Indian Institute of Technology Kanpur

National Programme on Technology Enhanced Learning (NPTEL)

Course Title
Bioenergy

Lecture -23
Conversion Technology

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Welcome back to the by energy core series so in the last class we concluded with the parameters of any kind of biomass what we are collecting from nature what are the features what we have to look into which include the moisture content which includes the fixed carbon versus volatile matters it includes the lignin to cellulose ratio the concentration of alkaline element present there the ash content and in between we talk in depth about each one of these parameters so today what we will be starting out the conversion technologies.

So when you talk about conversion technologies the first thing what matter what is the source of the biomass and after that we take into based on the parameter suppose the sources say from aquatic plants or say the sources from crop residues or the saw sources some bio waste based on the source we decide upon the conversion technologies so conversion technologies directly depends on that chemical nature of the biomass what you are obtaining and the conversion technology further depart decide for what purpose that bio soil which will be developed will be used.

Whether it will have applications for automobile whether it will have applications for generation of electricity through boilers or it could be used for some other applications so essentially what does that mean depending on the requirement of the end user the conversion technology takes its decision apart from it the another factor which has to which needed to be optimized in such operations is what is the cost for any such conversion as we have already mentioned in the

previous lecture if your sample has higher water content there are certain techniques which should not be done unless otherwise of water is being reduced or if it is a higher lignin.

Then certain methodology would not be able to give you good fuel efficiency so now what we will do will enumerate the process how we decide upon the current conversion technologies what are the parameters which are taken into account followed by that we will enumerate family of different conversion technologies and then under those families we will be dealing with each one of those modules or processes which leads to different kind of solid fill liquid-filled gaseous will too and so forth and as we will proceed further we will see how unusually important products could be derivative from these kind of by conversion route. So to coming back to the slides.

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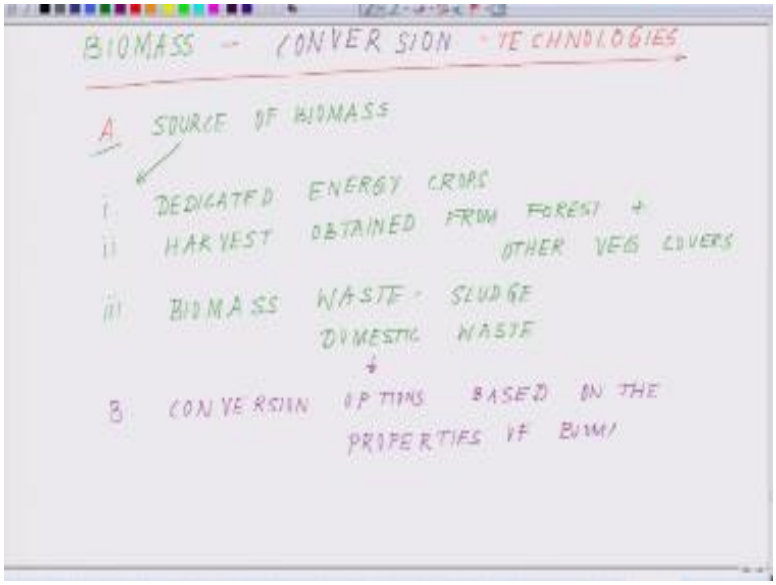

So today we are starting with the conversion technologies okay so essentially it is should add that biomass conversion technologies okay so this is the broad heading now we are getting into so if you just have a little recap where we started we started with the production of the biomass where we talked about photosynthesis and all other processes we talked about c3 plantc4 plants then we talked about the biomass which is produced what are the basic characteristics we just now I discussed and now we are going for that conversion technologies okay.

So among the conversion technologies what are the first steps the first step which is important out here is the source of the biomass throes of biomass so in terms of the source could be divided into three different categories category 1which is suppose we have a dedicated energy crop you are growing dedicated energy crops litigated energy crops these could be different kind of grass this kind of different kind of shrubs for herbs or even trees okay.

Then the next is harvest you're obtaining from forest obtained from for plants obtained from forest and other vegetation covers so this essentially does not mean that we are talking about deforestation what we are talking about there are many say for example dried leaves trees in the forest are being trimmed all those or as you know in many countries the rule people go inside the forest to collect you know for burning they don't cut the tree only the twigs witch over a period of time kind of dries and fall down or they dries out they break it and use it.

So that is what we meant by harvest harvesting harvest obtained from the forest and other vegetable vegetation cover which also includes if you have to see it also includes different kind of vegetable waste which are coming through okay say for example you have a cauliflower okay, so we generally use the flower floral part of the cauliflower but the lower part we generally discard so that is also a form of a biomass similarly whenever we are feeling safer titles okay so most of the time we peel off the skin that is the biomass we are eating a banana the peel that is a biomass we take an orange we peel it the range of it that is a biomass okay.

So these our different from biomass there is a third form of biomass which now I am highlighting which is basically biomass from waste biomass waste in the form of sludge okay and this could be even the domestic waste of course of the biological origin so these are the different sources of biomass and this is very important now if you look at this list carefully you realize all the basics what we have covered as of now is encompassing this say for example we have energy crop the first thing you have to understand what is the cellulose to lignin ratio of that particular plant okay.

Step one the next thing what you have to understand what is the water concentration at harvest curtain does this plant grows with lot of silica from surrounding or how much le metal person they detach how much fixed carbon it is having has compared to the volatile matters okay so all these have different numbers and using van keulen diagram you can place it exactly where it will stand okay now these two operators at once we are done with this part this is to once you have decided upon it is your conversion options at your disposal okay second thing is conversion option based on the properties of the biomass that is what I was discussing with you based on the property of biomass okay. So what are the different options you are we are having before we get into the option just okay.

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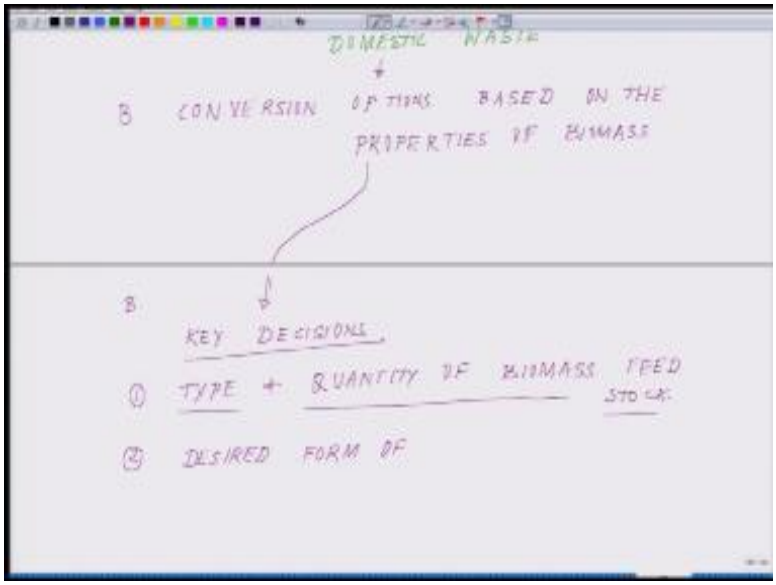

So I will continue with the point be okay chill out here okay so the key decisions before deciding the conversion efficiency okay so one of the key decisions what you have to take before we decide what kind of conversion route we are going to follow this includes the type and the quantity of biomass feedstock okay. Biomass feedstock okay what does that mean so that essentially means first of all type we have already discussed what is the carbon nitrogen or carbon oxygen carbon hydrogen carbon likewise okay but in terms of the quantity it is very important because we have to process them.

So we need some form of a reactor so reactor efficiency or reactor design the direct function of what is the input you are putting into it like very small reactors may not be very efficient again very large reactors may be very inefficient because we will be consuming a lot of energy in a large volume but if your input is not good enough okay. So for any kind of long-term planning you have to ensure your raw material in this case is the biomass that raw material is coming at a uniform rate so you have a reactor of a specific size.

So 365 days off a year you know every day this is on an average you are going to get an input and this will be the output so the whole planning of supply and demand and the conversion cost has to be worked out very right before we embark into any form of conversion technology which are available or which are at our dispose also that is why this particular point.

First of all the type of the biomass and the quantity of the biomass feedstock is very important the second is point to the key decisions is desired form of energy what form or in what state you want the energy desired form of energy so in terms of desired forms of energy if we talk about the form word itself so this could be divided into three different categories okay.

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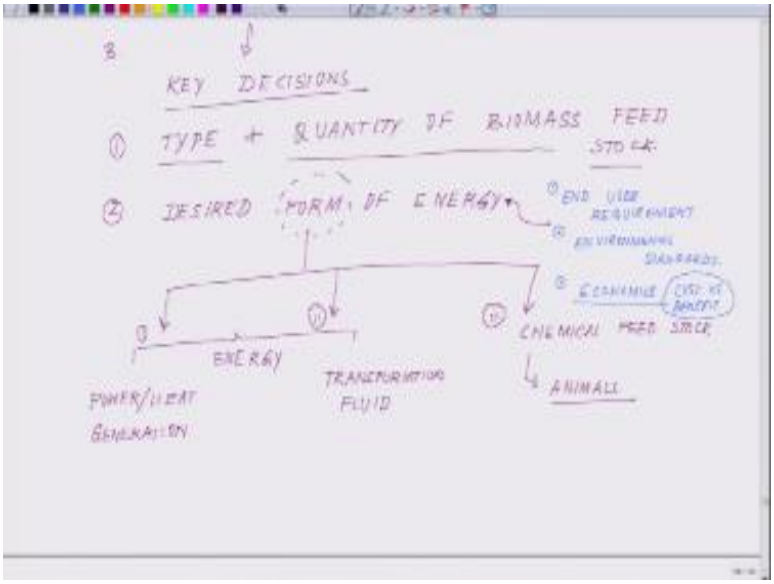

The biomass could be divided into three different categories out of which two falls under two falls on the energy category and the third one so if this is1 this is 2 and this is 3 the third one falls under chemical feedstock. So this is for animals okay and we will feed and all other stuff in terms of the two categories what we are talking about it could have either power or heat generation mostly using combustion which will be following up next or you could transform into liquid or gaseous well in terms of transportation fluid okay.

These are the desired form what we are talking about and most importantly out here this will further be worked out based on these three parameters which includes inducer requirement okay this is very important who is the end user second point is environmental standards will come with a case study on this one liter environmental standards.

Because whenever you are converting there are several environmental issues which has to be taken into account the third thing is the most important is the convex what is the cost benefit ratio of for carrying out such transformation what is the cost of the input one what is the cost of the conversion to and upon selling what is the benefit you obtain so if the cost-benefit ratio cost versus benefit ratio is not favoring then such technologies will not serve or will not survive the test of time okay.

So this is these are few points which one has to kept in mind while picking up or deciding upon what will be or what kind of conversion strategy one is going to follow okay now follow up on that once we talked about this let me go back to the slide and next what we will be talking about is the third point and user applications which we have already mentioned.

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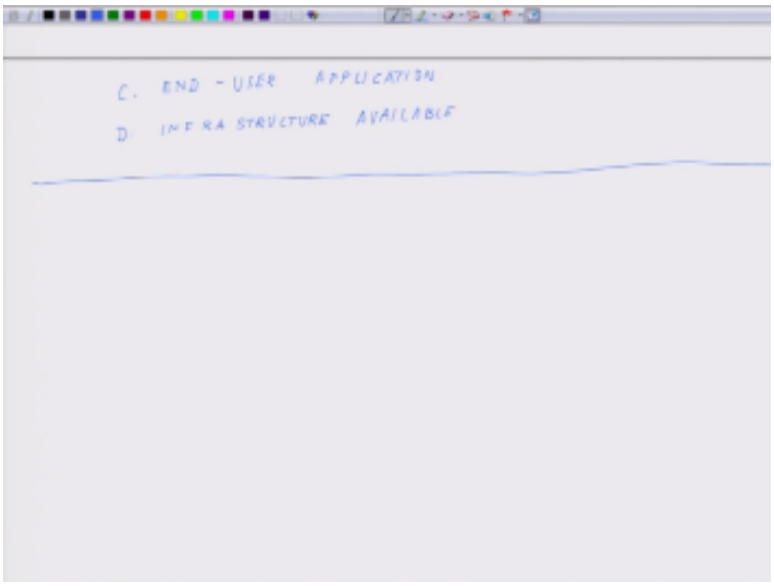

And user applications and last one taking into account will be the infrastructure this is exclusively and very important essential for countries like India where infrastructure development is a big challenge okay infrastructure available okay so these are the points which one has to take into account while deciding upon what are the conversion technologies what we are going to dealt with now from here after giving you this brief outline.

So let us again he will recap what I have talked I talked about the source of the biomass whether it is very dedicated and how uniform round the year how it is all coming like every day how much can tonnage of biomass is arriving second choice of conversion technology which is based on the supply and demand of the biomass as well as the type of biomass 3rd we talked about the end users of the application and what with the Applica and what kind of applications in terms of quality quantity and the type.

Say for example if we really need very high grade feel safe or flying airplane or a helicopter or something then we need very fine grade then maybe the conversion group may be totally different you need low grade field then the conversion could be a cheaper one then what form of conversion are we going for solid feel solid conversion are we going for liquid fills or are we

going for gaseous with okay. So these are the different parameters which will decide so next what we will do we move on to a new flight and we will talk about that now we will put on a tabular form the different conversion technologies okay so coming back.

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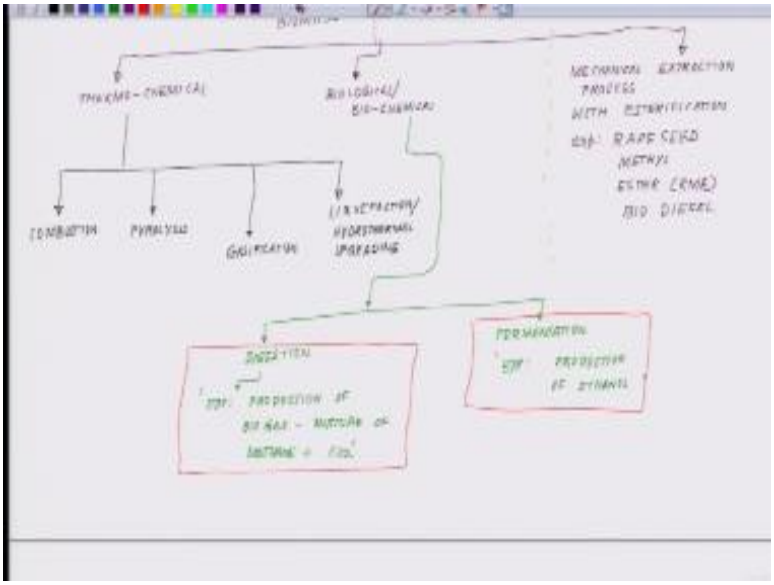

So you have the bio mass to energy out of biomass so here are the conversion routes so the conversion routes could be classified into three categories a category one is thermo chemical. Now in depth we will talk about thermo chemical which I have mentioned several times earlier and I told you that do not get worried we will come back to this okay, thermo chemical is the most popular approach the second one is biological or bio chemical biological flash biochemical and the third one which is not a very popular one though is in mechanical extraction mechanical extraction.

A clinical extraction process with the process called will come in depth later sauce is called with a steady vacation so one example I wanted to quote rapeseed since an oil seeped fix it methyl esters or our me biodiesel so there are other bodies overall so this is just one example okay if we could talk about j atrophy and all those things but at this stage we are not dealing with this we talk later about it okay.

Now in terms of the thermo chemical category it could be classified into four different groups which starts with the most simplistic of all called combustion one second one that is pyrolys is pyrolysis is a technique of combustion in the absence of air will come soon on to that third one is gasification and the fourth day one is liquefaction or this is also termed as hydrothermal upgrading okay hydrothermal upgrading and we will talk about each one of these processes one by one on the other hand in terms of the biological youth I am putting in green we have two categories two broad categories and the food categories includes digestion and fermentation.

So in digestion one of the examples I am quoting here production of biogas is the digestion process production of biogas which is basically a mixture of methane and carbon dioxide methane plus co2where is in the fermentation example is the production of ethanol production of ethanol as a matter fact fermentation route is has been followed by mankind since tiny memorials okay because most of the houses if you look at most of these processes that across Europe and many other cold places in the world you see people have been making ethanol from wood from other sources.

So this process of fermentation or ethanol production is a very old process this is not something very new so as a matter of fact if you think very rationally biomass to conversion of different products which are insert able product mankind has been followed this for a long period of time this is not something which will happen just by recently okay whereas if you look at the digestion or the production of biogas this is also a very not very I mean it is it is fairly old technique which has been followed.

So you have pit where the gases comes out that is being used okay of course now we are having very good biogas digesters and all those things but it is fairly old inning in contexts nice my childhood I have been seeing at least I can save for last 40 years there are a lot of biogas plants all over the place so in other word if you think a little bit backward in time if we talk about the forces of natural gases from where mankind has been drilling.

And you know taking up natural gases possibly those are nothing those are big dump yards of organic matters which over centuries have generated gas which must got trapped in the earth crust. Where we are bored and slowly you know pulling the gas out and you know storing it for our day to the purpose now what we are essentially I repeated this again I am repeating it the challenge of by energy is that till this day mankind has utilized the product made by nature or product which was developed in nature through centuries.

And felonious like coal patrol natural gas all these or even nuclear fuel these have been gifted to man through centuries but then when we talk about bio energy we are talking about a totally different thing we are talking about no man wants to develop the raw material from which mankind is going to derive its energy in other words the raw material which Nature has made in the form of coal in the form of patrol in the form of natural gas strings.

Now we want to mimic it and produce it in a controlled environment which by far if we look at the history of mankind as a whole by far probably one of the most challenging vision because what nature has done in billions of years we wanted to do it in a short span so that brings us with this is a very philosophically one has to think over it that over centuries organic matter transform went through a whole range of geological changes under heavy pressure high temperature transformed or something called cold.

Now having said this that we are really challenging cluster of time that means we really have to dedicate a lot of research into this area how such conversions can be done in an controlled environment it is not a easy task it is gigantically tricky and tough even to thinking that angle that you know we want to transform them so if you see the field it is moving slowly because it has every reason.

Because nature itself has transformed thing over centuries and here we wanted to do in black so with this background about what all the possibilities what we are having in this chart we come back to the chart again just let us go through this chart once again with you we of the thermo chemical route you have the biological or the bike in co route you have the mechanical extraction process which will be coming fairly late and within the thermo chemical duty of the combustion

paralysis' gasification liquefaction whereas in the biochemical root of the digestion you have fermentation so what we will do now we will take one by one each one of them and will elaborate further okay, so I will close in here next class will be starting in the thermo chemical group of combustion thank you.

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