Indian Institute of Technology Kanpur

National Programme on Technology Enhanced Learning (NPTEL)

Course Title
Bioenergy

Lecture-24
Conversion Process-(Combustion Process)

By
Prof. Mainak Das
Biological Sciences &Bioengineering &
Design Programme
IIT Kanpur

Welcome back to the Bioenergy lecture series so in the last class when you conclude it we talked about we rather we outline the different conversion strategies currently followed and we categorize the different conversion strategies into three groups. We talk about thermo chemical conversion, we talked about bio chemical or biological route of conversion, we talked about a mechanical route along with its verification where we extract biodiesels from rapeseed from jetropad.

And other sources and within the thermo chemical route we talked about four different routes which are being followed which includes the question pyrolysis gasification and liquefaction whereas in the biochemical route we talked about two techniques digestion and fermentation and we talked about the fermentation is a very age old technology which has been followed all over the world mostly in the slightly on the temperate part of the world where there it is cold where people view wine or beer or you know all forms of liquors at home in their cellars okay.

Where they convert wood and other things into alcohol where is in terms of the digestion part we talked about the global gas or cow dung which is used in this in a slurry form is used to generate the gas which is being used global gas plants and there are several other examples and then we correlated it back with what happened through geological periods. Where several organic matter got trapped and through digestion they started generating gas.

And which we are deriving as a natural gas today, meeting in another sources okay. So today what we will do we will come back to the chart where we left in the last class. So this was the outline what we formed by mass to energy formation.

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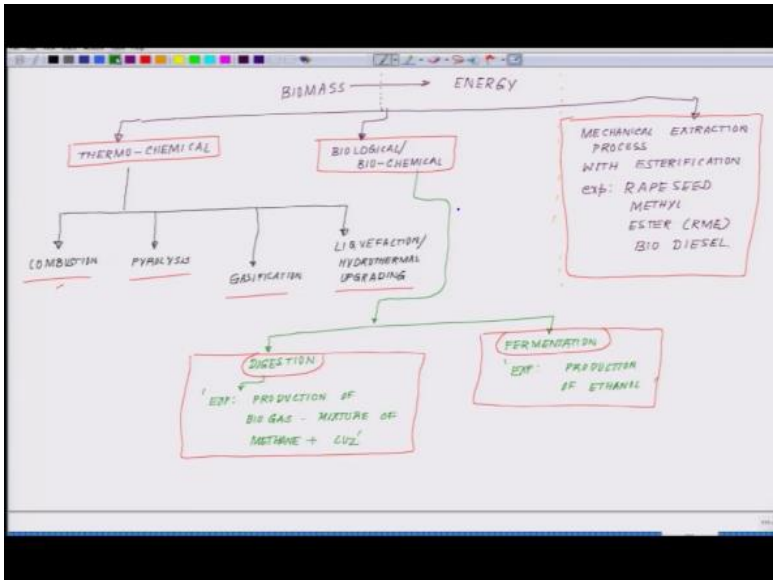

And today our goal will be to understand the most primitive and the most simplistic of all processes under the category of thermo chemical which is the combustion process. So today we will start with the combustion process. So let us move on to the slide, as we do in every class first of all we will talk about the simple combustion, combustion is very straight forward thing you take a biomass paper vegetable waste or anything as a matter of fact and you all have seen that the cow dung is being dried and used as a fill.

This every Indian has seen wherever they are, each one of have seen during the winters or any other day people cook with woods okay. These are common things so essentially a wood is biomass cow dung is a biomass. So you are burning them in the presence of air that is all combustion is all about. So when you are burning something in the presence of air, so you are having oxygen in the environment for what will happen, so you are biomass has lot of carbon it is reacting with oxygen of the environment and it will generate two things.

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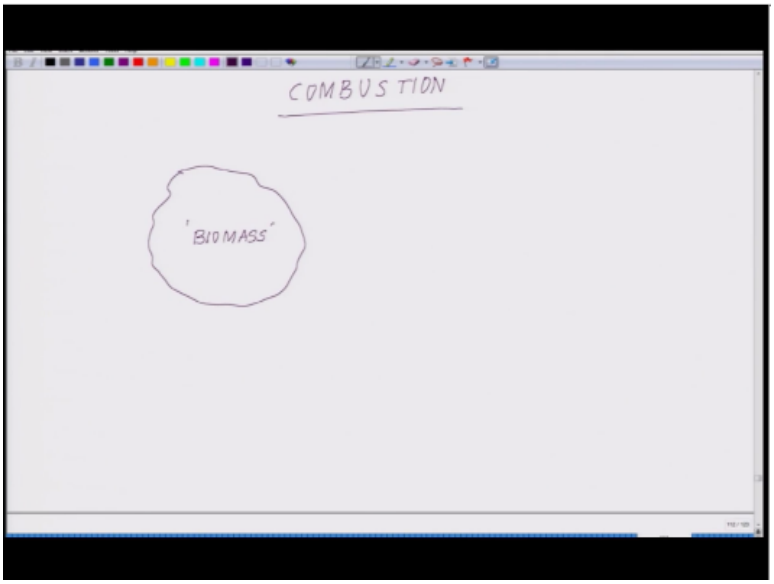

It will generate carbon dioxide plus heat, now what you do to that heat is important and how you can process that carbon dioxide okay. So just now what I have said let me graphically put it across for you so, so we are dealing with combustion okay and in the combustion section so we are dealing with say for example so we have a biomass like this okay, finite amount of biomass out here and one of the thing you all must have observed.

When in the villages or in the rural places where cow dung is being used for making or being used as fuel after drying, so what the drying thing does it removes the water from it, so this brings you back to that very first point about the properties what we talked about intrinsic water and extrinsic water you remember we talked about the water concentration. So essentially what you are doing you are getting a biomass a feces of a cow or a buffalo which is rich in water. So you are drying it in the Sun getting rid of the water and then you are using it.

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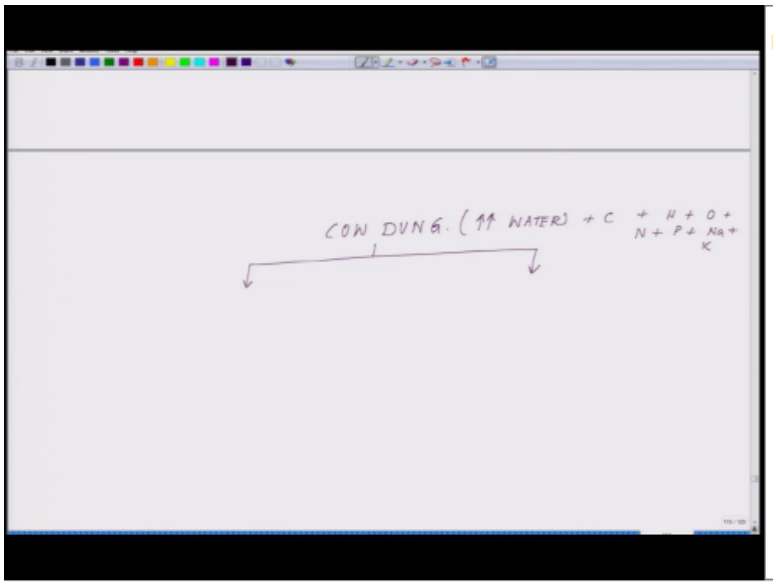

So say for example just you can think it very simple so you have new slide we have say for example you have cow dung, this is a good example for you to understand so you have two route one route is that you so it has significant amount of water trapped in it okay plus of course carbon material carbon and all other things okay. Carbon, hydrogen, oxygen and nitrogen phosphorus, sodium, potassium likewise.

Now one root is you dry this you remove the water and what you get is dried cow dung which is a fuel for burning where else you can follow another route you keep the water impact along with the water and you put it in a closed chamber, which is a bio gas plant. So what will happen in the bio gas plant because of the microbes which are present out there. This will go through a process of digestion and also certain degree of fermentation will take place we cannot avoid it. And this is going to generate gas so you see with a simple example and this gas is could be used for cooking which most of the places in our country especially in the rural places we use this.

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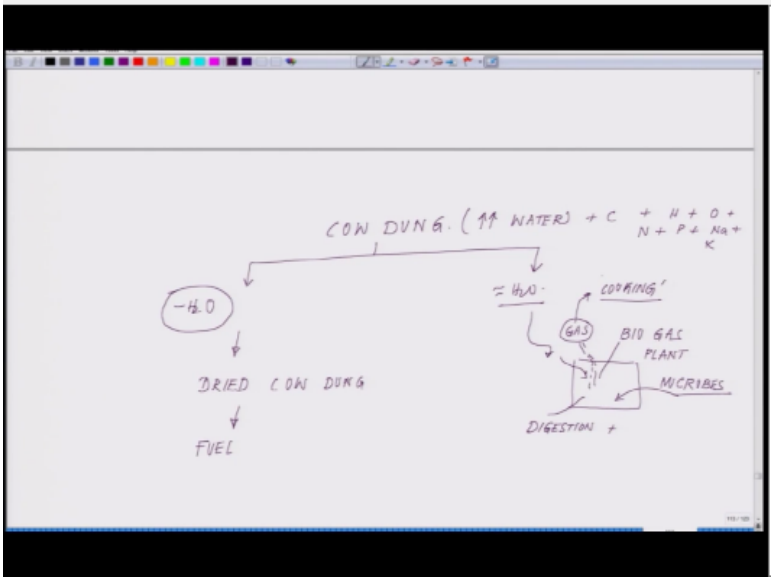

Now think see with such a small simple thing and this is mankind has been doing it since ages nothing new but today only we have started it but what is important is that these technologies have to be fine-tuned with time has to be make more efficient and what is important here to realize depending on the total x gram or x kilogram or x done okay kilogram or x done. How much will we are getting out of it and how much we are losing as ash that define the efficiency of that fuel okay. This is how so this will when you are burning it we are generating heat and CO_2.

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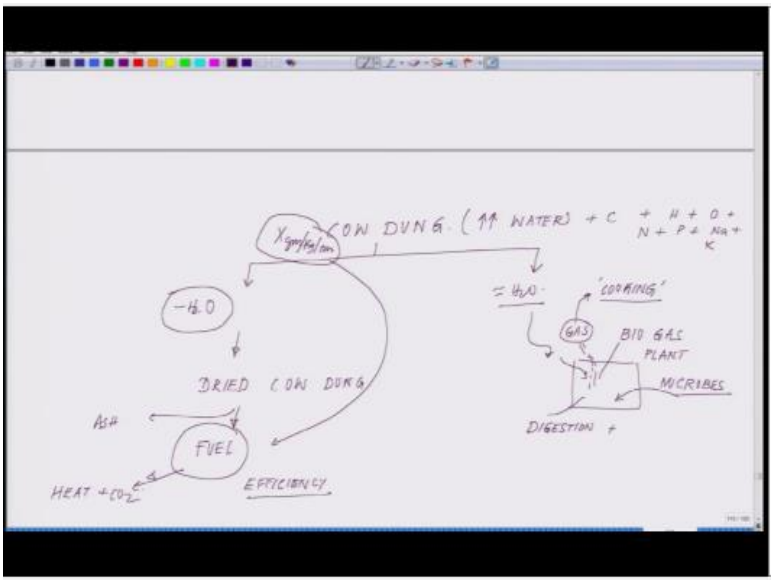

So coming back to the previous slide where we started when you have the biomass out here of course you have to ensure if you are going for the combustion root, less than fifty percent water this is very, very critical. So in other words one has to ensure that you dry up the sample significantly that at least fifty percent water of more than fifty percent of water is lost otherwise this is not suitable for combustion. Now what you do you burn this in the presence of air give the air or oxygen in the presence of oxygen you are burning it.

What you are generating is of course apart from carbon dioxide because this is a lot of carbons out here. Carbon dioxide which is getting to the environment which is a tricky thing of course and that is where we talk about a lot of carbon capture what you are generating is heat okay, now this heat what you are generating could be utilized for several things what you can do with this heat is you can make you can use this strategy to develop a stove which is the most simplistic of all you can develop a furnace, okay.

You can develop a boiler we will talk about a little bit about boiler later you can put it put it in the stink top line okay, similarly we can put it in the turbo generators. These are the different at least to name a few what you can do and what you are essentially doing if you remember the last

class last two last class you are breaking these bonds and these bond energies are so this chemical bond energy is liberated in the form of heat energy okay.

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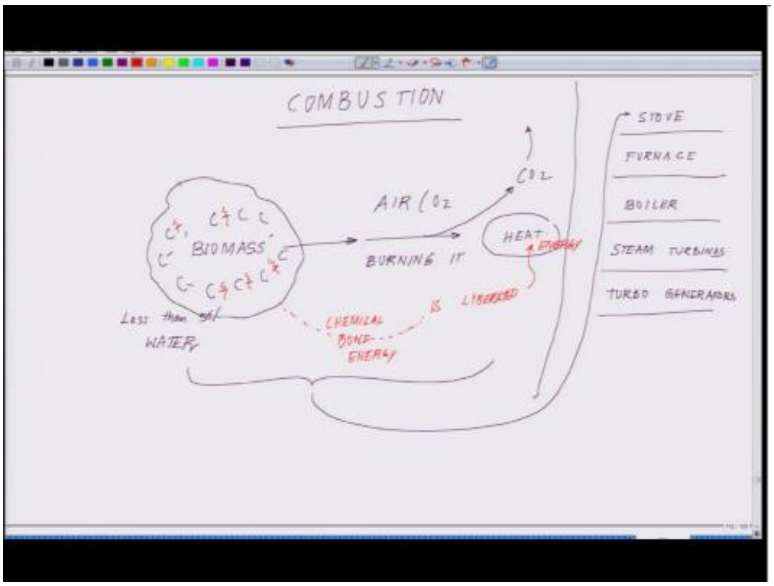

This is how we carry out the process now while you are running them running a see a boiler or steam turbines or something if you are essentially doing you are converting the heat through the steam and we will talk about this boiler design and everything in a sec. That is briefly so just before I get into this ,what is important here to know is that this combustion process what is happening out here this whole combustion process this combustion produces huge amount of hot gas which is of course a lot of it is rich in carbon dioxide at around eight hundred two thousand degree centigrade okay.

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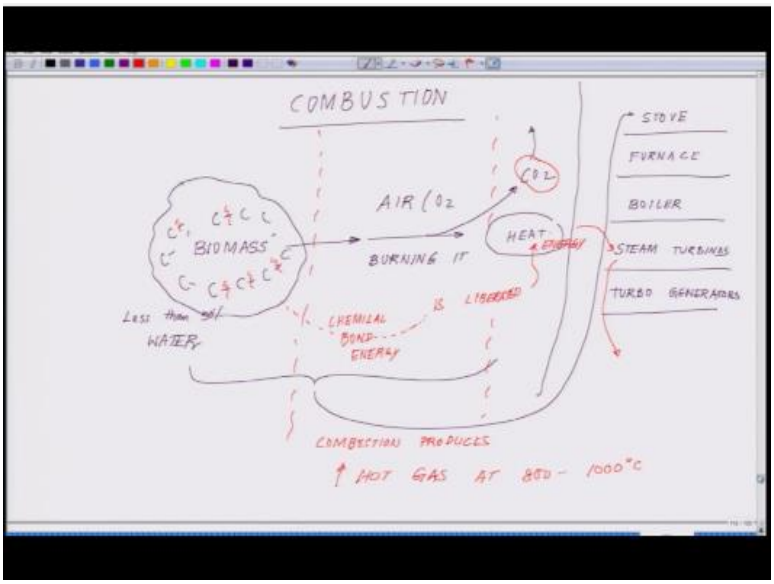

Now the question is coming back the question is what kind of combustion plants are we talking about. The combustion plant if we talk about it could be as simple as very small scale for the domestic use or domestic heating. Very small scale for domestic use or domestic heating purpose or it could be as large as 100 to 300 mega watt large-scale industrial plants okay.

So this is our the conversion but interestingly most of this if you look at their efficiency as we as I was telling you the efficiency is around twenty to forty percent net by energy conversion efficiency in the power plant ranges from 20 to 40 percent whatever where this is small with its a large plant.

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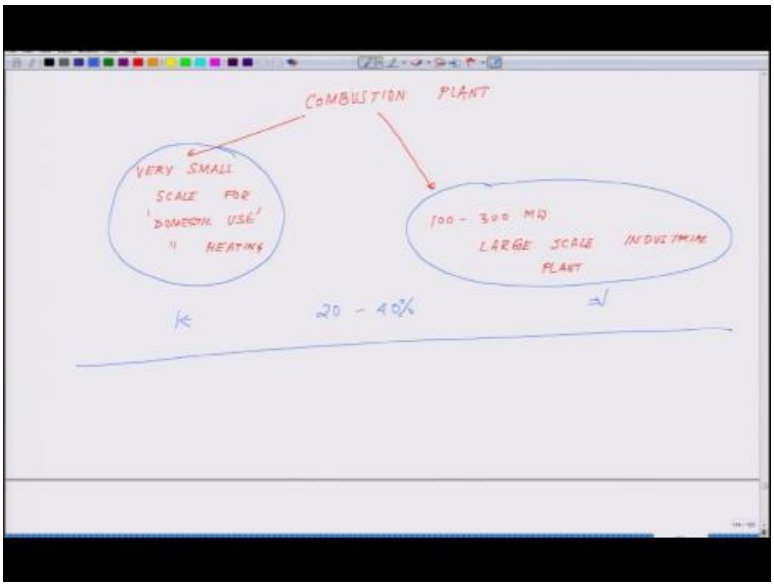

One of the ways by which one can really increase this combustion plant efficiency is co combustion of biomass now we will talk about this does that mean co combustion of biomass in coal-fired power plant okay. So what is coal-fired power plants okay before we get into the course out of power plants, we will talk just a little bit about the heat so what we are doing through combustion is we are generating a lot of heat okay. So one of the ways is that you use it in one of the heat engine cycles.

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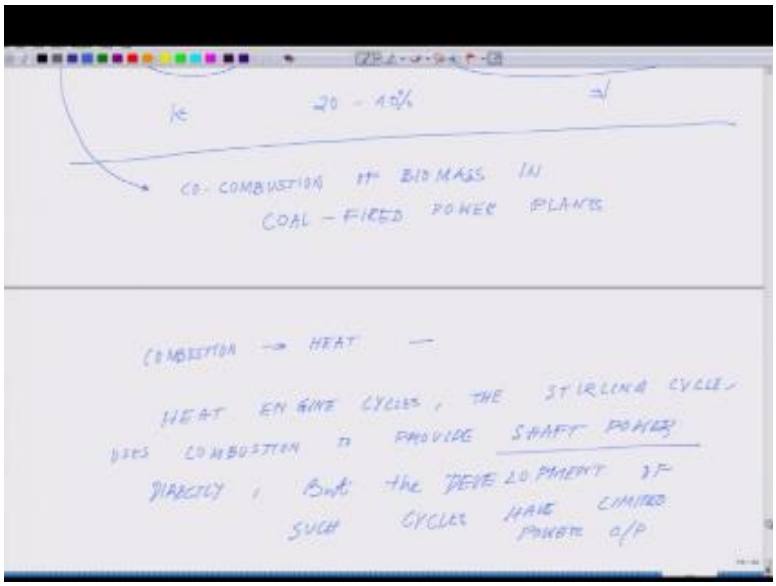

You can use them you can feed the sea tour set the sea to heating in cycles the one example is the strolling cycle. Okay which uses combustion to provide a shaft power okay we are moving the shot so it basically what you are doing is you are converting the heat into mechanical energy shaft power directly but very interestingly the development of the cycle is presently limited with a small power output okay.

Development of such cycle have limited power output and just putting output hook now coming back to the combustion plants we are talking about coal fires sterling what is this coal fire combustion plants so combustion plants the coal fire for commission plant cells those who have not never been exposed to this.

So try to understand what happens in them so there is a boiler okay fill it water underneath you have cool most of this cold fireworks they grind the coal and put it there and you heat the coal so as the coal is burning the water started to boil and it generates a huge amount of a steam. This steam is funneled through a tube and fed on a turbine because of the impact of it that turbine starts to move and once the turbine move there are generators which are there which is started to generate.

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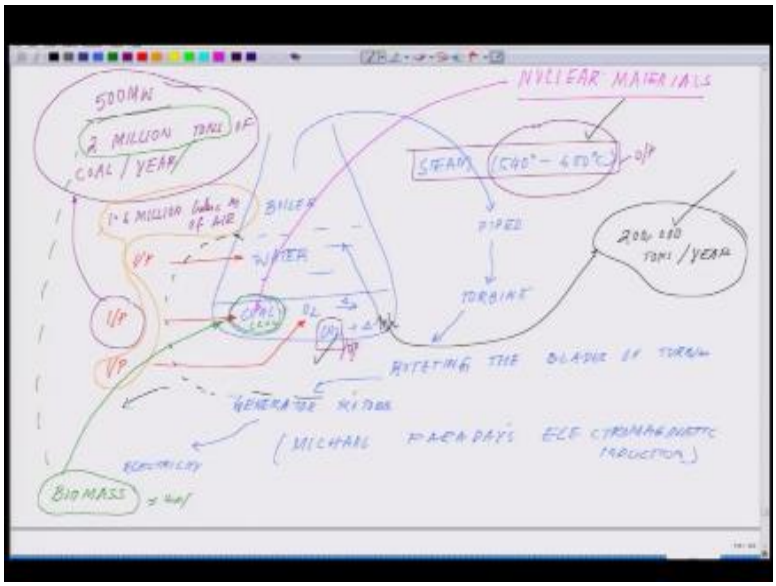

They also start to move and they generate the electricity so the way the schematics let me put the schematics for you that will make more sense okay. So you have kind of a you know boiler sitting here okay on the boiler underneath you are having this in a coal in the presence of oxygen you are heating it so what you are generating is lot of co2 and lot of heat and this heat is the one which is we have the water okay. So if we look at it this heat which you are generating out here is fed this is the boiling water this is generating a lot of steam okay the steam is fed and a steam at that time the temperature of steam such boilers comes out to be 602 around 600°C this team is piped through a funnel to a turbine okay.

And the turbine blades start rotating the turbine because of the impact of it rotating the blades of turbine and that activates the generator rotors and this generator rotor then generate the electricity which follows the Michael Faraday is electromagnetic induction okay. So this is the basics okay electromagnetic induction electromagnetic induction this is something you I do not know how many of you have seen it there are bulbs attached to the dynamos if you have seen it when you write the biocycle the bulb glows because it is a mechanical energy which is translated into electrical energy using passing it through the coils okay.

So just go back and check the basics and if time permits definitely I will come back to this but what is important here. So the point is what I am trying to make so it has been observed so if you look at what all the input few are putting for generating electricity so you needed regular supply of coal you need it significant amount of oxygen these are input I am just putting IT okay input you need fresh boiling water all the time and your outputs let me put another color on that and your outputs are here this is team which is an output you have significant amount of carbon dioxide as your output okay.

Output and then you have to run the turbine so we have to have the materials you have to have the piping which can withstand this kind of temperature and if we talk about a standard 500 mega watt plant so you will realize for a to run a 500 megawatt plant continuously oh you need 200 million tons of coal per year mark this number. So this is what is the input we are talking about okay and you need for a 500 megawatt power you need1.6 million cubic meter of fresh good quality year.

This is the second requirement when you talk about the year okay. This is the second requirement and what you are giving out in this whole process of burning apart from the carbon dioxide guys remember we talked about the ash there is a lot of ash which is formed and the ashes around 200,000 tons per year apart from you have co2 you have this team here 200 tons of ash and of course this steam is recycled back and re condense back in the water but there is always certain amount of water which is lost in that whole process.

So the reason to give you a outlay of this is to get you a feel that where the combustion research needed the by energy supply so it has been observed the meaning of these combustion plan or coal plants if along with the coal which is depleting if you use the biomass dried biomass it works really good so simple principle. So what you are doing so this is the addendum to the existing so here the coal what you are having input you are putting here biomass okay. But then you have to realize biomass and coals efficiency are different because they have different level of water concentration different level of composition because this is pure carbon, carbon, carbon.

But here you have lot of other things so now automatically where you will be needing cool of the range of you know 2 million tons coal per year. So automatically you have to realize that you will be needing far more amount of biomass as compared to two million tons of coal. So this is to just give you a feel that where everything fits in currently most of the thermal power plants across the world relies on coal and that is how the electricity is going to use except barring a siding us wear instead of what you see out here coal.

They use for this heating they use nuclear materials but that also comes with its own set of problems okay. So what we as a nation or as a race as mankind is trying that how we could bypass the coal so we need highly efficient wheel of course I mean dream will be something like what we have in the nuclear materials of course it is a far cry today but that is where lies our catch so the reason to kind of you know walk you over through how a thermal power plant works is like this.

And these are the zone of intervention where highest quality biomass can make all the difference okay so this is overall what I wanted you people to understand about the combustion process here in combustion always remember whether are you burning it in presence of oxygen or absence of oxygen so see go back little bit further up where we talked about the different routes.

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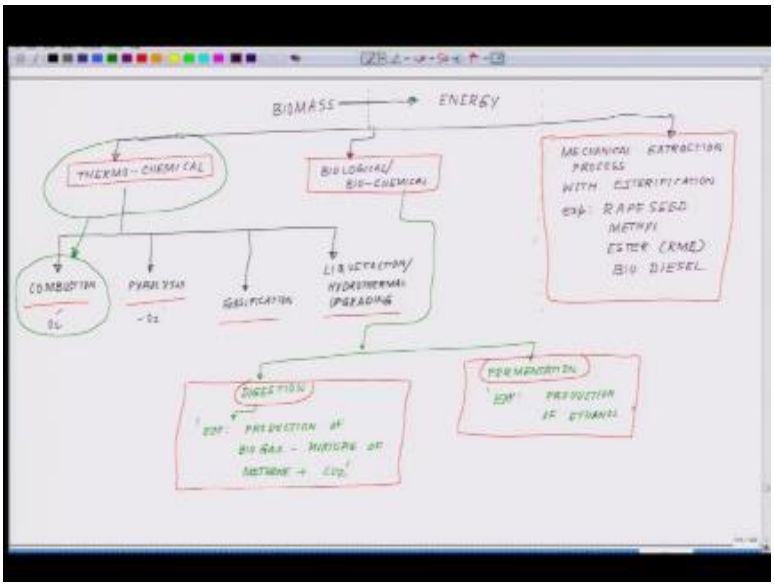

So this is what we talked about in the presence of oxygen and when you talk about next technique what we will be talking about pyrolysis we will talk about in the absence of oxygen so I will close in here we will take it up from here okay thank you.

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