Introduction to Machining and Machining Fluids

Dr. Mamilla Ravi Sankar
Department of Mechanical Engineering
Indian Institute of Technology, Guwahati

Lecture – 13
Machining Fluids/Cutting Fluids and Its Additives

Welcome to the major content of this course that is on Machining Fluids. So, westudy the basics of machining especially in the point cutting tool and we move after the machining fluids to the multi point cutting tool and conventional finishing process and all those things. The major content of this course is also depends on the machining fluid.

So, why I am giving you a great importance of this one is machining fluids nowadays occurred equal importance corresponding to the machining process. That is why this is a big topic nowadays from the point of research is concerned, at the same time from the humanitarian grounds and all those things whenever we come across some of the things like emissions of this cutting fluids, during the machining operation or finishing operation and all those things. Clearly listen because a many things are chemistry oriented here, biological oriented here, health issues will come ok.

This is not like (Refer Time: 01:43) like a metal cutting process where you are just doing feet depth of cut and speed and your measuring the cutting forces temperature and all those things. It is slightly beyond that where you can measure what is the chemical oxygen demand, biological oxygen demand. This type of words will come into the subject. So, be there to learn more things what we see and how we see this mechanical or the manufacturing aspects from the other perspective. Like a chemical perspective and a environmental perspective, and all those things ok.

Welcome to the machining fluids which is also called as the cutting fluids and its additives. I have just talked about what are the additives that you will had and all those things. And I will talk the beauty about these additives in this lecture and I will talk the negative aspects about this additives in the upcoming lectures.

The overview of my presentationfor this lecture goes like this why we required the machining fluids are the cutting fluids. Majorly I talk it as a cutting fluids from now onwards ok.

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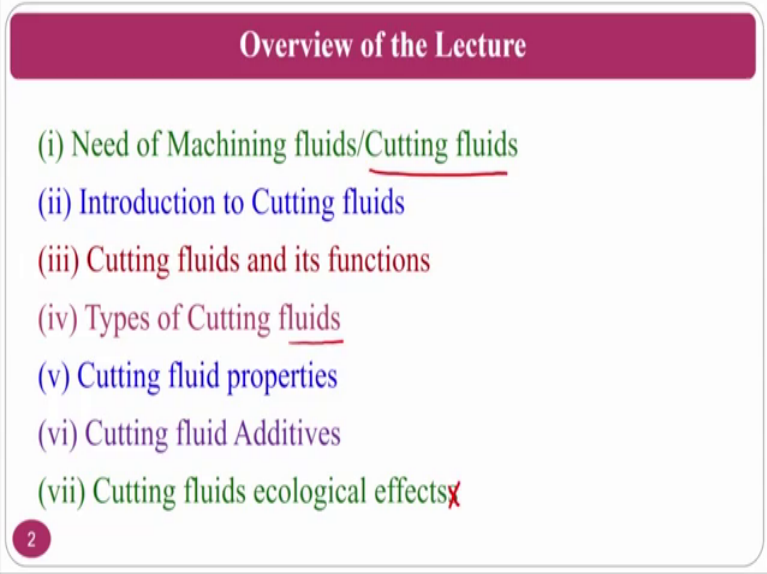

So, introduction to the cutting fluids cutting fluids and its functions; any how many of you know it, but it is my primary responsibility to remind you what are the functions not only what to study in the text books, for the functions are taken from the research point of view also ok. Those who are interested to take these cutting fluids as one of their prime research work it is a huge amount of work that one can take in this aspect.

Types of cutting fluids, what is the types, synthetic, semi synthetic are many things. The cutting fluid properties, what are the properties that you want in a cutting fluid so that you can achieve your goal. So, cutting fluid additives this is the one where you have elaborative ranging from emulsifier to rust inhibitor and all those things. And the cutting fluid is ecological aspects will be there ok.

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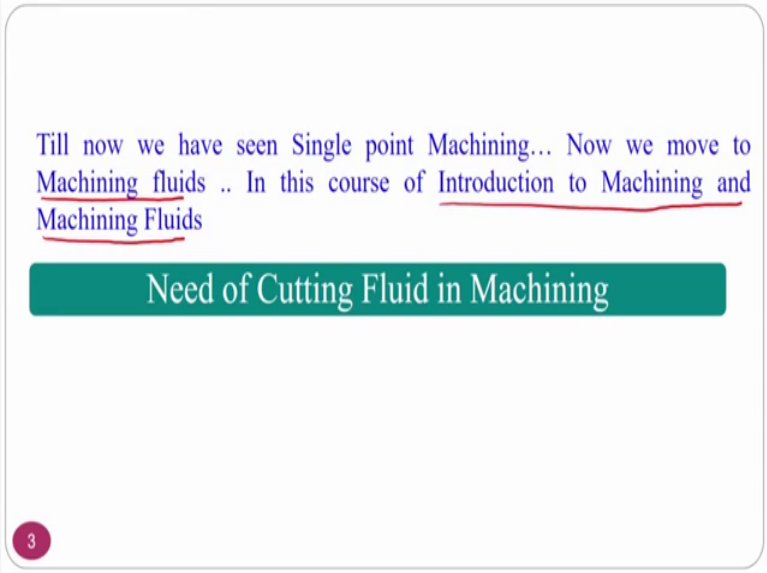

So, till now we have seen single point machining tool and now you are machining moving to the machining fluids. As I just now said in this course introduction to machining and machining fluids why I am reminding you is this course itself says machine includes. So, it is my responsibility to give you some slightly extra knowledge about the machining fluids compare to how a mechanical engineer or a manufacturing engineer. Look at that perspective need of cutting fluid in the machining. So, what is the need of the cutting fluid in the machining? Just you see here.

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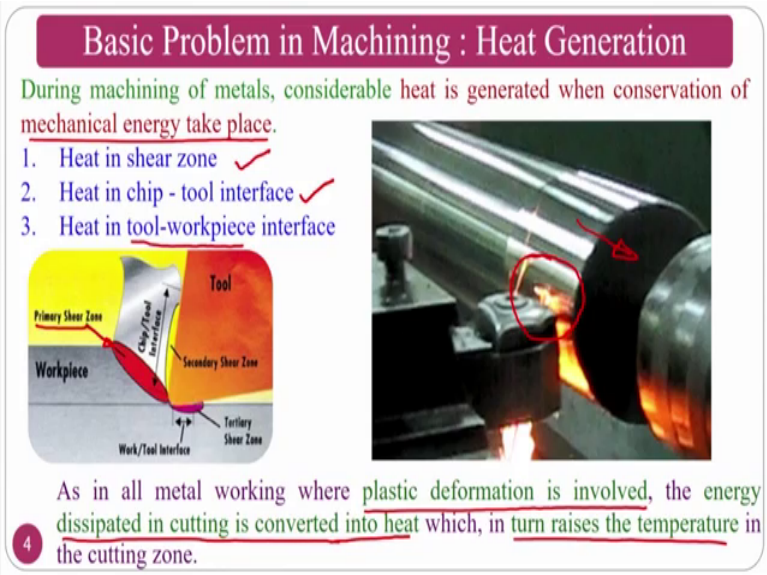

The basic problem in machining is heat generation. As we have seen thermal aspects of machining. So, during the machining of metals are non metals or something considerable heat is generated when the conservation of mechanical energy converts into the heat energy ok. Saviour plastic deformation will takes place. You can see this is the primary shear zone, saviour plastic deformation is taking place where the mechanical energy is converting into the heat energy.

So, there is a 3 zones where the heat generates one is heat in shearing zone which is a major amount of the heat generated for which you are using the cutting fluid to extract the heat. Heat in chip tool interface, heat we have already seen the heat takes place in the chip tool interface because of two things, one is chip is carrying the plastic deformation, zones temperature at the same time frictional heat between tool rake surface and chip bottom side will also causes two things. So, this two will be there and heat in work piece interface tool work piece interface tool work piece interface will have a fictional rubbing action where dominated by abrasion action that I also causes interference.

At the same time work piece also carry three to five percent if you see in all metal working the plastic deformation is involved. I am saying you the plastic deformation is involved which is I can even say that it is a saviour plastic deformation because it is taking into the saviour zone where the material feel you take place. As I asked already telling you that metal forming process and metal machining processfor failure is not required in the metal deformation processes, but failure is required in the metal cutting operations then only the metal shearing takes place ok.

The energy dissipated in the cutting converted into heat which is in terns raises the temperature machining. How it will raises? Just I might have already shown this video, but since it is an apt video for this cutting fluid application that is I will just go and show you again you see how the fireworks will takes place in this one. If you see here what is happening, the machining is taking place at the extreme conditions on a hard machine work piece. So, what is happening here is if you see in this video what you can clearly see is the lot of heat is generating, not only heat is generating the chips are coming like firing bullet us.

At the same time if you clearly see there is a accumulation of hot a chips which is a continuous chip in that location that is very harmful because your final product is coming

in this direction. If you are final product is coming in this direction if a chip is intended there it is disturbing my final surface roughness which is coming as a product plus it is also giving some heat input because my chip is red hot chip which giving the heat to the work piece which damage the micro structural on the surface of the work piece. That is two disadvantages for how to overcome all these things we will see in the cutting fluid applications ok.

So, further we proceed. You can clearly see the video. Now you can see the lump is coming out where the continuous chip red hot chip is coming and you can clearly see in this region, red hot chip is coming and it is disturbing the machining process. At the end also the same thing is clearly visible there is continuous red hot chip is there in this type of chips are presented this disturb the surface morphology as well as metallurgy which we have studied in the last week courses. How to eradicate all these things or how to minimise these things for that purpose we will use the cutting fluids or you can go for another alternative that is called alternative what you can go for it is hard cutting tools which may increase the cost of the production.

So, the cheapest way or the economical way how you can go ahead is cutting fluids ok. So, that is why that is a need of the cutting fluid ok. Proper method whenever these type of things are there how you have to utilize if you have a cutting fluid ok.

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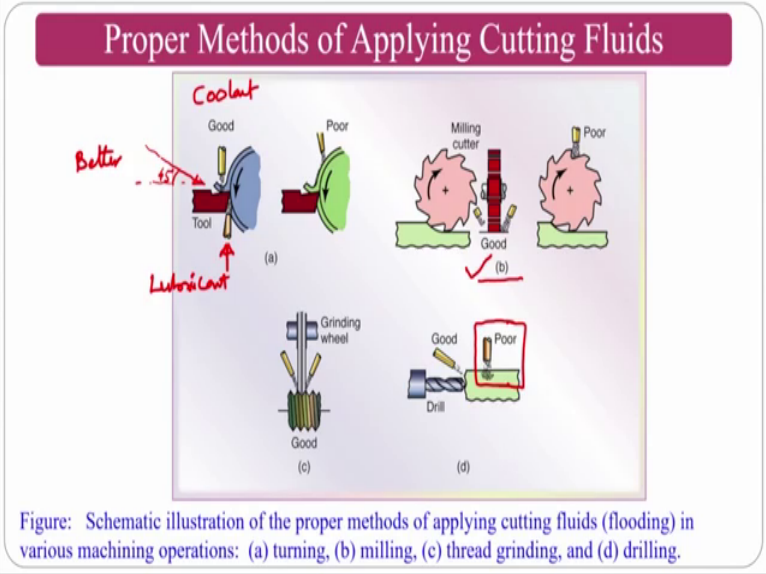

Figure: Schematic illustration of the proper methods of applying cutting fluids (flooding) in various machining operations: (a) turning, (b) milling, (c) thread grinding, and (d) drilling.

You cannot throw it like a mad person you should use fully utilise how to send if you see here figure this is a good way and this is poor way. Why? So, the heat is generated in this region where chip tool interface is there. At the same time in the good way also if it would have been done at certain degrees recently their studies shows that if you send at 45 degrees that will be better. That was the some of their searchers has conveyed ok. So, it may be better. Whatever is given is a good. So, what we can you can go ahead is better. So, this would be better. I am not saying the best, but it would be better.

The poor, why it is poor? Because the cutting fluid is falling ahead of my measuring region which is not for which is not required for us. At the same time if you see in the group there is a cutting fluid application from the flank surface side also where the work piece rubs against the cleaning surface flank surface of the real relieve surface ok. Here what normally you will send is a lubricant based, cutting fluid you will send in the flank surface here in the good one where you choose and the chip tool interface there coolant type you will send ok. Because the temperature extraction should be there from the top side and the operation is dominating in the bottom side that is why you always go for a better lubricant. So, that the lubrication will be done as you have seen the tribological lubrication and all those thing.

In the milling operation the good one is like in the milling cutting region I will come to the milling in the upcoming whenever I am going to talk to you about the multi point cutting tool and all those things. Anyhow in some of you know what is milling, what is up milling, what is down milling and all those things. So, anyhow I will teach you, but; however, just to show from the cutting fluid point of view this is a good way to apply the cutting fluid and if you are throwing on the tool top side where the cooling is already done by the atmospheric air to make you are just wasting the cutting fluid.

If you see the grinding normally teeth grinding and all those thinks this is a good way and if you see in the drilling normally you should send along the fluids. So, that that will be better rather than cooling the surface of the work piece at substance certain different locations where it may not be required. May be required, but thing is that is that the heat conductivity to the surface may not berequired that is why this is not a preferable choice. So, if you can send through the fluids are in the machining region. What will happen? It will lubricate it will cool as well as additional effect in the drilling process is it will try to evacuate the chips that is a beauty and the third function of the cutting fluid ok. In detail

functions will come across in this lecture about the cutting fluidand its requirements and all those things.

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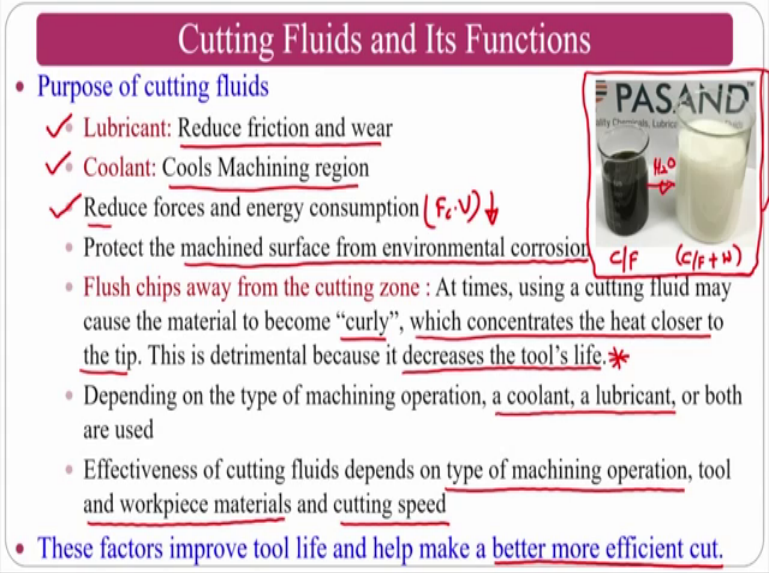

As just now I was telling. So, now we come across about the purpose of the cutting fluids and it are none other than its function. So, the first and foremost function is normally depend on the manufacturing process that you are choosing either it can be lubricant function or cooling function this has a equal choices or equal importance basically because if you are going for lower speeds lubricant type is required if you are going for a high speeds normally the coolant type is required ok.

So, lubricant type normally it will reduce the friction and where in the machining region about the I am talking about the tool ok. If at all I am using the coolant what will happen it will cool the machining region; that means, that it will try to cool the chip, it will try to cool the tool and it will try to cool the work piece also which is carrying certain amount of heat. So, if you are cooling and all those things if you are doing what will happen another benefit that you are going to achieve is reduce the forces. If you reduce the forces the energy consumption will be less that is; what is F c into V normal it will go down. So, your energy requirement or power input will be obviously, will go down ok.

Protect their mechanical surface from the environmental corrosion. What do you mean by this? If at all what I am talking is about the corrosion environmental corrosion. Environmental corrosion comes from where your environment contains oxygen,

nitrogen, and many chemicals it is all elements it is having. Nowadays if you see lot of pollution is there, so many elements are there many elements are there. Whenever the machining operation is going to take place lot of heat is generated the surface is very hot in that circumstances if these environmental aspects come into elements come into picture it will have corrosion on the surface especially in terms of iron based components there will be a conscious. So, in order to protect all those things you try to use the rust inhibiters are corrosion preventers ok. If you are cutting fluid contains a particular part of this rust inhibitors as a ingredient of the cutting fluid then you can prevent the environmental corrosion.

Flush away chips from the cutting zone as I said if you are impinging the cutting fluid with high pressure single point cutting tool or as I said in the previous slide in the drilling operation what will happen normally is, so you will evacuate the chips ok.

So, that is what at times using the cutting fluid may cause the material to become curly with concentrate the heat closer to the tip this detrimental because it decreases the tool life. As I just now I have shown you the video what will happen? It will concentrate if it is curly and which is concentrate the heat closer to the team because as the video stores that chip is curling there on the rack surface of the tool near the work pieceok, which is upgrading the tool rack surface at the same time it is importing the lot of heat to it that is why it decreases the tool life. That is most important point which practically you have seen the video. Depend on the type of machining operation cool and lubricant on both are used.

If your requirement is for lubrication you have to choose lubricant. If you are requirement is coolant cooling is measured are the dominated mechanism in your machining process then you choose the coolant. If both are required then choose optimally that is what it says. Effectiveness of cutting fluid depend on the type of machining operation which type of whether you are doing late operation, the disturbing operation, threading operation, broaching operation, milling operation tool and workpiece material call materials and cutting speed cutting speed normally determines the heat generation. Tool and workpiece material combination is also a factor if you are going for stainless steel versus HSS you cannot do machining for hours and hours because the hardness ratio is very poor. That is why you have to choose better work piece material tool material combination.

So, if you see here there is a picture that is what that this is a cutting fluid basically whenever you purchase from the market I am talking about this picture ok. So, normally the cutting fluid is a very good lubricant, but may not very good the coolant that is why always you add with this cutting fluid plus water. So, whenever you add water you it will become a milky type of colour that is white colour and all those things ok.

So, this is how it will convert from this to this whenever you add H 2 O to it ok. That you might know some of the people, butthose people who never experience the workshop practically for those purpose I am just telling you the basic. These factors all factors if you see the cooling lubrication evacuation of chip and decreasing the temperature and curling flushing away of the chips these are all directly or indirectly controls the tool life and it will improve the process that is nothing, but it is makes your the process efficient in terms of machining piece concerned. That is why always you go for the cutting fluids in the machining process if it is required.

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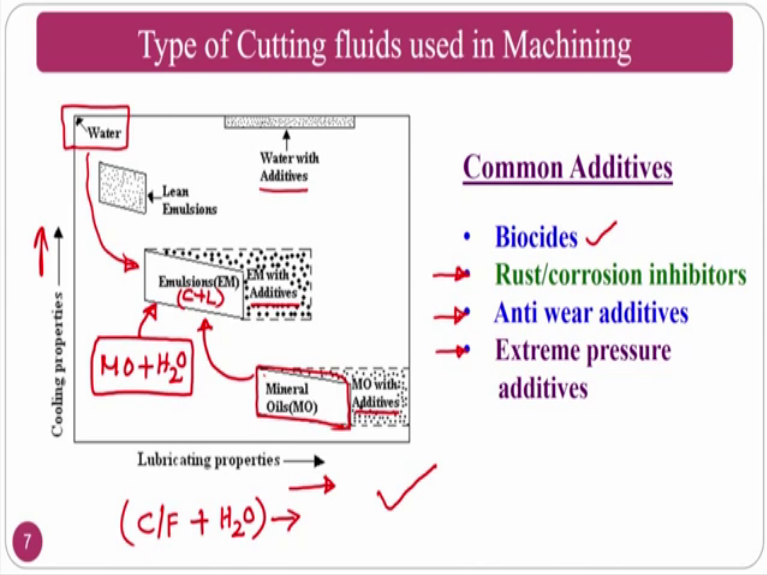

Now, you can see the types of cutting fluids used in a machining this slide I am going to elaborately touch in next class. Since I am going to talk about for the additives let me slightly say that on y axis you have a cooling properties on x axis if you have a lubricating property. Just now I told you if you have a cutting fluid you always add water to it whenever you are adding water you are improving the cooling properties. Why? The proof here from the literature is that water is a better cooling property liquid and mineral

oil or the lubricant whatever you are getting from the market isa better lubricant. So, if at all you want better.

So, you have to make the emulsions ok. So, what you do is mineral oil you take and you add H 2 O to it you are going to get the emulsions. We will have optimum cooling properties as well as optimum lubricating properties. This will have cooling properties plus lubricating properties both. If you choose mineral oil it will have a lubricating property if you choose water it will have a cooling property that is why to optimise both things if I required in the my machining operation both cooling and lubrication then I am going to use emulsions ok, cooling plus lubrication.

So, emulsions contains water if emulsions contains water whenever the high temperature machining is taking place the water will react with the iron based work pieces and causes rust for that purse always had some additives. You can see here always there is additives, mineral oil with additives, emulsions with additives, water with additives and other. What are these additives that was the major thing that we are going to see here? Some of the additives are biocides helps in a preventing the microorganisms rust inhibitor. So, rusting it helps as we have seen the previous slide. Anti wear additives it will help better lubrication, extreme pressure additives at extremely high loads your additives will provide the lubricity for proper lubrication and all these things.

The pressure are much much high in terms of broaching operation and others at that pressures how much additives are going to help for better lubrication in all those things that we will come and see ok. So, regarding this as I said we will see again this slide in the upcoming classes because this is the graph that have great importance from the point of lubrication as well as cooling.

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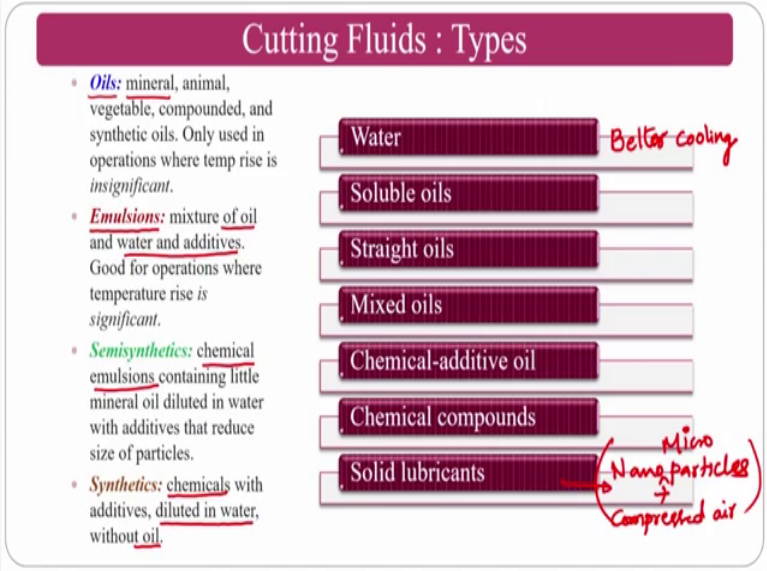

The cutting fluid types normally one is the oil types where ever you see petroleum. Nowadays if you see the companies like servo they will supply servo cut s is one of the oils ok, these are all mineral oils ok. So, animal, vegetable, compound lot of oils are there.

Then emulsions, if you just I will show you the emulsion emulsions are nothing, but the mixture of oil and water along with additives that you have seen in the previous slide. Good for operations where the temperature rises significant because it will also. Semi synthetic is are the chemical emulsions basically which contains mineral oil diluted in water with additives and reduce the particle size ok. These are the chemical emulsions.

The above ones are mineral oil based water based emulsion these are chemical based synthetic chemicals with additives. Basically here emulsions are used in the semi synthetic, here directly chemicals are used along with the additives and you can even dilute with water or without oil also ok. So, you can do that. So, if you see a range of cutting fluids as you have seen in the previous slide water is a better cooling, cooling fluid ok. So, soluble oils normally soluble oils which easily mix with water that is why it is called soluble oils.

Straight oils normally whose chain is very big, normally you if you see the chains like a large chain, small chain, medium chain these are the chemical compositions like alkanes alkenes alkynes if the chain is goes beyond the c 13 normally. These are main branch is

dominating at the same time the sister branches are the side branches will be not donating much. So, this type of oils are one of the straight oils. This is a mixed oils you can mix with 2 3 varieties of oils. Chemical additive oil, as I said semi synthetic oil is normally are called as a semi synthetic where you can add chemical synthesized oils along with the mineral oil, chemical compounds directly as I said synthetic oils are completely chemical compounds where you can add water to it make slightly emulsion and the solid lubricants.

Solid lubricants are normally nano particles or micro particles ok, nano particles where you used or micro particles also you can say micro particles also plus compressed air. With this you will send to the machining region and you will get the lubricant. If here basically the lubricant action is dominated compared to the cooling, whatever the air that you are sending assume that you are sending you cold compressed air that will be better here ok. So, whenever somebody want to take the research work in this area.

So, solid lubricant you can take along with that cooling fluid that is cooling gas are normally the air. Cooled air you can impregnate with the solid nano particles which are better lubricants and you can send to this one. So, your cooling fluid will extract the heat because it is at the low temperature at the same time being a air it can penetrate into the region. So, people very less work is done in this area. So, people who are working in the soil lubricants for machining applications you can try with low temperature high pressure air mixing with solid lubricants and you can send it to the machining region and you can check. And you can even compare with normally and solid lubricant particles also you can vary.

So, you sometimes the problem is whenever you are going for nano particles agglomeration is a problem. So, you have to optimise the particle size how much volume of the particles was sending, it is discharge so much you think. You can play with the volume amount or the discharged at the same time particle size, at the temperature of the fluid that is air that you are sending. So, you can play air, pressure air pressure and all those things will play on the volume discharge.

So, lot of interaction factors and all those things are there. So, if somebody is interested you can get a very good PhD topic out of this one. So, please work in this area as I was sayingyou know this is not only the course for beginners like second year B.Tech, it also

good for the first year M.Tech and a PhD also. So, my topic any B.Tech students likes it this topic you can take it M.Tech student or free to take are you can go to my website and you can write to us at this is what we were looking any suggestions you want to and all those things and we can always help you see as we work in this area. So, we have slightly better knowledge. So, we can help you and spreading knowledge is what we are here for ok.

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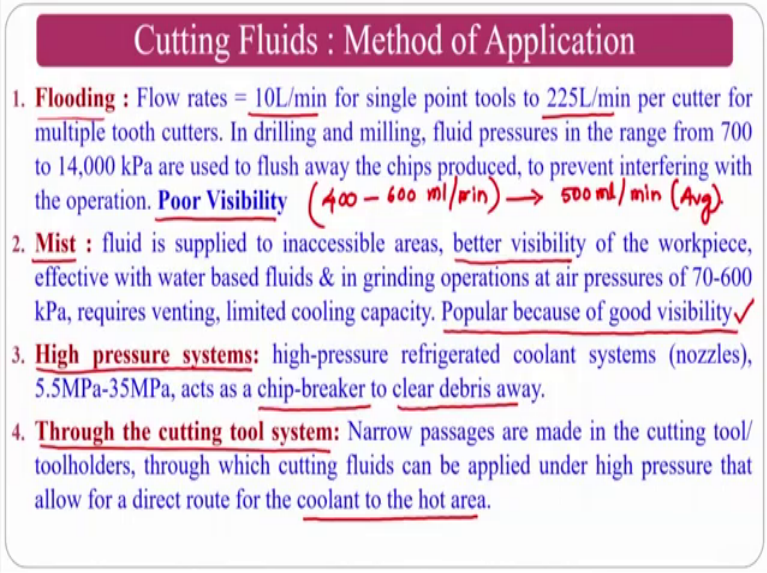

So, the cutting fluid method application the flow rates are normally if you see the flood cooling. If you see the flood cooling what are the method application, is there are many types of techniques where one of the commonly used technique in India nowadays in the industry especially small scale industries flood cooling ok, where the cutting fluid falls a 10 meter per minute. Normally it is too high, but whatever the text books refers is a 400 to 600 ml per minute is the one. So, this is slightly I because we have taken from some of the old textbooks. So, it may be at the same time the basic problem here is a poor visibility ok. I can say that this will be like a 400 effectively nowadays people are working in the range of 400 ml to 600 ml per minute ok. So, on an average you can say it is around 500 ml per minute. This is average value ok, the basic problem is poor visibility.

As you have seen the cutting fluid is extremely milky type. So, it will cover if the fluid content is very high what will happen? You cannot see the measuring region that is the

basic problem at the same time cutting fluid is very high, so emissions is also very high. So, emissions whenever you see in the next classes you will really see what is the basic problems. So, second one is a mist one where you have a better visibility what I mean to say better visibility does not mean that it is transparent or something.

Here you will mix the cutting fluid with gas and you send the atomize as you have seen in the MQL, is one of the other names are the synonyms for minimum quantity lubrication where you send the air plus cutting fluid and you just circulate into the grinding operation or machining operation, new type of machine operation ok.

So, this is most popular one nowadays abroad nations are following. So, India hopefully some of the companies are following where good visibility is there. So, people can see what is happening in the machining region and whether the tool is tool wear is taken or how the progress of the various taking place in all those things something you can see if not 100 percent. So, the third one is high pressure systems that is a if you want to send the cutting fluid with high pressure. So, normally you will go for this one. So, here the cutting fluid will consumption will very high even compared with the flood cooling ok. Your flood cooling I said 400 to 600 ml here with me even cross 1 litre also ok, and the beauty about this one is if you are sending a liquid jet very with the high pressure the prematured chip that is coming from the machining region way break.

That is why it will also act as a chip breaker ok. That is a one of the advantage of this high pressure jet liquid jet that you are sending at the same time it will also clear the debris if at all if there is any formation in the machining region or in the chip tool interface and all those things ok. This is the additional benefit that one can do, through cut through the cutting tool system is that you are making a or the cut commercial tools are available where you will have a through hole in the tool holder as well as in the tool through which the cutting fluid passes and directly enters into the machining region. To make sure that here also you may not going to the sticking and sliding regions, but he has a better chance because the holds are directed towards the chip tool interface as well as flank and workpiece interfaces that is why you can cool the hot area that is where the machining is taken place ok.

These are the forth techniques where the flood cooling, mist cooling that is minimum quantity cutting fluid or minimum quantity lubrication. High pressure systems that high

pressure cutting fluid applications and through the cutting tool system as I said through cutting tool system can normally work with high pressure cutting fluid system only, because the narrow holes that are made on the tool as well as work piece has to pass by certain pumping system which you fit externally ok. So, that is what you want.

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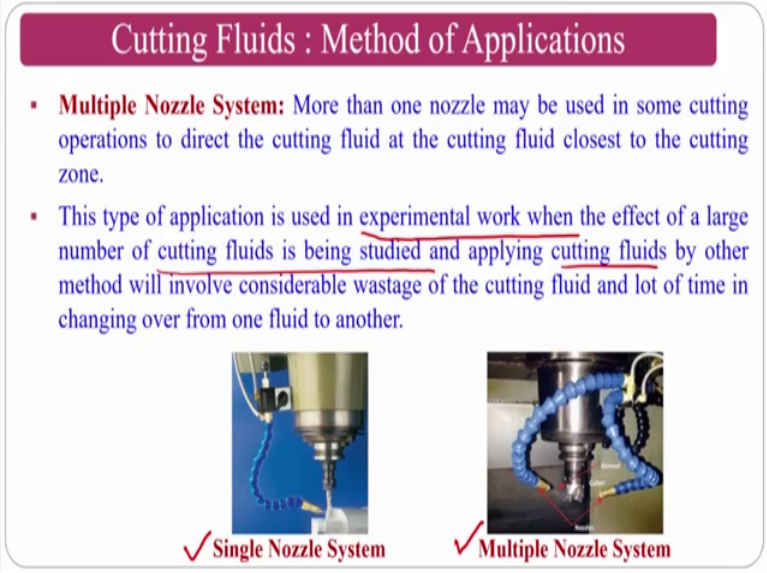

So, methods of application, if you see in the multiple login system normally this is another way of system since we have seen four systems there. If at all the measuring is for long time and if you are cutting the large structures like aerospace structures or another big structures there normally you require multiple nozzles to cooled your tool more than one nozzle may be used for some cutting operation ok.

So, that is what you can see here single nozzle system and you can use see amulti nozzle system normally depends on your cutter size also whenever you are cutting a very big aero structures like what you are cutting like plane wings and all those things. There you require tools should not break at middle of something you need multi jets. Not only that whenever you cut for advance materials normally you require multi jets.

This time applied application used for experimental work when the effect of large number of cutting fluids are being studied and applying. This is one of the technique apart from it nothing to do the only thing that multi jets are there if you have the different-different types of cuttings fluids you can also try so that the mixture of cutting fluids will be there. So, this is nothing to do with the sentence, but I am just guessing the

explaining that if you have multi tanks and multi pumps where the nozzle is individual entity then you just pump different-different types of cutting fluids and you can get the forces tribological aspects surface finish and also those that also can be taken up as a research and you can do it ok.

So, some special considerations are there if at all you are machining certain material you should not use this type of chemicals. If you are using this type of chemicals you use in the closed system do not use in the open system it will affect and all those thing.

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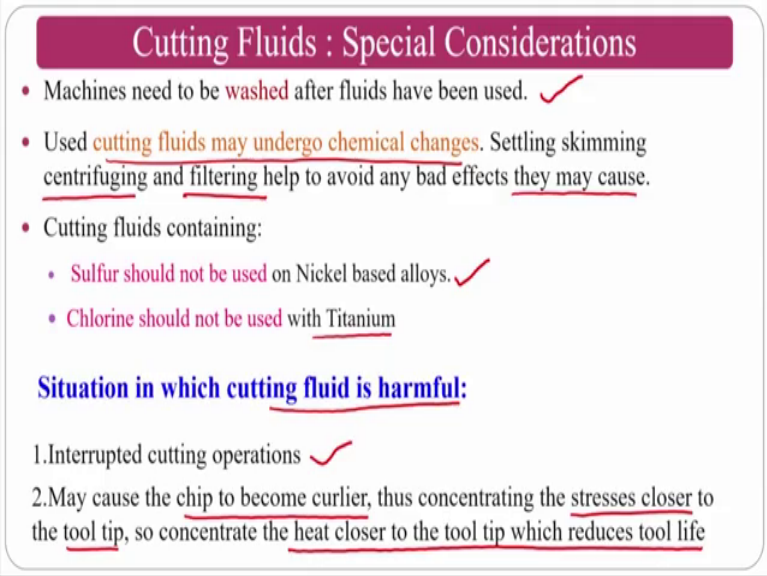

Thus special consideration are there so machines need to be washed after the fluids have been used this is the primary requirement because the cutting fluid viscosity are different to different-different fluids if that cutting fluid is falling if the viscosity is very high it is very difficult to wash off. So, you need regular washing. If you are if at all I have taken my lunch I have to clean my plate as soon as I complete. So, that will be easily clean if you are cleaning after two days are one day what will happening is it will dry. So, it will be very difficult to clean. So, that is why you should wash as soon as you use it. Use the cutting fluids may undergo chemical changes.

So, when the cutting fluids normally are mineral oil based which are chemical compounds or carbon compounds, alkene alkynes as I said. Whenever this fall in the high temperature region what will happen there is a chemical cracking takes place,

chemical cracking take place and its originality will be lose. Its cooling property lubrication property will be disrupted because it changes its chemical structure ok.

Settling and skimming centrifuging and filtering help to avoid this bad effects filtering, if you can filter it if assume that whenever the first machining is going on, but what is happening is particles in the machining particles will also come in contact with the cutting fluid and will also have a chemical reaction to it. That is why you will always should have some filtering and you can even use the centrifuging to separate it out ok. The cutting fluid containing sulphur should not be used for nickel based alloys ok. This is the one of the indications are precautionary indications that normally the cutting fluid suppliers will always do, if at all I want to do the for nickel based alloys they will give you certain different cutting fluid. Chlorine should not be used for the titanium because these are chemically affinity will be there for these two applications that is why normally it is preferred to not use the chlorine with respect to titanium ok.

Situation in which the cutting fluids are harmful normally are interrupted cuttings ok, in a interrupted cutting basically the thermal shocks will be there mechanical shocks will be there. So, the cutting fluid may not act properly because the cutting fluid will have sudden quenching after the cutting tool, but the sudden shocks sudden thermal shocks will have temperature will increase. So, increase and decrease of will be instantaneous. So, that is one of the reasons. Apart from is there are some other reasons some other text books also will give. So, interrupted cuttings normally you have to use some other cutting fluids may cause the chip, curlier does the concentration in the stresses closer to the tool tip sometimes it will cause this if the situation is like assume that the chip is coming there itself, your nozzle direction or your sending direction should not assist the existing one that is what ok.

Concentrate heat closer to the tip which reduces the tool life ok. So, what I mean to say is in the two points the basically the situation you should not bring if the thermal shock is there or the mechanical shock is there on top of it your again binging with very very high velocity it will have erosion effect. Another situation is if my chip is curling there itself if you are assisting by putting in a wrong direction of your cutting fluid it is not good ok. You put such a way that it will lift off and it will send out that is most important.

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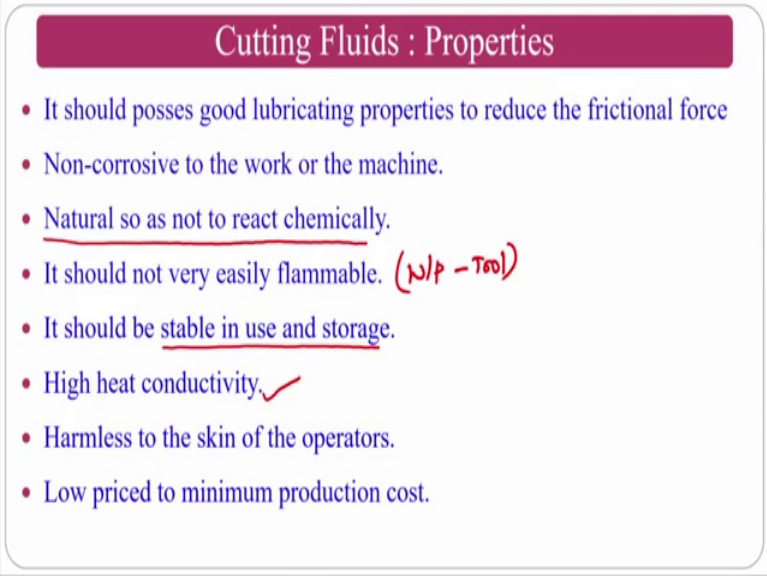

Now, we will look into the properties what are the properties that I am looking. It should possess good lubricating properties to reduce the friction which you have seen. Non corrosiveness that is rust inhibitors are inbuilt should be made whenever the suppliers of this cutting fluid supplies and natural. So, that not react chemically. So, it should be as natural as possible. Why I am telling this some of the papers if you see people are using coconut oil people are using castor oil people are using palm oil palm oil based cutting fluid papers you can see in Thailand based, Malaysia based many people are working in this area.

So, Jatrophine these are all that people are working. So, why do not any many people are in India also working. So, you go through the literature and find the combination of this ions or combination of these ions along with the water or can we mix with them mineral oil because mineral oil has a better lubricity if the cooling ability of this one is better then why do not we mix all with the water. So, only thing is that you should choose for a right emulsifiers which can do so that most of the cutting fluid will have natural tendency so that the chemical aspects will go down. For example, whenever you want to purchase a soap in a whenever you want to take the bath and whenever you want to purchase a soap the first thing a person who move some of knowledge about the soap he is just to rotate this and the back side and just check what is the t f m of this one ok. Why they will check? Normally t f m stands for total fat material or content of the fact which is non chemical.

For example, if you take a I am just not advertising for anything just let me take the advertisement of the government of India where people many people may not like the animal fat in it. So, the best way is going for assume that Mysore sandal soap is there. So, normally total fatmaterial the fat material that they are taking most of the material that they are taking is sandalwood oil. So, oils is nothing, but a fat. So, if oil content which is coming from sandalwood if it is putting on my skin it is good for me rather than the chemicals made soaps ok. So, sorry that I am my wish is not to advertise or something, just I am taking for example, because if you have less chemicals and if you have more fats which are natural fats that are coming to the plant which is good for your health that is very good.

So, choose a soap not only that what a specified where the total fat material is more which will help you if at all the fat is coming from the plants that is still more better because it is natural biodegradable everything will be there ok. That is why this point is completely valid where you should have a natural content. So, that the chemical reaction should be very very less on the machining surface or the operator health or it should not emit any chemicals or something. It should not very easily flammable; that means, the measuring conditions will go around 300 to 1000 degrees depend on workpiece and tool combination ok. On this tool combination normally the temperature will be slightly increase, in that circumstances what will happen there may be a chance of flame ability.

So, your cutting fluid always should avoid all this flaming things it should not catch fire and all those things. So, it should be visa versa, it should drop or it should avoid the firing that is all of the property. It should be stable whenever you use and you can store it should be completely stable it should not age with respect to the time in it will have certain age are after wards expiry date will be there. So, the expiry date should not be very low that is what the statements says. It should high heat conducting if it can heat conducting ability of the this one will be very high if it falls between my cutting tool and chip if it fall here what will happen it will conduct away most of the heat that is what everybody want conductivity of the fluid will be very high that will take away the heat ok. The harmless to the skin of the operators because whenever the workpiece assume that the still we have studied only the turning process.

So, workpiece is rotating with very high speed if my cutting fluid is falling what will happen, there may be a chance of splashing it may splash on the hands it may splash on

the face it may splash on the head depend on the operators position if he is like this it may splash on this one, so many things are there. So, even though its spalshes on his face you should not harm the operator ok. Low priced to the minimum production cost; that means, that the production cost of this one will be less. So, that you can (Refer Time: 48:07) economic price ok. These are all the requirements the properties a consumer looks at whenever he want to purchase these things ok.

How to choose the choice cutting fluids which type of cutting fluid I want? This type of cutting fluid you do not want, this type of cutting fluid I want and all those thing s how do you choose. You will choose based on which basis the cutting fluid is select just is the question.

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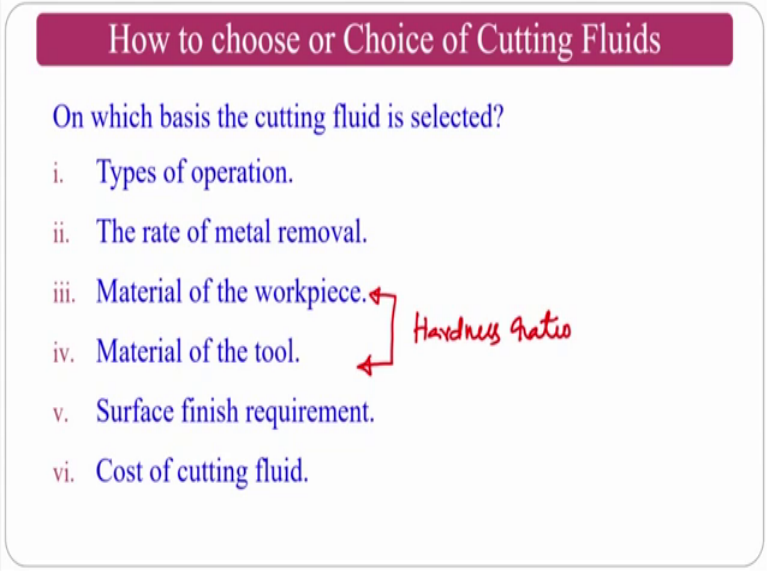

So, what is the basis for it type of operation? Whether I am going for turning operation with I am going for the broaching operations, whether I am going for the learning operation this is one criteria. The second criteria is the rate of material whether I want to remove a bulk whether I want to remove a minimal this type of thing with you if I want to go and remove a huge amount of material then I have to choose according to it. If my material removal rate is very fast heat temperature will be very high.

So, I have to use coolant based cutting fluid my conditions are slowly remove, but large time if the huge time. So, you go for lubricant based. So, the material of the workpiece if the material of the workpiece is very hard so the temperature generation is very hard. So,

you have to use both the things because the it also try to upgrade the tool. So, you have to choose a optimally at the same time material of the tool normally people talk about the combination and a hardness ratio. Normally tool hardness to the workpiece hardness should be slightly higher. If it is higher normally 3 times 5 times, if it is 7 times that will be better ok, depend on this combination normally it will you will choose the cutting fluid also ok. Surface finish requirement if the surface finish on my product is required then I have to obviously, choose lubricant dominator because the lubricant is helps the operation between my flank surface and the my final product ok.

Cost of the cutting fluid; obviously, whenever we go to the shop you just see what first you like the shirt 3 4 shirts then you just see the cost and do whatever is (Refer Time: 50:34) in your budget will purchase. So, even though the cutting fluid is very good if the cost is too high the production cost will go up in the product cost will go up, so obviously, you choose the effective cost of the cutting fluid.

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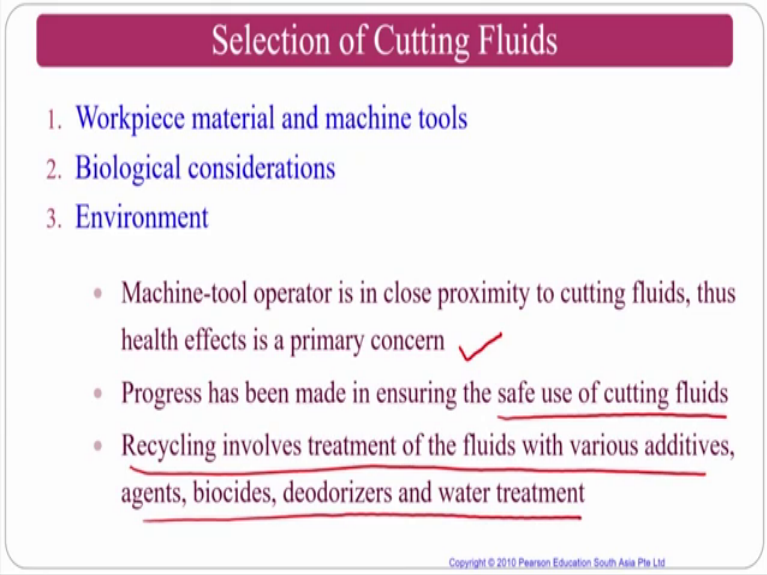

Selection of the cutting fluid how do you do? The workpiece materials and machine tools biological considerations you see the biological consideration like whether it is costly degradable or whether it is bacterial will formation is very fast or something you just see. And the environmental aspect machine tool operator is close proximity to the cutting fluid there is health effects is a primary concern ok. So, you choose the one appeal for the people who are from the industries you should not only look at the profits and just

now it is my intent it is not my intentions just I casualitily. So, you should also look at the safety of the operators are the whose staff is working, we should provide him the basic necessities to like mask proper apron glouses and all those things. So, that the splashing will not takes place at the same time fumes that are coming should not go into the operators nozzles and cause a lot of problem ok.

This problems I will discuss in the upcoming classes. Progress has been made to ensure the safety, safe in use of the cutting fluids. So, safety what are the safety precautions whenever you are using the cutting fluid? You have to, one has to ensure whenever you are selecting at certain cutting fluid. Recycling involve treatment of the fluid with various additives agents biocide deodorized and water treatment ok. You should able to involve in the heat treatment of the fluid where lot of additives are there, you should be what the bottom line of the story is you should select a good cutting fluid which gives the mechanical performance in a better way as well as it should not be harmful for the human who is near to that one that is what the intention is ok.

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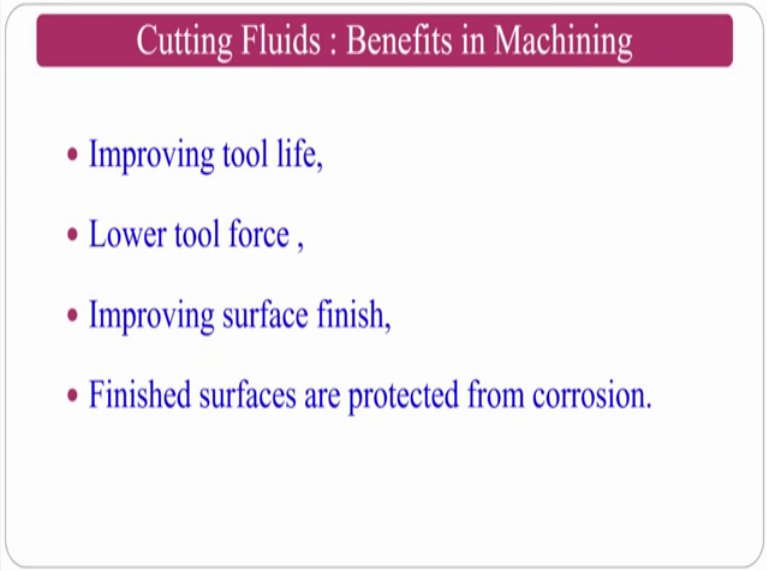

The benefits of cutting fluids in machining it will improve the tool life. Lowers the forces; obviously, after seeing all these things improve the surface finish because the lubricating characteristics will help and finished surface for protected from the corrosion because a rust inhibitors are the part of this cutting fluid. So, the corrosion will be minimum ok. So, these benefits will get if at all you used, but the cutting fluid cost if you

see the current market where we procure the normally server based cutting fluids is 20 litres is around a 2000 plus or minus 500, normally I am saying a 2500 plus or minus 500. So, it may range between 2000 to 3000 rupees so, but 20 litres each litre if you mix with 10 litres of water so it is economic, but the only thing is that you haves to look from the corrosion point of you because of water content is more at the same time you have to see whether the harmful chemicals are emitting whenever this cutting fluid is falling in the machining region ok.

So, anyhow these will give you input mechanical properties like, I am not saying mechanical properties sorry that the surface finish and forces will be anyhow it will be reducing, but you can see on the other side of the coin like ecological aspects ok.

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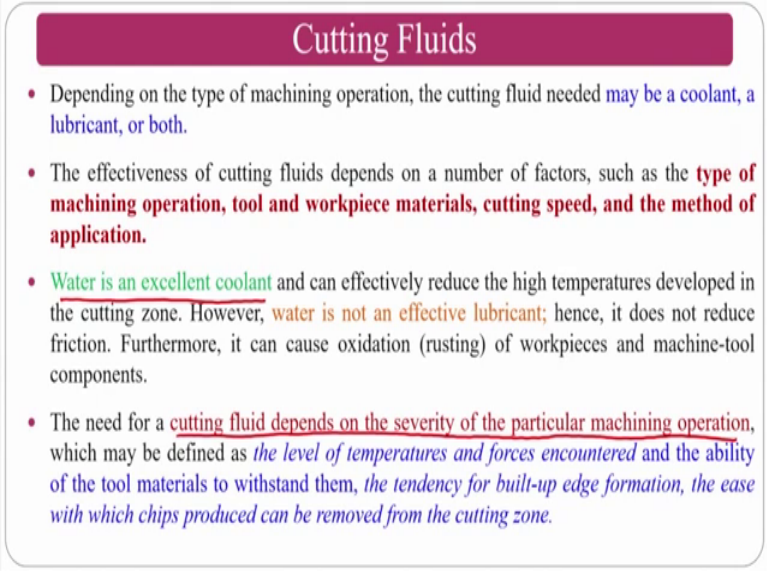

Now, the cutting fluids depending on the type of machining operation is need to may vary which is cooling or lubricant. It is same thing that and the effectiveness of the cutting fluid is depend on the number of factors such as type machining operation and others things. I said in the graph also water is an excellent coolant and the cutting fluid depend on the severity of the particular machining operation if it is a turning operation it is not much saviour, but if it is a broaching operation and all those things it is high pressure things where you need proper lubrication and cooling. So, for that purpose you have to use a special type of cutting fluids where you will have high pressure additives and all those things.

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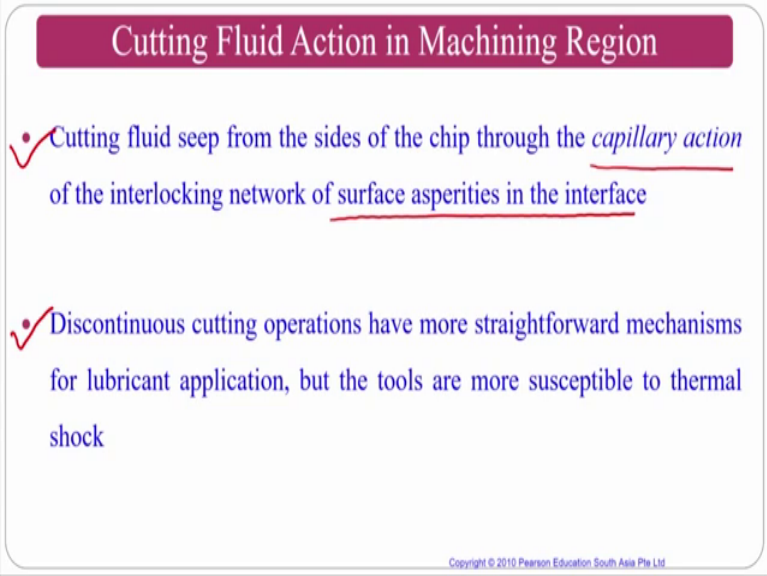

Cutting fluid action normally how the action takes place in terms of heat extraction or the lubricating. So, normally this is a capillary action just highlight first before reading this. Cutting fluid seep from the sides of the chip through the capillary action of the interlocking network of surface asperities at the interface; that means, whenever you are sending a cutting fluid basically it will go from higher concentration to lower concentration by the capillary action state will go and unlock the interlocking network between chip and tool that is the action.

Discontinuous cutting operations have more straightforward mechanisms for the lubrication application, but tools are more susceptible to thermal shock ok. What I mean to say whatever the above point this point holds good for continuous chips, if you are going for discontinuous chip it is takes forward because chip are not entangling there it will becoming a powder form or a small small fragments. So, the proper lubrication and cooling will be done in the machining region; however, this nano particles or micro particles that are forming is a discrete particles. So, discontinuity will be there in the nano range or a micro range which may cause shocks ok.

So, you have to take care about the cutting fluid appropriate cutting fluid in this is process. Normally if I am not using the cutting fluid what will happen? So, just let me take an example which I have taken from some other source.

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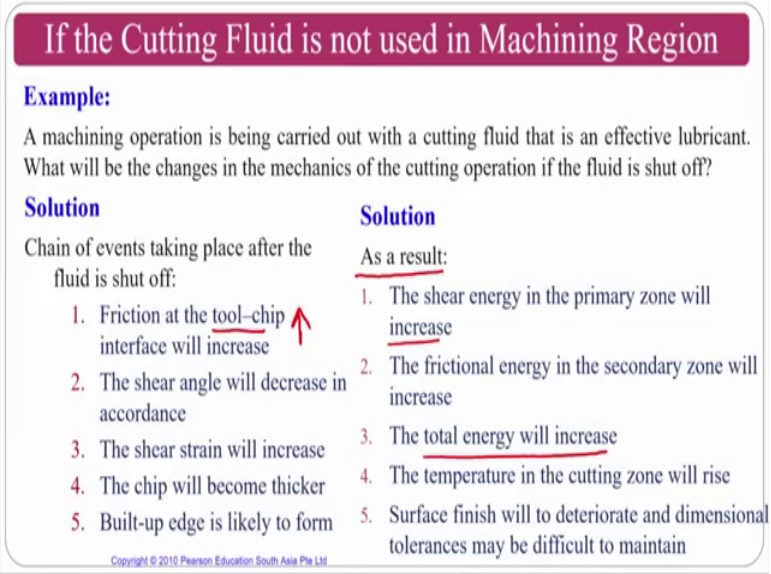

A machining operation is being carried out with a cutting fluid that is an effective lubricant. What will be the changes in the mechanics of the cutting operation if the fluid is shut off? Assume that I am not using the cutting fluid, but I am using the turning. What are the problems that one can experience with operator? So, chain of events taking place if the cutting fluid is shut off. What are the things? If you see the frictional at the chip tool interface will increase ok. So, which will destroy the tool the shearing angle will decrease because if the shearing angle decreases what will happen? Lot of problems will come the temperature in the plastic shearing zone will slightly increase ok. If my shearing angle is like this the line is, if it goes like this what will happen? My length will increase ok.

So, if it increases what will happen that temperature at the number of atoms in the workpiece material will goes up ok. So, there is a heat increase problems will be there. The shear strain will increase normally the strain will increase if the strain increases temperature increases chip will become thick as I said the shearing angle decreases. So, chip will become thicker and built up edge is likely to form. If the built up edge forms the surface roughness will deteriorate and tool wear also improve and other things will take place ok. How if you can see from other point as a result what are the problems it will be? The shearing energy in the primary zone will increase because I have to put more and more energy. The frictional energy in the secondary zone will increase. If the frictional energy increases what will happen? Coefficient of friction will increase. So, the

total energy will increase, on an average if the part of energies are increasing. So, the total energy that is required will also increase ok. The temperature in the cutting zone slightly increases if the temperature in the cutting zone; obviously, you have seen it is increasing if the increasing thermal softening up the workpiece takes place in a thermal softening of the workpiece takes place tool will fail at very faster it ok.

Surface will deteriorate on the dimensional tolerance. If the temperature of the tool increases what will happen this temperature will important to the machining of thermal conductivity will go across the flank surface which is contacted to the final product this temperature will go in to the product and the product heating will takes place. If the product heating takes place what will happen? The tolerances of the product will go; that means, the nano dimensions of the product will may increase ok. So, at the same time it will also destroy the metallurgical surface that is there on the surface, so metallurgical aspect of the surface also we deteriorate ok. So, not only mechanical dimension it will change it will also change metallurgicaly that is what I want to say ok.

So, now, we will move to the cutting fluid additives. So, in this class we have studied about the machining fluids which is the major part of this course. So, we will talk about this machining fluids in a continuous spectrum of at least 2 weeks. So, basic problems why we required to the cutting fluids we have studied, then what are the proper method, how to use cutting fluid in the right direction and the right place of machining we have to use like that we have studied. The cutting fluid functions we have studied, then types of cutting fluid, water based cutting fluids, semi synthetic, mineral oil based, what are the lubricating properties and cooling properties, how do we have to take care and all those things we have studied. We have also studied about the various type like flood cooling, mist cooling, that high pressure cooling and interconnected cooling and all those things, multi jet cooling for machining of big structures and all those things.

Special considerations normally what we have studied is like sulphur should not be used for chemical applications and chlorine should not be used for titanium applications and all those things. Some of the special consideration also we have come across and wejust moved to the properties like it should have high heat conductivity and other things. So, that it will take away most of the heat that is generated during the machining operation and other things. So, it should also have price, because a price is most important thing

whenever you decide or whenever you want to purchase a product 17 percent of the product cost goes to cutting fluid ok.

You have to choose the cutting fluid at minimum price easily accessible cutting fluid at minimum price. So, that the price of your cutting fluid cost that is in the product should be less at the same time you are should go for certain alter the alternatives like mist cooling. So, that the cutting fluid volume consumption will be very less that should be about the cutting fluid and it should not be claimable. So, it should not catch fire, especially when the machining action is taking place with respect to some of the advanced materials like a magnesium alloys and all those things you should be very careful because the oxidation problem of the magnesium is one of the problem. So, people who are interested to do the machining operation of magnesium alloys should be take care about the cutting fluid that flammable. So, you should avoid the firing and all those things ok.

Normally you should choose the choice of cutting fluid normal which are from the point of surface finish requirement or whether the high material removal requirement, whether your requirement is a high material removal then you have to go for whether your requirement is high speed machining application the cutting fluid should be cooling type. Whether if you are going for slow type of machining operations then you have to go for the lubricant type of cutting fluid and some other considerations also should be taken from the environment point of view as it should be chemically inactive or it. Most of the cutting fluid should be naturally oils. So, that if it falls on the operator and it should not damage is health like, if it falls on the epidermis of the skin then it will cause dermatitis and all those things. It falls on the hair, hair follicles will come just I will explain in upcoming classes anyhow. This is, so if you have a coconut oil based cutting fluid what will happen if it is rotated at very high speed even the coconut oil falls not much action will takes place ok.

So, that is about the cutting fluid benefits and what how type of seen. You are also seen one of the example where if you are not going to use the cutting fluid what are the detrimental problems that deteriorate the process and all those things in behave. So, cutting fluids where we have to use, where you should not use and all those thing like discontinuous cutting you should be wisely use the cutting fluids and all those things.

These all about today’s class and we will see what are the additives that we are going to use in the cutting fluid in upcoming next class, ok.

Thank you.