Indian Institute of Technology Kanpur
National Programme on Technology Enhanced Learning (NPTEL)

Course Title
Bioenergy

Lecture – 40
Biological Root of Gasification and summary of Course

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Welcome back to the bioenergy lecture series, so we concluded the last class with the gasification techniques. Today we will talk about history of the gasification in terms of the vehicle skills you might wonder that today we are teaching this subject but it will surprise you the gasifier based vehicles have been running. Since the time of Second World War even earlier than that as a matter of fact gasifier system was widely developed in Sweden where at one point during very early nineteen hundred. There was a lack of petroleum products petroleum supplies and they invested heavily on gasifier system and they use the flat bed gasifier will come will know down all these things for your convenience.

And after this during Second World War there was a shortage of fields and the technology which was developed in Sweden and few other places in Europe came very handy. So there were vehicles which were driven using gasifier reactor system okay. So what we will do today will just briefly enumerate the little bit of the history and then we will talk about the challenges and where the technology kind of you know lost and again getting revived in the present time okay. To start off with so talk about the vehicles will using gasified vehicles will using gasifier okay?

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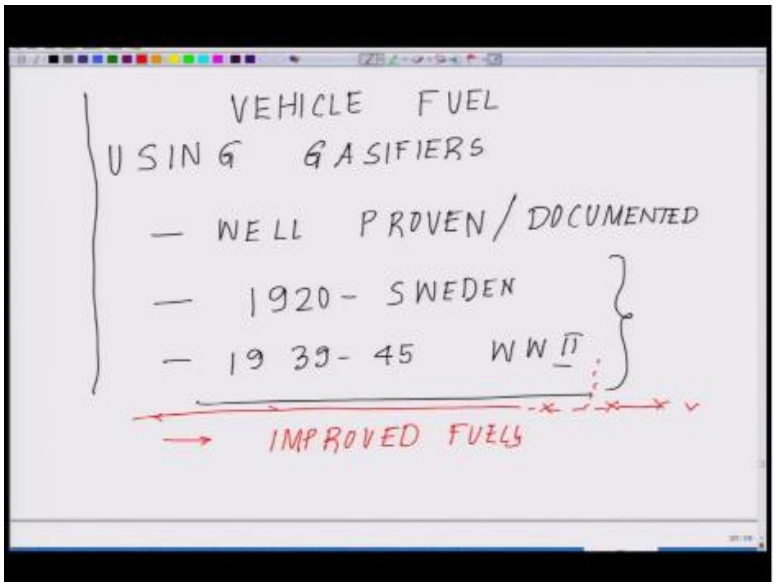

So they use a gasification to provide a fuel for motor vehicle for biomasses very well proven and documented okay. Well this is very, very time tested technology well proven and documented very well documented the last hundred years of literature has several side documentation and it all started during 1920s in Sweden this is post World War one okay. Where the technology was really picking up followed by 1939 to 1945 this is World War two this was the time there were shortage of petroleum products in Europe and led to the need to develop alternate technologies to provide fuel for Motor Vehicles. So if you look at it 1920s we are almost approaching 2020 now okay so this technology is very much there but what happened post-world War is I will just put it in red post-world words you are getting lot of improved fuels.

And due to the improved fills this technology somewhere get lost people post again world war there is not much investment happen in this technology because you are getting very high quality very refined oil for you know different kind of aviation purpose different transportation. So this technology kind of took a backseat but today let us revisit some of the pros and cons of this technology.

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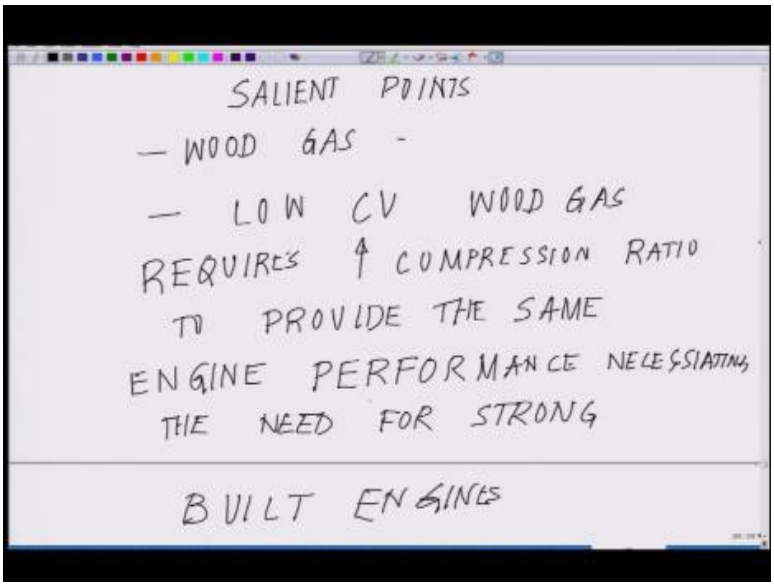

So let us jot down the salient points salient points of this technology are, so there is this wood gas technology there is hardly any bottleneck. There is no bottleneck when we know this technology it leads to low calorific value wood gas. And it requires what are the requirements to drive vehicle for this requires high compression ratio you remember when we are talked about the compression ratio will talk about talking about the engines high compression ratio. To provide the same engine performance to provide the same engine performance okay. Necessitating a thing the need for strong where it engines mostly they are very similar to the diesel engines. What could be used?

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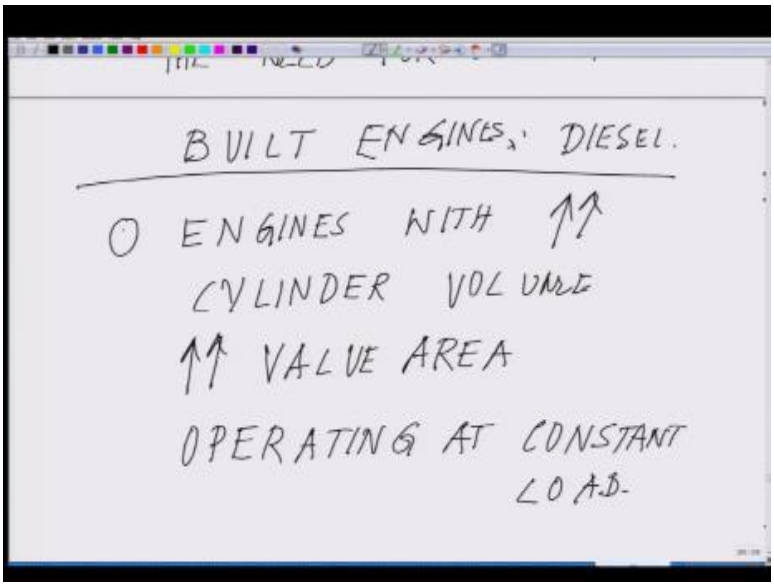

So mostly the diesel engines come very handy for this kind of situation okay. Whereas a second aspect is that engines with large cylinder volume engine with very large cylinder volume larger valve area operating at constant load operating at constant load at low rpm.

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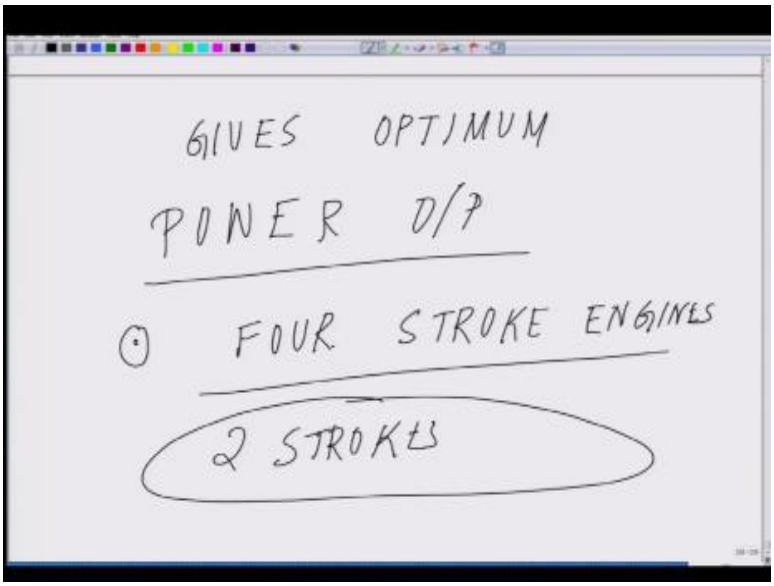

At low rpm gives optimum out power output optimum power output okay. This is very important so it is basically stationary industrial engines and secondly the small high speed engines like four-stroke engines are not very successful in this kind of setup four-stroke engines are not very, very successful they are not very efficient in this kind of situation. Whereas the two-stroke engines are very successful for this kind of wood gas system two strokes are fairly successful okay.

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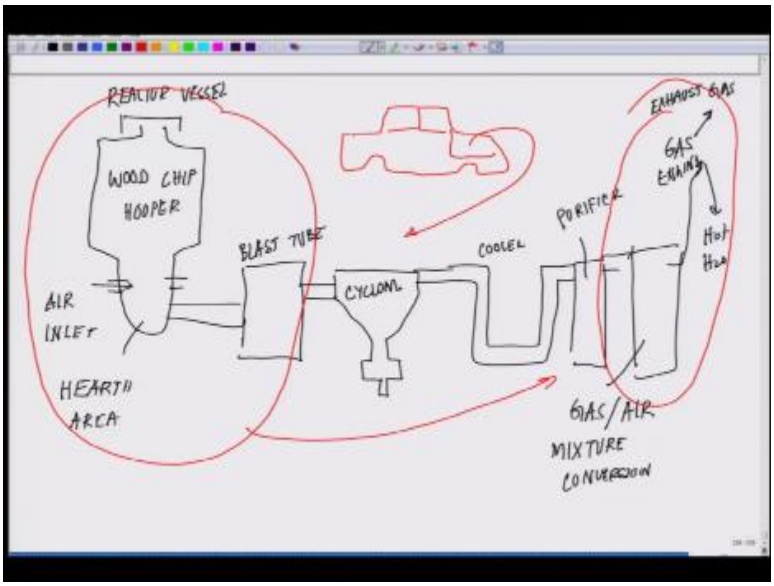

And if you look at how these are being made, so I will give you a flowchart of it gasification to produce oil from the gas for the gas engines so flow chart will kind of give you an idea something like this where do you have so this is your reactor vessel reactor vessel okay. So you have the woodchip hoppers which are present here. And you have the air inlet this is the third area and here you have the blast tube, so this is what you can put in the front of a car right and this is where you are having, cyclone sitting here from here it goes to the cooler area or the coolant where you are cooling down the gas.

And from here you move to the air purifier go on and here you have the gas here mixture conversion. So in order to understand this you recollect how we did this goes to the gas engine and here you have the exhaust gas and you have hot water. So if you look at it very carefully so this is where you have the reaction happening this is where the gas is getting generated and this is where you are running the engine. So in one unit so you can have the front of the car set for example this is your car so you could have this whole setup out here. This is what you see out here and there were cars which are developed in that whole process where you have the whole set up in the front and you run the car using these kinds of gasifiers.

But the challenge is that you will get a low calorific value you feel obviously the power of the engine will be less. And I as I mentioned earlier these can only run the two-stroke engines so automatically you know we will have to compromise on the speed and the efficiency of the system. And on top of that what all we have discussed there will be charging problems there will be ash problem. And if we look at this point very carefully there will be water which will be coming out with Lee utilizing the water which will be have a lot of contaminants you have to purify this water.

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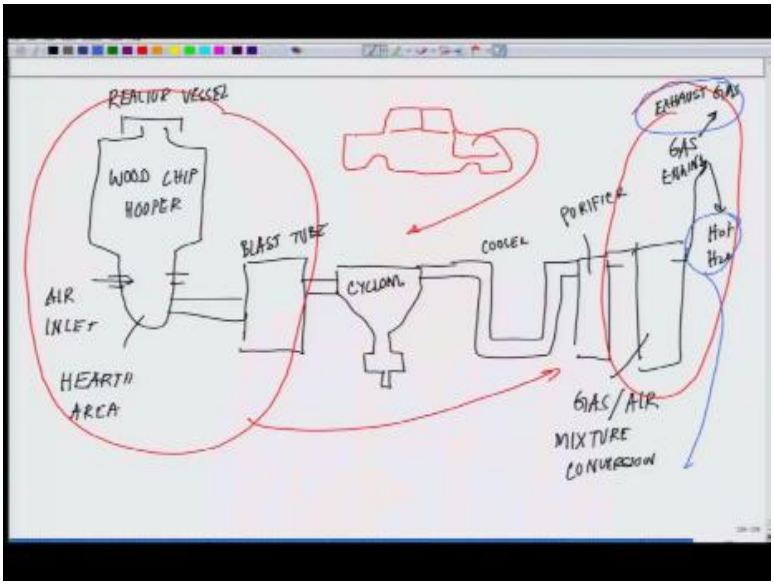

And of course you have the exhaust gas coming through so overall this is how this whole technology of 100 years functions. And there are different ways you can do it so this is one technique where you are doing the thermal and the other way of what I was mentioning of gasification is a biological route of gasification.

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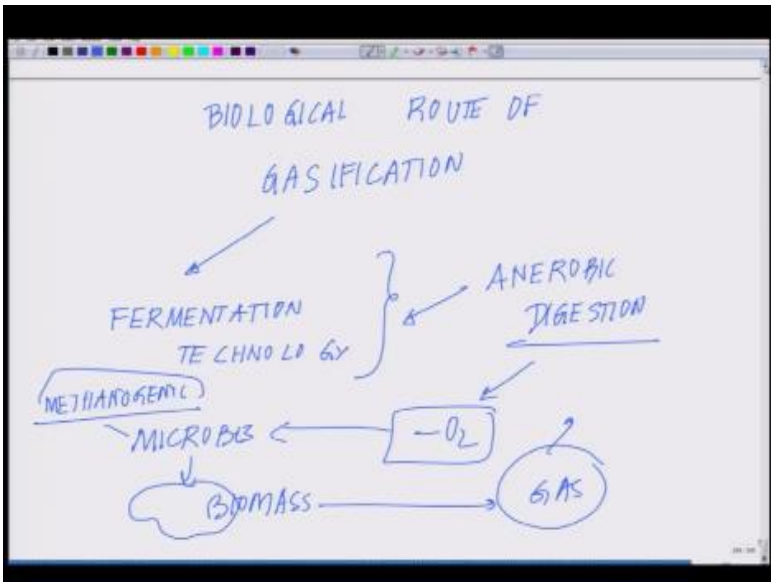

So in terms of the very briefly I will touch upon that biological route of gasification in the biological route instead of using high temperature. What you are doing you utilize two technologies the fermentation technology fermentation technology. This is one route the other route what you use which is basically follows anaerobic digestion. What we meant by anaerobic digestion is essentially there are series of bacteria microbes fungi which in the absence of oxygen as I could see there are microbes which works on biomass on top of biomass here if you have the biomass and they generate a lot of gas. Especially bacteria like you know you have such microbes like you know methanogenic microbes which produce methane and all this kind of thing.

So this is another route by virtue of which you can think of you know generating a lot of a lot of gas so in the beginning of gasification I told you. One is the thermo chemical route what we have extensively talked about and we talked about a little bit of the biogas plants in earlier. So most of these techniques the whole idea is very simple you have a biomass which has to be degraded and it could have liquid based will or you could have solid fuels or Oracle of gaseous well okay. So in terms of the league gaseous will you could either follow the microbial digestion route or thermo chemical route depending on your economy and how we ought to recover the system.

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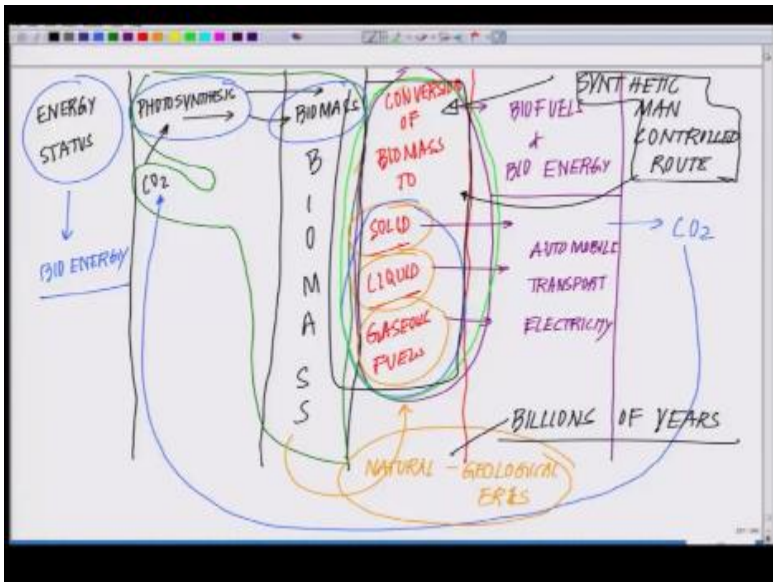

The thermo chemical route is very well-established microbial route we know what reality is scaling up is the current area of research which is going on. So this brings us to almost at the fag end where let us look through what all we discuss. So we started our journey with first we talked about energy status and the context of bioenergy okay. We talked about in a very early part if you remember energy status followed by we talked about the photosynthesis and we talked very extensively about photosynthesis because this is the route which leads to the formation of biomass. This is where all the carbon dioxide is coming and through green machinery is converting into biomass.

This was one area we invested or investigated very, very profoundly the biomass formation okay. Next what we talked about is that different conversion process which is the technology party conversion of biomass to solid liquid and gaseous fuels. And by no-count that this course is fully complete because there are whatever whatsoever you try there were certain parts which will remain. But what is important is that where I have put the maximum thrust is this two aspects one is this aspect where I invested a lot of time for you people to appreciate that.

This is critical ones on one has to understand that why we needed to increase the photosynthetic efficiency of the plants which are going on earth. And the second part the overall, overall the conversion technologies which are at our disposal then this lead to the next part where we talked about the different kind of biases which partly we discuss here. And they are all over the conversion process by swells and bioenergy okay. And of course we have talked about the solid liquid and gaseous wells and there where they are applied in terms of automobile which transport electricity generation electricity likewise and so on and so forth.

And all these processes if you realize leads to emission of CO2 and this very same CO2 again comes back to feed this cycle. So you are realizing it is a continuous process which is happening so based on this energy status we moved on to the whole area of bioenergy with a specific stress on by energy. Then we moved on to the basic process the photosynthesis to the biomass conversion then again the conversion of the biomass to solid liquid and gaseous will. Here I have highlighted time and again that nature has also done this process through natural geological year.

That process nature has already formed natural gases petroleum and coal these are nature's analog. What we are trying to do is that now man wants to do this whole conversion in his life time which is essentially. So this whole process must have taken nature some billions of years where through geological years it has converted most of the biomass at high pressure and high temperature to different kind of cells. Now man wants to understand all those things and wants to do the same thing in a synthetic condition.

So this whole conversion process what we are talking about my man is through a synthetic route or synthetic microbial. Which so we call it synthetic man controlled root it is not that nature has not done it. But when we do this so that is why I was high lighting that this has brought us to a very different time and civilization where human being by sharing unity did to do nature. The way nature has done it so it is a very important time for us to appreciate this area which is very tough it is not something very easy.

And it is not that little bit investment here and there is going to make it make a huge it will take it will be a journey of young people coming into this area of research investing their life probably

another 50 100 years of research is needed. Before we can even understand some of these different geological processes which lead to the conversion of biomass to natural gas sources to petroleum to coal and we wanted to do that now in, in the last that is no joke that is a very daring dream for mankind. So that is where I highlighted that this whole area of synthetic man control route understanding the chemistry behind it understanding the physics behind it and designing the reactors and everything in order to utilize them it is kind of exceptionally challenging.

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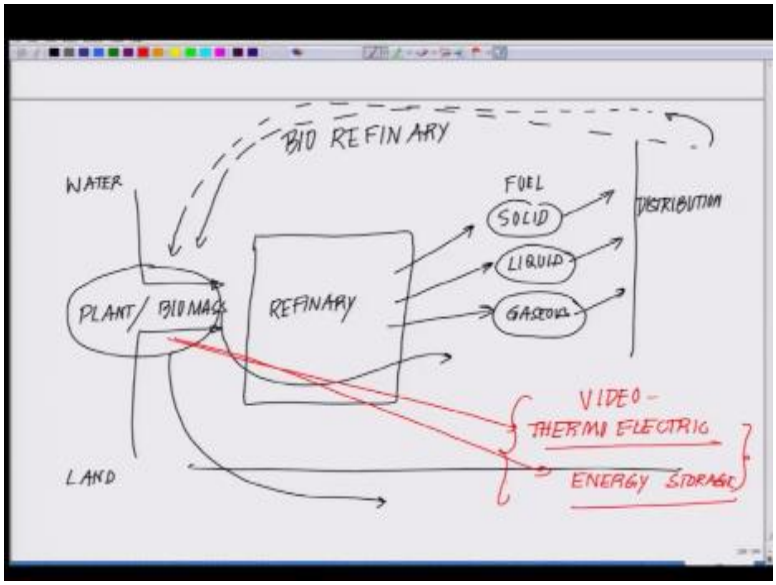

And this brings us to a concept what I was trying to mention what we really understand by bio refinery because it is very open concept. So it is essentially it will be something like this from different sources say for example your plant sources coming from water bodies okay. Water and land you know all the plant sources plant or all other sources what we have talked about the biomass sources biomass sources. They come to one platform which is kind of a refinery where all are converted to different kind of product say solid fuel in terms of the fuel product solid liquid and gaseous will and. Then distributing them for different kind of you know application and what all exhaust what we are getting is again fed to some way into the nature in order to convert it into biomass.

So this whole concept is what will be the modern-day bio refinery where most of the biomass to fuel conversion process in a very, very systematic and med controlled fashion where this is going to happen okay. So here I will highlight few additional aspects there will be a then there will be two small capsules of videos where I promised you I will show you how the pyrolysis process could be used to make graphene like material where electricity production takes place. And how to store it and there is another aspect which I have added there where you can use natural fiber so. We talked about this biomass sources these natural fibers could act like thermoelectric materials.

Where if you take a natural fiber and you know expose it to waste heat it could generate sufficient electricity which could be stored. So it is a very preliminary research but I have just gave you a glimpse of another area of thermo electrics and energy storage materials which could be derivatives from different biomass kind of pro biomass okay. So thermal electrics and I have not I mean this is not part of like I know if it will be too exhausted for the course. But just I have given you some video modules which will help you to appreciate it and you will have energy storage materials and I just to reach okay. These are the different kind of materials what we have talked about in the video module.

So that pretty much brings us to the end of the course where we have started from the energy status we talked about photosynthesis. We talked about the photosynthesis to biomass conversion and then we talked about the conversion technology is available to us we talked about the design of the engines. And then finally we sum total the whole thing and we talked about what is the future. So it was definitely a great learning experience for me and I hope it has helped you to get an overall picture of bioenergy.

And we show all the best and keep posting your questions in the forum as long as it is active will answer it otherwise you will have my email ID. So many of you email me I could not really respond back during the course because it was very busy schedule please feel free to contact me over the email and the TA who is answering who is also available and all the best and do well thank you.

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