Indian Institute of Technology Kanpur

National Programme on Technology Enhanced Learning (NPTEL)

Course Title
Bioenergy

Lecture – 35
Gasification Types - Up Drift Gasifier

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Welcome back to the bio energy course so we are following the gasification okay in the gasification we have covered the introduction of gasification and in the previous class I requested you to give maximum thrust on the chemistry because that is the most important chemistry of gasification where we you have formation of carbon dioxide or formation of co depending on what is the level of partial oxidation taking place and then the hydrogenation reaction where Co plus hydrogen making CH4 in the presence of water.

And all the efficiencies shift and now the how the efficiency goes down in the presence of nitrogen so now today what will when after that we talked about in the section 3 we talked about the pretreatment of the feed stocks followed by the properties of the feedstock so today what we will do will come to the fifth section of it which is our gasification types.

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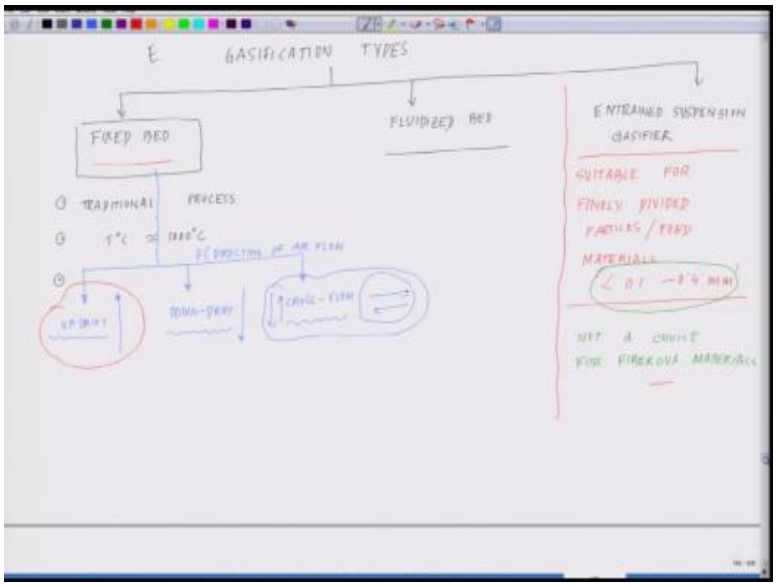

So this is E or fifth section gasification types so in terms of the different types of gasifiers which are which have evolved through the years and through decades we have three different kind of gasifiers which are available one is called the fixed spread gasifiers the other one is called the fluidized great gasifier and there is a third one which is entrained suspension gasifiers so let us put them together under one somatic so the most commonly used is fixed bet gasifiers second one is fluidized bet the third one is entrained suspension gasifier entrained suspension gasifier.

So in this course we will not really talk much about this in train suspension gasifier but just for your general knowledge these kind of gasifier are very suitable so if you are in industry and you needed a situation where this is very suitable for very fine particle okay suitable for finely divided particles or feed material particles or slash free materials okay and the size in which it works is less than 0.1 to 0.4 millimeter and these kind of particle size is very tough to achieve in when we are talking about fibrous materials.

Fibrous materials are typically between 20 to 18millimeters and here if you see the number it is around 0.1 to 0.4 millimeter so that is why so this is not really not a choice for fibrous material okay fibers materials so but this is just for your general knowledge if you have a situation or very

fine particles to be processed to be gasified and you should go for entering suspension gasifier now what we will be dealing in depth is are these two fixed bet and fluidized bed so we will start off with the fixed bed okay in terms of the fixed bed gasifier these are the very old traditional gasifier.

So it is a traditional process and the temperature at which it works it around the around thousand degree centigrade this is way and for the fixed bet classifier could be classified into three different categories depending on how the airflow is happening in to the system so it is a function of the direction of airflow okay direction of airflow it is this considered as up drift sixth grade class gasifier down drift up drift down drift second one and the third one is the cross flow okay cross flow okay.

So here it will go up drift down rift possibly there is a cross flow like okay so what we will be doing first is we will talk about in depth about the up drift gasifier system so before we put down the notes let us draw the schematic of how the gasifier up drip gasifier looks like.

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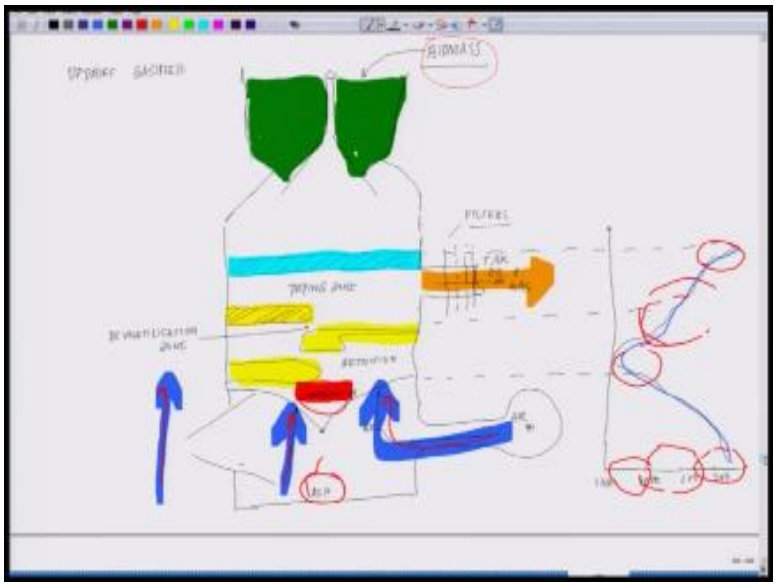

So this is how it more or less looks like okay so this is a kind of okay now okay so you have one for coming out like this and they are both coming out like this and okay the other side you have okay now once again okay so there is a boat out here and is another port out here and I will label all the porter to be very clear typical okay and you have three different zones I am changing the color for your understanding I am shading the region okay.

So the green this is from where you are putting the biomass into the system okay now followed by underneath it you have just bear with me a little bit okay and okay so now this is the top what you see that this is where you feed the biomass this is the biomass feeder okay so now this orifice what do you see out here through this is from where the tar which comes out oil and gas this is kind of through which outlet okay this is the drying zone and out here what you see there will be lot of filters which are here you know you can put a lot of filters or you can put them externally once you are there coming out where you have to trap the tar and all other stuff okay this is drying zone.

This particular location is called the D volatile zone this zone is the reduction zone and underneath you have okay and this is the combustion zone and this is where you are having the air coming in this is the air or refers and the air is moving like this okay this is very of the ash the air movement so I told you this is what we term this as up drift okay this is the up drift gasifier.

Now you see how the air is moving so you have a structure like this right and you are supplying air from the bottom and you are supplying the feedstock like this so air drift is like this okay from bottom it is going up so that means you are pushing the air to move up upward that is why it is called a up drift gasifier and these are the different sections of it if you see the cross section so let us go through it so here you have the biomass feeder present here okay so which is essentially this zone we are feeding the biomass which I am now highlighting in green okay biomass feeding zone right okay.

And then you have the drying zone which is present here this is where you are drying the stuff and while drying several thing goes exhausted out through this port this is the port through which is going out then you have the reduction and the combustion zone so here you have the reduction

and the combustion zone so the drying zone okay and this is where the D volatile taking place if you remember we will talk about the volatiles I told you that if the material is what most of these have lot of terpenoids and other compounds which are volatile matters and they have to be it has to be ensured.

That they do not unnecessarily escape out in the environment they have to be trapped and converted to some value added product or at least should be a way to dispose them off so this is where so you are having the sample you are drawing the sample that brings you to the basic concept or you removal of water next you remove the volatile matter trapped in these molecules or because of the hydrocarbon breakage and everything there are lots of volatiles which are produced there.

So this is the devolatilization zone and your air supply is coming all the way from the bottom like this and this is why it is called an up drift system and here is your combustion zone here where you are doing the combustion process all the reduction and everything which is happening here so since your movement of air is like this from bottom to up we call it as up drift system now if you look at the system there is a very interesting variation in the temperature across the system and that is what I am going to highlight now I will draw this right side of it and that will give you an idea what I am trying to tell you okay.

So say for example so let me divide it into x axis in terms of the temperature that you are starting the access at 1400 degree centigrade 1600 or 2000 and if you follow exactly what is the temperature here what is the temperature here what is the temperature in this combustion zone you will see a very typical pattern of something like this at this zone and this will come very handy for your understanding the temperature started increasing and then it contains the maximum in the combustible zone and then again it stopped.

So what does this picture tells you what just now I draw like this falling and then moving and then so which means that inside this gasifier the temperature is not uniform so the temperature varies at different part of it so at the drying we thing about if you look at this so at the drying level we are talking about at temperature around so if you follow it up to this temperature varies

from around here where is the drying zone taking place in and around 200 or something okay little more than 200 okay.

Now if you go down in the devolatileasian zone which is out here the temperature is hovering somewhere here which is out here and if you go further where is a combustion zone we are talking about this temperature so you can classify the zones where the temperature is higher zone which is lower so it means the biomass is going through a time of course it is taking time to move through and in terms of varying temperature okay and your air supply is coming from the bottom okay like this and whatever combustion is taking place the ash is getting collected out here you see the ask is getting collected here .

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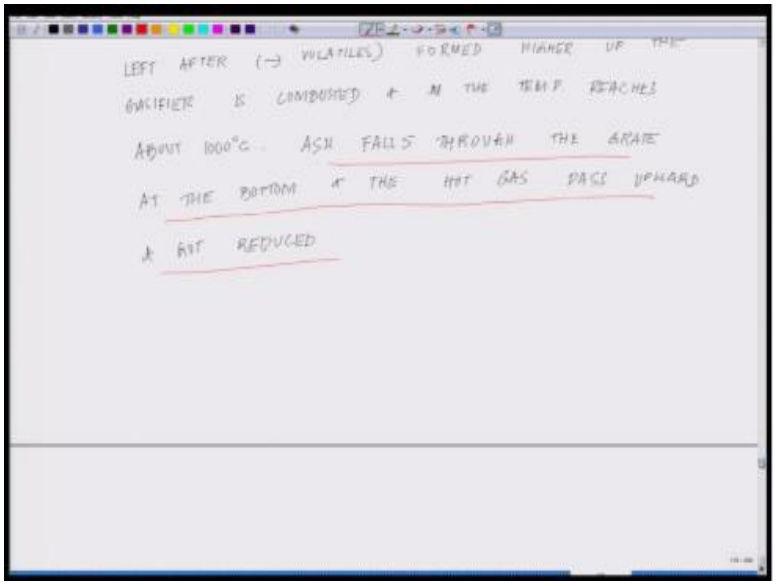

Now let us pull our attention to some of the salient feature of it okay, in the drip gasifier up drip gasifier some salient point what you people need to remember saline points regarding up drift gasifiers okay, the salient point the first important point is that immediately above the grate immediately grate in the above the grate so the grate is sitting out here if you look at it out here immediately okay, immediately above the grate the solid char or the which is basically the

residual solid remaining after use of volatiles okay, residual solid left after minus removal of volatile okay, formed higher up a solid chart formed higher up the gasifier okay, is combusted.

And the temperature reaches about 1000˚C okay, and I showed you in the if you follow the picture right, I would see the ash this is where the ash is falling down so all the important things are all I happening here okay all the major critical aspects are happening here and the ash is basically falls through the grate at the bottom fall through the grate at the bottom okay, and hot gas pass upward energy use pass upward and got reduce, this is what you have just now observed ash falls through the grate at the bottom and the hard ash pass afford and got reduce so look at it.

So here the ash is getting collected as the air is moving getting so here all the combustion and all the chemistry is happening and the ash which is coming out is now falling down like this through the great maybe getting accumulated out here whereas most of the gas or products which you needed product the gas is all forming out here in this location okay, so the next important point for you people to remember is higher up the gasifier again okay.

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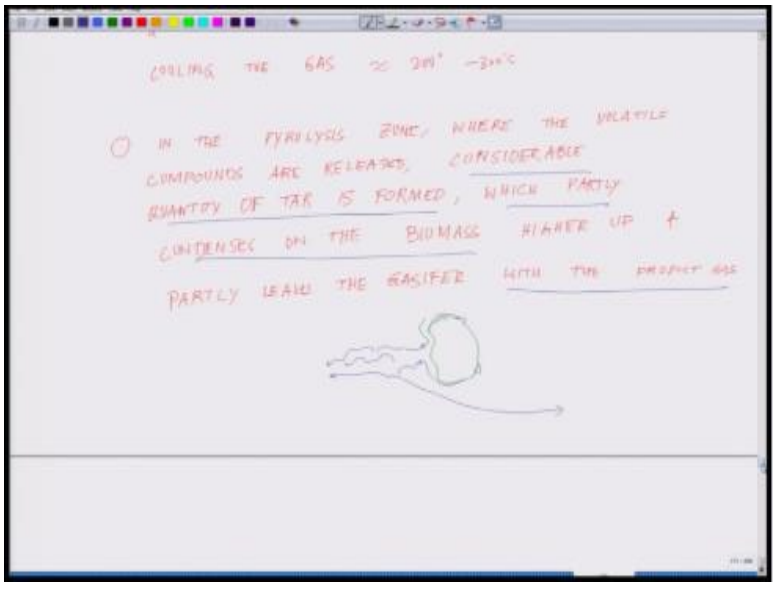

Higher up the gasifier again the biomass is pyrolyzed in the top zone I have the gasifier biomass is pyrolyzed and in the top zone okay, the feed is dried that is all you have seen the drying zone if you follow the picture cook so this is the drying zone where the feed is getting dried okay, feed is getting dried toxin and feed is getting right, and cooling the gas at around 200 to 300˚C which you can follow if you follow this stuff this plot you will see around 200 to 300˚C.

We are in this zone the gases kind of getting cooling down so what you are the gas you are obtaining is around 200 to300˚C which using you need to handle at a lower temperature the efficiency of the system is much higher at first such temperature, okay. So coming back when it is a third important point what you will have to remember is in the pyrolysis zone where the volatile compounds are released considerable quantities of tar is form condenses partly leads the gasified of the product gas, so that means basically in the pyrolysis zone where the volatile compounds are released volatile compounds are released considerable quantity of tar is form considerable quantity of tar is formed okay, which condenses partly on the biomass higher up.

Which partly and this is the interesting aspect partly condenses on the biomass higher up what does that mean okay, and partly leave the gasifier with the product gas so this is very simple, now let me refer to the diagram you will see what is happening so the gas is moving up okay, so this gas is out here it is the air is blown and the gaseous vomit is moving up now this gas it is in the paralyzing zone okay, part of it escapes out as I just not and part of it kind of you know is absorbed along with the tar on the biomass which is getting fed okay.

So this is a zone where you are losing some of the efficiency of the system overall efficiency because some of it again got absorbed into the biomass itself so it is not a not that whatever is forming is coming out, so there is a kind of mixing partial mixing which is happening which is basically to highlight the fact that in the pyrolysis zone where the volatile compounds are released considerable so this is important considerable quantity of tar is formed which partly condenses on the biomass so you have this star coming, okay.

If this is the tar material so and here you have the biomass material so it is condenses on top of it like this okay, and part of it of course leaves it as along with the product gas this is another important aspect about it. Now there is a fourth point about this up drift gasifier.

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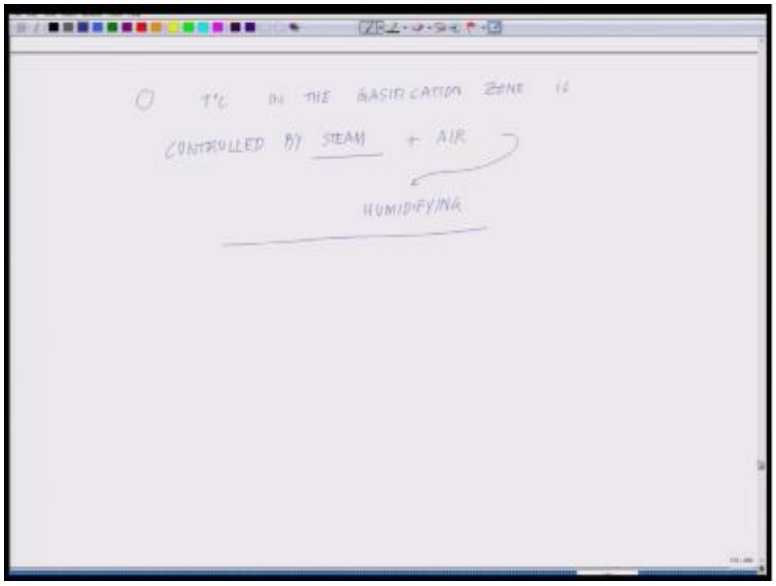

We needed to highlight that is temperature in the gasification zone is controlled by adding steam okay, so temperature in the gasification zone is controlled by steam okay, and adding a steam along with the air which you are going from the lower side object okay, which further basically leads to ship you are humidifying the situation. So while I am writing this I wanted to show you those four reactions what I am highlighting.

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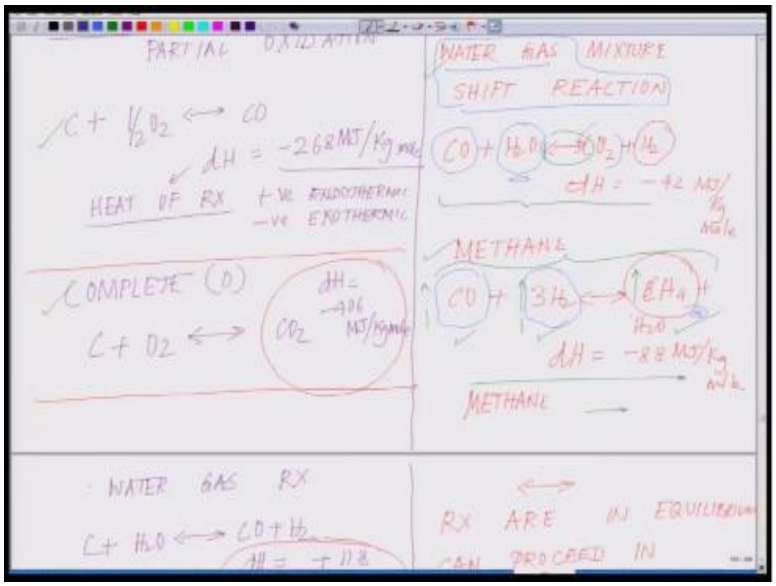

If you look at them again carefully you really do not need to remember things by logic so you can put it in place so think of this situation here see here, so this is say for example is coming as a team okay what will happen so this will lead to the methane production COH2O this is not you can really put the steam in order to control the temperature because this team has a much more higher temperature, okay so coming back to the points what I was trying to highlight.

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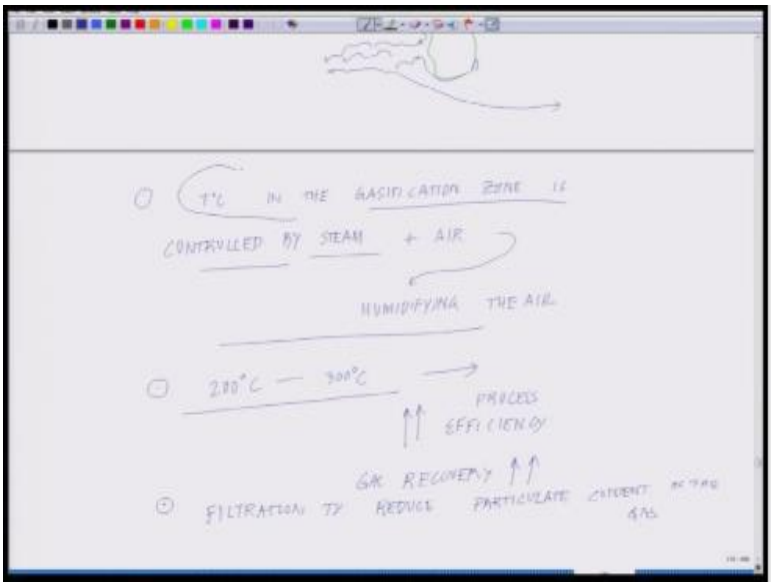

Is that temperature in the gasification zone is controlled by steam plus air thus humidifying the system okay, humidifying the air this is how you are controlling the temperature so there is the fourth point due to low temperature of the gas this is I mentioned that the temperature which is why we at the gas is coming out is around 200 to 300˚C if you are if the gas is leaving at that temperature of 200 to 300ºC the efficiency of the process is high as well as so this leads to two advantages.

So this leads to higher efficiency process efficiencies highest plus the recovery, gas recovery is also higher and the last important point is the filtering effect on the feed helps to produce gas with low particulate content so filtration to reduce particulate content in the gas, so again refer to the picture this is what I am trying to tell you, so here if you put lot of filters out here you can trap the tar you can of course this is encaustic proposition you can trap the different particles so this is where you have all the different kind of particle/star trapping filters, okay. So these are the points which is salient point of the gasifier.

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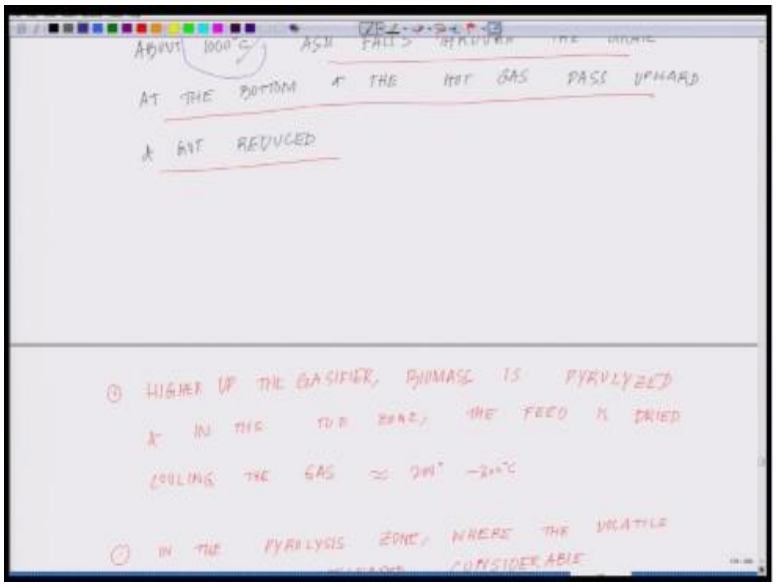

First of all immediately above the grate so that is where the solid char residues left after the volatile is being removed from higher up in the gasifier combusted and the temperature reaches about 1000˚C this is critical this is what temperature and the ash falls through as we have already seen in the picture ash is falling through that stuff which is present there which is basically from where you are you know along the air to flow so you have to ensure when ash is falling out it is not blocking those ports through which the air is going to go up into the up industry.

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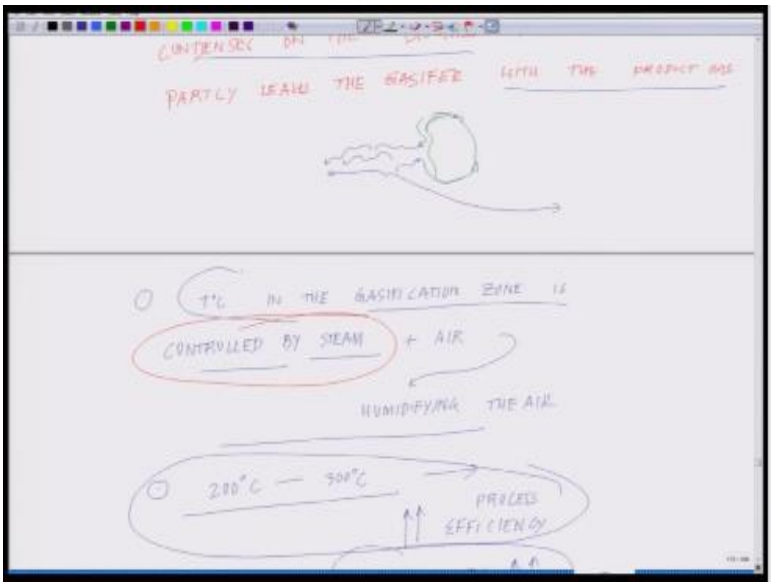

Second what we talked about higher up the gasifier biomass is paralyzed in the top zone and the seed is dried in the cooling gas right cooling the gas to around 200 to300 degree centigrade and in the last part we mentioned that one it was not 300 degree centigrade in case the process efficiency as well as the gas recovery, okay and another aspect the temperature out here is controlled by the steam so the take-home message for most of it is lying in your chemistry those four reactions.

If you understand those reactions and what is happening inside the gasifier you can pretty much imagine even without seeing a gasifying system okay, so remember those four reaction and this is the first gasifier we have talked about today which is the up drift gasifier next we will talk about the down trip classifier and then the like you know crises cross flow gasifier what we will be talking about and then we will go to the fluidized bed gasifier. So once again my take-home message will be please be very careful in the chemistry and try to put your imagination in place based on that you can even design a much more highly efficient gasfiers okay, thank you.

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