Indian Institute of Technology Kanpur

National Programming on Technology Enhanced Learning (NPTEL)

Course Title
Bioenergy

Lecture – 39
Operation & Performance of Fluidized Bed Gasifier

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Welcome back to the lecture series on by energy so in the last class we talked about the fluidized bed gasifiers and before that rather earlier to that we talked about the fixed bed gasifier so today what we will do we'll talk about the performance of the fluidized bed gasps gasifiers and from there we will move on to talk about how these gasifiers are used for full in the vehicles motorized vehicles okay, to start of it.

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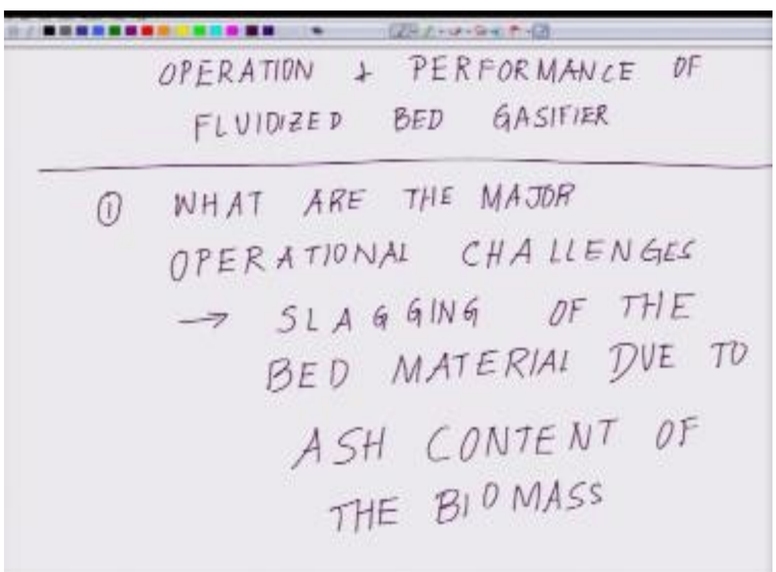

So essentially what we will be doing today is operation and performance of fluidized bed gasifier operation and performance of fluidized bed gasifier so in terms of its performance what are the first we will discuss what are the major operational challenges what are the major operational challenges operational challenges so in terms of the operational challenges broadly there are several points what we will be dealing with broadly you have to realize when you are transforming biomass directly to a gaseous product there are a lot of big organic molecules which are getting broken down by cracking and several other processes and many of these molecules in one step or two step cannot completely disintegrate instead they form a lot of torts.

And these stars depending on the temperature of the reactor vessel kind of condenses that is one of the major problem as the star condenses all along the walls along the tubes this target is deposited it is just like what happens in our blood vessels in air you have the deposition of fats and everything which kind of create clocking so similarly on the reactor vessels reactor vessel surface along the tubes connectors you have lot of deposition of the tarts and that led to a lot of slugging and all those other things.

So we will come one by one so let us put across the major operational challenges in terms of the major operational challenges the first one is the slugging, slugging of the bed material due to ash content of the biomass slugging of the bed material due to ash content of the biomass so higher the ash there will be more slugging as content of the bio mass.

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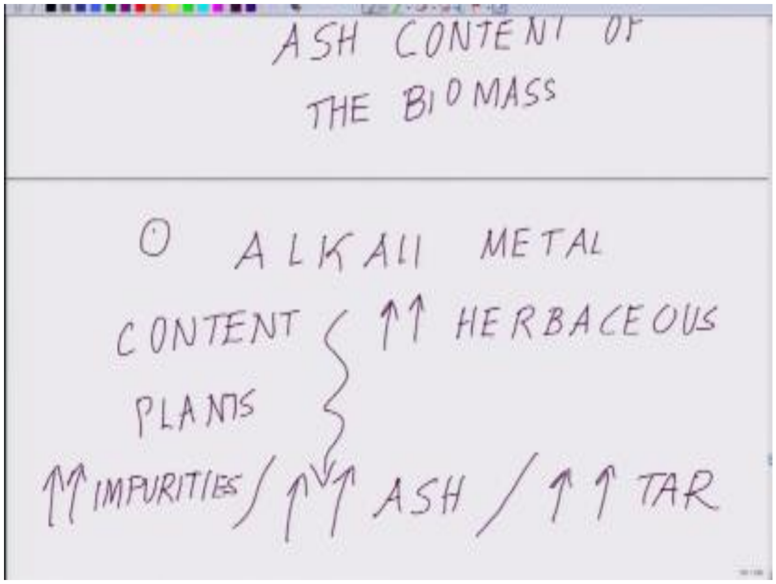

The second problem in the same line one comes across is alkali metal content which is fairly high herbaceous plant leads to this slugging alkali metal content and this also help in higher tar formation alkali metal content which is fairly high in herbaceous plants lead to more as more tar and all other impurities and of course this will lead to more impurities okay now one of the ways by which you can counter.

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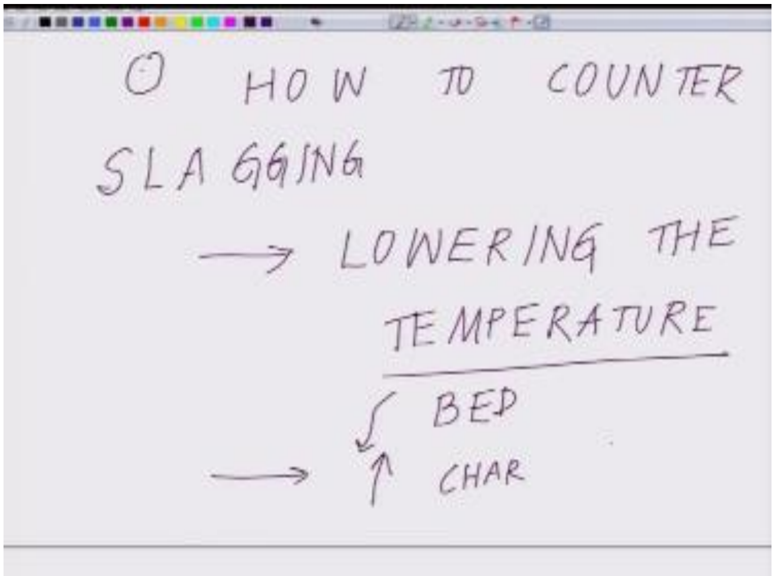

The slugging is how to counter slugging so it is kind of a trade off as you see you can one approach is lowering the temperature but if you lower the temperature will realize what to the challenges which is going to come in terms of tar formation lowering the temperature is one technique showing the temperature of the basically here in the temperature we talked about the bed temperature where the reaction is happening but then that leads to if that is happening there will be an increase char formation from which all these things have to be removed all the impurities up to the removed

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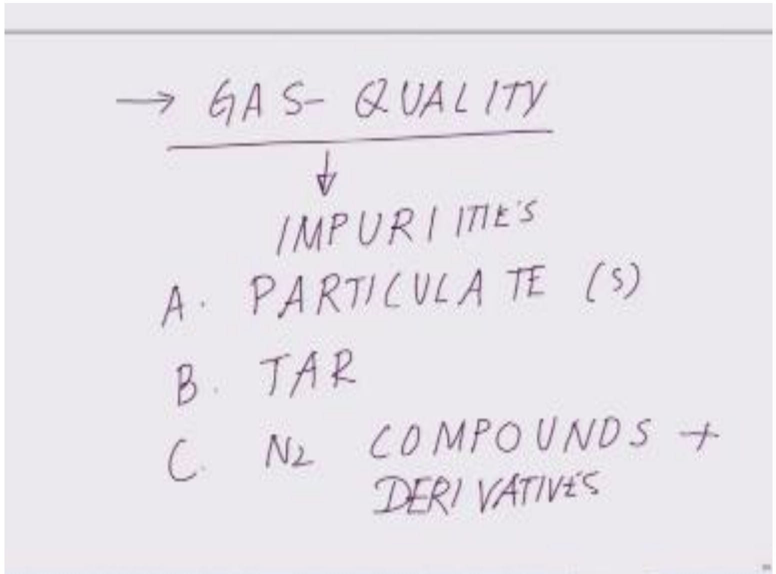

And in terms of the gas quality of gas one has to quantify what are the impurities which are present or which arises out of post classification the impurities could be classified years soak impurities could be classified as particle that matters one of the big source of impurities second as I am mentioning is tar content third you have nitrogenous compounds or their derivatives nitrogenous compounds plus their derivatives which are formed during this whole gasification process which of course leads to the reduction in the calorific value.

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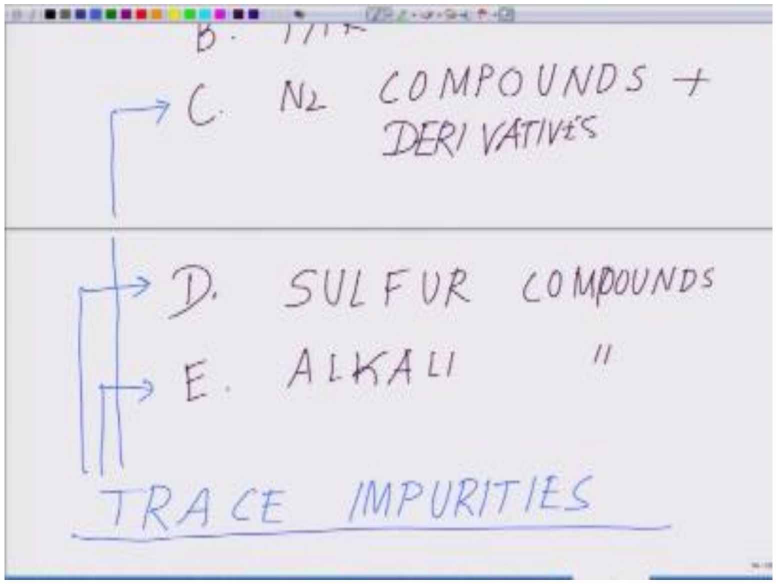

You have lot of sulfur compounds which are derived then you have all Kelly compounds okay and these three the nitrogen sulfur and alkali they fall under the trace impurities so all this blue what you see out here they fall under trace impurities okay, now we will briefly talk about these three points the particulate matter tar and some of these compounds which are present there okay.

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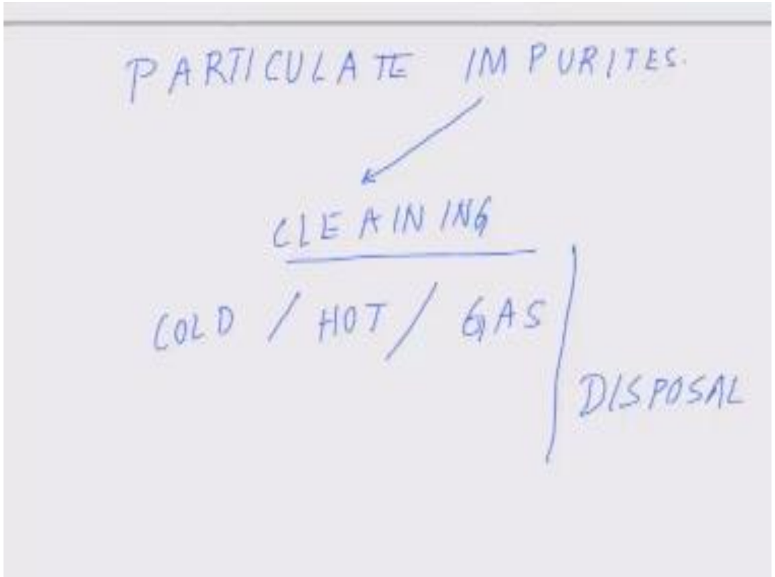

In terms of the particulate matter so this is one more thing I wanted to you know highlight here for all these impurities so most of these impurities has to be basically cleaned up okay cleaning and this depends on what kind of cleaning you are doing what is the temperature of the gas where there is a hot gas or it is a hot or cold gas okay and what are the relevant disposal issues which has to be taken into account and we will come one by one into this matter what are the different kind of particulate matter which are generated and how you can get rid of it what are the compromises you do in terms of the tar formation and how you can get rid of that stuff and what are the compromisers we do in this whole process to start off with particulates okay.

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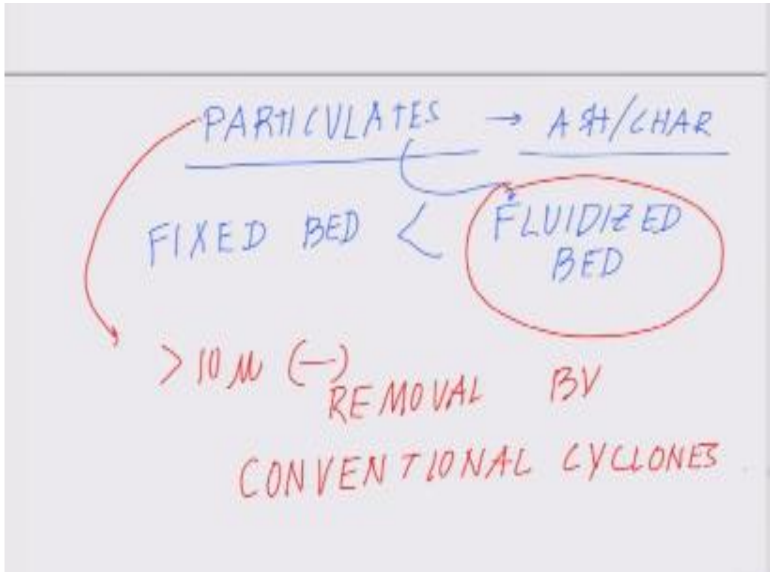

In terms of the particulate matter we are having two kinds of particles which are forming ash and the char particles following the charring incomplete combustion so it has been observed in the fixed bed reactor the particulate matter formation is much less as compared to fluidized bed so in other word your particulate formation will be higher when you are dealing with the fluidized bed reactors okay and particulate is removed by conventional cyclones if the particulates eyes is so.

What are the removal technique of particulates if the particulate size is say more than 10 micron particular it is more than 10 micron it could be removed I am just showing the negative sign here or removal just for no further confusion removal by conventional cyclones you have already exposed to the Cyclones where there are a lot of this reaction is taking place by the movement of all the reactants okay conventional cyclones whereas if your particle size is less than this.

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Or rather below 10 micron then the option is different in that case you will be needing filtering devices using needing filter bags it will be needing sintered ceramic metal candles centered or ceramic metallic candles and most of these technologies have an efficiency of around 99% which it can remove.

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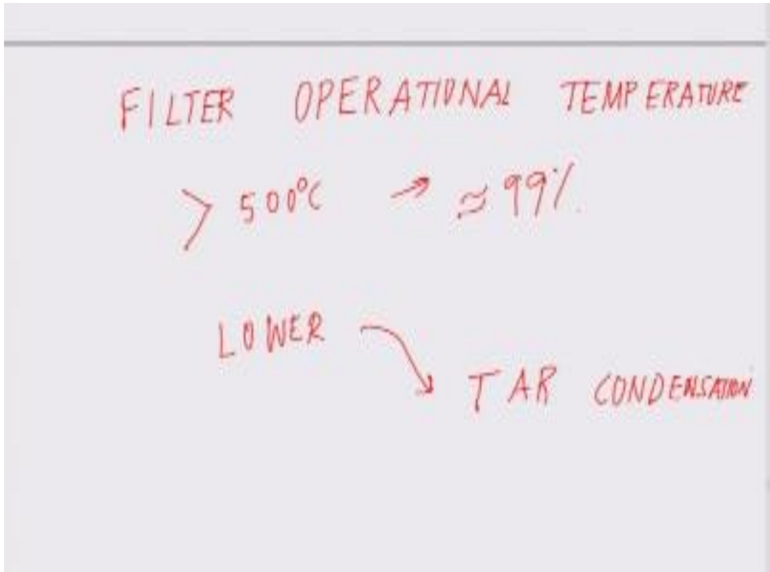

Filter operation temperature is very critical here filter operational temperature if filter operational temperature is more than 500^0centigrade you get a higher efficiency which is approximately ninety nine percent what I mentioned you. But if it is lower than this then you land up with a next problem which will be dealing with a star condensation as I was mentioning earlier that if you reduce down the temperature all those big molecules which fail to crack accumulate at that lower temperature and kind of with little bit of a fluid which is available there they form kind of a sludge or kind of you know sticky stuff which sticks onto the walls.

So if you reduce down the temperature out here this is the problem you face but again if you have the high temperature then you have the problem of a storage of the gas so it is always a trade-off at what temperature your output is coming and what temperature you are running the reaction that will inevitably decide the performance of the reactor at which it is working so keep that in mind there is no absolute rule there is no absolute protocol which you can follow you can say this is perfect.

So depending on the kind of biomass you are having depending on the kind of economics you are having you have to decide that at what temperature at what pressure you are going to run the reactor and of course it will have its own trade-off it will have its own advantage and disadvantage you will becoming along with it okay.

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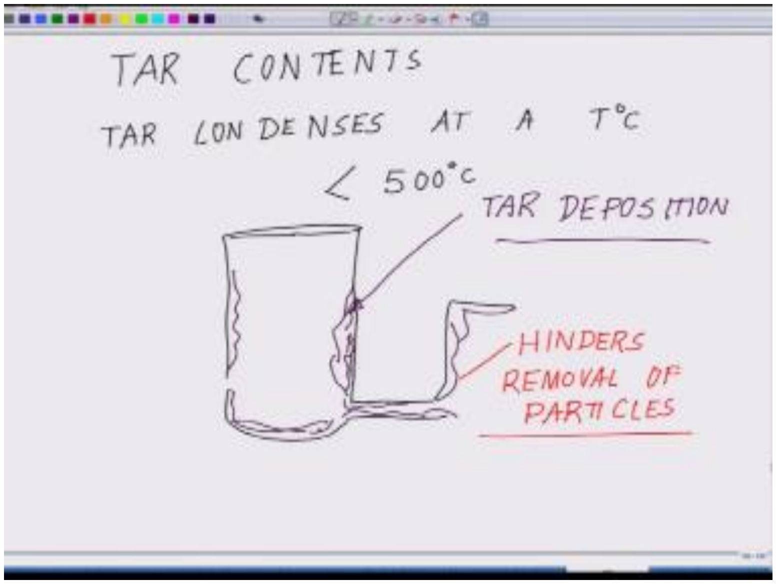

So okay next problem is the torque content so this is one serious problem most of these gasifiers suffers from Tar contents okay so tar condenses at a temperature less than500^0 condenses at temperature of less than 500^0 centigrade and what essentially happens as I was trying to verbally trying to tell you say for example this is the vessel where there action is happening or these are the connectors where things are moving.

So what will happen along this walls you will see there is a deposition of tarlike this they condenses and they can clog there were a lot of inefficiency we shall arise because of this kind of you know dark deposition on the surface and this has to be either scrapped or by using different techniques you have to kind of get rid of it tar deposition okay. So this is a perennial problem what you deal with so and this also further tar deposition leads to a second problem it leads to is the hinders removal of particle hinders removal of particles okay. Now post this what are the ways star reduction or removal.

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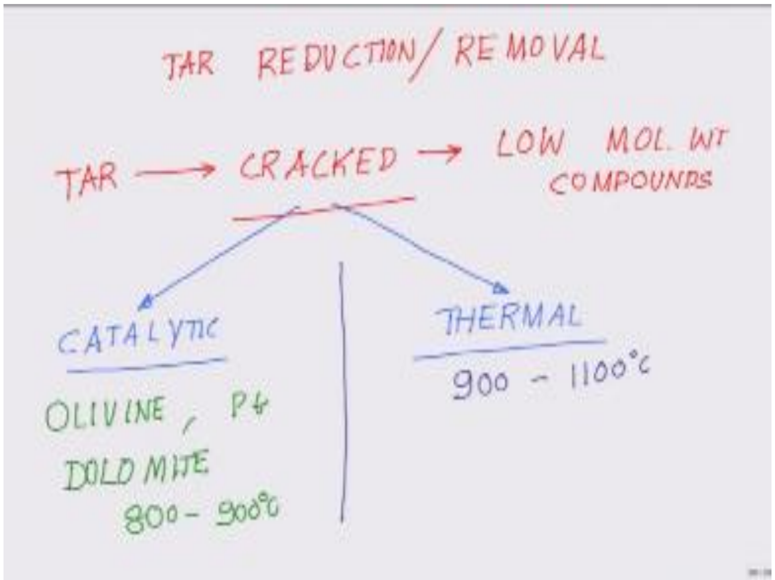

Tar reduction / removal what are the techniques which are being followed one of the thing is that tar could be cracked further basically you are breaking the molecule tracking of the tar to low molecular weight compounds low molecular weight compounds using either. So this whole cracking could be done there are two techniques by which you can do one technique is a catalytic technique which is called catalytic cracking catalytic process the other one is called a thermal process.

Now in terms of the catalytic cracking you can use different kind of catalytic agents which arc attack at a list which could be used which includes you can use olivine you can use platinum you can use dolomite there several catalyst which are being used and it functions around 800 to 900^0 centigrade whereas in terms of thermal process which functions at around 900 to 1,000 1200^0 centigrade is thermal cracking thermal cracking is more to do with like you know you are exposing the these molecules at a very high temperature the molecules cracks out and forms lower particles lower size particle particles and then those are filtered out okay.

And there is one more thing it is worth mentioning that most whatsoever do we can reduce the particle size and everything but then you will have to vary continuously change the filters or there is another thing which is very critical once you do a thermal cracking the next step what leads to is that you have to cool the gas because you are raising the temperature all the way to 1000^0 centigrade.

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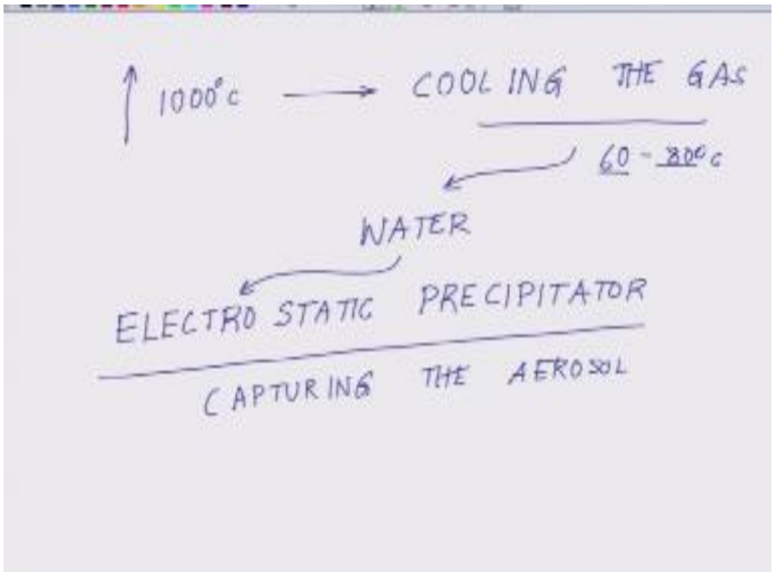

So now you have two cooling the gas so cooling the gas is a challenging task here and that you do and cooling the gas to around 60 to 80^0 centigrade you have to use this is a to okay, 60 to 80 that you use using water but when you are using or rather you use electrostatic precipitator electro static precipitator when you use electrostatic precipitator you are capturing a lot of aerosols but in doing so you are polluting the water which are using for this process and if you do so then you land up with another set of problem that now you have to purify that water.

So in other word this whole research or this whole area of development is a very interdisciplinary area so let me add here so when you are doing it so you needed a water purification assembly out here because water is a very prized commodity water purification because you are really contaminating the water so you realizing there is no one way and one has to think from the very beginning of the course.

Now so here the fag end I have been repeatedly telling that one has to think very holistically whenever we think of following or emulating nature so this is another way you have the gas you wanted to get rid of the tar in order to get rid of the target of two techniques either you follow the catalytic route or you follow the thermal route but which super route you follow you are raising of the temperature of the gas to 800 2000 degree centigrade but then at that temperature it is tough to collect the gas.

So you have to bring down the temperature when you are bringing down the temperature you using it while passing it through water but well you are passing it through water pickoffs all the different results which are present there and in that process the fresh water now getting contaminated with all these aerosols so next challenge is that on one hand you really got the gap right but then you have to purify this water so you're realizing that there is no absolute rule there is no absolute process by which I can say okay.

This is how it is going to work so one has to think very rationally how we can optimize these processes next centuries in order to meet our fill the mud okay now coming back to the third set of contaminants or particulate matter which are present there which includes your nitrogenous waste okay.

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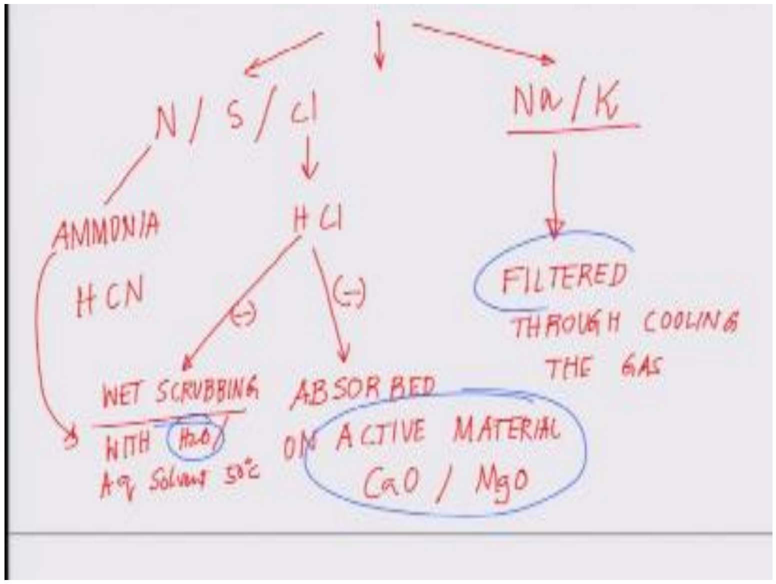

So we will be talking about nitrogenous waste we have sulfur waste we have chlorine which mostly comes in the form of HCL or hydrochloric acid this comes out in the form of ammonia sometime hydrogen cyanide sulfur comes in several forms h2s and other product and you have a lot of this sodium and potassium which are present there so most of these are filtered after cooling the gas we have already discussed about it okay filtered through cooling the gas.

Whereas HCL could be removed this negative sign shows the removal absorption on active material absorb on active material like calcium oxide or magnesium oxide further this could be removed by weight scrubbing there is a technique called weight scrubbing okay in aqueous solution or in water way to scrubbing with water or some eco solvent at a temperature of 50degree centigrade okay you can also remove the ammonia and all other things using water scrubbing so if you look at it the rate limiting point out here is water you need active materials you need filters.

So you will realize in order toemulate nature in the form of forming gas gases you have to go through this whole route off you know ensuring all these raw materials are being taken care and series of different things so this is what I wanted to cover in the gasification section and that pretty much brings us to the very end of it of all the different processes so what we will do in our next classes will summarize this whole thing before summarizing we will talk about one small fragment we will talk about how these what is the genesis and what is the history of this gasified fields we need to all start it and we're all it could be used and we will give a schematic after that we will talk about a summary of what all we have covered in the course and we will talk about the bio finery in our next class. Thank you.

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