Introduction to Machining and Machining Fluids

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Lecture – 17
Eco Friendly Cutting Fluids Part 2

So, now we are discussing about some of the eco friendly cutting fluids in this course that is introduction to machining and machining fluids so; that means that we are in the second part of machining fluids later on we will go again back to the multi point and abrasive processes.

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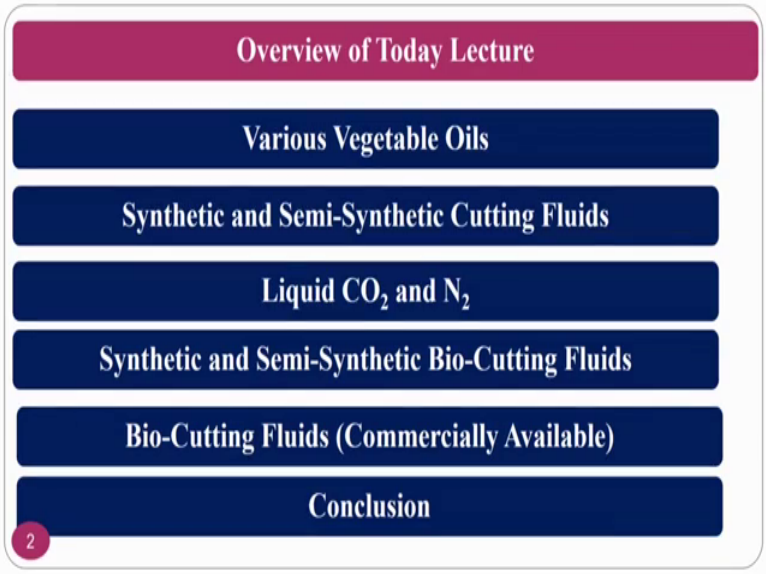

So, before that we will see what are we are going to study today's class that is various vegetable based cutting fluids or vegetable oils, synthetic and semi-synthetic cutting fluids and the liquid CO 2 and N 2, since we have already touched liquid nitrogen and all those things.

We do not talk much about this, but we will give you the glimpse and the synthetic and semi synthetic bio cutting fluids we will see then the bio cutting fluids what are the commercially available bio cutting fluids and all those things and then we will go to the conclusions of today's class ok. So, vegetables oils or the vegetable based cutting fluids which we are already saw two type of vegetable oils in the previous class. Now, we are moving forward to another variety or some of the varieties which will have the similar

things that is one of the thing is sunflower oil. So, which is one of India's abundant cooking oil, or biodegradable oils that you can see.

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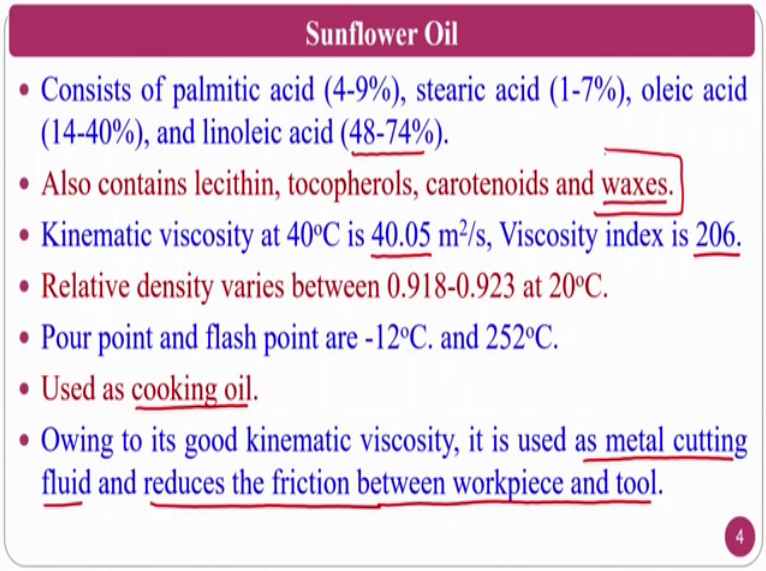

So, the basic thing see all the oils will have similar type things. So, some of the oils I will tell the composition and some of the oils just I will skip off. So, it consists of palmitic acid that is 4 to 9 percent, stearic acid 1 to 7 percent and oleic acid 14 to 40 percent, the linoleic acid is 48 to 74.

So, it is a compress of linoleic acid should is the highest content it is also contain lecithin and these other type of waxes also which helps in lubrication basically. So, kinematic viscosity at 40 degree centigrade is around 40 meter square per second and viscosity index is about 2.6 if you are looking for the operations where the viscosity index or the kinematic viscosity will false in this region you can choose it as you are all.

So, relative density varies between 0.918 to 0.923 at 20 degrees, the pour point and flash point are 12 degrees minus; that is a negative 12 degrees and 250 degrees. This is and normally this is used for cooking oils of the primary purpose of the people will use it cooking oil, whenever you take it if you can consume it then the emissions are the adverse effect that are there if it is no causing much since it is biodegradable oil.

So, it would not harm you if you are using as a one of the ingredients of the cutting fluid owing to it is good kinematic viscosity and used in metal cutting fluids a, because of it is

good kinematic viscosity normally it is used as a good metal cutting fluid which reduces the friction between the work pieces and the tool as I said know it reduces the friction because it contains the waxes ok. So, the wax is better lubricant like creases waxes this is a better lubricants. So, if you have proper lubricating properties, then the tribological properties will be high as we have seen that the lubricants will help in tribological or friction and cooling which is a water base will help in the cooling process.

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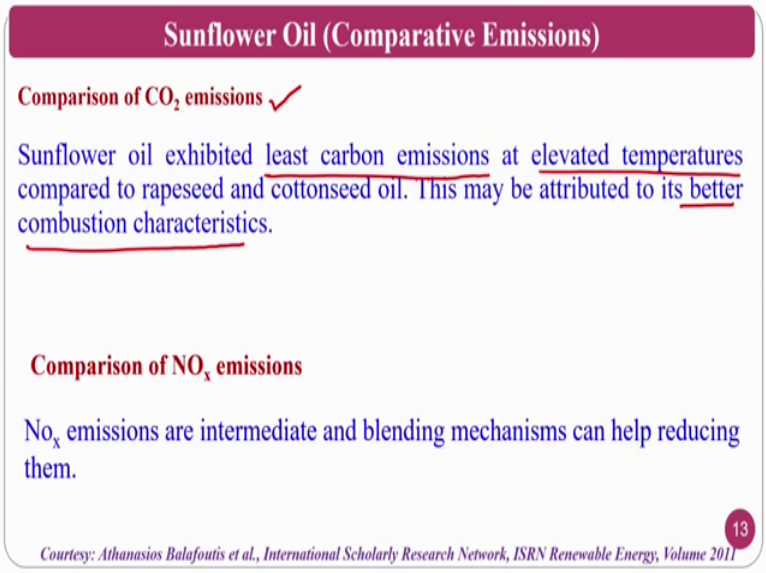

So, sunflower if you see the comparison of CO 2 and NO x and sox other things.

These are also used in the 4 wheelers or 2 wheelers, what are the engines are combustion type of testings; they have done for the sunflower oil and they have tested that sox and NO x are not that much sunflower oil if you see the CO 2 emissions sunflower oil exhibited least carbon emissions at elevated temperatures ok. And compare to the rapeseed oil cottonseed oil and these are the other varieties of the oils that we have not touched, but compare this is slightly better that is it has a having a better combustion characteristics.

If you see the NO x emissions NO x emissions are intermediate and the blending mechanism can help reducing them; that means, that if at all somebody want to use it as a bio lubricant or bio combustible oils, what will happen; if you can bled it with respect to the whatever the fluid that you are going to subjected to the chemical compatibility you can reduce the NO x emissions.

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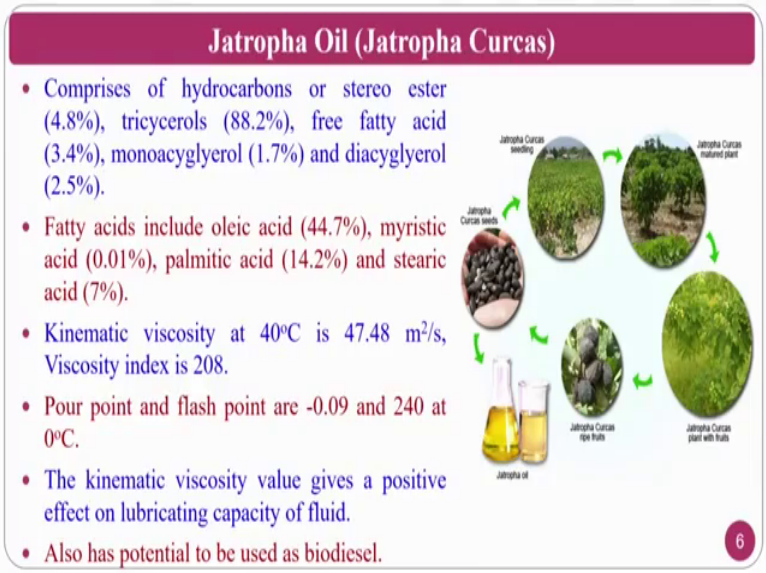

The second one which we are going to see today is jatropha oil; jatropha oil has a good application the metal cutting as you can see here.

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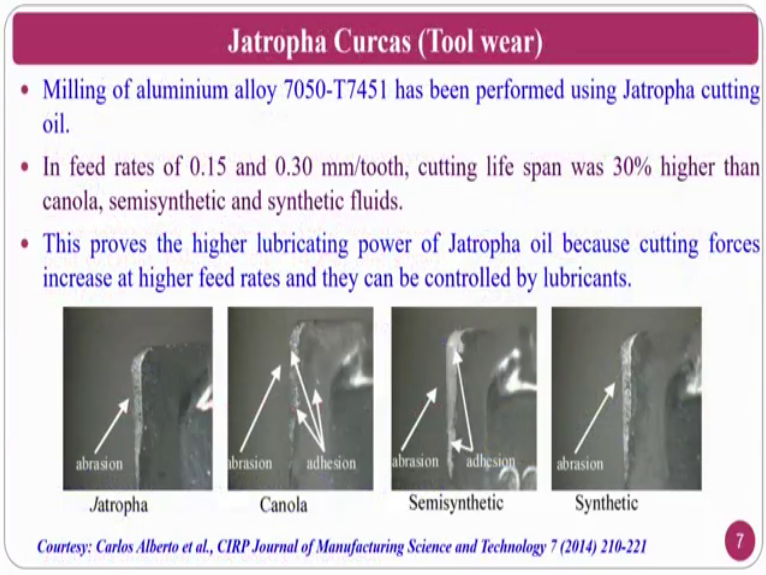

But will come back to the tool wear and all those things using jatropha oil if you see the comparison of it comprises of hydrocarbons or the stereo esters that is 4.8 tricycerols are 80 and which is major constraint and free fatty acids monoacyglyerol. These are all diacyglyerol these are all the other things. So, on an average, what I want to say is; it contains the major amount of tyicycerols.

So, fatty acids include oleic acid and other palmitic acid and stearic acid these are the other acids which it contains very less percentage is there. So, that is why we are not talking about the myristic acid the kinematic viscosity at 40 degree c is 47.48 that meters per second and viscosity index is 208 the pour point and flash point are like this.

The kinematic viscosity value gives a positive effect on the lubricating capacity of fluid again if you see this one. So, it is also a good cutting fluid for if at all you are looking for the lubricating purpose. So, it has a potential to be used as a biodiesel also normally many people not only uses for metal cutting operation they also uses for biodiesel production, how these jatropha oil is produce? If you see normally this jatropha oil is produce from jatropha acids jatropha acids this is life cycle.

How it goes seeding will be taking maturing then just you get the fruits from the fruits plant, then that the ripe and fruits will come from the ripe and fruits normally you will get a seeds from the seeds you will get this is jetropha oil ok. So, jetropha oil we are seeing that it is a better lubricant from the manufacturing point of view, but from the thermal point of view automobile point of view it is also use as a biodiesel if you check the performance that is a machining performance milling of aluminum alloy 7050-T7451 has been performed using jatropha cutting oil. Then it is observed that it proves that higher lubricating power of jatropha oil, because of the cutting forces increases at higher feed rate be controlled by the lubricants.

That means that if you are using the jatropha oils at higher a cutting whenever the input conditions are very high at like feed is very high and depth of cut is very high normally force will be very high at that time rubbing action will be taking place, because assuming that the cutting speeds are low in that circumstances there is tribological wear between tool and work piece there this worked as a better one; that means, that it act as a lubricant basically you can see the abrasion wear normally the jatropha the canola semisynthetic and synthetic semisynthetic and synthetic will across. So, as per the study is concern if you see the abrasion is very minimum are comparable to other processes ok.

And this jatropha oil is also not much costly you can afford it you can purchase it and you can do some of the people who are interested to carry of the work they can play with this one along with suitable additives ok.

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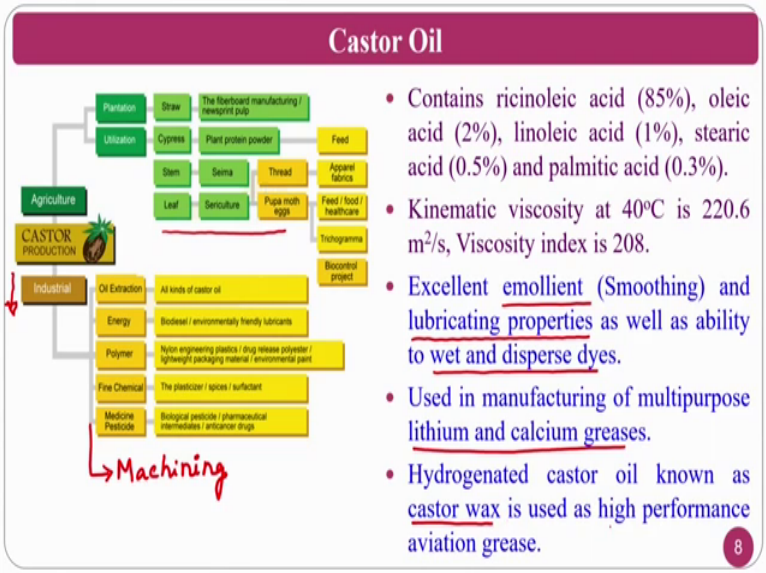

So, castor oil if you see the castor oil castor oil is exclusively highly abundant oil in terms of a in the regions like several part of India and some part of north India also this has a tremendous applications from the manufacturing to thermal to biomedical and other applications ok. So, if you see how do you do the agriculture normally agriculture plantation utilization and if you see every part of this castor plant normally will have lot of application like straw stem leaf everything will have it is own application.

You can see the leaf sericulture normally the warm silk warms and all those things you can feed it and all those things if you take towards the industrial applications; which we are talking about their oil extraction all kinds of castor oil you know polymer medicine fine chemicals many locations it will be used apart from these you can also use in machining, that is conveyed by the researches you can also use this in the machining and it is performance is also tested ok, but those people who are interested in performing the experiments here you can take this as a challenge and you can test it as a lubricant coolant by using various whether it is miscible or immiscible with water.

If it is not immiscible then what type of emulsifier you have to use what type of anti rusting you have to use and all those things, why I am telling this is castor oil is? So, economical fluid that you can get at an certain parts of India, I am not telling the about the pure medicated one if you go to the manufacturing joule where this is crushed that castors seeds they will put there and they will just rotate it and all those things including

I saw practically in my village or nearby towns that this castor oils are. So, chip that normally when we used to get we used to get 50 rupees or 100 rupees per liter; I am telling about if you go to that manufacturing person where it is a smalls house where there will be rotating it in just you take it and you can with and fresh one will be may be much better.

So, you can filter out and you can use if you do not filter also no problem, because the shell of the castor may not be that much effective in have to change the surface surface of your component or something. So, what I mean to say is that this is a economic oil if you want test you can test with this fluids along with some additives that is a bottom line castor oil is concerned it contains this is the composition and if you kinematic viscosity if you every we are I am talking about the composition and kinematic viscosity that we not talking much about all these things what I want to emphasis here it is a excellent emollient that is nothing, but the smoothing ok. So, many people it will use for a smoothing application see people in the villages and all people they will apply to the; their bodies for making it smooth and lubricating property.

It is a better lubricating properties and ability to wet and disperse dyes it will disperse easily at the same time it has a beautiful lubricating property if my machining require own lubrication and less you can go afford you can choose the castor oil as a choice. So, used in manufacturing for multipurpose lithium and calcium greases. So, lithium calcium greases are manufactured from this one. So, hydrogenated castor oil known as the castor wax is used as a high performance aviation grease if it is used in a aviation grease where the temperatures are so high. So, why cannot you use in the machining applications ok; however, it is a just a wax form they are using you can use before at from that is a lubricant at the liquid form you can use as a cutting fluid ok.

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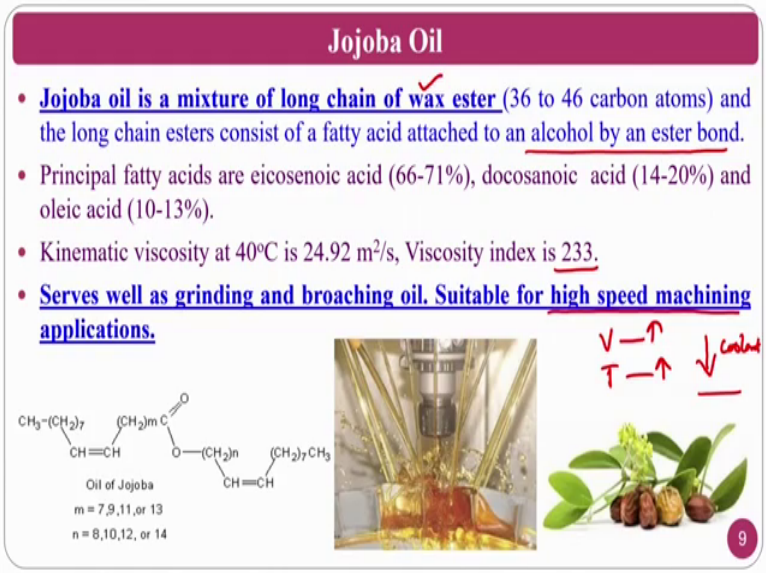

So, next we go to jojoba oil jojoba oil is a mixture of long chain of wax ester here itself a you have seen the wax that nothing, but 36 to 46 carbon atoms that is the long chain esters consist of a fatty acids and attached to the alcohol and ester bond it has the alcohol and ester bond ok. The principal fatty acids are these and the this is the kinematic viscosity index is about 233 serves well as a grinding and broaching oil suitable for high speed machining application; that means, this particular jojoba oil contains better cooling property sorry rather than the lubricating properties, but some of the sentences if you see here high speed machining where we have already seen whenever the speed is very high.

Cutting speed is very high what will happen temperature also in the machining region goes high, that is why; if you can use this you will reduce it will act as a coolant and it reduces the machining region temperature that is what about this high temperature application. If you are looking at you can choose the Jojaba oil if you are looking at the lubrication castor oil. So, again another commonly available nobody will eat this seed that is called Karanja seed which normally if you see in the villages it is commonly available ok.

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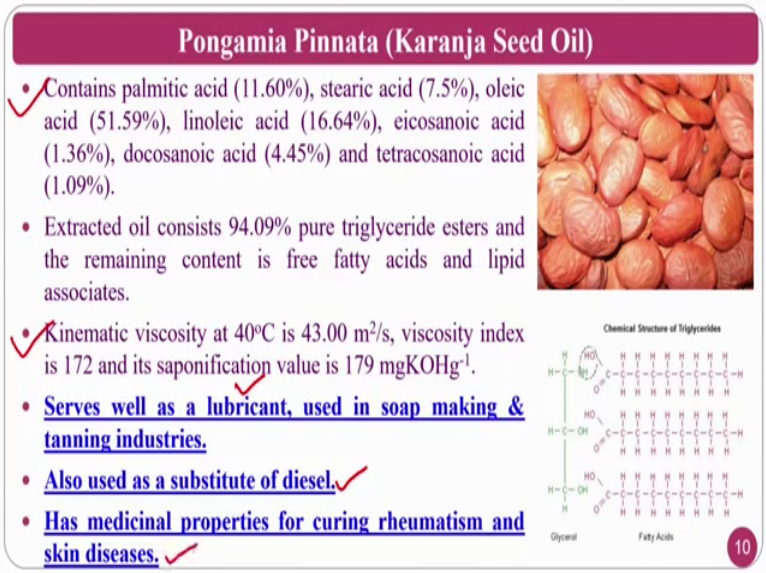

So, people do not eat this ok. So, if you or getting at free of cost you can get and crush it I am I am not saying that you have to you can give and take the oil from this one ok. So, regarding the composition and how the kinematic viscosity and all those things are like this.

So, if the specialty about this one is serves well as a lubricant and used in soap making and tanning industries this will be a good lubricant so; that means, that it has pour lubrication properties and you have it is pour cooling properties and having the better lubricating properties also use as a suitable substitute for diesel some of the papers are there bio development by Karanja seed oils and all those things.

So, the emissions also or not that much if the emissions are not that much you can also use for the applications of cutting fluids also it has a medicinal property of curing skin diseases and all those thing; that means, that by enlarge if the work piece is rotating at certain speed and all those things if you are using Karanja sees oil as your cutting fluid what will happened if it falls on you if mineral oil falls on the human or the operators hand or something content dermatitis and all those things will come.

In the mineral oil place if you are using Karanja seed oil what will happen; if it falls if you have the sin disease on top of it I mean to say that, because of the purest form of Karanja seed oil falls what will happen it would not be negative effect rather it will have a positive effect that is if you have any skin diseases or something just and it will give

the smoothness also so that is good. So, it is a good oil from the health point of the operator as well as from the lubricating point of the machining process that is; why you can go for this oil as a substitute for the mineral oil ok? You can see the Karanja seeds here. So, these are the Karanja seeds normally which are available on our trees.

So, it is freely available in many parts of India. So, it may not be that much costly; however, has the bio diesel is coming up in a great way may be that cost might be going up. So, we have to check it.

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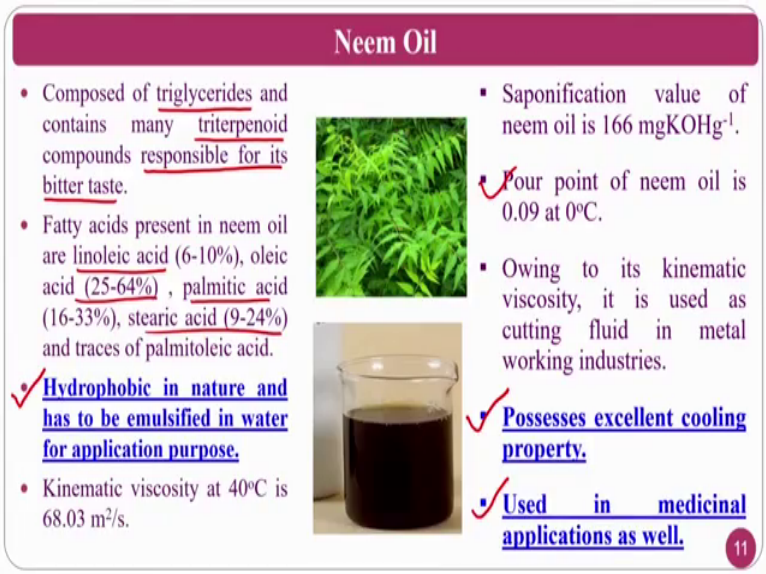

So, neem oil if neem oil is another one which is a you can use as a cutting fluid neem oil is you can generate the neem oil from the neem seeds as the leaves also many varieties stems also the neem oil has a lot of medicinal if the neem oil falls on the operator also it will be better like Karanja seed oil. So, if you see the composition it comprises of triglycerides and contains many triterpenoids and compound responsible for bitter taste actually you know if you eat whenever there is some problem in the stomach or gums or something parents used to tell just go and have some neem leaves. So, that it may have it and if you go to the villages also many people use the neem stem as their brush.

So, that that helps in terms of gum bleeding and all those thing that that shows the beauty about the neem tree what are the medicinal values and all those things ok. So, it fatty acids present neem oil are linoleic acid that is oleic acid and palmitic acid and stearic acid these are the traces that are present in the neem oil. So, this will hydrophobic in

nature and has to be emulsified in the water for purpose. So, this is a hydrophobic in nature we have seen; what is the hydrophobic and what is the hydrophilic? And all those things this liquid itself is hydrophobic; that means, that it tries to have form some hydrophobic nature.

It may not have the philic nature; that means, that may not spread properly if at all I required spreading and all those things you have to use certain emulsifier certain other ingredients the other thing normally you can see the pour point of the neem oil and all those things is. So, the specialty about I am just concentrating on the blue ones, because I just highlighted because every oil if I start telling the composition viscosity, viscosity index and all those things it will may be like slightly bore, that is; I am emphasizing on the specialty of this one from the point of manufacturing or mechanical engineering.

So, that you can appreciate, what is the beauty about the; that particular cutting fluids or that particular oil? So, possess excellent cooling property and ah; that means, that you can use for cooling also so; that means, whenever you are going for slightly higher speeds and all the things you can use this one used in medical applications as well.

That means that it should be vice versa if at all generalized we are studying normally this is used in a medicinal then metal cutting since we are studying the metal cutting we will say that it can be also used in a medicinal so; that means, that it has a good cooling property, that is; why some of the people uses it as a hair oil also in small proposes along with their other oils, but only problem here is that if you are going it is may slightly smells in a not good way ok so that does not mean does not matter ok.

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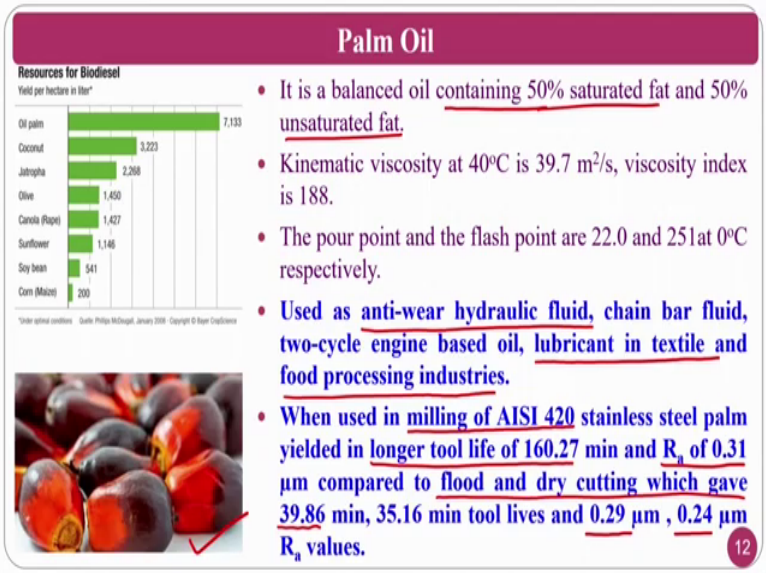

So, another one is a palm oil if you can see palm seeds and all those things these are the palm seeds. So, it has a balanced oil containing 50 percent of saturated and 50 percent of unsaturated fat it is a beauty about is 50 percent saturated and 50 percent unsaturated fat is there and the kinetic viscosity these are all there 4 point.

And, if you see the specialty about this one it is used as a anti wear hydraulic fluid or chain bar fluid and lubricant in textile and food processing industry, that mean that it has a better lubricating properties. So, the lubricating properties if at all looking then you can go for the palm oil when used in a milling of AISI 420 stainless steel palm oil yields longer tool life, that is; 162.3 approximately minutes and surface roughness of 0.31 compare to flood cooling and dry cutting which gives around life around 40 minutes and 35 minutes where the surface roughness is 20.29 and 0.24 values.

That means if you see from the point of surface roughness it is not giving better than the flood and dry cooling, but whenever you see from the tool life it is giving you a better value. So, the if the not see there is no much difference between 0.31 and 0.29 surface roughness, it may go if the customer comes and tells in a tolerance if he says plus or 0.3 plus or minus 0, 2 then you can go between 0.282, 0.32 in that is your 0.31 will come. So, there is too much change in the surface roughness it is you can say with the minimum surface roughness variation is there, but if you see the tool life it is

tremendously high that is how you can improve the performance of your machining process.

So, this is about the palm oil now we have seen till. Now, the various oils vegetable oils plant based oils and all those things now we will move to synthetic and semi synthetic bio cutting fluids.

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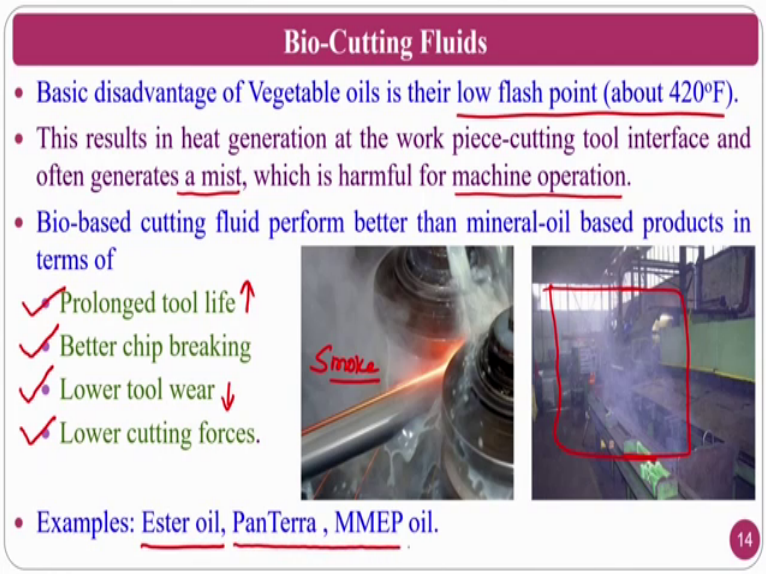

So, the basic problem if you see in the vegetable oils is low flash point that is a biggest drawback, because these are all will have low flash point and if you see bio based cutting fluids perform better than the mineral oil based products in terms of prolonged tool life whatever the biog based cutting fluids and talking about better chip breaking ability lower tool wear, that is; tool wear reduces; that means, that tool life; obviously, will increase and cutting forces are low; that means, if the forces are low the power requirements are low ok.

So, if you see which is the thing normally the another problem that this one is heat results and interfaces generates the mist which is harmful for the machine operator some of these oils will generate some smooth type of thing if we can see here this is another thing ok. So, there is pros and cons, but these emissions which the smoke that is coming may not be that much harmful for the operator; however, the visibility of the operator may be disturbed due to this one you can see the smoke here the smoke is coming and all

those things. So, the first variety of synthetic and semi synthetic is if you can see here Ester Oil, Pan Terra, MMEP oil this is a standard names actually.

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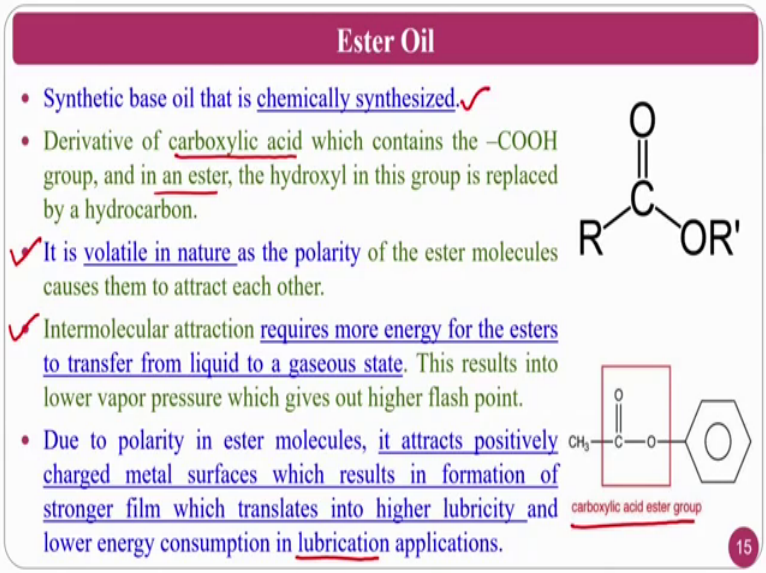

So, the now we will come to the ester oil.

So, synthetic base oil that is chemically synthesized the first and foremost thing is it is chemically synthesized ok; it is not the natural one it is a derivative of carboxylic acid which contains COOH group, and in an ester, hydroxyl and group is replaced by the hydrocarbon. Basically, you can see the ester group here. So, it is volatile in nature as the polarity of the ester molecules causes them attract each other.

So, slightly it is volatile in nature; that means, that it may evaporate if there is a slightly temperature is very high in the machining region the intermolecular attraction requires more energy of the esters to transfer from liquid to gaseous state this result into lower vapor pressure which gives out the higher flash point; that means, if I somebody want to convert esters from liquid state to gaseous state.

So, it requires lot of energy; that means, that it is not that much easy to get into the vapor form sentence two-third and sentence four are slightly contradictory; that means, that some of the esters may be volatile in nature some of the esters that are non volatile in nature. So, in that circumstances you have to choose depend on if the temperature that you require which type of esters that you want due to the polarity ester molecules.

It attracts change the metal surfaces which result in the formation of stronger film that translate to higher lubricity and forms a stronger film on top of it; whenever the cutting fluid as an ester if you are using it falls it will have a stronger affinity to form a layer on top of it and act as a lubricant application; that means, will form a layer on that work piece and it will act as a lubricant. So, that what will happen if the machining comes in the next time if I am cutting once the cutting fluid already used.

So, there is a lubricating layer if I am cutting second time it may slightly help in a form of lubricant, because at the same time we are using also cutting fluid in that one .

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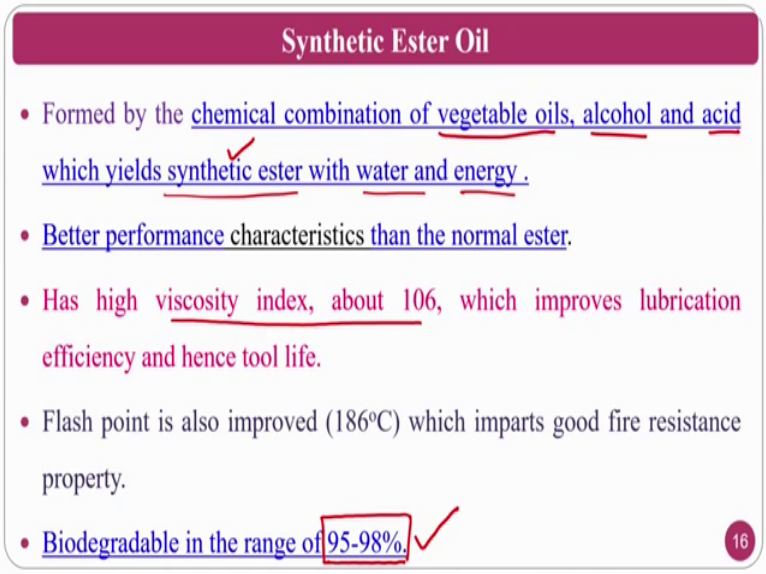

So, synthetic ester oils formally these are the chemical combinations of vegetable oils, alcohols and acids. There are three things are there vegetable oils, alcohols and acids you combined these things you will get synthetic esters plus water and energy. So, what we want is; here is a synthetic ester if at all we want the synthetic esters you have to combine vegetable oil, alcohol, acids, better performance characteristic than the normal esters which we have seen previously. So, the ester oils come not better than this one; that means, this synthetic esters are slightly gives much better characteristics from the point of machining and all those things has the viscosity index is about 106 and all those things.

The flash point and all those things the beauty about this one is it is biodegradable in about 95 to 98 percentage; that means, moreover if you are using this cutting fluid and if

you are recycling also and after the sometime you want to dump on to the soil or something; where if you are digging you have seen in the cutting fluid emissions chapter where there are two types of dispose: one is into the water bodies and other one into the soil bodies if you dump into soil body also it degrades by 95 to 98 percent where the mineral oil is . So, less degradable; that means, this would not cause much problem or it has slightly minimal problems not much; that means, this is a very good oil from the point of bio degradability.

So, people are now a day's talking about degradable polymers for the carry bags for the cops and all those thing because the plastic is accumulating a huge amount and it is causing lot of problems to the nature; if we can generate the biodegradable polymers including the from the grocery items to the bio degradable implants you can it will degrade and all those things some of the people talks about bio degradable implants also degradable implants and degradable internal fixations the one of the areas, that is; booming.

Now and it is already in the trending where if the person got the fracture just you put the internal fixation device with respect to the time normally once the, heal completes it is start degrading. So, there are polymers p l a polylactic acid p z these are the polymers which are the bio degradable just I come across the word bio degradable.

So, I just want to share this knowledge. So, that if somebody want to work not only in machining the machining of bio degradable implants that itself is a very good and new area as per 2018 is concerned you may be watching this again and again. So, I have telling about 2017. Currently, if you can take up the job like bio degradable base synthetic ester oils as our cutting fluids if you choose your cutting suitable cutting tools which do not changes the chemical structure of the polymer ad you can generate the bio you can cut the bio degradable implants. So, you have a bio degradable polymer that to be machine to your required size of your implant you have biodegradable synthetic oils or synthetic ester oils and the tool; which do not impart it is elements to the implant.

So, if you choose this type of system that is beautiful system. So, where you can get a good amount of publications at the same time you can get you can generate the commercial products also. So, some of you may be from the companies. So, for you this may be a good opportunity if you looking the direction just I m giving a . So, you can

explore in that area. So, same thing you can do with the bio ceramics machining or the bio implant machining like titanium if at all you are machining you can use this degradable things and all those things even though the if a film is farming it is biodegradable. So, your implant there after sometime it may degrade on surface and it will get a pure you get the original composition of your implant like titanium or something.

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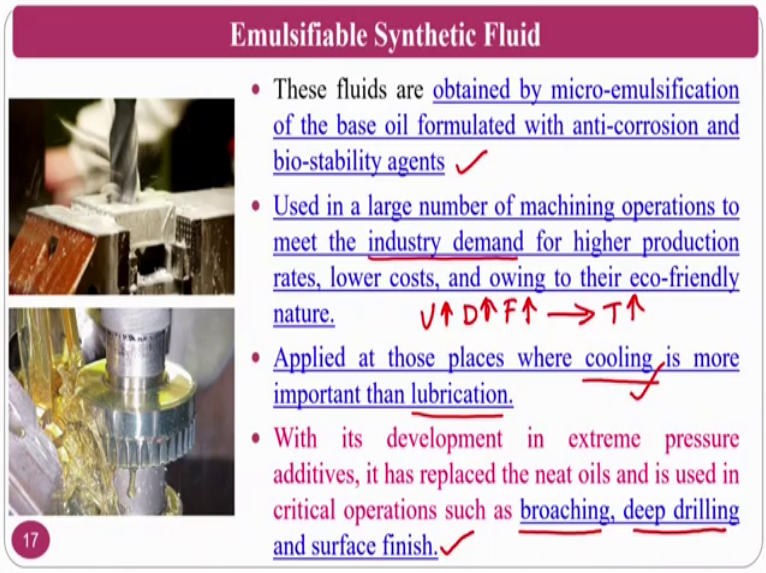

So, emulsifiable synthetic fluids if you see this one these are obtained by the micro emulsion of this pbase oils formulated with anti corrosion and bio stability agent.

So, then it is used in large number of machining applications meeting industry demand for higher production rates and lower caste owing to their eco friendly nature these are the eco friendly cutting fluids where these if at all you are looking for high production rates at lower cost; that means, that these are all economic fluids the cost in the market of this fluid is slightly lesser at the same time the application of this cutting fluids is at the higher production rates; if I say that higher production rates means normally your input conditions are slightly harsh enough ; that means, that I want to remove the material in faster. So, that I can complete work in a little time like depth of cut will be high speed will be high and feed will be high and all those things.

So, this is about that emulsifiable synthetic fluid applied where the cooling is more important than lubrication that mean you have seen it if at all I am going to give high

speed cutting velocity is high depth of cut is very high and feed is very high if; that is case what will happen temperature also will be high. So, you can use this one where cooling is more prominent or important; that means, that this fluid is specially designed or one can design or one can get from the industry for if you are looking for the cooling applications rather than lubrication application it does not mean that you do not have lubrication applications it will have, but the dominating a cooling characteristics are there. So, it will normally used for broaching deep drilling and where the surface finish applications are required.

This is about the emulsifiable synthetic fluid if at all you want look for the industry where the temperature is very high in machining operation.

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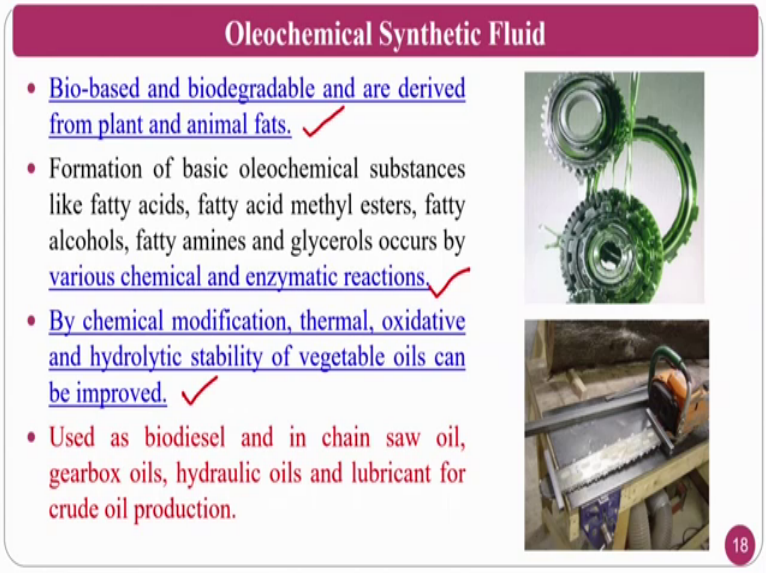

You can go ahead with that emulsifiable synthetic fluids oleochemical synthetic fluids these are the; bio-based biodegradable things this is oils these are taken from plant and animal fats some of the plants also you can generate this thing bio based oils at the same time some of the animal fats. So, these animal fats normally those people take the non-vegetarian and all those things. So, the fat may not be consumed by the people. So, in the circumstances they may be transferring to the biodegradable oil manufacturing industries where they can mix some of the oils for the plant some of the oils from the animal fats and all those things. So, that you can combine it and you can get it ok.

Another one is can the formulations of oleo chemicals substances like fatty acids and methyl esters fatty acid alcohol fatty amines and glycerol's occurs by the various chemical and enzymatic reactions. This also can be generated by this process by the chemical modification thermal oxidative and hydrolytic stability of the vegetable oils can be improved. So, the people since this are s a synthetic; that means that it is developed at the laboratory you can play with your ingredients.

So, you can change by using some chemicals that is called chemical modification you can do it thermal modification also you can do it oxidative and hydrolytic stability of the vegetables oils can be improved. So, if you can change or play with the chemicals that you are going to use once you have synthesized this one and if you are playing with your chemicals normally thermal oxidative and hydrolytic stabilities of this fluids you can vary.

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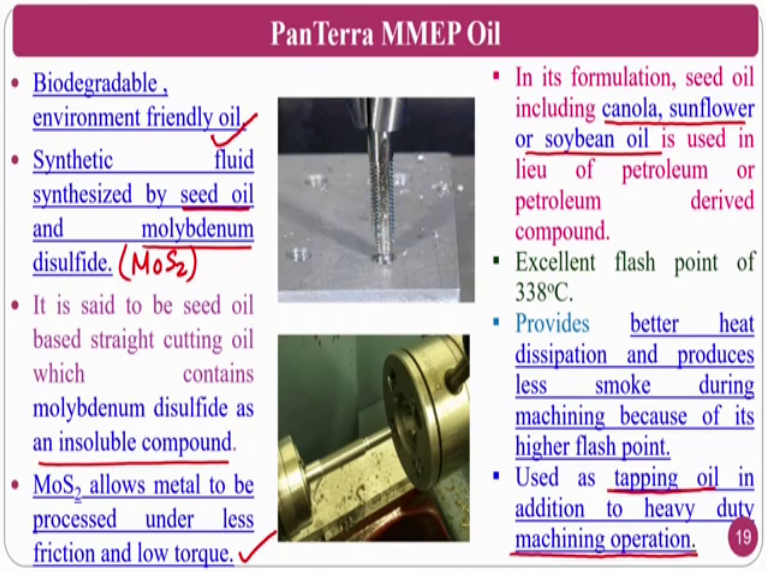

So, this about the oleochemical synthetic fluids so, Pan Terra MMEP oil this is one of the standard name for this one. So, this is biodegradable and environmental friendly oil. So, if at all you are looking for the biodegradable point of view and the environmental friendly. So, that you can give your operator says safe life at the same time safe environment to the surrounded people synthetic fluid synthesized by the seed oil and molybdenum disulfide here you will have two things one is a synthetic fluid which is nothing, but the seed oil at the same time you are also using molybdenum disulfide that

is MoS 2 may be nano particle are you can go for the micro particle and all those things. So, these molybdenum disulfide particles are insoluble compound

These are insoluble, what is the beauty MoS 2 allows; the metal to proceed under the less friction and low torque this is nothing, but you can even say these are one type of nano cutting fluids where the nano particles are suspended in the cutting fluid in that circumstances you can what is happening; if you are sending with certain pressure the liquid and nano particles are the micro particles will also travel this particles will travel at high velocity and occupy the interior designs of chip and tool interface.

So, that these MoS 2 MoS 2 itself you have seen that it is having low shear stud material. So, it will help in the sliding that is about the beauty about the MoS 2 particles. So, some of the formulations of the seed oil includes canola sunflower or soybean oil normally in in place of petroleum oil.

You can use this oil; that means, you can use sunflower oil or soybean oil along with MoS 2 particle check about the compatibility before using because what are the other ingredient that you are using provides better heat dissipation and produces less smoke it is better heat dissipation; that means, that cooling properties are better at the same time it would not generate any smoke previously in that drawback of some of the vegetable oils that if you see that is a smoke generation is there, but here also here the that smoke generation is not there, because it is one of the vegetable oils are there, but the thing is that they are modifying it at the laboratory scale with the chemicals . So, they are modifying it with suitable chemicals which are eco friendly chemicals at same time they are also adding molybdenum disulfide particles this during the machining operation that is; why high flash point.

So, there is no problem of fire and all those things. So, especially this type of cutting fluids you can be used in tapping and heavy duty machine operations like, broach men and all those thing you can use it. So, that the about the Pan Terra MMEP oil which is look a nano fluid where you have a seed oil plus nano particles of MoS 2 can be mixed along with suitable eco friendly chemicals at the laboratory scale where you can generate this things.

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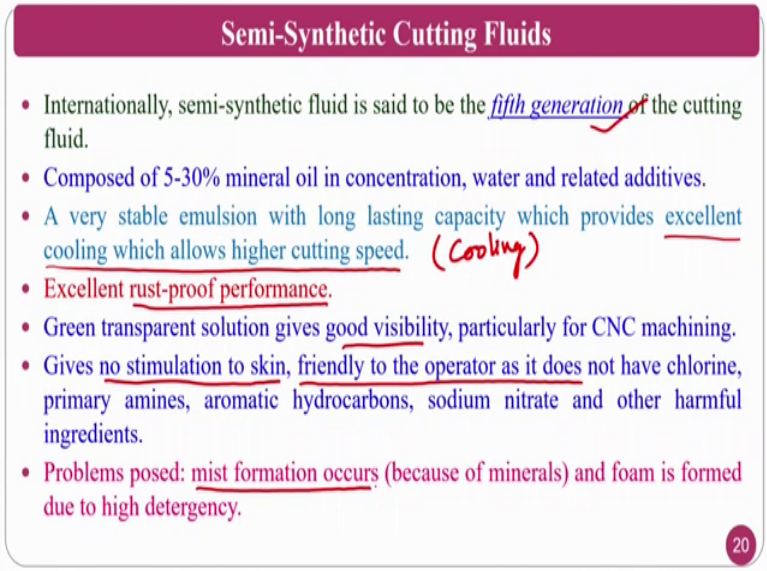

So, another semi synthetic cutting fluids there are normally semi synthetic cutting fluids are the 5th generation cutting fluids there are first generation and second generation there are many many generations of cutting fluids are there it is composed of 5 to 30 percent mineral oil in concentration and water and related additives will be there.

So, it is rust proof performance it is very good from the point of lubrication and all those things and green transparent solution gives good visibility and particularity in the CNC machining, where is a system is very close enough in that circumstances. Normally, this will be can be used actually if you use, what will happen; if it is a good visibility normally CNC systems are closed systems in that circumstances operator may be watching from the glass that is transparent enough to see what is the machining operation is going on? As per my CNC codes that the system is running or not for that purpose you need proper good visibility that is why you will always if at all your requirement is that you can go for this one. So, it can give the excellent cooling for the higher cutting speeds; that means that it has a better cooling property ok.

It is having a cooling property it is having a good visibility like a transparent say person to person taste is differ from person to person. So, every machining operation also have it is own requirements if your requirements falls in that range you can choose it. So, it no stimulation to the skin that means; that it is friendly to the skin there is no dermatology effect like contact dermatitis. So, epidermis if even though it falls on the your epidermis

are it may not have that allergic effect and all those things and it can go into outer dermis also of your skin it would not have much problem, that is; why it is friendly to the operator does not have the chlorine primary amines aromatic hydrocarbons sodium nitrate and other harmful ingredients, that is means it is completely are most of the times it is eco friendly to the operator. So, the problem posed is mist formation occurs, because of the minerals forms and high detergency.

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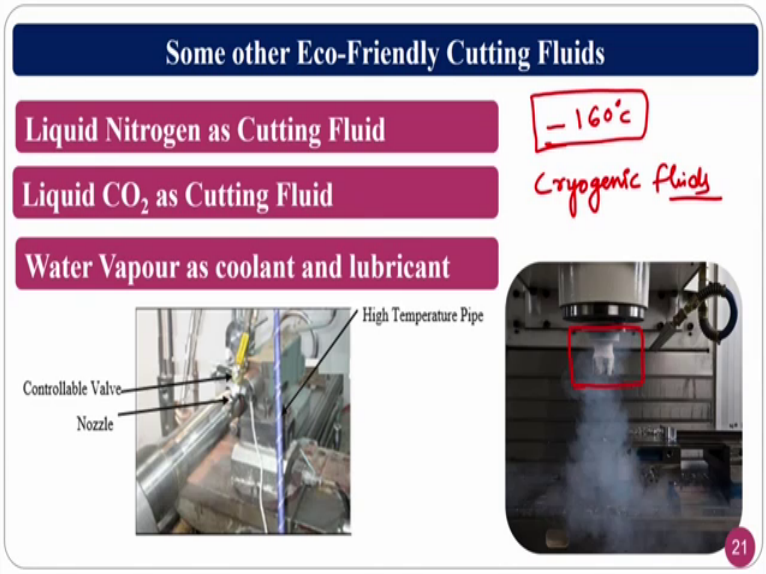

So, some of the other eco friendly cutting fluids if you see that are just if you what we are going to see is; we have already studied in the types of cutting fluids that is a liquid nitrogen as a cutting fluid liquid CO 2 as a cutting fluid if you see here liquid nitrogen. Normally, the temperature range is minus 160. So, it is a vary it is range basically 140, can be 150, can be 160, 170 like that. So, if you see liquid nitrogen, that is; cryogenic fluids normally these are called cryogenic fluids ok. Cryogenic fluids whenever it comes into the normal atmosphere what will happen you can see how the milling cut are is having a freezed type of thing.

So, it is cooling properties tremendous. So, wherever your requirement is cooling where you can go for this cryogenic fluids so, that like liquid nitrogen liquid CO 2 and all those things other one is water vapor are some of the people will use water vapor also as a cutting fluid water what it can a it has a only H 2 O. So, already your air has oxygen as well as hydrogen as nitrogen and all those things. So, whatever it will emit it will; can

emit only oxygen and nitrogen ok. So, if you see the application of this it is one water vapor or cool water you can send at high jet and all those things the beauty about this one is if at all you want to machine as I said know ductile regime machining of brittle materials and all those things that up much you may not go with the vapors, but you can go for those type of machining materials which are Non-Effie based.

If you are going for aluminum work pieces type of thing which is Non-Effie based work pieces where, because of the water if it is not rusting then you can go for this one.

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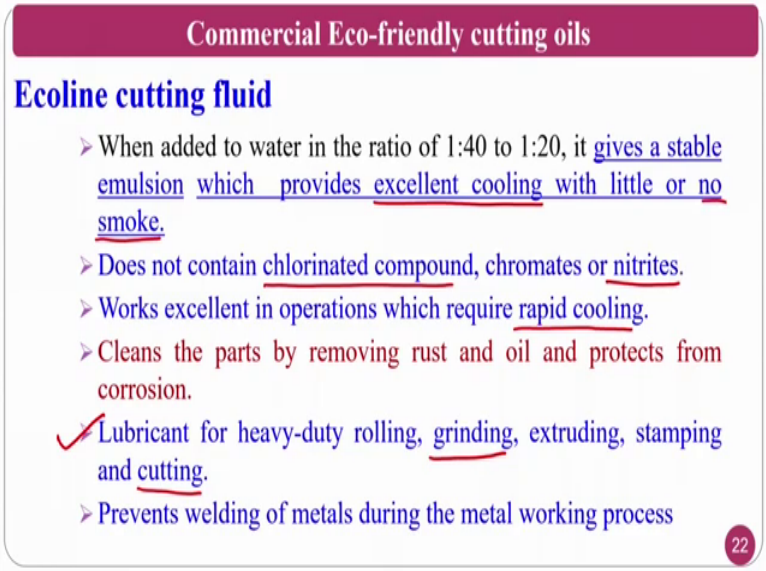

So, some of the commercially available eco friendly cutting fluids you can see the that is one of the thing is ecoline cutting fluid this is one of the commercially available cutting fluid which you can purchase when added to the water in the ratio of 1 is to 40 or 1 is to 20 it gives a stable emulsion which provide a excellent cooling with no smoke there is no smoke and excellent cooling property can generate or it can provide for that purpose if high speed machining you can go for it does not contain chlorinated compounds or nitrates; that means, that because of the nitrates cancer is one of the biggest problem.

So, the operator may not come across the cancers at the same time chlorinated compounds also are less; that means, that dermatitis folliculitis these are type of diseases people may not get the operator who is working may not to be faced works excellent operation with required rapid cooling. So, it has a better cooling properties if at all I want cooling at faster rate; that means, that machining region is sudden it is a sever plastic

deformation which is taking place at faster rate in that circumstances you need a rapid cooling that is faster cooling for that purpose you can go for a ecoline cutting fluid lubricant for heavy rolling grinding and extruding and stamping as well as cutting applications.

Also you can use this for cutting grinding grinding also a subtract to process cutting also a subtract to manufacturing process you can use it prevent welding of metal during the metal working process; that means, that built up edge formation wont to be taking place because it is acting as a lubricant.

It is acting as a rapid cooling; that means, that the sticking nature it prevents because of it is liquid lubricant nature. So, it is having a better cooling properties the bottom line of this slide is it is having a rapid cooling characteristics which slightly lubrication which helps in subtract to manufacturing like cutting grinding and all those things welding especially in terms of grinding operation if you see the chips will weld when the next run comes assume that a chip is not going out or it is adhering to that particular portion of the work piece the next round or the next upcoming abrasive particles will try to bend to the work piece surfaces. So, those type of things it will prevent.

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So, another one is bio aluminium cutting oil this is also one of the commercially available eco friendly cutting fluids if you see this the beauty about this one is toxicity will be low and low volatility which helps in multi performance at lower cost. So,

volatility list; that means, that there is no fumes formation at lower temperature and toxic it is not toxic or it is minimal toxic; that means, that there is no problem for the operator and all those things used as a machining coolant; that means, that it will be normally used as a cooling for that one if it is for the cooling.

Normally, you can go for any type of subtract to process, that is called machining process act as a corrosion inhibitors; that means, that it will form a layer on top of it even though atmosphere moisture come into contact of the product it may not corrode that product it will act as a corrosion inhibitor that is about the bio aluminium cutting oil.

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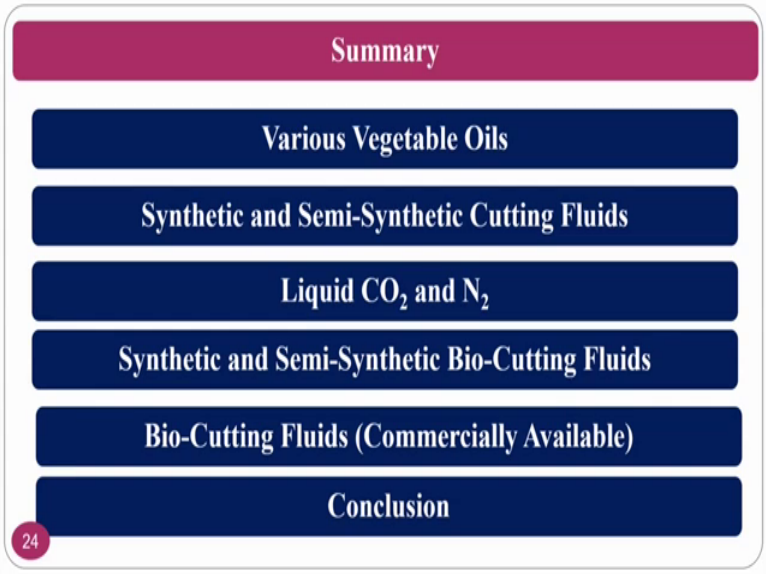

The summary what all we have seen till now is various vegetable oils which we have seen second we have seen the synthetic and semi synthetic cutting fluids liquid CO 2 and N 2 we have not talked as I said know the dis cryogenic fluids we have talked much elaborative way in the types of cutting fluids synthetic and semi synthetic bio cutting fluids in normally available bio cutting fluids that is commercially available and we are going to see.

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The conclusions in the next slide the conclusions are nothing, but the only one conclusion that is go green and use the cutting fluids which are non toxic and helpful for the operator even though it falls like neem oil or some other oils.

If it falls Karanja seed oil, neem oil, coconut oil, sunflower oil, these are the oils ok. These are all individual oils individual oils will have individual nature some of better coolants some of better lubricants you have to choose right amount of volume of this fluids you can mix if and only if; they are chemically comfortable and you can make out a good composition which has better lubricating property better cooling property or you as you add those amounts of this cutting fluids depend on your application your application is high depth of cut high speed and low speed you need higher lubricating characteristics in the circumstances you should go ahead with lubricating property vegetable oils more and cooling properties list vice versa.

If at all I am going for high speed machining where the temperature generation is very high in that circumstances, you just go ahead with high amount of cooling type of cutting fluids rather than lubricating type of cutting fluids and only thing is that; you have to strike the balance at the same time you should go ahead with suitable emulsifiers, because whenever you add to the water to make it a composition you should able to emulsify it. So, these type of cutting fluids the people who are in the bachelor level in the

master level in the PhD level they can play with the amount of these cutting fluids. So, so that they can come up with good properties that they want for their particular application.

I am saying for the metal cutting application; however, some people if at all who are watching may be looking for the metal forming applications also this for the metal forming applications the dominating should be lubricating characteristics those people who are looking for the dominating lubricating properties just choose those oils, which are eco friendly and you can and most important thing is that cost 17 percent of that product cost is from the literature says it is from the cutting fluid cost.

So, if you can get the cutting fluid as economic price, that is; good if we can use like a minimum quantity cutting fluid where you can have forced convection as well as tool life will be increased. So, this about this one, next in the upcoming class we will just go ahead with rheology and thermal aspects of the cutting fluids.

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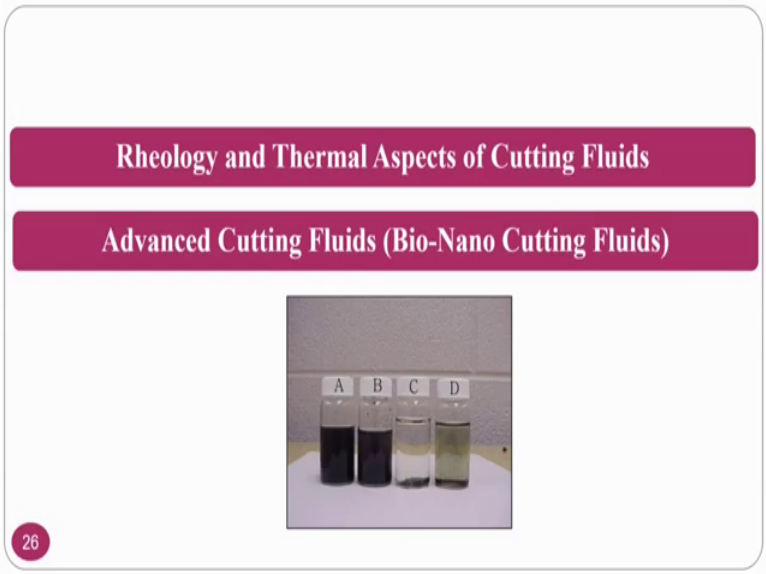

Where we see about what is rheology? Rheology is nothing, but the flow and deformation just and thermal aspects.

How to calculate the thermal conductivity of this fluid there are standard equipment are there just you can if the thermal conductivity of this fluid is good; that means, that it can take out the temperature in a great way. So, at the same time flowablity of this cutting fluid is good; that means, that it can go to each nook and corner of the cutting machining

region this also we will see ok. So, at the same time we will also see advanced cutting fluid that is called bio nano cutting fluids where we were seen one of the semi synthetic bio cutting fluids where the particles are there MoS 2 is mixed with some of the bio cutting fluids or some of the mineral oils where some of the researched our laboratory we have done and we are demonstrate here not much things that we just demonstrate you that how this nano bio cutting fluids or going to help one side you have a bio cutting fluid on another side you have a nano particle just blend it uniformly then you use it.

So, as I said this particles are suspending at very good uniformity location uniform locations that will be good what this MoS 2 particles are better lubricant and you you choose your bio liquid state having the better cooling properties divide this enrolled ok. There is a concept called divide enrolled you just choose your liquid as a better coolant and particle as a better lubricant coolant does not mean it is 100 percent or it will have it is own lubricating properties and all those things.

So, it you can come up with good cutting fluids. Thank you for this particular class we come in the upcoming class to study about rheology thermal aspects as well as bio nano cutting fluids which some people they say it as nano fluids in the refrigeration in air conditioning also they will be used ok.

So, thank you once again for listening patiently of some of the chemical things in the mechanical classes.