Indian Institute of Technology Kanpur

National Programme on Technology Enhanced Learning (NPTEL)

Course Title

Bioenergy

Lecture – 36

Down Drift & Cross Flow Gasifier

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Welcome back to the lecture series and Bioenergy, so the previous class if you remember we started with the different forms of gasifiers. So we talked about the classification of gasifier type and there we talked about the fixed bed gasifier, fluidized a bed gasifier as well as interim suspension gasifier. And further we classify them under these three heads to the different types which are available. So if we recollect in the last class we talked about the fixed bit.

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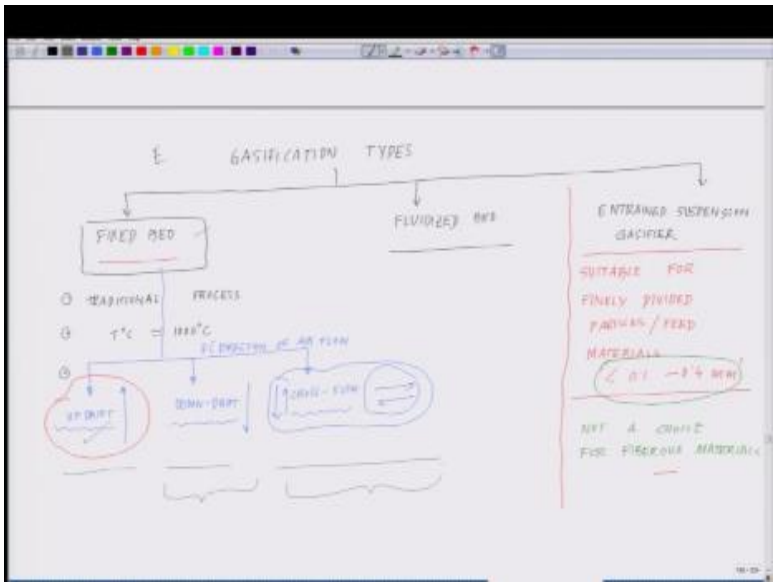

And within the fixed bit we talked about the three different types up drift, down drift, and cross flow, and previously we have covered the up drift. So today what we will do we will talk about the down drift design and the cross flow design okay. So before we get into the gasifier anatomy let us again revisit the up drift gasifier.

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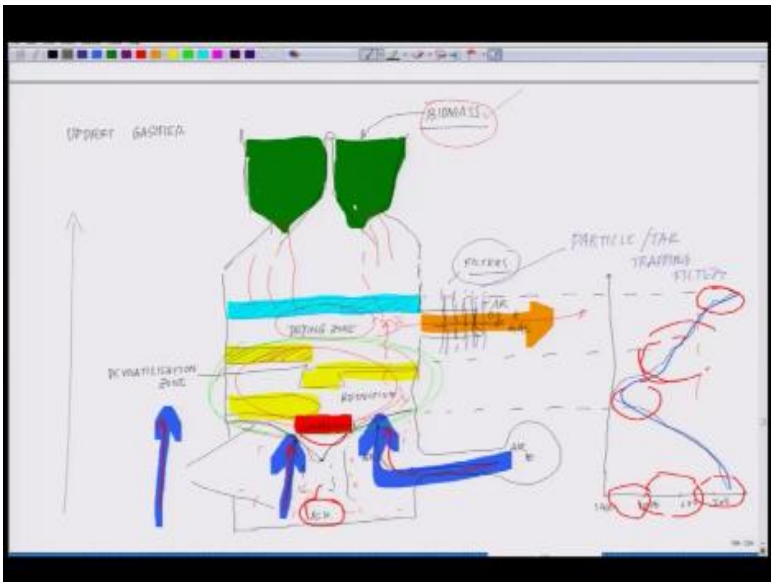

Where you can see that the biomass is inserted from the top okay, and the ear is coming from bottom so what is essentially happening air is moving in the upward direction up drift. There is a drift of the air which is moving from bottom to up. So if we have to talk about down grip then it should be reversed right. So the air should move downward okay instead of moving upward. Now look at another interesting aspect into it where I showed you the graph you see the temperature how it is varying. So at different zone at the drawings zone you see the temperature is around 200° okay.

In degree centigrade so the temperature scales temperature scale okay. Whereas the gas which is coming out of it out here so look at it that is coming out at 200°C, and we talked about it if the gas is coming out at a lower temperature as compared to the combustion and gasification temperature. It is the system is generally much more robust and much more efficient keeping this picture in mind now from up drift we will move to the down drift gasifier. And let us start with the schematics of the download classifier.

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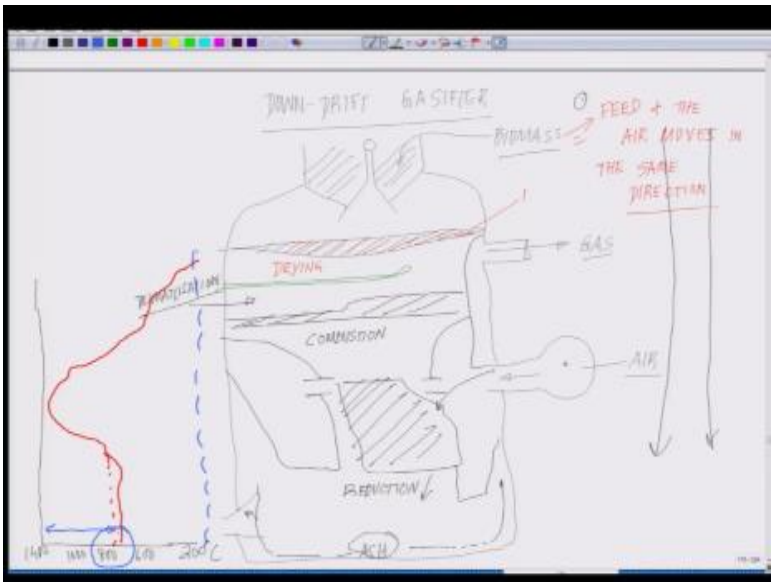

Down drift gasifier okay exactly we will follow the same protocol what we followed in the previous class. First of all we all have the schematic in front of us so that will kind of give you a visual seal how it looks like. And I request you whenever you get chance it should visit where this kind of gasification plants are there this would be a very good experience for all of you to look at. But how much of these things work okay so. So here you have it is not by scale so this is the air poured which is poured forth air entry okay. And this is okay no this zone if you remember this is where you are introducing the biomass okay.

So this is the biomass introduction zone and from here the gases is keeping out okay. And this is the port through which air is being pumped into it in order to promote the combustion process combustion pyrolysis. And all other processes and just above it above this port the region what you see out here, which I am now shading let me use a different color for better understanding. This is where you are having the drying zone okay, and underneath it out here which I will be putting in green something like this okay. And there is one small partitioning out here okay. So this is the drawing zone and this is the drying and this zone what you see out here is the D volatile, volatilization zone where the volatile materials are getting escape.

And here is the combustion zone the combustion is taking place and underneath it you are having small kind of partitioning which is being done something like this and likewise and on the other side also you see the combustion zone there is a port taking care of it. So what is happening is that here is coming like this so instead of if you compare this figure and just let me finish the driver. So here you are having the reduction taking place and underneath where you are having the ash which is getting accumulated because of the charging process okay.

Now if you complete this picture with the previous picture which is the other gasifier up drift we talked about you see the air is moving out here and it is moving all the way into the top. Here if you look at it air is not following that fruit here is coming into it and moving down and this where the reduction is taking place and ash, ash is getting accumulated here. So in other word here the arrow will be like this does that mean that means feed in the air move in the same direction point one for your take-home message will be feed which is basically the equivalent to biomass feed and the air moves in the same direction.

That is both of them are moving downward that is why we call it a Down ripped gasifier and if you compare the temperature as we did previously is the temperature plot what I will be drawing now let me put the scale. We have the 200 which is the lowest 200°C all 1° okay 600 here you are having 800, 1000, 1400 okay. All in degree centigrade and if you map it the way temperature is changing out here, so the mapping is very interesting you to start at around 200° and then it moves all the way during a combustion zone it almost hit this kind. But the temperature at which is coming out the gas is coming out could be something like this.

So if you look at it so look at carefully in the graph, so you see it started at drying started at 200°C okay. As is going down this is the zone where temperature is kind of the highest where we are talking about between 1800 to 1400. But the gas which is coming out is also at higher temperature. Unlike if you compare this with the previous one.

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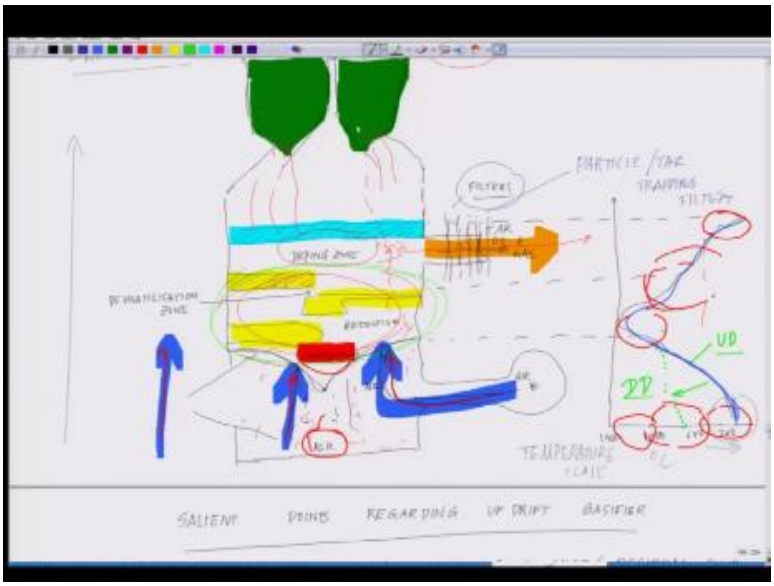

Up drift one you see when the gas is coming out it is kind of at a lower temperature as compared to hear what you are saying is that just for your understanding I am doing it do not get confused. Here what is happening it is modeled it is happening more like this so there is a shift in the down drift and this is the up drift okay. So DD stand for the down drip classified, so in the down drift that blue line is shifting more towards the left. So more towards the high temperature okay.

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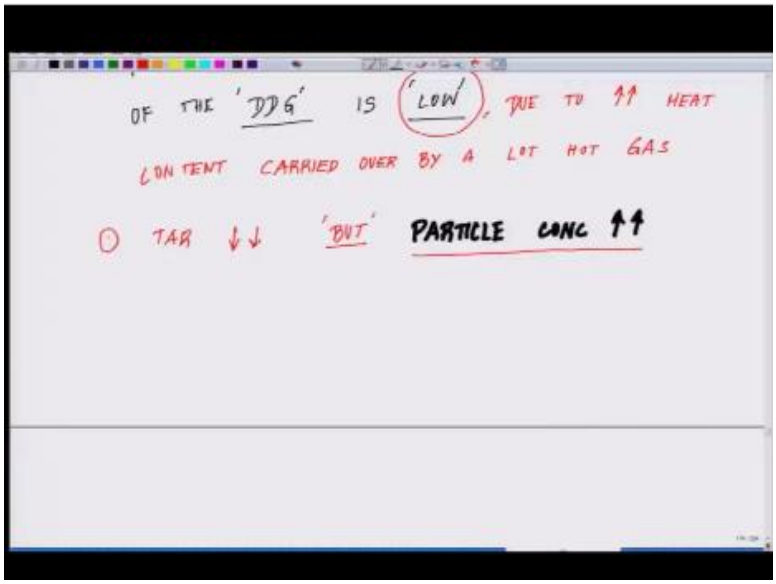

So now coming back so the first characteristic about it is that in the down drift gasifier what we are having the proof the gas which is coming out is at a higher temperature. So what is the second salient point about this is that the product gas leave the gasifier the product gas or which is your actual product you are looking for leads the gasifier unit at a temperature T°C or around 900° to 1,000°C. Thus as I mentioned in the previous class thus the overall efficiency of the system is low overall efficiency of the DD stand for down drift DDG Stand for down drift gasifier DDG is low as compared to up drift.

So this is the first take home message the down def has a lower efficiency and due to high heat content carried over by a lot of hot gas carried over by a lot of hot gas. So keep this aspect in mind second thing there is a very interesting trade-off which happens the tour concentration which is produced here is low tar really goes down. But, but here is a catch though you are reducing on the tar because it is getting more time why just you have to ask this question why you are you are having lesser tar because if you look at the situation out here because of persistent maintenance of a higher temperature.

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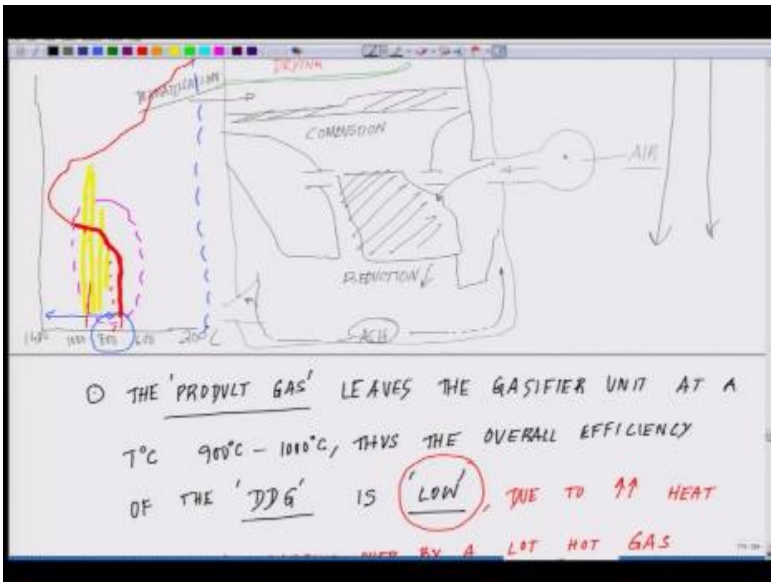

Lot of tar molecules kind of gets broken down so look at this region so you can have the graph little bit more shift like this also. So this is the zone where lot of tar is being is being taken care this is the zone okay one second picnic the yellow hatching what you are seeing is the where the tar is being taken care. But having said this always have to remember particle concentration is higher. So on one hand you are getting a better or other lower taught level but you are simultaneously increasing the particle concentration.

So it is always a very big trade a trade of what you are doing okay. And there, there is a huge amount of ash which is created in the system okay, so this is the fundamental difference if we have to talk about up drift and the down drift gasifiers. These are the two basic gasifiers which are being used there is a third type which will be discussing now which is called the cross-flow gasifier. So just to understand if you look at it so what is happening?

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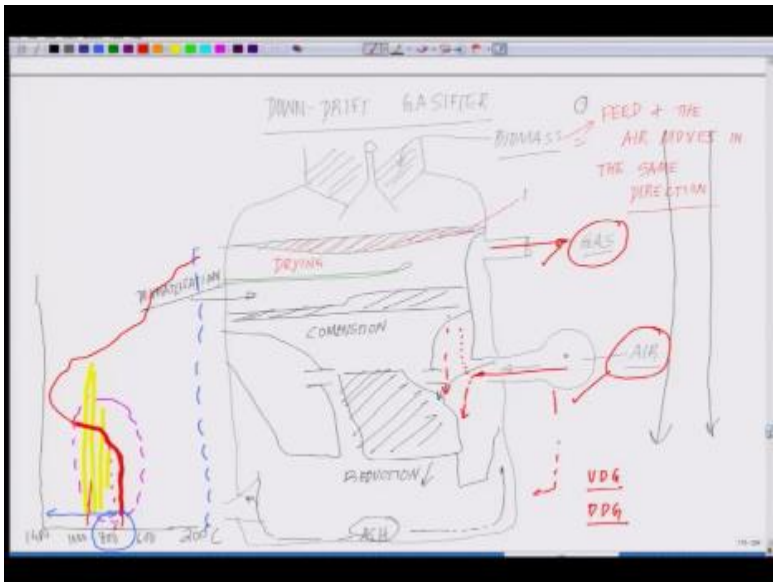

Gas is coming out at a different level here is coming at a different level from here air can either move up of course if the air chamber is somewhere out here. Then we call it a drift gasifier UDG okay, and if the air is moving in this direction along with the movement of the feed then we call it down drift gasifier. But here realize that this is at a different level the gas emission and the air is at the different level ejections are happening at a different level.

Now think of a situation if we see both gas and air they are getting out and getting it at the same level kind of Kris crossing each other. So let me just draw the gasifier that will make more sense to you people what we meant by cross flow gasifier okay.

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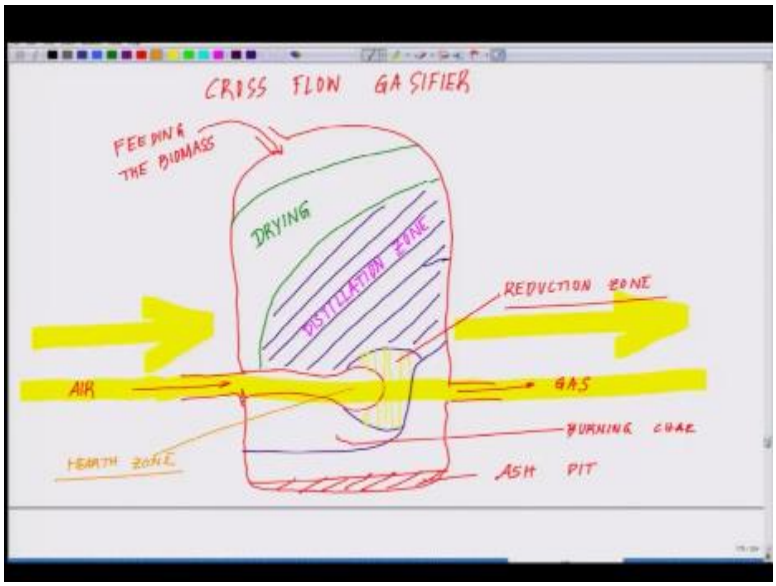

So cross flow gasifier so the schematic of cross flow gasifier is something like this okay. So here is this is the entry port for air and at the same level you have the exit port for the gas okay. And the way and this is the cedar from which from where you are feeding the biomass to the system or the biomass feeder and the first level is your drying region one minute with me okay. So the first level what you see will be the drying region where biomass is getting dried up next is the distillation zone which is putting a different color for your better understanding. So this is something like okay, now okay.

So this zone what you see which have now using violet color to you know hatch the zone this is called the distillation zone. Distillation zone the region which is out here just where I am putting yellow coloring I am doing we follow my yellow coloring shade or the vertical lines what I am drawing. This is the reduction zone okay, and out here what you are seeing is the burning char this is underneath is the ash pit okay. And we have talked about the reduction zone and this particular part is called that you remember in the previous class we talked about the hurt this is the hot zone.

This is an example of a very classical gas gasifier with a cross-flow anatomy okay, and so this is what is the high lighting feature of this whole thing same level. So there is a cross-flow happening at the same level unlike the other ones if you follow that either both of both the gas port and the air port are at different levels. Whereas here both the ports are at the same level it just air is coming out and gas is going out like this okay, so this is the classic signature of a gas flow cross flow gasifier okay. So now what we will do we will write some of the basic characteristics of the cross-flow gratifier.

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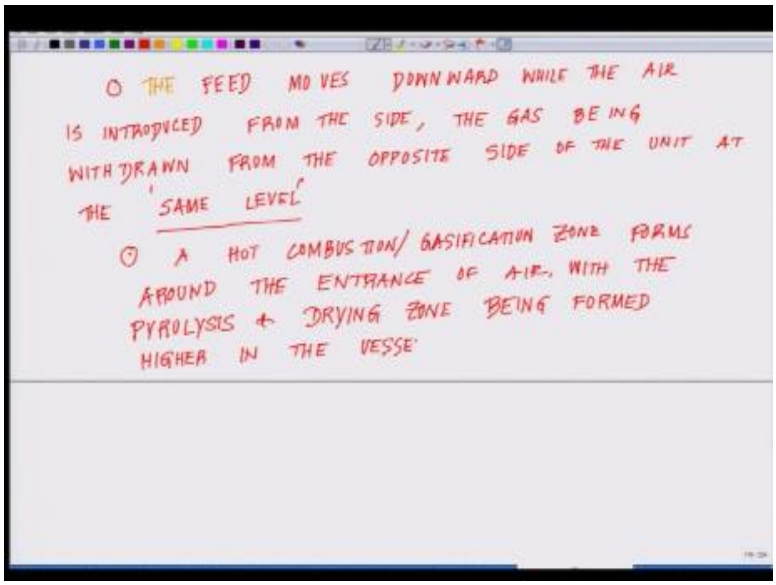

So in this situation the, the seed or the biomass or the feed stock feed moves downward as you could see the feeder is at the top. So essentially feed is moving downward okay feed moves downward while the air is introduced from the side okay. The gas being withdrawn the gas being withdrawn from the opposite side of the unit at the same level withdrawn from the opposite side of the unit at the same level.

This part is very important for you to remember the same level this is the fundamental difference with other gasifier types or six bed gasifier what we have talked about a hot combustion or

gasification zone from around the entrance of the air. A hot combustion / gasification zone forms around the entrance of their forms around the entrance of air.

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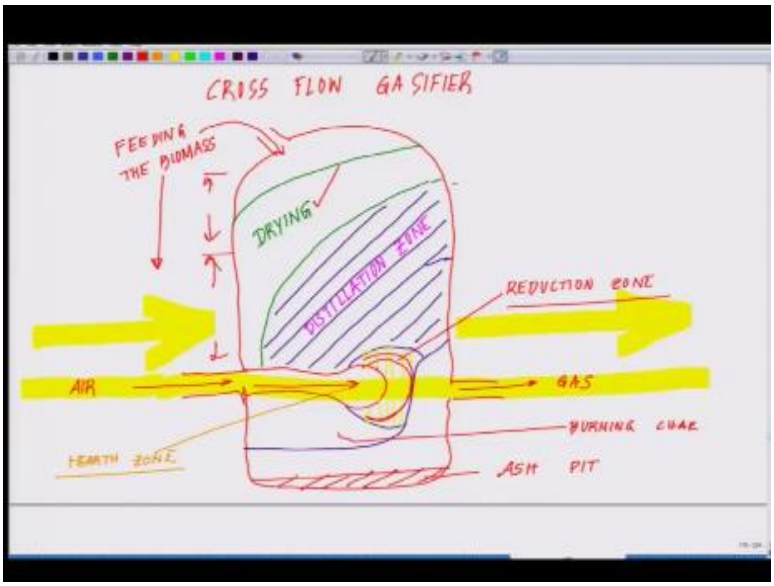

That you can verify if you look at the picture very carefully you will see so this is where what we are talking about so the air is entering out here and this is where lot of the reactions which are taking place the reduction zone okay. So now at the entrance of air with the pyrolysis and drying zone being formed with the pyrolysis and drawing zone being formed higher in the vessel being form higher in the vessel higher in the vessel.

So that also you can verify with looking the picture see this is a drawing as taking place at a higher level okay. Similarly distillation of pyrolysis all what is happening all is happening at the higher level and at this level the final reaction where the air is coming in contact with those process stuff okay.

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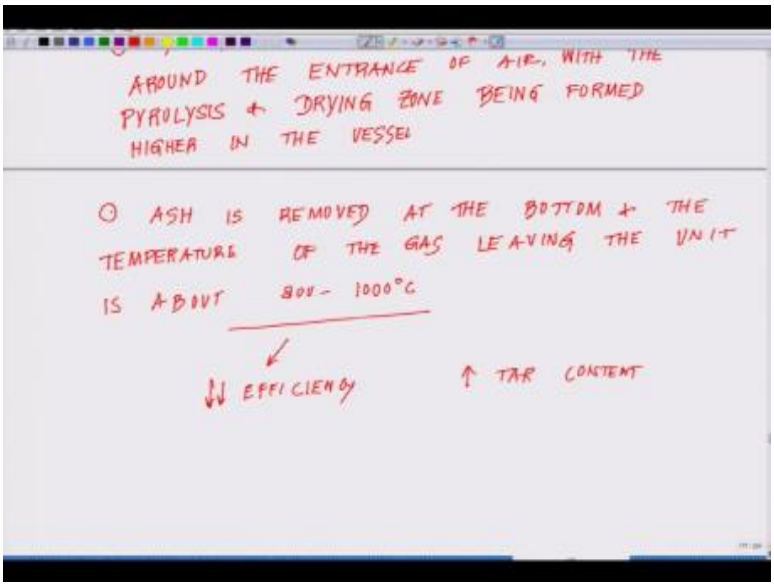

The third critical point is and this is ash is removed at the bottom as you could see there is a ash pit here they collect the figure again. So you see there is an ash pit from where you are recollecting the ash, ash is removed at the bottom okay. And the temperature of the gas leaving the pit of the gas leaving the unit is fairly high just like the down drift leaving the unit is about 800 to 1000°C. Thus what you are getting in such a situation is that the system has low efficiency and this gas has higher tar content. Why is it so? If you look at the anatomy carefully of this reactor you realize it.

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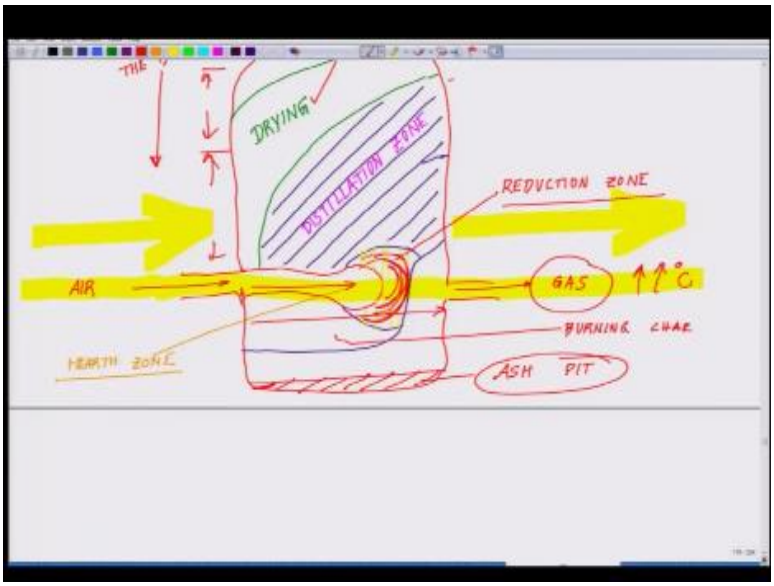

Because this is the only zone where most of the reaction is taking place so there is no other way you can remove the tar okay. So it is not really falling down it is at one specific location in this taking place so you really cannot remove the tar. Tar concentration is higher and the gas which is coming out that is hardly getting any time to travel through the gas is at a very high temperature.

So that reduces the overall efficiency of this kind of like the cross-flow gasifiers what we had what we have being seeing. So let us summarize we talked about where air is moving from the bottom going up we talked about air is moving from up is going down, down drift. You have the up drifty of the drawing drift and you have the cross flow like this here is coming and hot gases going and they are the same level.

So these are the three classic fundamentals fixed-bed glass gasifier what you needed to know on top of this several modifications have been made depending on different parts of the world. Where different kind of biomass is being obtained either with higher moisture content or higher tar content. And whatever you know there are so many parameters what we have already discussed based on that the gasifiers are being modified all over the world. So next what we will

do after this we will talk about the efficiency of these fixed bed gasifier. So I will close in here okay thank you.

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