equation and calculate theoretical air fuel ratio. So, to balance this one actually you have to put C8H18 plus 25 by 2 oxygen plus 3.76 nitrogen 8 CO2 plus 9 H2O plus 47 N2. For balancing 79 by N2 by 21 percent, so that is giving actually 47 N2.

Theoretical air flow rate, air flow ratio, mole, not weight, this is mole. So, 25 by 2 mole oxygen plus 47 mole nitrogen divided by 1 mole C8H18. So, this should be giving 59.5 mole air divided by mole fuel. So, theoretical air-fuel ratio, so theoretical air-fuel ratio equals 59.5 into 28.84 kg of air divided by kg of fuel.

So, this is your solution. So, thank you very much for today's lecture. Next, we will start new topic. Thank you.


Problem 3:
See the reaction:
C8H18+O2+N2 -> CO2+H2O_N2
Balance the equation.
Calculate theoretical A/F.
NPTEL
Fuel Oil properties