Indian Institute of Technology Kanpur

National Programme on Technology Enhanced Learning (NPTEL)

Course Title
Bioenergy

Lecture – 27
Bio Oil – Solution for Thermal Instability & Corrosivity

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Welcome back to the lecture series in bio energy.

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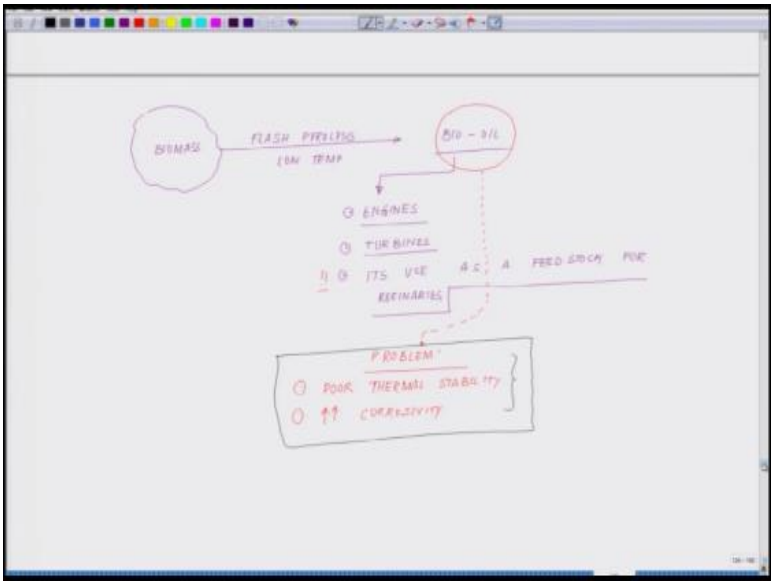

So let us see what are the technologies which are currently being used.

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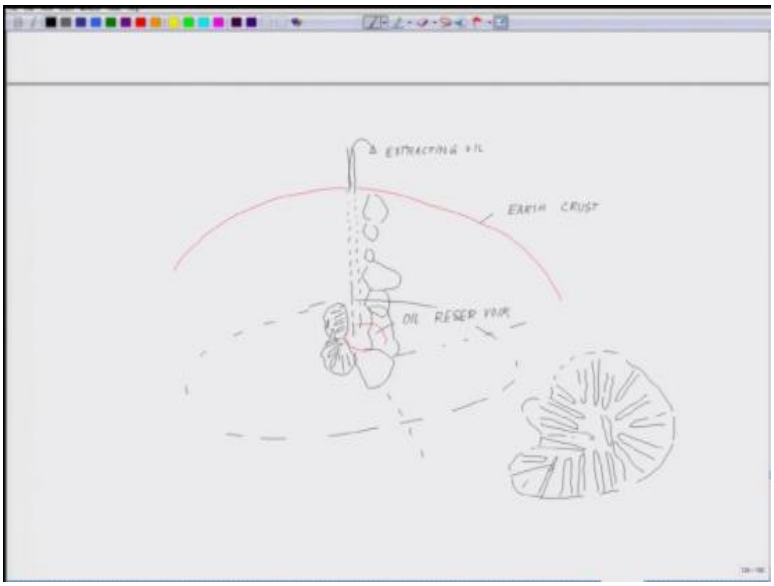

And what are the relevance to the drawing which I made just underneath out here where this comes very handy okay.

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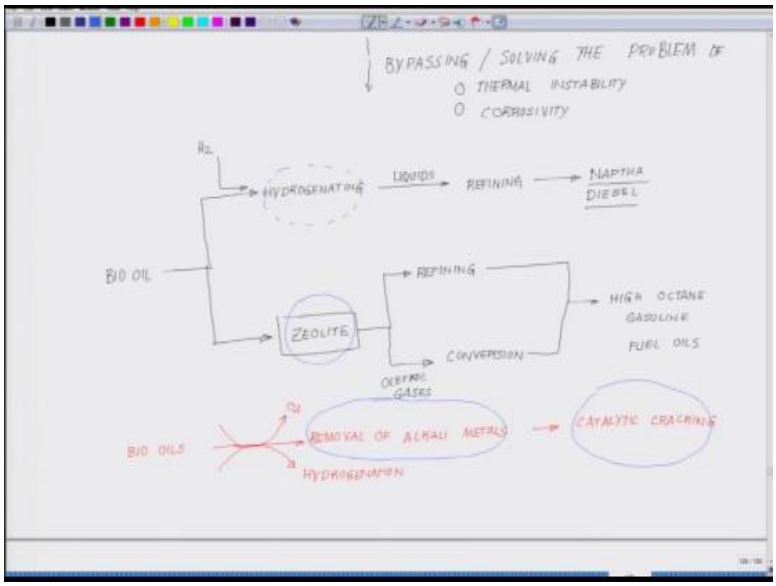

So now what are the technology is what we have in order to bypass the problem. So we have to bypass the problem of bypassing or you know or solving thermal problem solving the problem of thermal stability and corrosivity.

So one of the ways we get a bio oil okay you have two routes you can hydrogenate it okay hydrogenation thing so what is meant by hydrogenating is the process where you are adding hydrogen to it by adding hydrogen you are ensuring you are enriching it into a much more reduced condition you are getting rid of as much oxygen as possible, and you are reducing it further all these different hydrocarbons to further reduction process okay.

So essentially out here what you are doing is you are adding hydrogen by hydrogenating and the liquid which is formed liquid feature form are gone for the refining further refining and what you get out of this hydrogenation our products like naphtha, and diesel will come later about these products okay maps and diesel.

The other group what is being followed is zeolite treatment will come soon on this topic what does that mean zeolite treatment and plus your light treatment here you are refining following

your light treatment or you can do a further conversion missing form of to me all the cynic gases one second all this is gases okay. And what you get out of this is you get high octane gasoline okay high octane gasoline and you get fuel oils and this process of zeolite.

So you can basically classify them into two groups we try to summarize this picture or this flowchart. So you have the bio oil and what you are essentially doing is you are removing oxygen, as well as you are, and they are doing it by hydrogenation and you are doing one more process you are doing the removal of alkali metals which is done for the followed by catalytic cracking.

So I use some big terminologies here will come one by one what does that mean there are three new terminologies what I have interviews I introduce the terminology is zeolite, I talked about already about hydrogenating, I talked about another term catalytic cracking and I talked about removal of alkali metals okay. So now coming back where we started if you remember when we talked about the characteristics of the biomass we went into in-depth detail about talking about different kind of ratios.

And then in the end we talked about the ash percentage and alkali metals. So most of these biomass comes with quite a good amount of alkali metals and these alkali metals are another reason for increasing corrosivity. And most of these alkali metals are cationic in nature, so what one has to do is one has to remove these alkali metals one step. So there are two things we talked about if there are trace amount of oxygen that has to be removed.

So that could be done by hydrogenating it you are pumping more and more hydrogen into the system and it reduces it further. So if it gets reduces further hydrocarbon there is not much scope for it to get oxidized, and you know convert it into some kind of corrosive materials okay. That is one step the second thing is that these kind of materials are rich in have a significant percentage of alkali metals that has to be removed and while removing the alkali metals.

There is another process which is followed which is called catalytic cracking what does that mean. So now let us take a step backward, so the first word what I have mentioned here is you

remember I told you about the zeolite. So what this does this word bring in your mind what is a zeolite most of you in your day-to-day life are using your lights you have seen different kind of water purifiers where you have these cation exchangers and anion exchangers.

Likewise so those are nothing but zeolite what are your lights and what is the little meaning of it is very interesting. So now what we will talk about, because will and once again to remind you do not forget this picture we will come back to this picture very soon.

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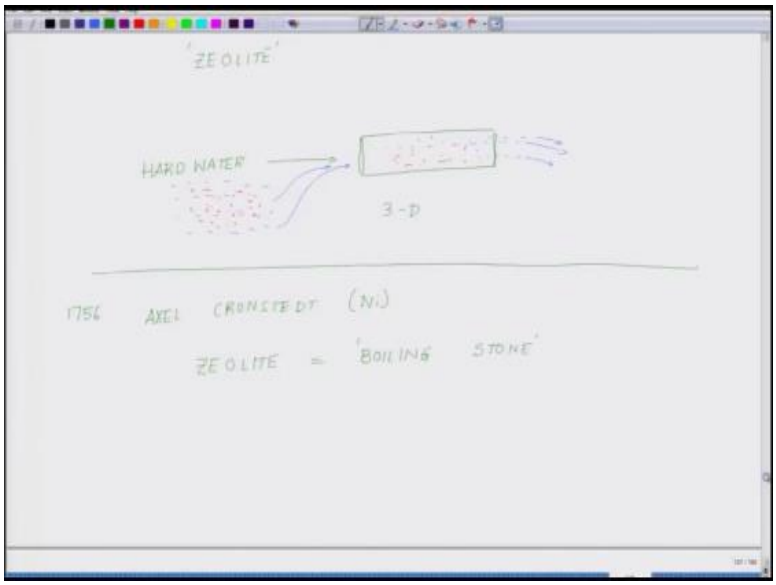

So now coming back what either zeolite and what is the role of your light it is ensuring that we are purifying the oil bio oil and making it free from these alkali metals. So let us have a detour from this, so at your house many of you get hot water right you pass it through what is purified water purified does when you talk about hard water we talk about there a presence of alkali metals in the water. So you pass it through a material where these different kind of so for example you have hard water and you pass it through a processor or through a material where all those alkali metals.

Say for example if this is the water sample what we are talking about okay and you are funneling that water sample through this. So this has a lot of this residues of alkali metals what you see. Now when the water goes through it water comes out fairly devoid of those material, and those red dot what you see gets trapped in custody this is how such filters are being made and those filters are nothing but very unique three-dimensional architecture of atoms arranged such a way with very small for size.

So what are those kind of materials so I will have to take you back to somewhere around 1756 okay that was the time when there was one element we all are heard about Nichols right there is a Swedish geologist who discovered nickel okay. And his name was axel chon stood it he is the discoverer of nickel in 1756 he was a geologist by training and he discovered another thing.

And as a matter of fact he is the person who gave this name called zeolite which is also called which actual meaning is boiling stone what does that means suppose you have water right, you give heat we see steam coming out. So you have rocks instead of water and give heat nothing will come out, but you have realized a very unique form of mineral you give heat you see steam coming out what does that mean it means there are materials which have formed on the earth crust far below which traps significant amount of water molecules.

And those water molecules if you could pull out such materials or such minerals and just to start giving heat to them you will see water coming out of it having said, this having said this I bring your attention to the picture.

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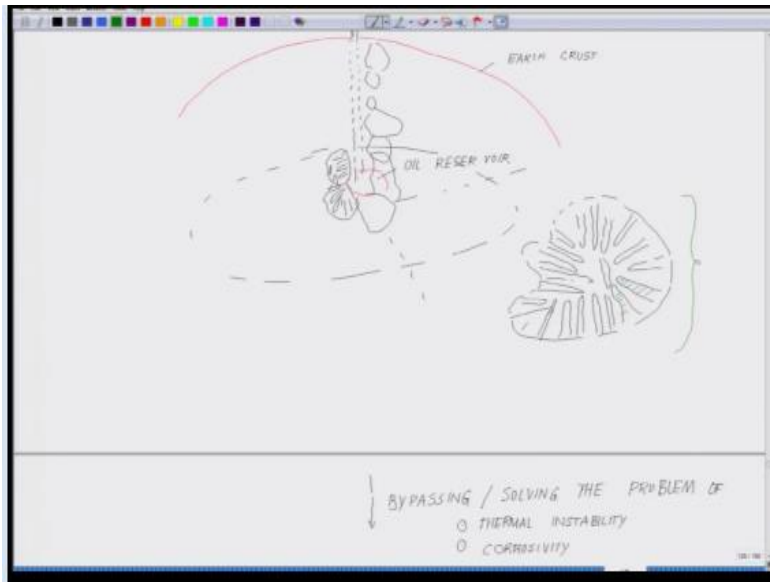

What I drew out here you see this rock you remember. And I told you that it has a lot of such cavities of course I told you those cavities are filled with oil and oilfield, but there could be such material which could be filled with water also.

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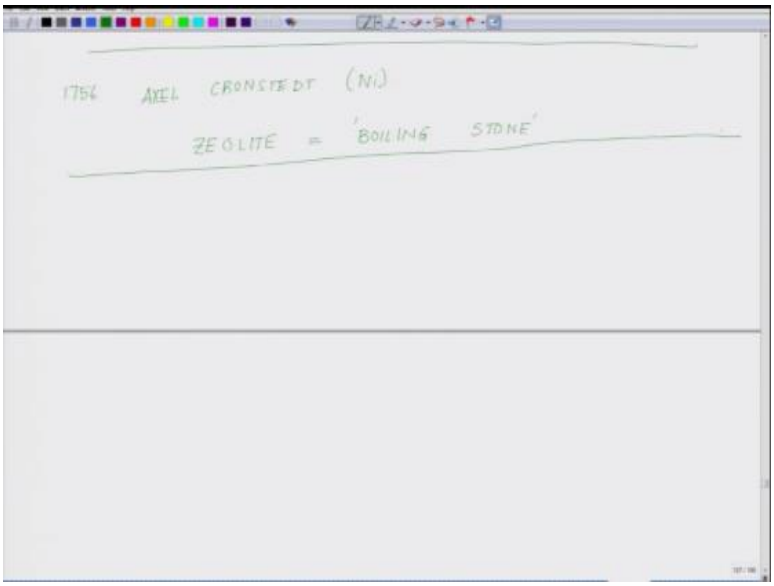

So they are asked such materials on the earth crust which deep underneath which could trap a lot of water molecules. And the now having said this let me put down some of the details about the zeolite, because this will come handy well it talk about the catalytic cracking. So these the elite's are basically these are hydrated aluminum silicate materials okay.

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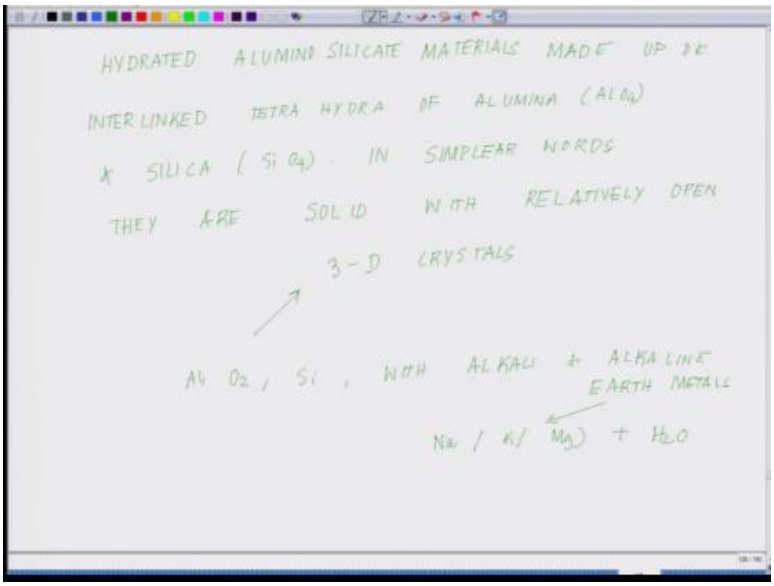

These are hydrated aluminum silicate materials made up of intellect tetra hydra alumina interlinked or 0 4 okay. And silica which is very abundant on earth crust okay, in simpler words if I have to put it simply would be our first point they are solid with relatively open three dimensional crystal structures with relatively open crystals with a lot of force in them as I have shown you and build from there made from elements of aluminum oxygen silicon, and with alkali and alkaline earth metals such as sodium potassium magnesium plus water molecules trapped index such structures.

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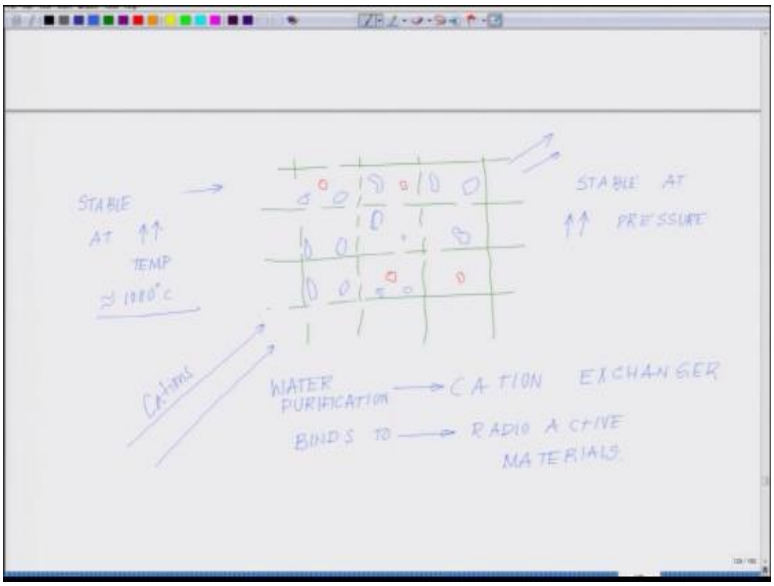

So if you kind of wish try to visualize it will be more like something like this it will be a structure of lattice of structure like this just for your understanding say it is kind of a mesh of different ferocity where you are having alkali metals tracked in them and there are a lot of water molecules which are trapped in such structures.

And it has some very unique properties will come to the properties it can is stable at high temperature very, very stable at high temperatures high temperature approximately 1000°C nothing is going to happen these are stable at high pressure, and they can trap several cations could get trapped in that such as a matter of fact such material could be used as cation exchanger and this is one property which is very widely exploited for making water purification with it they can bind to a series of radioactive material.

So this is for water purification binds to radioactive materials as a matter of fact it was surprised to know all of you have heard about the Fukushima disaster in Japan the leakage in the nuclear power plant. So in and around Fukushima region the farmers in the field in a paddy field they use different kind of zeolites. In order to trap the radioactive materials which got leaked out and

contaminated soil and apart from it most of the zeolites are used to clean the areas where there are radioactive contamination.

So apart from it there is a third property these have come to that so these pores act as very similar to so this is a kind of hypothetical structure which I drew these force are very similar to something what I do out here they are almost like CDS of a small test tubes or reaction results which are there and coming back. So these are small reaction results, so if anything which gets trapped into them.

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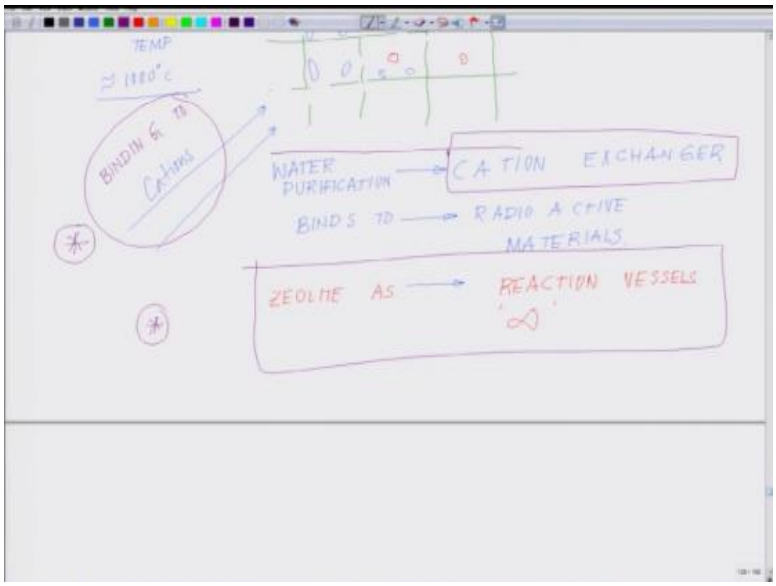

So zeolite reaction vessels will come to this what does what is the significance of it as reaction vessel I just put infinite number of reaction vessels before I come to this reaction vessel concept which is of direct significance. So there are two things which are of direct significance to us in this aspect one is the catalytic exchanging property or in other word binding to cations this is one thing which is important for us.

And second thing zeolite as a reaction vessel these are the two aspects what we are we going to deal with which is of our direct concern for bio oil purification. So before we get into that what

are the different kind of true as you know through geological eras we have different kind of rocks which are form endogenous metamorphic and sedimentary rocks okay.

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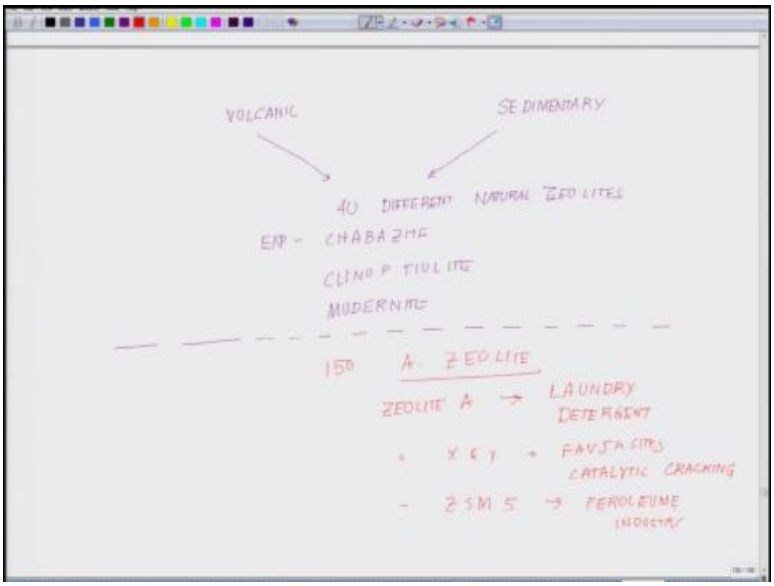

And in most of these rocks with its a sedimentary or most of the igneous which is a volcanic want volcanic or sedimentary rocks through sedimentation you will see at least there are 40 different kind of your lights which are formed okay.

And example R kappa site 40 different natural zeolite okay, some examples are cab aside then clean up your light more tonight okay whereas there are at least 150artificial zeolite which has been made a stand for artificial which has been man-made real lights which are there like you have zeolite a which is used in laundry detergent okay. Then you have zeolite x and y which is also called for your site which is used for catalytic cracking will come to this what is this catalytic cracking is all about.

Then you have read these are all which is used in the petroleum industry petroleum industry okay now having giving you a brief idea about your lighter it is a vast subject. So our concern as again to reiterate is this part what this catalytic cracking is all about.

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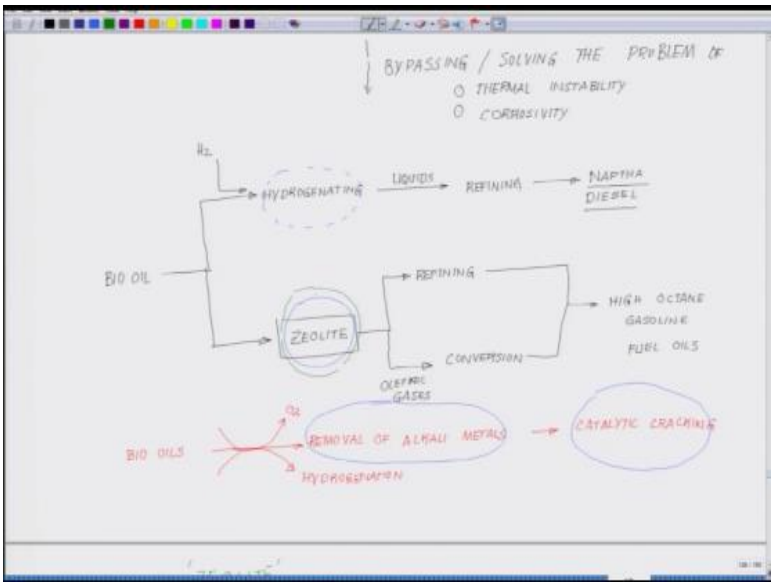

Now coming back to where we left, so now we know what is a zeolite. Now these your lights are being used for removal of the alkali metals we have talked about it.

So they have qatar exchanging ability and they could be used for removal of the different kind of materials different kind of alkali metals which are present their second is the last one is the catalytic cracking. So what happens when we are flash by realizing the biomass in order to make bio oil. So when you are doing in the laboratory conditions there are two three things which happen one is there is still some oxygen left out there.

So that could be removed by a hydrogenation process what you have already talked there will be a series of alkali metals which are present there which along with residual oxygen. And likewise will create a lot of problems was from corrosion will form deposits scaling on in the engine which will damage the engine. So those could be removed by passing the oil by oil through a zeolite.

But that zeolite does something more as I have told you that go light has three or four very unique properties to remember where we talked about this real light here come back to this machine.

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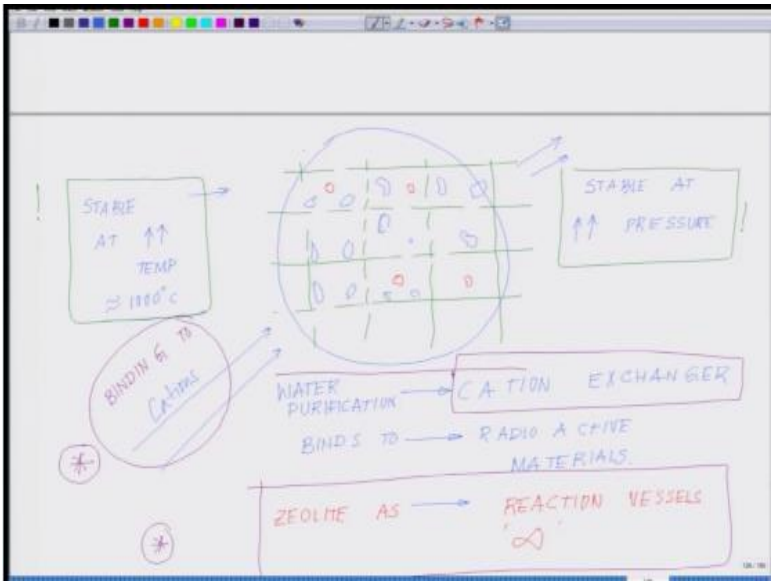

They are stable at high temperatures this is one critical property they are stable at high pressure this is a second property. In other words this particular stuff is our very good matrix for a reaction to happen because you can do any kind of reaction at a high temperature and high pressure.

So one of the challenges what these through flash pyrolysis the problem which is being faced by us is there are a lot of hydrocarbons which remain in a long chain. So now what is being done these long-chain hydrocarbons when we are moved through the zeolite they get tracked into these small pockets which are as I told you we are like that picture what I showed you last class.

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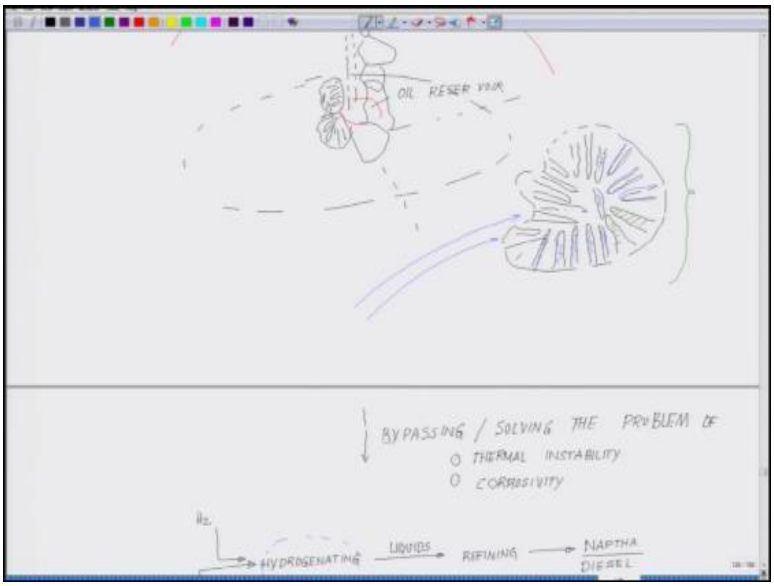

As if say for example you have the oil you are pushing it through this. And they are getting trapped into these lot of these test tubes okay and now you are having a high temperature you are giving it a because they are stable at high temperature okay. Now out here what is happening what you are deriving out of it is in those small vessels those long-chain hydrocarbons gets broken down into fragments. In other words you are using zeolite at four catalytically cracking the hydrocarbon long hydrocarbon chains into smaller fragments and by breaking them down you are increasing the fluidity of your oil.

Because solid particle eyes like potentially longer chain will make it more solid defying where you are you know cutting it in small pieces. So you will have lesser blockage you are increasing the fluidity and mobility of the oil and on top of that you are able to catalytically crack all those bigger. So that is why that word came catalytic cracking of the oil okay. So we will talk a little bit more will close in here and we will talk a little bit more in the next class about this catalytic cracking and how to how that is so very helpful okay. Thank you.

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