Indian Institute of Technology Kanpur

National Programme on Technology Enhanced Learning(NPTEL)

Course Title
Bioenergy

Lecture -20
Factors Determining The Conversion Process-I

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Welcome back to the lecture series in bioenergy, so in the last class we talked about the different composition and the plants which should be selected, or the algae which should be selected for biomass and subsequently for the bio fuel production. So today what we will do is systematically enumerate the features of those materials which could be used for biomass and bioenergy production so in parts here and there. We have talked about them we have talked about lignin versus cellulose ratio or cellulose to lignin ratio we have talked a little bit about water now we will talk in detail about it. And we have talked a little bit about alkaline metals presence of alkali metals and the problems what is being faced.

So now let us enumerate all the points so the way we will do is we will first of all right down or jot down all the points or all the features which are essential and then one by one will pick up the factors and we will describe about them and the basic understanding of this factor will eventually help you to understand which particular material will give what level of efficiency while will we will be converting it into some form of fuel, some form of energy.

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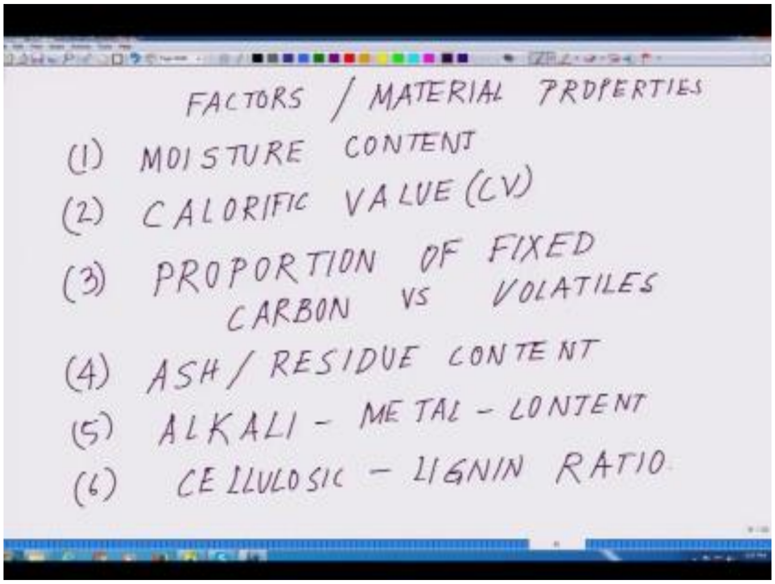

So let us getting back to the slides what are the factors, or factors or the material properties which were very way we want to understand it factors, or material properties okay. So the first thing first and for most thing is the moisture content and we will talk in depth that what kind of moistures are there and how it influences our understanding, and calculation moisture content of the sample okay. Second thing so first of all as we promised that will enumerate all the point next important thing is the calorific value this is the next important thing waiting short also called a CV.

Calorific values then we have the proportion of fixed carbon versus the volatile in any sample proportion of fixed carbon versus the volatile okay. Then there is a fourth factor which we call as ash residue content how much ash is being too loose and these are all linked to the carbon level, and the volatile content okay. Fifth factor is alkali metal content and here specifically we will talk about the role of silica alkali metal content and followed by lost important feature is what we have already discussed will be briefly try to know pick up those points which we may have missed cellulosic lignin ratio okay.

So these are the six critical features which eventually determines how much energy you can derive from the material so let us start with let us get an understanding about this water content concept what really what content is so there are two levels of water one is called intrinsic water the other one is called extrinsic water intrinsic water is that small amount of water or that internal water which is inherent in the material in other words the material is made up of proteins carbohydrates lipids the in between them there are lot of water molecules which we will surround them.

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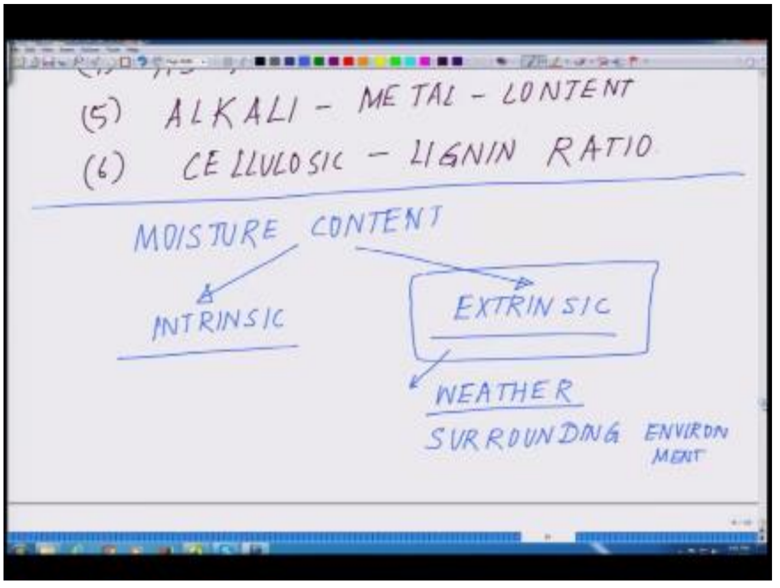

And it is the presence of the water molecule that minimum amount of water what helps bees bio molecules to function. So that is called the intrinsic water so let us getting back to the slide and let us start jotting down those point. So now what we will be talking about is the water okay, okay moisture content or water content okay moisture content so moisture content falls under two heading the first one is intrinsic, intrinsic the other one is extrinsic in terms of the intrinsic without then so there is intrinsic water if we talk about intrinsic water has no influence from the weather condition that much bare minimum of water is the bare essential for that bio molecule or for that system to function.

Contrary to that there is something called extrinsic water extrinsic water is the function of the environment see for example you are harvesting a croc in the correct season or in the rainy season post so in those seasons the cross will have more water in them or when you have harvested the crop there is a rainfall they may pickup that moisture and moisture plays a role in determining what kind of conversion strategy. We have to follow you muster call a couple of lectures before we talked about it that there are certain plants because of higher moisture content they follow us they could only be processed by fermentation or biochemical route okay.

Whereas at a lesser water content you can use the direct heating technique or chemical degradation techniques but that solely depends on the water content let us say for example let us take up a case of study there is a lot of work happening across the world about algae now I will be grossing water right so say for example we you have a population of algae which is growing there which is all producing algae. But now you are pulling that algae out from water it is rich in water. So the first step comes you have to remove the water as much as you can and then only you can process it any further if you have to extract the oil out of it.

But that process is not so easy first of all it needs the space second it has its costs second it means energy or you allow it to dry in the Sun, but then you do not have any control on it so this is just one such example where if you have to remove that extending it is extrinsic water it is not the one which is present inside it is because of the environment from where you are getting it. And that environment is either the sea, or it is a pond, or it is some River right. Some water body so that kind of water which is coming externally into the sample because of weather or because of the surrounding falls under this category which is called extrinsic water okay.

And so this is basically either due to the weather one route is whether a second route is the surrounding environment surrounding environment okay. So these are the two forms of water now if you see a table I will just draw a table for you an expert as an example to understand this fact so,

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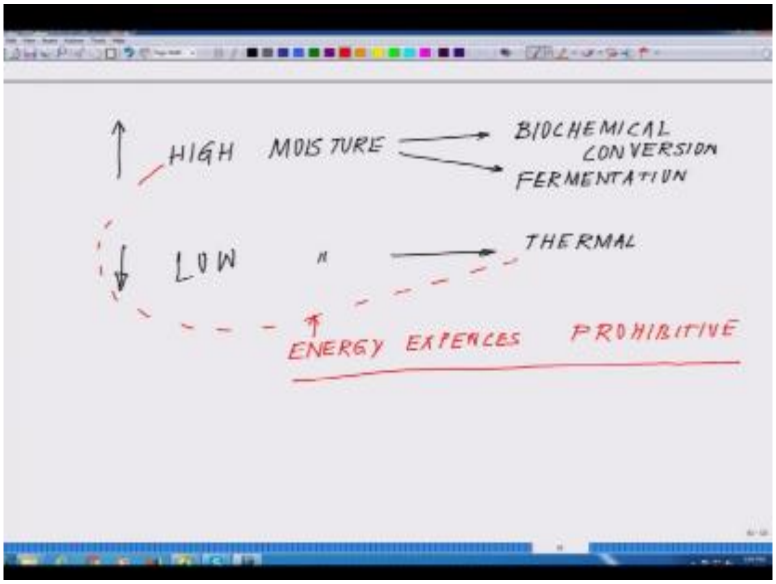

So before I put the table there is something which I mentioned which I wanted to highlight it so say for example you have a high moisture sample so this high moisture sample is generally suitable for any kind of conversion is either through biochemical root or biochemical conversion root or you could have fermentation route contrary to that fermentation contrary to that. If you have a low moisture content such sample goes through a thermal route that does not mean that you cannot use a high moisture for thermal rule of course you can do so. But the energy consumption out here will be fairly high energy expenses will be prohibitive prohi bitive.

In other words you will have to spend a whole lot of more energy in order to transform a higher moisture sample by a conversion root of thermal conversion once will come to all this classification of different conversion looks it will be clear to you. But just for your from your basic understanding you can kind of visualize that it has more water and everything you may have to go through a fermentation convert into alcohol and so and so forth okay.

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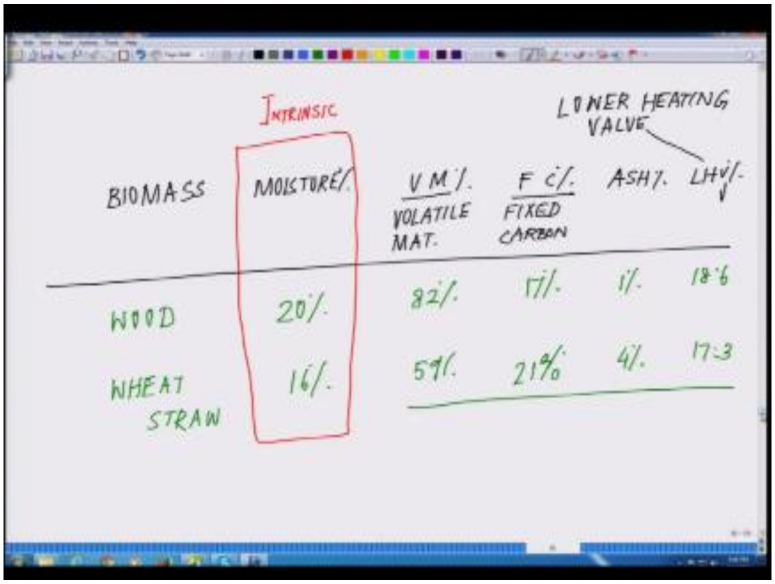

So now coming back so this is the energy expansion which is a prohibitive route now, I was talking to you about the table so let us draw tables for your better understanding okay. So you have the biomass they put the column moisture person page then the volatile material which is stands for VM volatile material I am just putting m84 material then he has FC percentage so please get used to with this terminology which is called fixed carbon percentage

Then you have ash percentage and then there is another terminology which will come which will come in the next in the calorific value which is called LH, LH V percentage in percentages lower heating value lower heating value will come to that what does that mean what is the meaning of lower heating value what is a fixed carbon and all those things lower heating value now see for example let us do one comparison and this table will come very handy in the calorific value if say for example we compared between woods.

And we too strong so what you see is that in the wood essentially there will be twenty percent moisture where is in the we destroy love sixteen percent moisture so the first comparison in terms of volatile ma see the difference eighty-two percent volatile material whereas no wait you have only 59 person volatile material contrary to it fixed carbon here twenty one percent whereas fixed carbon here is seventeen percent okay. And ash is one percent where is here ash is four percent and lower heating value is eighteen point six percent whereas17.3 % just at this stage do not worry about this part of the table just concentrate out here this value is very critical.

And this value what is being reported in any literature is intrinsic value so always remember these kind of tables when they talk about they talk about the intrinsic value they do not talk about the extrinsic value okay. So that is the reason why I put the table in front of you now coming back so this is what all you needed to know about the water content okay after the water content we will talk about the calorific value the phase two of it okay. So this is the second parameter which is very important for us okay.

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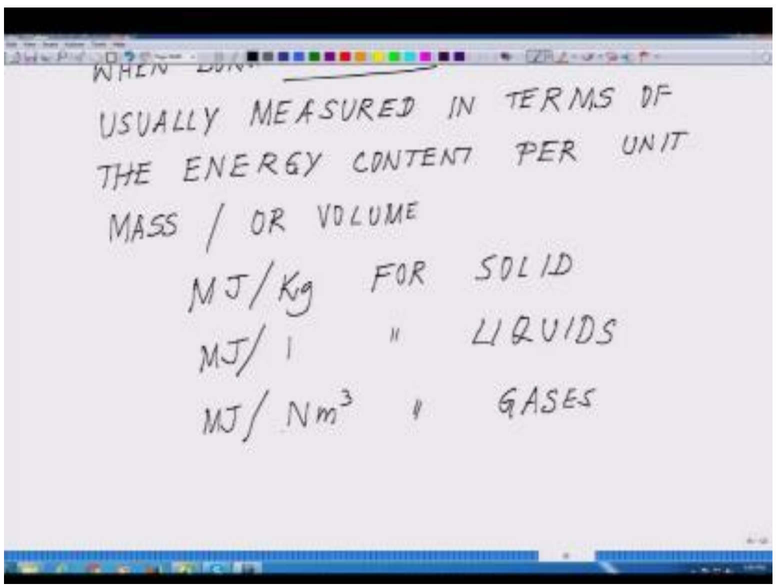

So coming back to the side slide so this is B which is our calorific, calorific value okay which is also as I told you denoted by CV calorific value so calorific value is an expression of the energy content an expression of the energy content of the energy content or it is also heat value since it is in calorie heat value released when burnt in hair when burnt in here. So this is another part to remember when you are burning it here, here CV is usually measured is usually measured in terms of now you remember in the very first class the first phase of lectures told you about all the units which will be essential in terms of the energy content per unit mass per unit mass okay.

And or sometime or volume this because when you are calculating it for any kind of liquid hence the unit is joule some per kilogram for solid Joule per liter for liquids. And a Joule per Newton meter cube for gases. So this is the unit which is being used and CD can be expressed at two ways,

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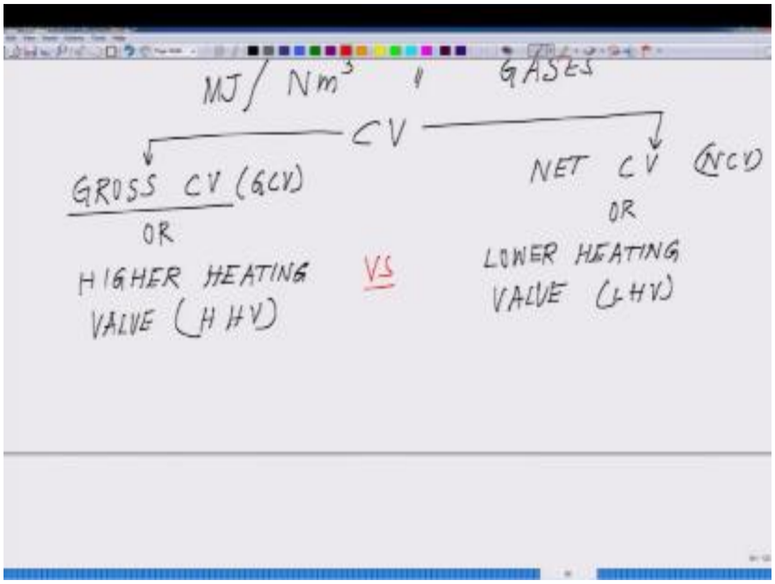

There are two forms by which TV just like water content intrinsic and extrinsic see we can be expressed in to process one is called gross calorific value GCV okay. GCV the other one is called net CD net CV okay, n CV which is also synonymous to gross is also called higher heating value higher heating value which is hhv fire heating value whereas the neck cv calorific value is also called lower now remember where this word cause came from lower heating value. LHV now what is the difference between the two so to explain in the difference,

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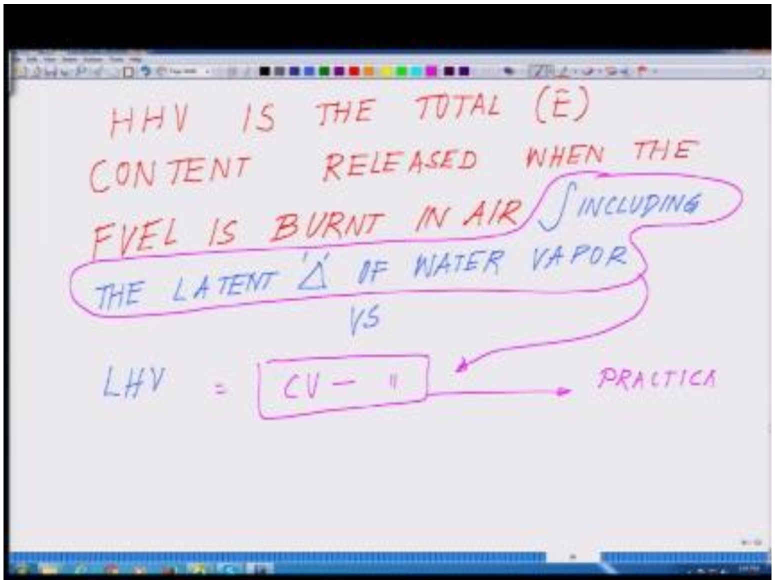

There is something like this, whenever we calculate the calorific value we take into account the latent heat of the water vapor say for example what does that mean say for example I have a sample this is a sample and I want to measure the calorific value of this stuff. So there are a lot of water molecules inside it right so if you remember the last course I was telling what are we really deriving we are deriving the breaking of the bonds between carbon, carbon hydrogen carbon hydrogen oxygen likewise so on and so forth. Wherever there is a bond we are breaking the bond while we are breaking the bond.

We are pulling two things a part it is liberating and energy and that is the energy what we are using right in order to do that in that process what is happening say for example there are two entities a carbon-hydrogen there are a lot of water molecules present in and around right So when you are calculating the calorific value those water molecules are getting evaporated they are getting be so seated and getting an operated in other words, when you calculate the complete calorific value you are calculating the latent heat of water vapor.

But in real sense that gives you an overestimation and that complete picture of calorific value is what is I have wrote here is called higher heating value so in other word if you have to define higher heating value is the total energy total I am just putting e for energy total energy content released when the fuel is burnt in here. When the fuel is burnt in air including now this is the important part including the latent heat of water vapor now latent heat and just looking at the triangle of water vapor.

Now versus when we talk about the next one which is lower heating value what you are getting rid of in the lower heating value is this part this is the part which is not included in the lower heating value okay. So calorific value minus the is what makes it the lower heating value so essentially this is the more practical term more practically used for all this kind of situation okay. You LH v is equal to the CV which is calculated for hhv higher heating value minus this value okay.

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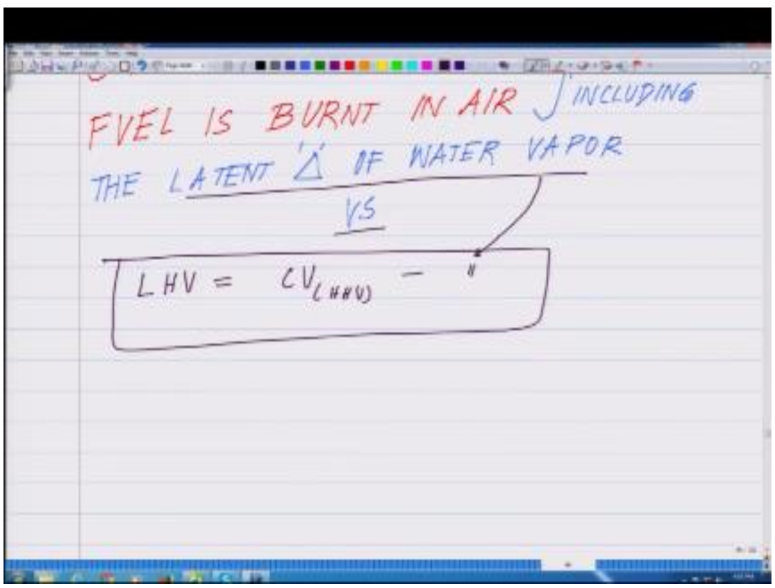

And this is what is more practically used so wherever you see hhv lhv do not get confused because it is a very simple concept so I believe this concept is clear to you so you are removing the water vapor and then what you are getting is this real value now if you see the table,

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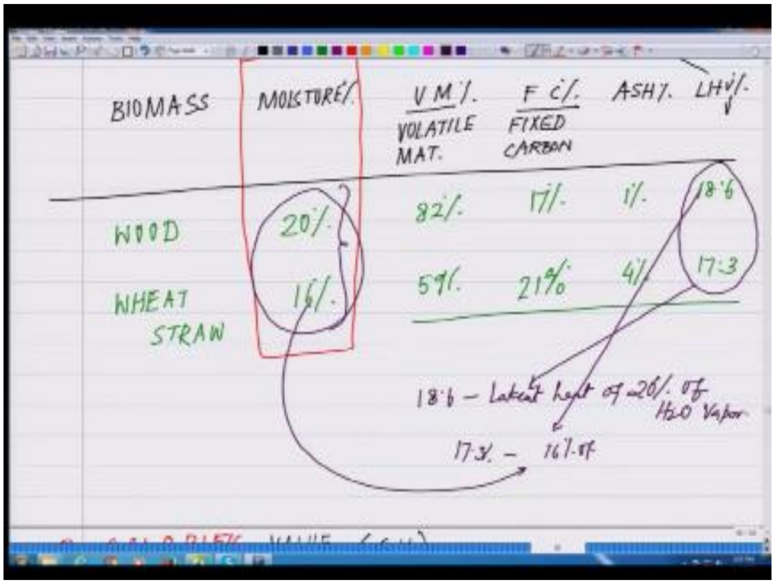

Now if you look at this table so in this table you see there are two kinds of water which are present here twenty percent moisture sixteen percent moisture whereas lhv value is eighteen point six percent 18.6and 17.3 now essentially what you have to do when you have to do this you have to you have to really proportionately reduce the heat or the value which will be generated while from the latent heat of this twenty percent moisture or sixteen percent of sixteen percent of this other product so in other word sixteen percent of the moisture value.

So whatever value you are getting say for example you are getting from here 18.6minus the latent heat of twenty percent of water vapor similarly 17.3 percent minus sixteen percent of latent heat generated by sixteen percent of water vapor. So you see these calculations whenever you see this kind of table you should be able to proportionately makeup in your mind that this is the amount which I have to duct otherwise I will get a superfluous value so what we see in this there are two points what we have discussed as of now the first point what we have discussed is about the water content.

So we talked about two forms of water content intrinsic water extrinsic water intrinsic water is the water which is embedded within the molecules in the core of that system whereas extrinsic water is either from weather conditions or something you are getting out from water or likewise that is external water which is getting to the system and whenever the values are given it is always the intrinsic value which is given next we talked about the calorific value in the calorific value we talked about one cross calorific value one net calorific value.

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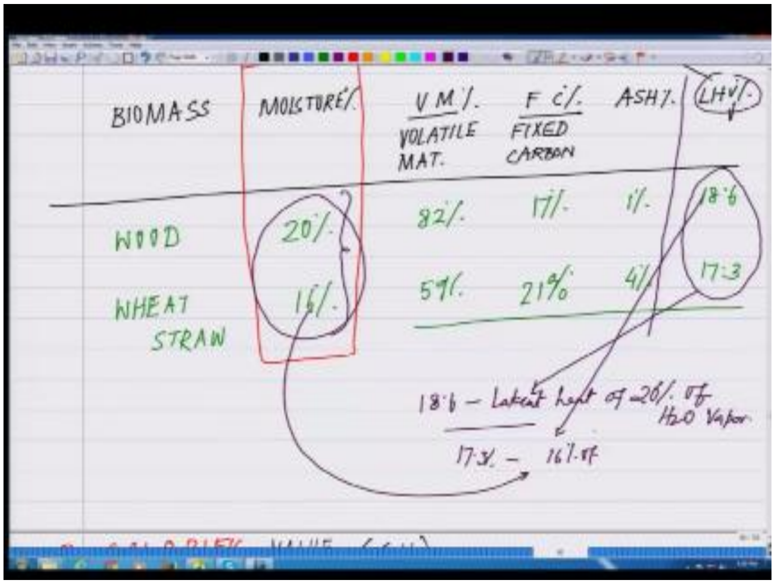

So gross calorific value takes into account the value of value which is which is including so sorry I made a one small mistake on the slide sorry just getting back to the slide so yeah so when we talk about the lhd value here if, if it would have been sorry because this is one small correction if you drive in HH d then you have to remove this value so this is in the LH v so you really do not need to remove the tag proportion of moisture from it okay. So what we realize is that from the gross calorific value GCV you have to remove the percentage latent heat given out by the water vapor that value has to be reduced.

And then what you get is the LH v value so that was one small mistake I did because I did not keep an eye that, that was an LED p value so if you drive in HH p value high or the gross calorific value then what we have to do is that from the gross value we have to remove in the latent heat of the water vapors if you remove that you get that you get the net calorific value which is also called LHC okay. Lower heat value so these are the first three concept next we will go after this to that other four concept which are there which will include the proportion of the fixed carbon versus the volatile.

This will be the next one what we'll be dealing with followed by the ash residue content and the alkali metal and we have already discussed part of it okay so let us stop here thank you.

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