Indian Institute of Technology Kanpur

National Programme on Technology Enhanced Learning (NPTEL)

Course Title
Bioenergy

Lecture – 28
Spark Ignition Engine

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Welcome back to the lecture series in bio energy so we will pick up where we left in the last class we were talking about the role of the zeolites or zeolites in terms of leading to the catalytic cracking so if you just recap what essentially happens.

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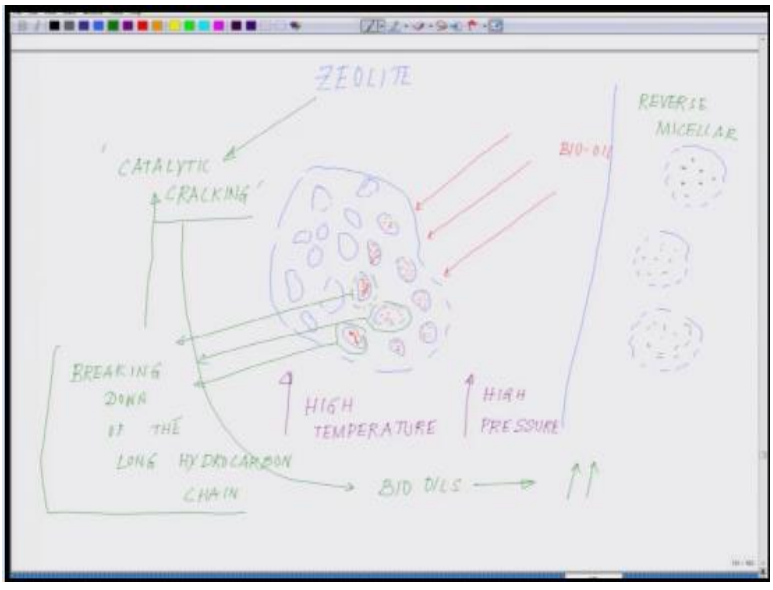

For example you have a real light molecule if something like you know something like this and which has a small pores out here all over the place okay sometimes they are very uniform for

certain situation there are non uniform for depending on their the size of the pore this could be used for you know purifying certain group of molecules which bigger than that will not pass through and smaller than that will pass through so now if this is a zeolite molecule and here you have you are putting the bio oil through it okay.

Now within it what happened up oil molecules get trapped into the small pores okay. So essentially what you are doing is so these dots are showing that whatever the oil molecules are getting trapped. So what you are having essentially is as if there are small reactor vessels it is a strategy which is also followed when people does the reverse micelle synthesis when they make nano particles what they do they try to make my cellar structures something like this just an analogy I am using it for you.

So for example, you wanted to build so when paper does reverse micelle and those kind of synthesis what you do you have this my solid structures my cells are basically hydrophobic structures on them you are having those different kind of nano material what you want to synthesize like weight which is an analogy a similar analogy like, you know reverse micelle method on my solo synthesis like okay.

So that is how you kind of you know and separate out the nano particles in small myself. So they act individual my cell act as a small reactor vessel following the same analogy out here what is happening your oil molecules are getting trapped in it, and there are some bigger ones some smaller ones likewise. And now we expose this to high temperature and high pressure in this situation what will happen each one of those small pockets.

What you see out here say for example, these are individual reaction vessels just what I showed you as an analogy of the reverse myself and out here it leads to breaking down of the long hydrocarbon chain. The reason being since you are confining the reaction in a small volume in a small space.

So the amount of collision which will be taking place between the molecules will be significantly higher as compared to when you are doing a reaction or bulk put in a large vessel just think of it

if you want to boil water in a large vessel the amount of energy it will be needed the amount of collision which will be much more lesser as compared to if you want to reduce the vessel size. And let it be very teeny-tiny where is little very finite amounts of molecules are there and they are continuously colliding with each other, and the amount of heat which will be generated because of those nano confinement will be much more higher, because of the molecular collisions among each other okay.

So this is where this whole process which leads to the breaking down of this long hydrocarbon chain in these zeolite structure what we call as catalytic cracking this was one of the tail piece of the previous class where I was talking about catalytic cracking. So I wanted to give you a visual feel of how the catalytic cracking is taking place. So just to talk about zeolites are we used for catalytic cracking of the bio fuels or bio oil in order to increase their efficiency.

So we will come about this efficiency how we measure the efficiency now going back in the previous class which will suppose remember we talked about that particular table layout.

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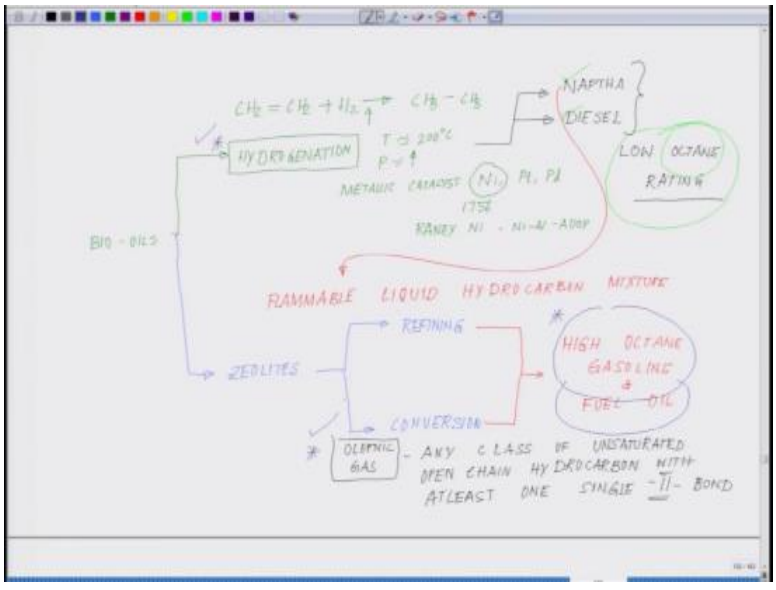

So we talked about when you have the bio oil what are the transformations we are doing okay one transformation what we do is we talked about the hydrogenation reaction okay so what essentially is an hydrogenation reaction. So just to give you an brief idea it is something like just I am giving you the most simplest example say for example if CH2 and CH 2 double bonded okay and you are adding hydrogen to it in other word is reducing it even further you get something like this ch3 and chg okay.

So now such reaction can take place at a temperature around 200°C and in the presence at the pressure which will be higher than normal so P stands for pressure and using different kind of metallic catalyst okay metallic catalyst which are used and one of the prominent catalyst which is used is nickel you can use platinum you can use palladium. So you remember nickel talk to you about the discovery of nickel in1756 by the Swedish geologists and in the laboratory conditions.

Sometime they use something called a ran in nickels ran a nickel is essentially an alloy of nickel and aluminum alloy okay. So this is how the hydrogenation is being done and hydrogenation leads to so you remember in the last class we talked about hydrogenation leads to the two things you are getting naphtha and I told you that I will talk later about this naphtha and diesel. So Napa and diesel these are considered as low octane ratings so what is this octane rating and what is the will and laptop okay. So talking about Napa baptized essentially it is a flammable liquid hydrocarbon mixture so that is essentially what nap pie is so this is flammable.

So it is basically a liquid-filled flammable liquid hydrocarbon mixture okay hydrocarbon mixture that is what is not price all about and while following this we talked about the other route which is underneath I am showing now, we talked about using the zeolite. And using the zeolites we have to route one is for refining and another one is for conversion okay, refining and other ones is for conversion and I have already talked to you about the conversion here I will talk something else while I was writing conversion must have seen I put something called all the sonic gaps what is olefin gaps okay.

So all of any gas by definition are basically any class of unsaturated open-chain hydrocarbon having any class of having one double bond at least one double bond any class of sort of

unsaturated class of unsaturated open chain hydrocarbon with at least one single bond one single double 11 at least one single double bond okay this stands for double okay one single double bond okay. Now if you see the chart if you remember in the last class if you look at it very carefully we talked about these two leads to something called high-octane gasoline high-octane gasoline and fuel cells oil.

Now we are looking at this whole thing may realize there are few words which are coming new to you which I have not discussed in the last question I told you. In the next class I am going to discuss it. So the first new word which is coming what you have discussed was nuts how we have already discussed about this diesel is another fuel which has low octane number so this is a word which we have not discussed what is octane number okay.

Then we talked about something out here which is high octane gasoline and fuel oils what are these, and how we can understand it and we have talked about the defending gases okay, and we have already talked about the hydrogenation okay. So now in order to understand what are these concept of octane numbers, now we will draw I will draw your attention to the concept of octane number what is really an octane number.

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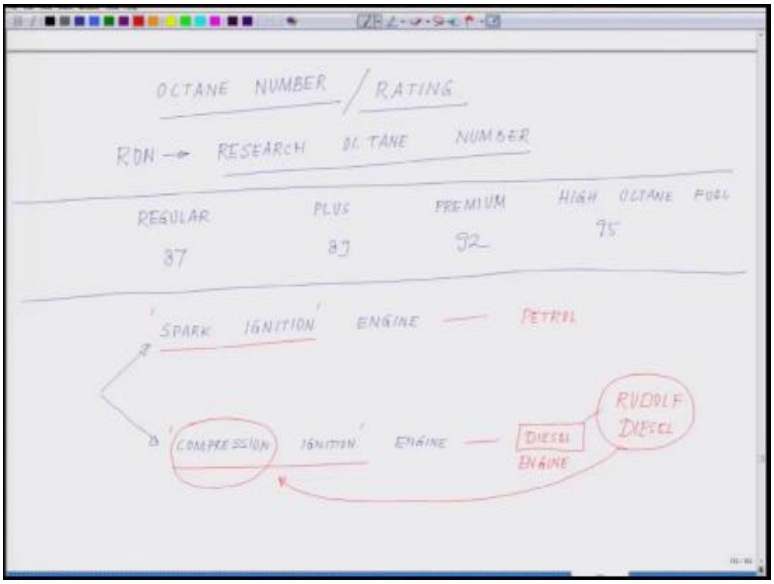

So octane number a basic understanding of octane number is very critical so going by the definition if you talk about what is an octane number or octane rating. So sometime you will see octane number or it is also called octane rating okay. And there is a common unit which is used for that it is called R0N this is the most simplistic expression of octane number which is called research octane number.

And if you go in a patrol pump you will see some of these numbers which is basically the octane number. So if you this is a common site you will see I am just putting it in whenever next time you go you just have a look at it. So it will be written like in a regular one or 87 plus full of 89. So the numbers could vary 92 and then you will get something like high octane wheel if you have traveled outside the country this is very common here also you will see in several gas stations you will have this kind of things which are mentioned.

But then what is really octane number is all about, so in order to explain this we will have to go to some of the very basics of the engine, because that will help us to understand what we meant by high-octane fuel what we mean by low octane fuel. So in order to understand it I believe all of you have one the basics up to standard 10 and fines. So I will use just acknowledged for you to explain the basic architecture of the engines.

And from there once the basic architecture of the engine is clear it will be very easy for me to explain what does that octane number means, so all of you travel many of you are having different kind of vehicles maybe electric vehicle will not avoid that today are diesel vehicle or a patrol vehicle. So is basic difference between the two, so there are scooters where many of you have taken out the spark plugs.

And you have cleaned the spark plugs and yet there are vehicles where you do not need a sparkplug okay, they function in a different way. So most of these fuel engines or gasoline based engines are of two categories. So today we will be first of all talk about the different kind of Indian, so either you will have engines which are called as spark ignition engine okay or you will have compression ignition engine compression ignition engine.

And just for your knowledge listen put it there most of the spark ignition engine uses Patrol whereas compression ignition engine use diesel, but let us understand the basics first what are these two words what is meant what they will talk about spark ignition and compression ignition. So when we talk about ignition means you are firing up something you are igniting fire or something okay.

So all of you burst crackers all of you switch on the gas. So in order to switch on the gas what we do you just use the lighter or a matchstick and ignite the gas right you can do the same thing with the crackers you just ignite the cracker and it bursts. So this word is creative what is meant by spark ignition, but there is another word here this is what is talking about dick. So there is another word which is called a compression ignition.

So in terms of the compression ignition what you are talking about, so as if you are compressing something compress means you are, you know bringing something compressing if something your compressed if you compress it ignite okay. So these are the basic will draw the whole schematics to make you understand. So first of all just by looking at the word you should be able to understand spark means for ignition you have to use a spark for ignition when you have your compressing of something that is called compressed again okay.

So now let us talk about first about the and the compression ignition let me put this name what you see diesel is actually nota foil it is after a gentleman called Rudolf diesel who is the father of engine which follows compression ignition and that is why it is called diesel engines okay. So it is not a name of an individual, he was a German, and he was the one who for the first time proposed and developed what we call as diesel engine of today where most of the trucks, buses, cars a series they run on diesel engine.

It was after this gentleman Rudolf diesel okay, now let us talk about the basic architecture of these engines because that will help you to understand what kind of bio-oil you are using a where you can use and what are the improvements you have to do.

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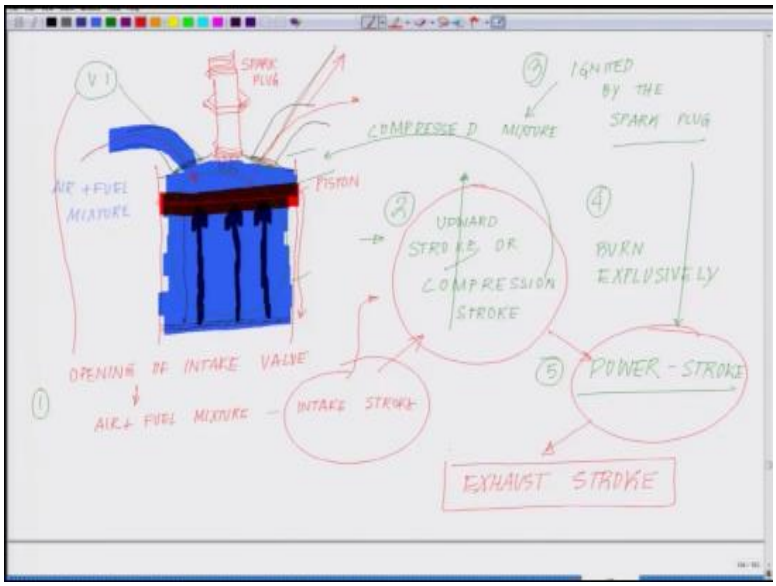

So in terms of the spark ignition engine so it is something like this so it is a more simplistic way I am going to show it purely technical, but do not worry about it okay. So this is a cylinder what is it just drawing okay. And then here you have a spark ignition okay. So this is essentially the spark plug okay, and underneath you have you all have seen inside the scooter the world scooters what you have you will see a spark plug like this and on the side you have something like okay.

There is coming like this, and so if you can search any other places you will see a lot of complex drawings and just trying to make it very simple for you. So that it kind of so there is a valve out here what I am showing green okay. So this is the spark plug with the red color what you see out here this is the spark plug okay. So you see the spark happening here, now what you have is okay.

Now from here what you see this valves the step one, so this is a spark plug baseball okay step one. So this is the inlet for a mixture of air and here plus fuel mixture. So the first step what happens this valve 1 open okay, to find your open and there is an intake of the mixture careful. And as it makes sense before you see it moves down okay somewhere out here.

Once it moves down what will happen, so this whole place will be now filled with the mixture okay. So this is step one just now I did okay, so the step one is integral opens. So this is the intake valve opening of intake valve step 1 followed by step 2 air plus oil mixture moves in and that pleased to intake stroke why it is called intake stroke, because this plunger this is moving down okay, it move down like this okay.

So this is the first step the piston is moving down, so here is a system which is moving down. So now this whole vessel is the cylindrical vessel the cylindrical vessel out here is filled with the air-fuel mixture. So now the next thing what happens is step 2 from here is where this piston starts to move backward it has come down. Now this system is going backward like this okay. So this backward movement of the piston, so what you are essentially doing out here.

Now you are pushing this back like this, so the system is going up. So in a small area now you are concentrating the, so all your mixture is now concentrated in this small area. So now the plunger is back out here okay for the piston is back out there. So now what you do so this is called your second step which is the followed by upward stroke or compression stroke it is also called compression stroke.

Because you are compressing the gas compressing the mixture okay or the fear compression stroke this is step 2 where you are doing the compression stroke. Now in this zone, now follow here and this zone it is all a complex mixture this compressed mixture is now ignited by the spark plug step 3, is then ignited by the spark plug. So having seen this try to visualize the situation what is happening.

So you have a cylinder in front of you so it is filled with your fuel. Now you are pushing it from the bottom like this you are pushing it like that you are compressing it so while you are compressing it you are bringing these fuel plus air molecules much more closer and if this will lead to a lot of thermal agitation between these molecules huge amounts of heat will be generated because we are in close proximity.

Just imagine you have 1000 people who are this much distance apart now you are pushing those 1000 people in a smaller room what will happen those 1000 people is fighting with each other we almost close into each other okay they will be much more collision between them that is exactly what happens when they are going up and this will generate a lot of heat and in that situation if you push the spark plug switch on this is a slight spark this will really burn the bullets inside it what will happen.

Now followed by one so if this is your step one is going on so this is your step two going on this is you ignited by the spark plug then the fourth thing what will happen will be spark plug ignited the sparkplug.

And in the compression mixture and this will it will burn explosively okay this burning what will do is it will force this piston. Now because now see this was the size it came back and it spark and this will generate a lot of gas and lot of will and that explosion will allow the piston to come down. So next step what will happen this piston which has gone from top to bottom step one the next it went back as a compression stroke.

Now will again come down because now this whole place will be filled with bones will once it comes down that is called the power stroke okay that is it that is called the power stroke which is, so piston step one system coming down filling the whole tube or the cylinder with air and fuel mixture just in going up compressing the air and the fuel mixture spark plug ignite leads to an explosion by default the piston comes down while it comes down that is called the power stroke.

So how many strokes we talked about we talked about intake stroke step one upward stroke or compression stroke step 2 followed by something called a power stroke ok now after the power stroke there is a 4 thing which happens here that is exhaust stroke. So as of now what we talked about was only this port from where the air and fuel mixture into it but there is another one out here which is basically taking out the exhaust.

So basically burn gas or anything which comes out through this and out here this was open on this valve opens it throws away so this is the exhaust stroke or you can call this is the first stroke

and forth this is the fourth stroke so what you see there are four motions which happens so the first step was in the reaction vessel there is an intake of the fuel and the air mixture and that push the piston downward therefore one like from top button right then you pushes the piston upward in order to compress the air and fuel mixture in a very small volume.

So initially the volume of 10 yard almost sinking in down to one cubic centimeter which the way we ought to explain okay now you will spark it using the spark plug ignited using the spark plug once you do so the next thing which happen it leads to an explosion in the chamber which pushes the piston down automatically which is third time piston is coming making a movement first down second up compression then again down because of the power stroke.

And the fourth that exhaust the exhaust gas which is formed because of the combustion happening inside that because of the ignition which is done by this spark but throws away that gas through the second valve which was there on your right hand side and that is called the exhaust stroke so essentially there are four strokes which happen here so this is how most of the patrol vessels or patrol vehicles function thank you.

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