Introduction to Machining and Machining Fluids
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Lecture – 16
Eco Friendly Cutting Fluids Part 1

Now, we are moving into the deep of machining fluids as the course is machining and machining fluids. So, till now we have seen the what is the problems of cutting fluids at the same time what are the advantages of cutting fluids and additives, to summarize that just to be move the cutting fluids additives and its advantages.

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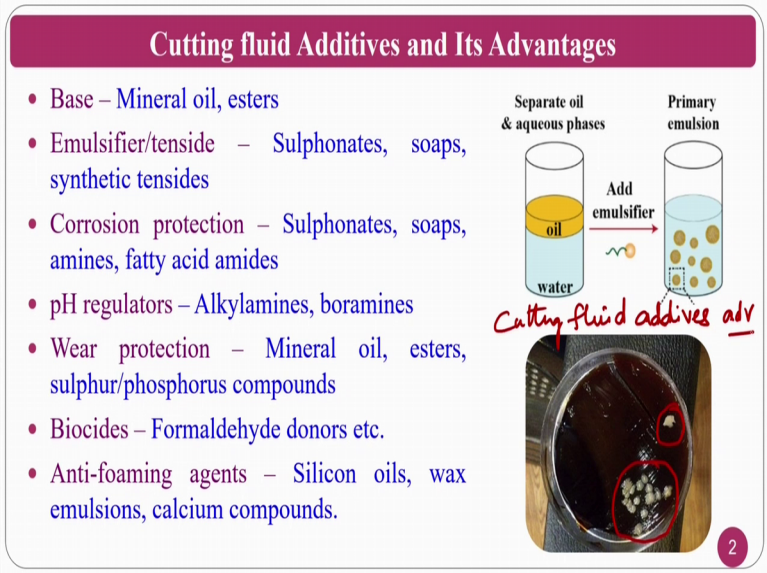

Which we have studied in the one of the lectures of the previous class just you see the base is a mineral oil or esters and the emulsifiers, that is called sulphonates and soaps, synthetic tensides, and corrosion protection that is called rust inhibitors sulphonates soaps and all those things like a pH regulators alkylamines water protection your mineral oils esters and all those things we have seen.

Biocides which are most important from the point of not going the microbial organism and deforming agents like hydro fobric silicon all those things we have seen. So, these are the advantages, if you take the additives like emulsifiers, emulsifiers its will have polar head and non polarity which will mix the cutting fluid with the water that is mineral oil with the water that to be we have seen that is a how it is done also we have

seen at the same time biocides, how the biocides are going to help in order to prevent all these type of microorganism formation ok. So, this is the advantages of additives like cutting fluid additives, additives advantages ok, these are the advantages.

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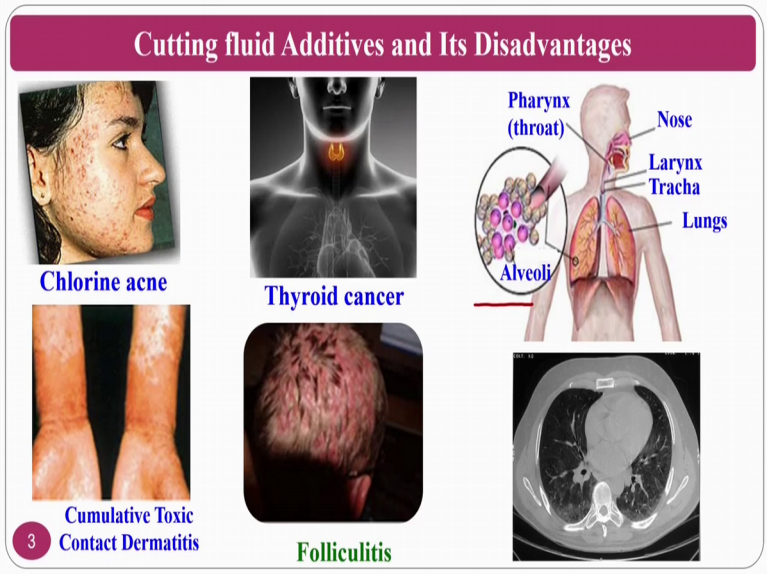

So, at the same time this will have side effects as well as other things that is called disadvantages of cutting fluid which we have also seen in the previous class. So, everything will have the prons and cons like it will have the positive side. And the negative side one side of the coin if you see it is very, very positive things if you are adding the additives that we have seen in the previous slide.

Now, we are going to see the on the other side of the coin that is the disadvantages. If you use emulsifiers, if you use the biocides, if you use rust inhibitors and all those things; some of the disadvantages that also we have seen just I am going to summarize, that is one of the thing is chlorine acne is another one another thing is dermatitis which is contact dermatitis whenever the flashing is taking place on the operator.

Thyroid cancer whenever you intake it then the thyroid cancer will folliculitis because when the operator is operating by bending his head if you are looking at the operator operation and you have seen there if this flashing is take place.

So, it will fall on the hair and this oils will go into the pores of the hair and wherever it occupies the hair growth is not going to takes place, that is why irregular hair growth is

there that is called folliculitis this is the advantage and you can see that the particles normally ten microns are below person can breathe if the particle size is 2.5 microns, normally it can go into the alveoli of your lungs, and which will affect that is why normally this is particles as well as the vapors that is coming out should be carefully prevented from the breathing and all those things ok.

So, this is the on the other side of the cutting fluid, if you use the cutting fluid advantages are there disadvantages are there then, as a mechanical engineering as a manufacturing engineering how you are going to take only the advantages and avoid the disadvantages that is the most thing that one has to look ok.

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So being a manufacturing engineer things are very complicated from if you see the advantages and disadvantages. The some of the other additives and its disadvantages is if you later this is what the operator is concern, if you want to look at the environmental point of you like water pollution or soil pollution this is how it will take place ok. So, normally once the cutting fluids is used they will going to dump into the river nearby river bodies that will causes the ecological system of that river it will damage that is called water pollution and the soil pollution.

How they will dig a whole and just dump it, so this will causes the soil pollution these are the two disadvantages apart from the operator's point of you ok. So, what is the

precaution that one has to take the precaution one has to take is you should make sure that.

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This should be properly treated before whenever you are going to use it this is before disposing of this cutting fluid into the sewage system one should ensure the following it should be water soluble. So, it should be water soluble, so that there would not be much problem in the soluble are if there is a oil if it is insoluble if there is a oil formation on top of it then ecological system which is depending on the sun light many other things will destroy, check the rancid nature normally the smell bad smell or something should not come, so you have this normally you can avoid by their biocides addition.

Chips and fine particles have been removed normally you have to make sure that the chips and fine particle should be removed, otherwise if it mixes with water and goes in a fishes are there prawns are there what are the a living body ecosystem is there this will at just if they intake what will happen it will cut at their internal organs and all those things these are very dangerous from the point of water body organisms as concerned, does not contain any toxic concentration and heavy metal ions ok.

It should not have the toxic concentration, if the toxic concentration is there then the ecological system toxic properties will goes up at the same time heavy metal ions normally whenever you see or aquagaurd or Kent whatever we use at our homes, normally you will have to use iron filter heavy metal filter many, many, many filters

apart from your aquagaurd basic system is concerns. So, this has a big disadvantages from point of drinking because the, our fishes the river water or the pooled water whatever wherever its taste that is their source of drinking water.

If it is these are this type of elements are there then it will be a problem for them, that is why one should avoid all these things or you should prevent all these things whenever you just you dispose into the nearby water bodies all these are regarding the water pollution is concern, so regarding the water pollution is concerned.

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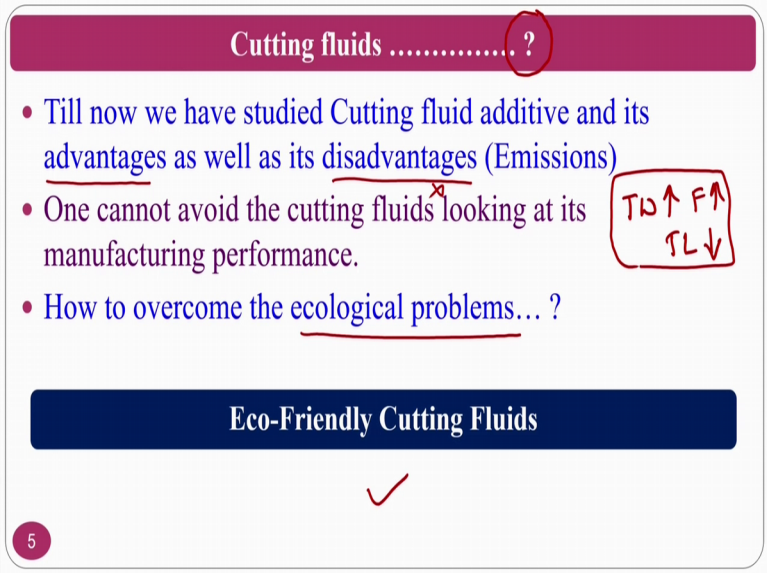

So, now you have two things to load one is advantages another one is disadvantages as a manufacturing engineer you get a big question mark that is how to tackle this. So, you need the advantages, but you do not want disadvantages right ok.

So, till now we have discuss or the studied the cutting fluid additives and its advantages as well as disadvantages, only I want to take advantages, I do not want this emissions in it, so how you should overcome it. So, one cannot avoid the cutting fluids looking at its manufacturing performance ok.

If you do not use the cutting fluid you can say that the mechanical performance will go down like tool wear will increase, tool forces will increase, and tool life will decrease, these are the things that is problematic if you do not use the cutting fluid, that is why you need to use the cutting fluid, but in a wise manner how and you should choose the

cutting fluid composition such a way that it should not harm or it should not emit lot of dangerous emissions, but the performance should be equalant to whatever the mineral oil that we are talking about ok.

So, how to overcome this ecological problems by keeping the mechanical performance as I required ok, for that purpose eco friendly cutting fluids are coming into picture ok. So, we will see about the eco friendly cutting fluids, what are this eco friendly cutting fluids? How the eco friendly cutting fluids are going to help is they are going to generate any type of emissions (Refer Time: 09:27) and all those things we will see ok.

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So, now we will move to eco friendly cutting fluids this itself is a very big area, but I will summarize in a suitable way ok.

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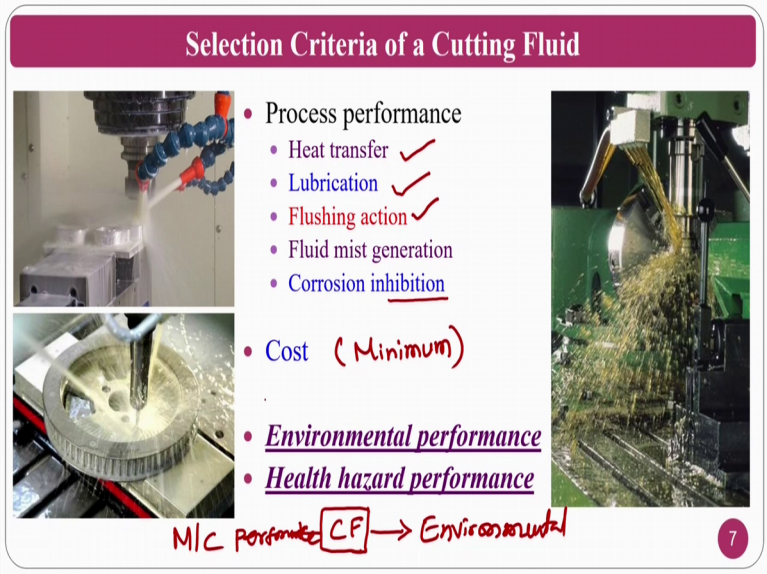

So, normally if you see the cutting fluids cutting fluids selection criteria normally depends on many things such as heat transfer performance. So, process performance whether it is highly it is transferring the heat properly, whether it is tribological performance that is lubricating properly or not, flushing action whether it is flushing the chips properly or not it will decide and fluid mist generation whether if at all I want to use as m q l whether it is giving me the next generation properly and corrosion inhibition.

So, it will it should not corrode the product afterwards apart from all these things the cost of the cutting fluid also should be as minimum as possible, it should be minimum as possible ok. So, at the same time environmental performance and health hazard performance is also most important, for a cutting fluid if at all I consider, if I want to use in my company mechanical performance is important; however, the environmental performance or environmental aspects whenever I use this cutting fluids. And health hazards that causes those emissions causes should also have equal importance that is what you know.

So, a cutting fluid is there if a cutting fluid is there it should have both equal that is called one should be mechanical performance, performance and another once is environmental effects, environmental performance you can say environmentally it should be good. So, these two things should be equally important for a cutting fluid or emissioning fluid ok.

So, based on these normally the selection criteria will takes place as the pollution is growing if you see the greenhouse effect is coming and global warming is taking place, because the pollution is coming into picture, that is why lot of companies are the government organizations are imposing lot of strict stringent rules on the companies, where if at all somebody want to put a company they would have to get the green tribunal clearance or environmental clearance from the state as well as center in India.

That is why this equal to your missioning performance are more than important if you are you are giving more emissions; that means, on the second day the government may ask you to close your company. So, environmental pollution water pollution or soil pollution this pollutions also have greater influence on the sustainability of your company ok. That is why you should choose the cutting fluid based on mechanical performance, since you want the profits at the same time you should not close your company in between by emitting lot of emissions.

That is why you should be taken care the two things you have to merge and you should solve your solution for that purpose you have to choose certain good and environmental friendly cuttings fluids ok.

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So, various eco friendly cutting fluids that we are going to choose you may be assuming, why doctor Ravi Shankar has given this title. So, machining is important at the same time machining fluid also important hope by this time many people would have

understood this thing; however, that is why when we are taken machining as a mechanical engineer you may be many things you may be aware as a machining fluids, some of you may be aware some of you may not be aware, that is why whenever I have two things one is a machining one is a machining fluids, I have advantages and disadvantages for both then, I will explain at the end how this disadvantages can be overcome that is a motive of this course hope you understand now.

So, some of the various commonly available eco friendly cutting fluids, one is a vegetable oils, second is bio cutting fluids, bio cutting fluids you can make by the mixture of eco friendly vegetable oils or there are some standard companies which sell this bio cutting fluids ok. Semi synthetic cutting fluids and the liquid nitrogen this is cryogenic fluid where this cryogenic fluids will have better cooling properties ok.

So, ionized air cooling system and water vapor as a cutting fluid some people they will use water vapor as also cutting fluid water cold water as also a cutting fluid and also thing, but only problem is rusting. So, are oxidization problems will takes place further purpose you can use the rust inhibitors the electric fluids and all those things ok.

You can see some of the examples like sunflower oil coconut oil canola oil and liquid nitrogen that is these are all the one of the eco-friendly cutting, I cannot say this liquid nitrogen are something because a liquid nitrogen is a costly from the economical point of view it is may not be that much until and less the your institute have the liquid nitrogen plant and all those things.

So, easiest ways of using normally locally available oils ok, like coconut oil or sunflower oil, soya bean oil these are all the oils that you can use as a cutting fluid, because if you use this cutting coconut oil and all those things some of the states in India like Kerala those people will use as a one of the food ingredients. So, it biodegradable and its good second thing is that whenever you are using in the pan the temperature goes up vapors also come.

If the vapors is not dangerous that is why whenever this coconut oil or the sunflower oil whenever you put as an lubricate or a cutting fluid what will happen even though vapors comes it will not affect, so that is user friendly ok.

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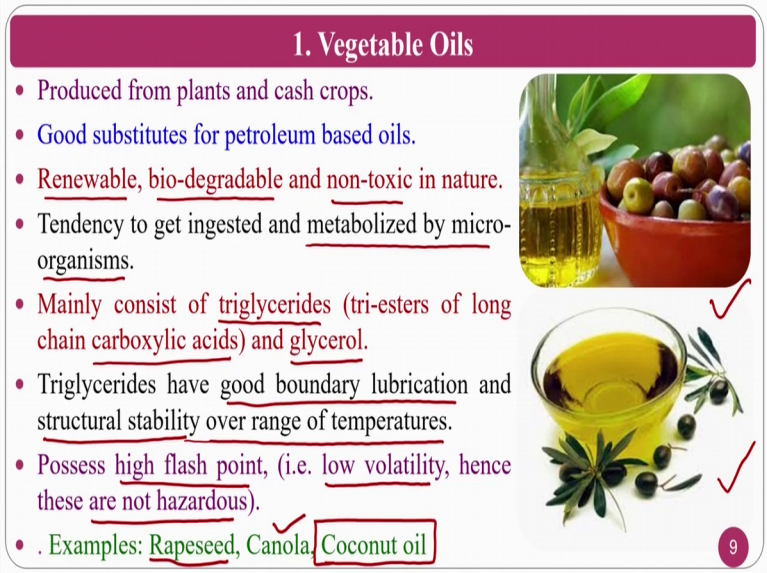

So, common vegetable oils if you see they produced from the plants and cash crops you can see here these are the some of the things that you can see here good substitute for petroleum based oils petroleum based oils are the minerals oils which develop lot of emissions which will be very dangerous for the operators, that is why we can replace with vegetable oil with this type of petroleum based oils can be replaced by the vegetable oils ok. Renewable and biodegradable and non toxic in nature these are renewable you can get it easily.

At the same time these are biodegradable as I said know coconut oil for example, or the sunflower oil you can use as a one of the ingredients in the food ok, this is bio degradable people eat it if you can eat it this things why can't you use if they have a better cooling property better lubricating property then in the machining operations that is what and it is non toxic in nature because since, you are consuming it, it is not affecting yours ecological system, so it is non toxic ok.

So, you can use this as a machining fluid tendency to get ingested and metabolized by microorganisms if you want to discard this cutting fluid after sometime. Assume that I am using a coconut oil or sunflower oil. So, if you recycle it recycle it and all those things there now you want to discard as you have seen in the previous line. So, in that circumstances if you want to dump into the nearby the water bodies also, it would not be much problem it may be a problem for that particular instant, but this can be metabolized by the microorganisms that are present in the river ok.

So, after sometime there would not be much problem in it. So, mainly consist of triglycerides, this triglycerides are long chain carboxylic acids basically and glycerol some of these vegetable based cutting fluids will have the long chain carboxylic acid, this long chain carboxylic acids whenever they are first time whenever they fall into the machining region what will happen is they crack down at thermally and becomes a small chain and all those things it will also will have glycerol in it ok.

So, triglycerides have good boundary lubrication as you see the boundary lubrication, you have seen three types of lubrication in the tribological aspect of machining, one is boundary lubrication, mixed lubrication and hydrodynamic lubrication, in that circumstances the boundary lubrication means where you have a solid to solid dominating can contact. And you will have a very, very fine lubrication in it even though if it is having a very fine lubrication still it looks or it works very perfectly that is what it mean to say and they do not losses its structural stabilities, structural stability for any fluid it is most important.

If it is losing with respect to temperature the structural stability it goes assume that I am putting a certain cutting fluid in it and if the thermal cracking is taking place, and the big chain breaking into two chains and at the same time this is happening for those cutting fluids which are falling for touching the machining region, those cutting fluid which are not touching the cutting fluid that is 75 to 80 percent of the cutting fluid just flows in to the cutting fluid tank. In that circumstance you have a mixture of thermally cracked and a non-cracked cutting fluid in the cutting fluid tank.

So, you are destroying the cutting fluid tank that is why if you have structural stability good structural stability even though it falls in a machining region then it is very good; that means, that the cutting fluid that is going into the cutting fluid tank will be good ok.

So, it is not destroyed that is why the structural stability of the cutting fluid should be good, and it will over the range of temperature that is what know temperature in the particular range of operation if the structural stability is not changing; that means, that every monocular the cutting fluid within the cutting fluid tank after the recirculating also will have a good structure or uniform structure ok, possess high flash point normally that it means low volatility; that means, that it is not volatile. So, whenever exposure to atmospheric conditions or whenever you exposure to the low temperatures like 100

degrees or something it should not be volatile at that particular temperature or machining temperature.

If it is volatile there is a chances of catching fire and all those things and it may cause lot of hazards also that is why you should be very careful in choosing the flash point fire point and other points and all those things for example, of this vegetable oils is rapeseed oil is one like example, canola oil is another example, and most importantly in India, we will get coconut oil and the coconut oil is one of the local oil that we can have across any part of India wherever the coconut trees are abundant example Kerala such type of places you will get that economical price if you can pay with this coconut oil for your PhD, but only thing is subjected to all these additives ok.

You should choose the chemical stability structural stability of your coconut oil and at the interaction of this various chemicals that are there that you are going to add to the cutting fluid and all those things you should be very careful ok.

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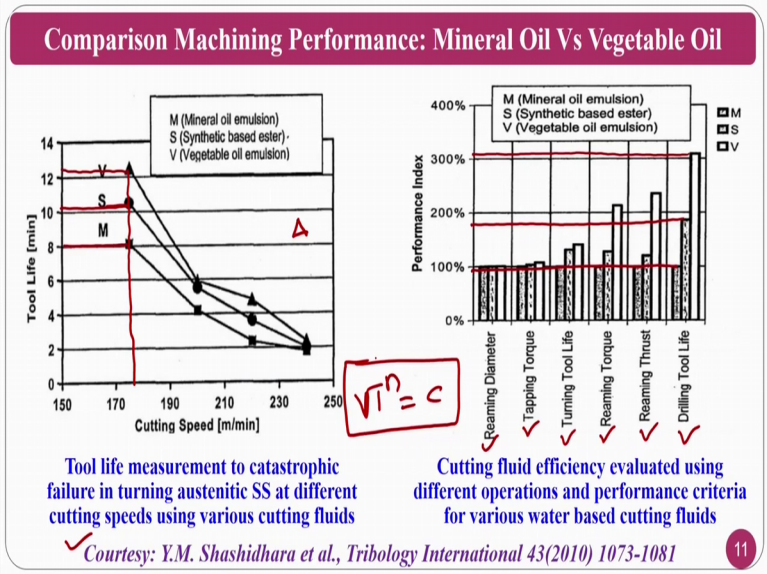

So, we are going to see the comparison measuring performance of mineral oil versus vegetable oil ok. So, whenever we are going to use a particular vegetable is it is going to give me better mechanical performance or low performance or higher performance than my standard mineral oil ok, my mineral oil is what the standard curve on which if my if I am going to use my vegetable oil am I going to get better or not that is the first thing one has to check before you choose to go towards the vegetable oil ok.

If you see the cutting speed versus tool life we have three type of oils one is mineral oil emulsion is there another one is the synthetic based ester is there, the third one is the vegetable oil emulsions are there ok.

So, the triangle which is shown here will represent the vegetable oils in that circumstances, if you see here what is happening here is the tool life particular conditions assume that I am going to use a particular condition like 175 or something is a cutting speed it will be like 8 minutes. The tool life and 10.5 are is there, and 12.5 are something is the tool life for this particular speed you can see or any other particular speed, if you see always my vegetable oil is giving better results compared to my other tool that is reported by one of the authors in the paper ok.

It is a technical lee specified results; that means, the technically verified after doing these three for the cutting speed versus tool life normally if you see VT power n equal to constant, where your cutting speed is major component in deciding the tool life ok. If you see another performance this is what we have seen in a normal machining condition, if at all do this cutting fluids which are an choosing as a vegetable oils are going to perform for some other a mechanical machining processes like a reaming process, tapping process, turning process, again reaming torque reaming thrust and drilling tool life and all those things.

Is this going to work for us that also the author has checked the performance index he has given and if you see just for example, in a drilling tool life it is tremendously high if you see tremendously it is high, and it is performance index is above 300 where as if you see the synthetic based esters and mineral oils, it is approximately 100 percentage is a performance index.

If you see particularly for this one the performance index is this is 100 percent and this holds good for approximately 190 percent or something this holds good for 3 10 or something above 300; that means, not only for normal machining for the drilling for the reaming for the turning other applications also vegetable oil gives me better results compared to mineral oil that is what the technical proof is concern from the research paper.

That what I want to say from this particular figure or this particular slide is concerned is my VT power n equal to concern, whatever the tool life or the performance of the cutting

fluid mechanically is better than mineral oil. Now as you have seen mineral oils will give lot of emissions my eco-friendly cutting fluids would not give harmful emissions. So, from that point ecological point of view I am mineral oils are not good cutting eco friendly cutting fluids are good, from the second from this particular slide mechanical performance also is much better compared to my mineral oil.

Now two things are matching for me one mechanical performance is very good at the same time it is ecological from the point of health of the arga operator from the soil pollution from the water pollution. Now, I can move forward for testing further if you see now I am moving to soybean oil.

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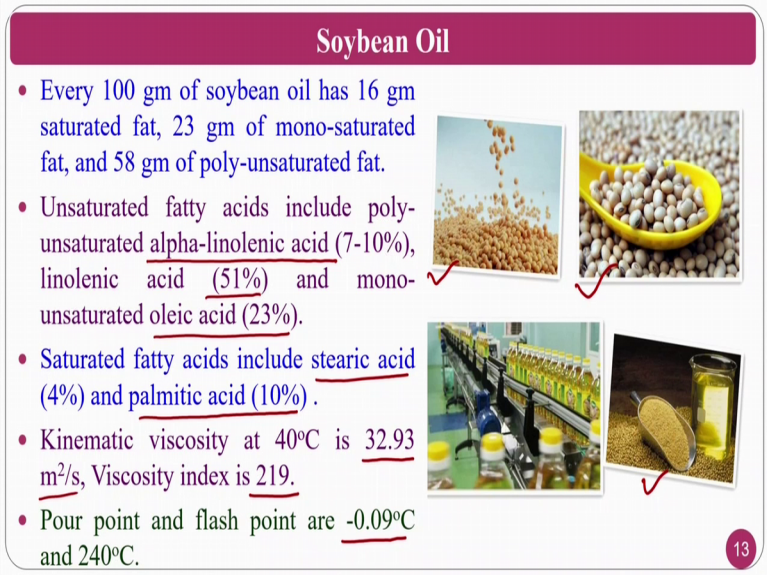

Soybean oil is one of the oils that normally available and this is eco friendly in nature, these are the soybean oil how the soybean oil or the soybeans basically look like these are the soybeans, this is a soybean, and these are the soybeans, how it look like and the oil normally this is the food greed oil one of the food greed oils every hundred grams of soybean oil consist a 16 grams of saturated fat, 23 grams of mono saturated fat and 58 grams of poly unsaturated fat ok, so most of the things oils will have the fat ok.

That is why for example, if you see whenever you go if you are obesity patient or something, whenever you go to doctor normally they say why you are you try to reduce the oil consumption and all those things, because it will have lot of fats in it ok.

At the same time that is the negative side of that one, if at all I want to see from the positive side, whenever I want to purchase or whenever you want somebody want to purchase a soap, whenever you go to the market what you will see whenever you want to purchase a soap the first and obvious thing that you check is a cost ok. The second what I suggest you, you, you should see that a t f m, if you just rotate in the back side of the soap you will have t f m total fat material content; that means, it will have the fats that are taken from the plant or from the for example, I might have already told you that one of the government soap is Mysore sandal.

So, mysore sandal soap made up of mysore sandal oil that a sandal wood oil. So, if the t f m is above seventy percent; that means, that seventy percent of the constuients of the that particular soap is from the oil remaining all other things if the fat material is more; that means, that oils are more in the soap that will be good for your body and all those things ok.

So, that is about the oils soybean oils unsaturated fatty acids include poly unsaturated alpha-linolenic-acid that is 7 to 10 percent linolenic acid is 51 percent and unsaturated oleic acid is 23 percent, these are the biodegradable things are there or the fats are there which are the chemical names saturated fatty acids include stearic acid and palmitic acid these are the two acids will be there in the saturated fatty acids ok. So, you have unsaturated and saturated fatty acid.

At the same time the viscosity of this one that is the kinematic viscosity at forty degree c is 32.9 that is approximately 33 meters square per second, and the viscosity index is two one nine; that means, that it is a low viscous fluid if it is the viscosity of this fluid is very low; that means, that it can penetrate into the loops and corners of the metal cutting assume that I have a cutter I have a chip it is moving if the viscosity is there is low; that means, that it can penetrate or it by the capillary action and to the intricate regions of the metal cutting ok.

So, pour point and flash point are minus 0.9 and 240 degree Celsius ok, so this is good from the point of machining. So, if the machining is below 240 that is the machining temperature till that there would not be much problem about the soybean oil.

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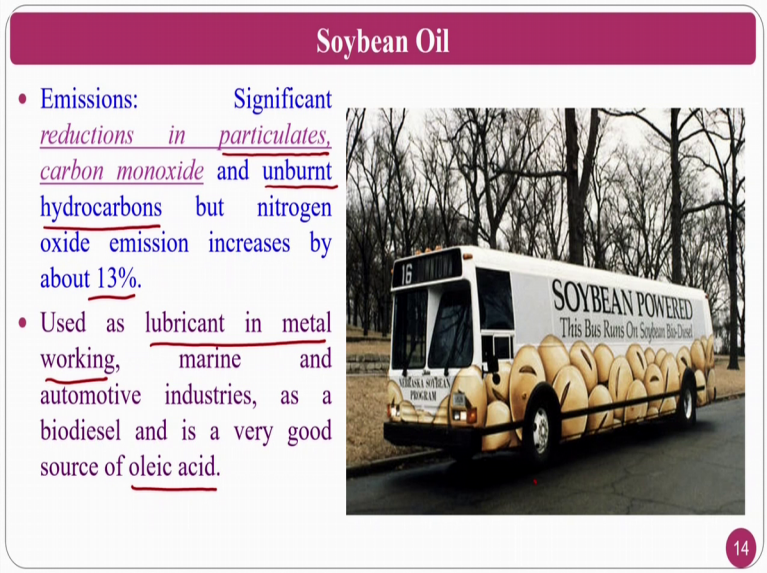

Not only this will be used as a cutting fluid, but also this is soybean oil is used as a biodiesel also you know some of the countries like I do not know exactly in Malaysia or somewhere.

You can see this is a soybean powered; that means, the this bus runs on the soybean biodiesel, biodiesel is one of the other application of this soybean. So, why I am emphasizing biodiesel also here is that biodiesel whenever it goes to combustion there also temperature effect is there in a metal cutting temperature effect is there if the emissions are dangerous four stroke engine that is used in a bus the same emissions maybe possibility in metal cutting may not be the bus temperature, but possibility is there and improper combustion may be another reason in the metal cutting because the temperatures are not, so high.

So, what I want to prove this soybean oil from the biodiesel point of view at this particular slide is it is significant reduction in the particulates and carbon monoxide and unburnt hydrocarbons, but nitrogen oxide emissions are increased by 13 percent.

That means if anybody is uses the cutting fluid the carbon monoxides are reduced and particulates are reduced in the mechanical machining the temperature is not, so high as the four stroke engine or the two stroke engine that is used in automobiles, in that circumstances there is a improper combustion and if there is a improper combustion in the four stroke engine basically carbon monoxide chances are there in that circumstances even though you have improper combustion I cannot say combustion improper

temperature heat generation is not sufficient to do the combustion of this soybean cutting fluid then it would not generate the carbon monoxide highly at the same time it would not generate the particulates also ok.

So, unburnt hydrocarbons also it is reduces this is the good thing which a manufacturing engineer can take from a thermal engineer from about the soybean oil. So, used as a lubricant in metal working and marine and automotive industries as a biodiesel is a very good source of oleic acid. So, you can use as a lubricant in the machining operation or the tribiological operations is concern next we will move to the coconut oil which is one of the commonly available oils in India.

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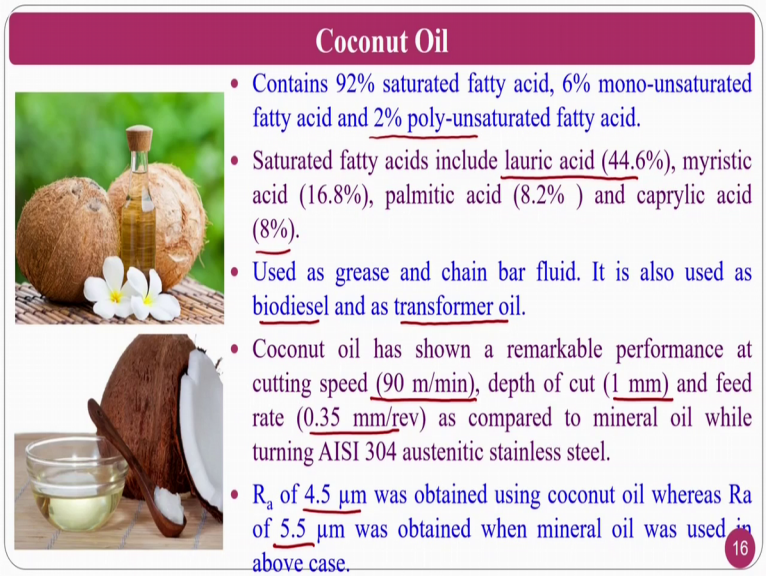

So, now the coconut oil if you see the coconut oil we use it for hair we use it for body massage, so many, many, many, applications Indians uses it. So, contains 92 percent saturated fatty acids and 6 percent mono unsaturated fatty acids 2 percent poly unsaturated fatty acids.

So, it is completely the basic of unsaturated and saturated fatty acids that oils basically saturated fatty acids include lauric acid and myristic acid and palmtic acid and caprylic acid these are the compositions in the saturated acid used as a grease chain bar fluid it also used as a biodiesel and transformer oil it is also used as a biodiesel if it is biodiesel; that means, that its emissions will be tested by the thermal engineers. So, we should not worry much about to the emissions of these one.

So, we can directly uses as I said know some of the people even they consume inside the body the coconut oil that is biodegradable and all those things, coconut oil I have shown the remarkable performance at the cutting speed 90 meters per minute depth of cut 1 mm and feed rate compare to the mineral oil that mean the performance of the mineral oil is much poor compare to the coconut oil.

If you are comparing for this particular performance and you can also see it gives 4.5 centerline average value compare to mineral oil with that gives 5.5; that means, the product quality that one is getting from the coconut oil based cutting fluids during the machining operation is much better compare to other. So, what the some students you may be seeing 4.5 and 4 5.5 see as a surface roughness is going down; that means, that my surface finish is better that though if you there are any new students are in between some people miss the classes if my r a value is less; that means, that my performance is good please note that one, so coconut emissions.

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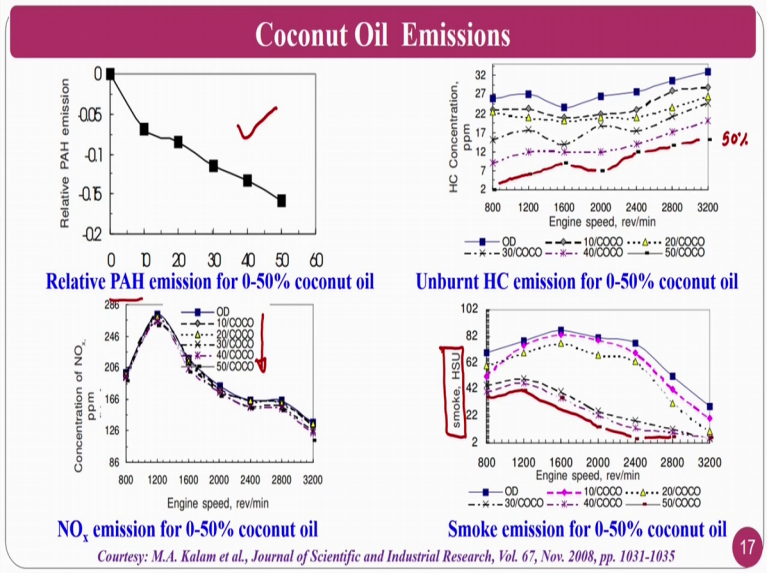

If you see the coconut emissions from the this one, so here also people they have used for the combustion application they have mix the coconut oil with respect to the commercially used biodiesels all those things.

If you are mixing it and if your checking as the coconut oil increases my PAH polyaromatic hydrocarbons, which are very dangerous from the point of cutting fluid emissions are enormously decreasing; that means, that it is very, very good from the

ecological point of view like PAH causes dermatitis problem folliculties problem cancer problem many problems it will occurring, if it is reducing that is good if you see the nox emissions that nitrogen oxide base emissions nox and sox are basically two components of the emissions in the automobile industry.

If you see the engine speed verses concentration of nox as you increase the amount of your coconut oil inside what will happen if you see this is going to reduce that is p p m e of nox is going to reduce as you increase the coconut oil in the mineral oil.

You can you can see is engine speed versus hydrocarbon concentration, hydrocarbons concentration normally is reducing it you, you may (Refer Time: 37:20) is it only points are there just let me connect this points you can see this one this is the curve that represent 50 percent of coconut oil if you are going mix the 50 percent; that means, as it is increasing from 0 to 10 to 20, 30, 40 and 50 my hydrocarbons which are dangerous from the environmental point of view is going to reduce; that means, hydrocarbon emissions are going to reduce that its good for the environmental point of you at the same time if you see the smoke normally the smoke that is coming out from the engine also is reducing.

If you here also the curve I am just going to connect it you can see the points. So, this is what I want to say from this particular slide is concern is that if the coconut oil is used for the combustion purposes; normally the emissions are going to decrease enormously that is what and we can also see the machining performance of this one.

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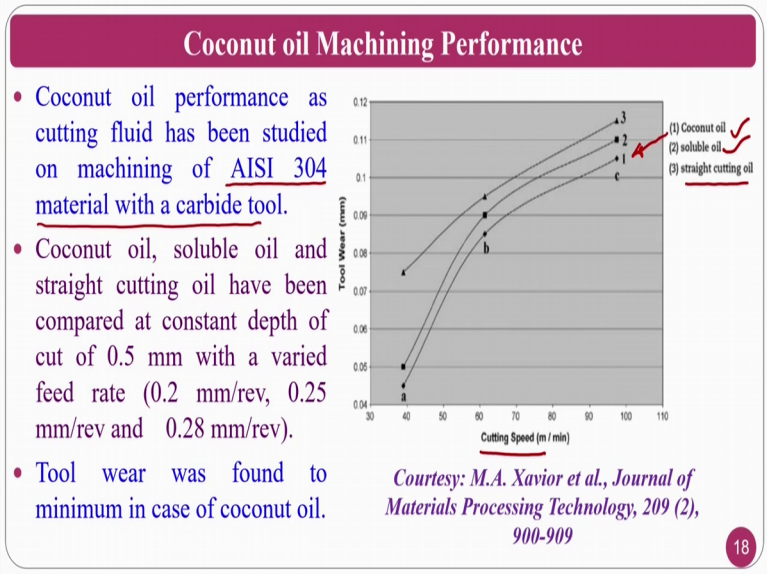

If you see the machining performance till now we have proved even though for high temperatures in the automobiles or the engines the coconut oil consumption or the coconut oil usage gives less emissions. So, now, with that analogy it is eco friendly that is proved there now we are using for the mechanical performance, if you see the cutting speed versus tool wear what is happening coconut oil performance of the as a cutting fluid has been studied when the machining of AISI 304 material with carbide tool.

if you see this one anyhow let me see coconut oils and soluble oil and straight oils have been compared, you can see here coconut oil is there soluble oil is there and straight oil also is there these are the three varieties of oils are there among which if you see here coconut oil gives the less tool wear that is one represent to coconut oil; that means, the tool wear is lower compare to soluble oil and straight oils that is mechanical performance is better compare to other oils.

So, we have the less emissions; we have better performance this is what we want as a mechanical engineer or a manufacturing engineer or as a metal cutting person in particular ok. So, we will come to the summary what all we have studied today we have seen two things.

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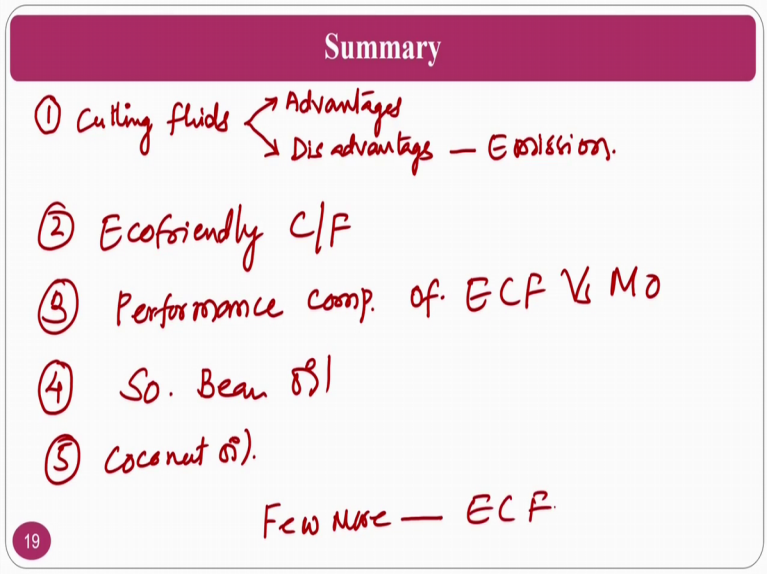

That is first point we have summarized the cutting fluids, two things we have seen advantages and disadvantages like advantages what are the emulsions how the emulsion function is going to takes place and all those things if the you do not going to use emulsions there is a agglomeration of the oil particles and all those things disadvantages is like emissions and all those things ok. We have studied this then we got a question mark how to maintain the performance, but emission should be decreased for that purpose we entered into the eco friendly cutting fluids in the eco friendly fluids, eco friendly cutting fluids we entered in to eco friendly cutting fluids.

In the eco friendly cutting fluids we have seen the various the vegetable based cutting fluids and all those things in the vegetable based cutting fluids, we have seen the performance, performance comparison of eco friendly cutting fluids versus mineral oils. So, mineral oils are much lower performing compare to eco friendly cutting fluids then we went to two types of eco friendly cutting fluids the soybean oil and coconut oil till now.

And many more oils will come in the upcoming class, so this is the summary about today class. So, the thing whenever you want to understand whatever the study you do it is for the human kind if you watch some of the big person lectures recently I was watching one of the lecture great discoveries are meant if you are using for the mankind that is good.

So, my course also is if you learn this machine machining fluids and if you can implement for the humankind with mechanical performance also as your concern it is

good, I those people who learns about this machining fluids how. So, you will use a right machining fluid for the machining application whatever the machining application that you are going to by choosing the chemical compatibility of your cutting fluid along with the additives that you are going to add and all those things.

Please take care and I will come up with some more type of many more are there; that means, that again few more eco-friendly cutting fluids I will discuss in a upcoming class.

So, thank you for this class.