Polymer Assisted Abrasive Finishing Processes

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Lecture - 05
Surface Morphology and Surface Metallurgy

Hello and welcome to the course on Polymer Assisted Abrasive Finishing Processes, where in today we are going to see about batch and mass abrasive finishing processes.

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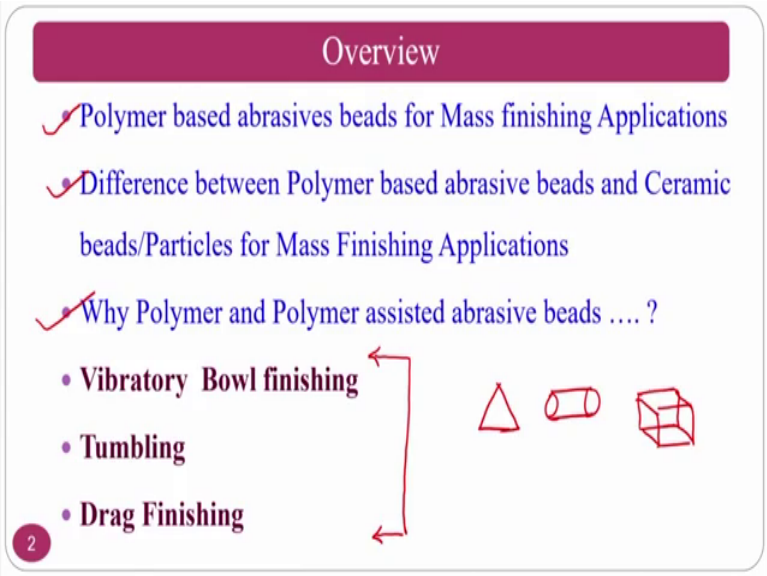

The overview of today's lecture we will go ahead with the polymer based abrasive beads are for the mass finishing applications, how the polymer beads along with abrasive particles can assist the mass as well as batch finishing processes and difference between the polymer based abrasive beads, at the same time ceramic beads and metallic beads for the mass finishing applications, shy polymer beads, what are the advantages of the polymer beads, what are the advantages of polymer ceramic beads and other things, we will see from the point of vibratory bowl finishing, tumbling and drag finishing.

These 3 processes are mass cum batch finishing processes. Here normally, you will use beads like a triangular beads, cylindrical beads and other things. What I mean to say is, if we are going to use the ceramic only then what will happen interacting forces will be very high; if you are going to utilize the metallic still interacting forces will be high, if you are going to use either polymer or polymer plus ceramic in that circumstances the

forces that are interacting between work piece and this polymer assisted abrasive beads will be slightly less. So, you can get a better surface finish, but only thing is that you may require slightly higher time for finishing.

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Basic abrasive based mass finishing processes are batch finishing processes. The first one is vibratory bowl finishing where just you place the abrasive beads along with implants. What will happen? This will rotate and the finishing will takes place, this is a mass finishing, but the basic problem here is that local control may not be there it is overall system will rotate. So, number of parts that are at the central line will be less movement in dynamic movement compared to the parts which are on the periphery of the bowl. So, there will be a slight change in the surface roughness that may be a drawback.

Similar to the tumbling, tumbling will have horizontal as well as vertical full details we will see in the upcoming slides. So; however, here you are seeing is a horizontal variety of a tumbling process. You place abrasive beads as well as components, what will happen? Here also those components that are near to the central line move very less, at the same time those components which are far away from the central axis those will move in a higher way. So, there will be a slight change in the surface roughness of the parts that you are going to get at the central and you are going to get at the corner or far away from the centre.

In order to eradicate or to overcome this drawback, the researchers came up with another process that is called drag finishing process. Drag finishing not only the abrasive particles will have dynamic motion this individually it hold. So, it can be called as a batch production process also and locally also this will rotate. So, that local as well as global effect, at the same time all the components which are there in the drag finishing can have uniform surface because this can be locally controlled. Now how to fabricate this type of beads that are used in batch as well as mass production.

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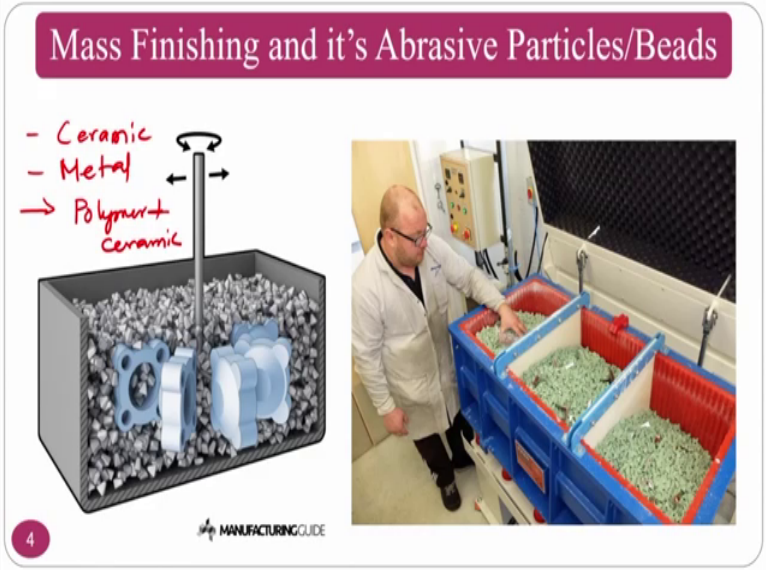

Which type of beads normally people uses? You can see here, this is one variety of beads that can be made up of ceramic, that can be made up of a metal and that can be made up of composites also. In composites, you can have polymer plus ceramic or any other thing also. This can be used for finishing in that is many companies produce many types of abrasive beads and the abrasive beads shapes and other things so, how to use and which type of to use.

If I have a complex features very thin structures in that case it is very difficult to go for ceramic as well as metal because interacting forces will be very high. For that reasons the researchers can go for the polymer based which have much higher strength at the same time composite based, where polymers along with abrasive particles can be blended and you can make it.

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So, you can see here these are the samples that are to be finished, these samples once loaded now these are sent beneath the abrasive particles then given the local motion along with the abrasive interaction what will happen is this will be polished. So, this can be polished using ceramic assume that these are ceramic beads or you can go for metallic also beads and you can go for composite or polymer based also, assume that these are composite wherein you have polymer plus ceramic.

Now whenever you are placing these into the finishing system or a vibratory bowl feeding or drag finishing or tumbling, what will happen? Ceramics will interact this is a hard material ceramic will interact with force F c and metal will interact with force F m and composite or polymer because subscript C is already used for ceramic, we will use F p interacting forces with respect to the work piece in a drag finishing operation for example.

Here what is the normal quality to statement that one can give your F c ceramic force that is interacting of ceramic beads with respect to a particular component assume that the component is a stainless steel component. What will happen? It will be higher compared to the force that is exerted by the metal beads that will be higher than force exerted by the polymer or composite. Now if you see here what will happen, if you want a rough finishing then you can go for ceramic, if you want medium finishing you can go for metal, if you want a fine finishing even though the interacting forces are less.

Whenever you want the nano finish or the sub micro finish what will have your interacting forces should be low; that means, that your composite or the polymers will have good interacting forces from the point of finishing.

So, even though the finishing time maybe slightly high you are getting the surface finish will be much better compared to your ceramics and metals. That is a beauty about polymer composite based ceramic beads or you can go for high strength material or high hardness polymers also as a beads.

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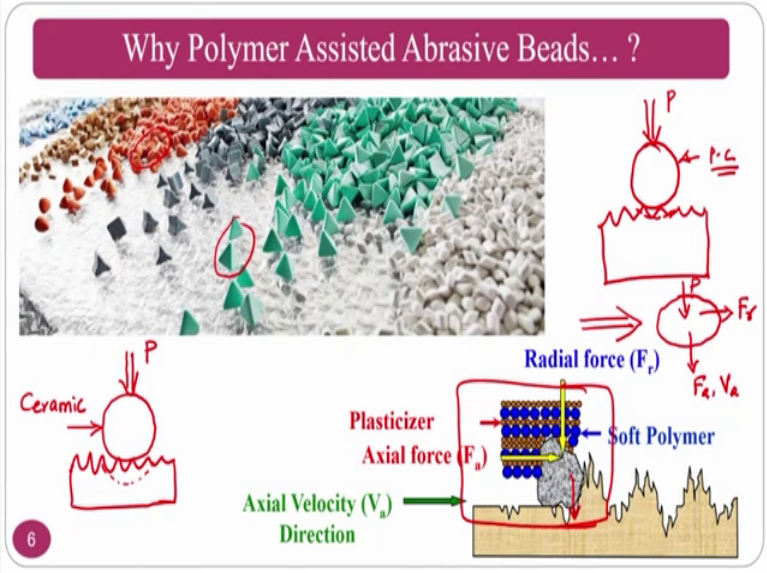

Why polymer assisted abrasive beads only? These are all the polymer assisted beads if you see polymer assisted beads assume that I have one sphere which is interacting with respect to a surface. If I have a sphere this is a ceramic particle, this is ceramic bead assume. Of I am going to put certain pressure P, what will happen? Indentation will be approximately this much; that means, in the high.

If you are going to have the similar surface roughness and same pressure on the polymer ceramic composite bead again we have this one and you are going to put some same pressure only the material is different, this is polymer composite or polymer only. What will happen? Your depth of indentation will be less because your radial motion will be there for your bead; your bead will convert like a ellipse because it has viscous components and elastic component; this is radial force which is a elastic component axial force and axial velocity because of the rotation and other thing.

The same thing mechanism is explained here. You can see the abrasive particle is here, the abrasive particle is getting the support from the polymer chains and a radial force is there. Here the directions are slightly different what I mean to say is that your ceramic particle is a brittle material and it cannot deform about, but you are having a polymer based ceramic, what will happen? Your major constituent will be a polymer.

So, whenever you try to apply a pressure P same pressure, what will happen? It will deform into a ellipse shape. So, the indentation will be reduced that is why for the same pressure the indentation is less that mean that your interacting forces is less. If your interacting forces is less your size of the chip that is removing will be less. So, in a long run you will get a finishing. So, whenever you are looking for a finishing of mass components, you can opt for polymer beads or polymer assisted abrasive beads.

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You can see various varieties of polymer beads and this polymer beads can be prepared by various techniques which are commercialized from the commercial companies developed. So, assume that these are the polymer plus ceramic beads or polymer beads what is the beauty about what I mean said in the previous a slide is, if I have a sphere if I apply certain pressure P, what will happen? If it is a polymer, it will convert like this because of it is elastic nature which is called wise embers effect. Because of this, what will happen? Indentation depth will reduce and the surface finish that you are going to get in long run will be much better. And depend on your requirement and depend on your

component shapes size and other things you can go for big abrasive particles or small abrasive particles or medium abrasive particles and you can play with the composition also. I want 10 percent abrasive particles along with 90 percent polymer or like that you can play with the parameters of making the beads; making beads.

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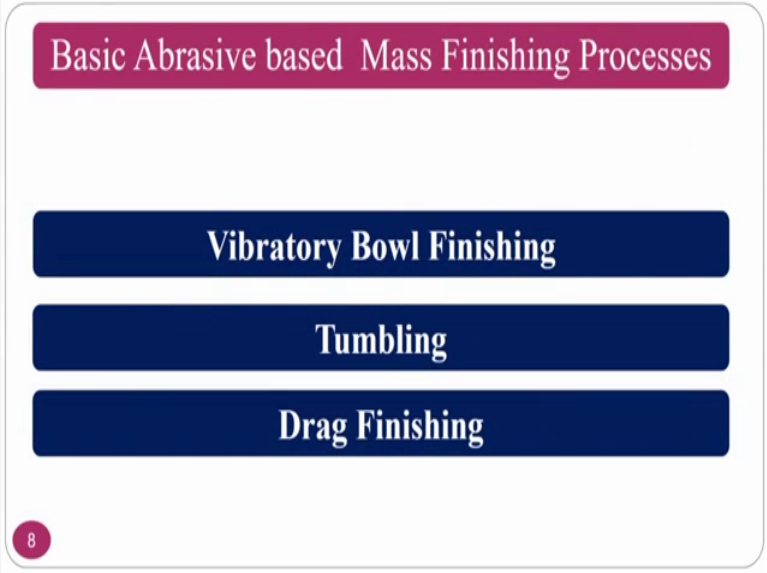

Then once your beads are ready; that means, that this is a major thing for you, now you can utilize these beads for any type of mass or batch finishing processes, such as vibratory bowl finishing process, tumbling process and the drag finishing process. These are the three process which can come under batch process as well as mass finishing process depend on how many implants or how many products that you are going to finish. Once you make this polymer abrasive beads, you can utilize it further ok.

Now, we move on to the vibratory bowl finishing process.

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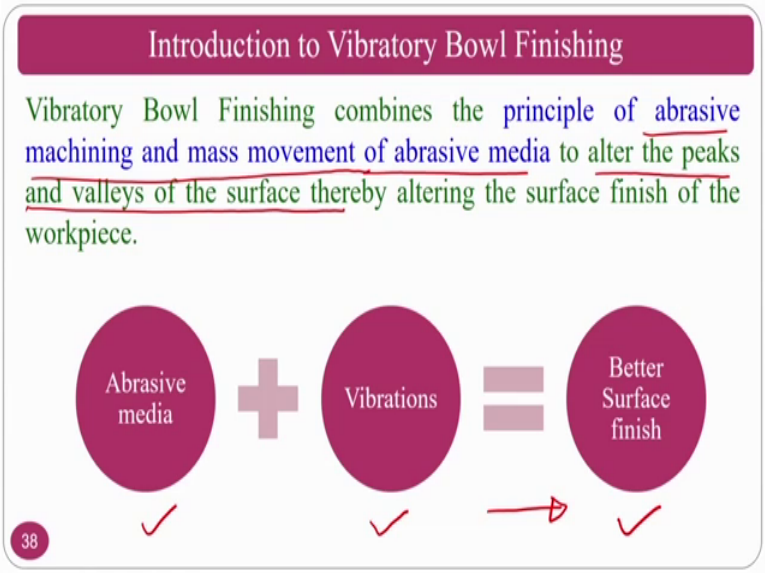

So, in the vibratory bowl finishing, we will combine the abrasive machining as well as the mass moment of abrasive media ok. So, abrasive bowl finishing is a mass finishing process where just you dump some of the parts in a batch I mean to say 50 parts or 30 parts as per your requirements some of the parts you have to dump then you give some motion to the machine then it will do that ok. Here what will happen? Abrasive machining will be taken in a mass spectrum.

This will, how it will work? It will alter the peaks and valleys of the surface thereby altering the surface finish of the work piece ok. So, it will shear the work piece peaks at the same time sometimes it will burnish also. So, there is two options: one can it can shear off the surface peaks at the same time, it can do also the burnishing in if the peaks are very small. So, abrasive medium you will use and vibrations you will use and you get a better surface finish in the vibratory bowl finishing process.

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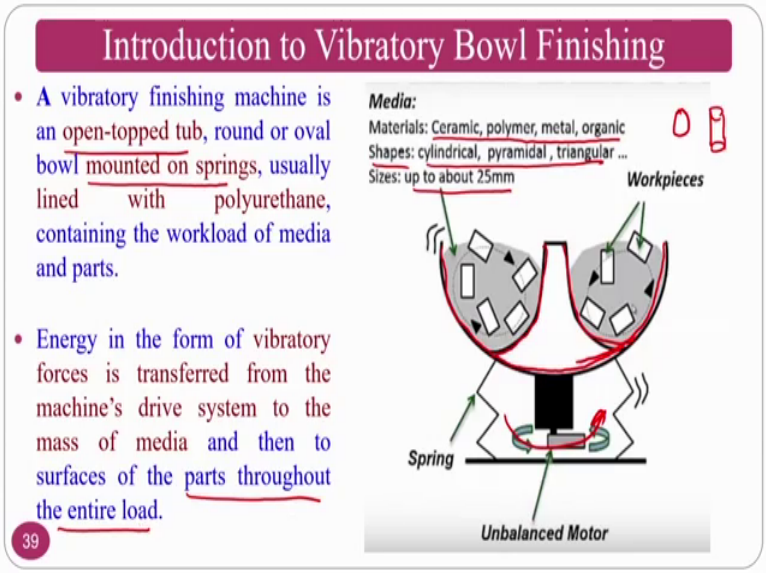

If you see here a vibratory bowl finishing machine is a open tub topped tub round or oval bowl mounted on a springs usually lined with polyurethane containing workload normally this particular coating inside will be polyurethane coating because polyurethane is a soft polymer. So, even though it fill the work pieces are even though the work pieces are (Refer Time: 14:54) then if you have a metallic surface then there will be a chances of dimensions change in a nano level or a micro level ok.

In a media normally materials like ceramic, polymer, metals, organic shapes, shapes like cylindrical, pyramidal, triangular, size up to 25 mm the peak. These are the medium will be used like ceramic particles you can be used or metal particles. We can use of cylindrical shape whose dimensions are up to 25 mm you can use like these things are like, these type of medium you can use; that means, that particulates medium means particles that you are going to use inside a vibratory bowl finishing process.

Energy in the form of vibratory forces is transformed from mission drive system to the mass media. Normally this is the drive system here, the drive system is there. From here the drive system rotates, what will happen? It will be transferred to the media and then through the media, it will transfer to the entire load to the work pieces and this abrasive particles continuously indent or continuously try to shear with respect to your vibrations.

Now, you are giving the vibrational speed to the bowl, this will be carried by the abrasive particles. The abrasive particles gains the energy and it will try to hit the work pieces and try to shear the surface peaks of the work pieces to get the better surface finish.

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So, this is how the vibratory bowl finishing process setup looks like. So, these are the components some of the components are placed and these are the abrasive particles, abrasive particles and these are the work pieces ok, vibratory motion is induced to a by an eccentric weight system mounted on the drive mechanism.

Normally in the you will see all these things in the upcoming slide, next slide and the other slide; this vibration motion is induced by a eccentric weight system. Normally there will be a weight system below this one here normally in a you will have at the bottom there eccentric weight system will be there on top of it vibratory motion will be given. Adjusting the degree of eccentricity; that means, that amplitude and drive speed that is how much speed or frequency, we you can shake the bowl which is their vibratory bowl and you can transfer this particular vibrations to the particles then to the parts.

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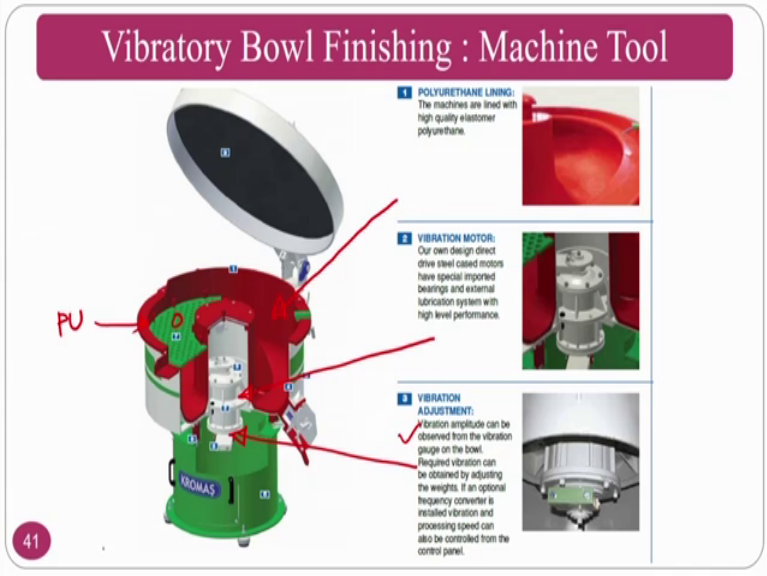

If you see in this one machine tool so, this is what the polyurethane, here is polyurethane is there, the second part is here and the third part is slightly below this one ok. So, the polyurethane lining this is normally lined with the high quality elastomer polyurethane because if I have a particles this work pieces should not get hurt by the metal or a ceramic. If you coat this red liner this PU, if you coat with respect to metal or something what will happen it will damage the components because the interaction forces will be very high whenever you are rotating at very high speeds.

So, normally vibrational motor this will be slightly on the eccentricity this have a drive that is caused by the motors on a specially imported bearings and external lubrication system with high level performance, normally vibration motor will give the rotary vibrational motion at the same time vibration adjuster. This vibration adjuster will be used for vibration amplitude changings, if you want to change the vibrations or load and other things you can go for this adjusting or the vibration adjustment system.

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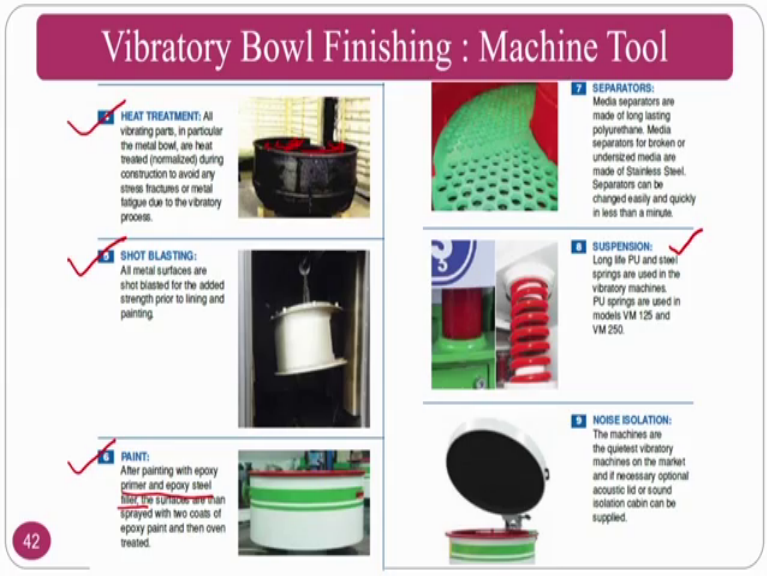

In the other machine parts, normally the bowl before coating inside you will have a heat treatment metallic component on top of it you will have a polyurethane coating. This is a rare area is a polyurethane coating will be done on inside and the shot blasting also will be done on this one because all metal surfaces are shot blasted for added strength.

Normally if at all heat treatment this is not only sufficient then you have to do the sand blasting or some other blasting. So, that it will gain more strength at the same time you have to go for the proper painting for the epoxy primer and epoxy steel filler and other things. So, that it will get some soft touch for the components that are moving or hitting the surfaces, on top of it you will go for many other coatings and other things.

This is a separators, normally separators are normally used to separate out the particles, this media separators are made up of long lasting polyurethane media separator broken undersized media and made stainless steel separators can be changed easily. What I mean to say is that, if at all you want to keep the particles down in that case you can activate this separator. So, that the particles will go down and the work pieces will stay on top of it so, that it will be easy to segregate.

At the same time suspension system is required because you are always play with the vibrations other things and you require the size suspension system and noise isolation you should go for a noise isolation like very closed system. So, you can do the closing so, that the noise is one of the major drawback of this particular vibratory bowl finishing

process. So, that if you can close it. So, the noise which is doing because of the vibrating particles or the moving particles will generate lot of noise that can be minimized by closing the system.

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So, the operations if you see these are the normally all the component that are finished using vibratory bowl finishing process. So, the commonly it will be used for cleaning applications of this particular components, de flashing of this particular components and conditioning of the casting and moldings because the molds are to be treated at the fine at these surfaces are very critical surfaces. So, if you put inside the vibratory bowl finishing process. So, the abrasive particles will goes to each and new corner of this complex molds and that can create a good surface on top of it.

Descaling can be done if there is any scaling problems are there you can do the de scaling operations and removal of rust and brazing residues can be done the and burr removal if you have any burrs after machining operation like drilling or milling. These type of things if you have any burrs now you can remove this particular things. And generation of radii material removal and size reduction if at all I want to generate some a radius; that means that sharp edges are there use it to be very difficult to handle it if you have a sharp edge component it may damage my fingers and other things. So, for that purpose you can go for generating radius so, that the component will be easy to handle.

Surface finish; obviously, this particular process will be normally used for mass finishing; that means, that surface finishing of many components or many varieties of component in a one go you can do and normally this can be done for batch production. And improvement of burnishing preparation; that means that if at all I want to do some burnishing operation. So, you can do the pre burnishing operation using by the vibratory bowl finishing so, that the burning operation will be very easy whenever you want to do in a liter case. And polishing of plated parts and silverware you can use, at the same time developing of lubricative surfaces like honing if you see the lubricating surface cross such patterns are generated here also you can generate this type of surfaces.

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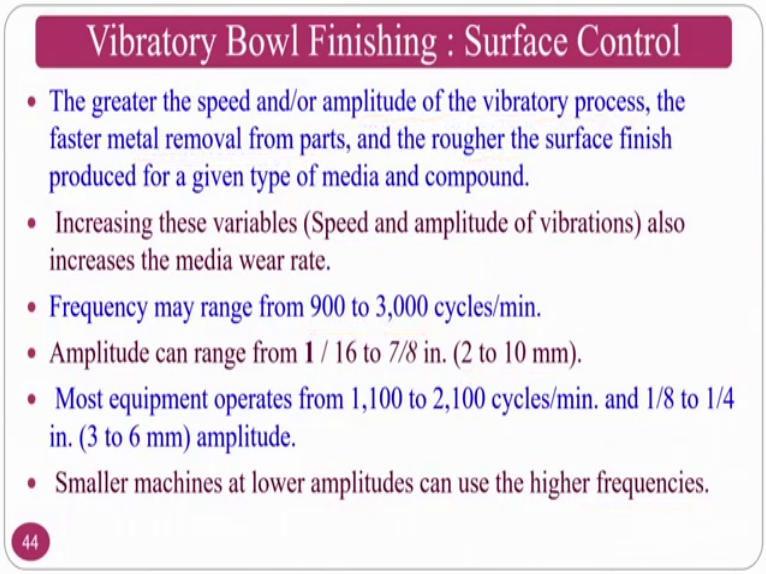

Vibratory bowl finishing surface control if at all I want to control the surface, the greater the speed or the amplitude of the vibration process in this circumstances the material removal will be very fast and the surface roughness that you are going to get is very rough surface ok. So, if at all I want to remove the material or delaminate material then you have to go for higher speeds and higher amplitudes of vibrations if at all then the problem is that you will you are end up with a rough surface finish. It will increase the variables increasing the variables like speed and amplitude of a vibration also increases the media wear rate; that means, that the particles that you are using this one also break ok.

Frequency may range from 900 to 3000 cycles per minute, the amplitude can be range from 2 to 10 mm vibration amplitude and the most equipment operates from 1100 to 2100 cycles per minute at the same time 3 to 6 mm in vibrational amplitude normally. The smaller machines at lower amplitude can cause the higher frequencies. So, if at all people want to go for higher frequency with lower amplitude you can even purchase a small equipments, small equipments I mean small vibratory bowl finishing processes.

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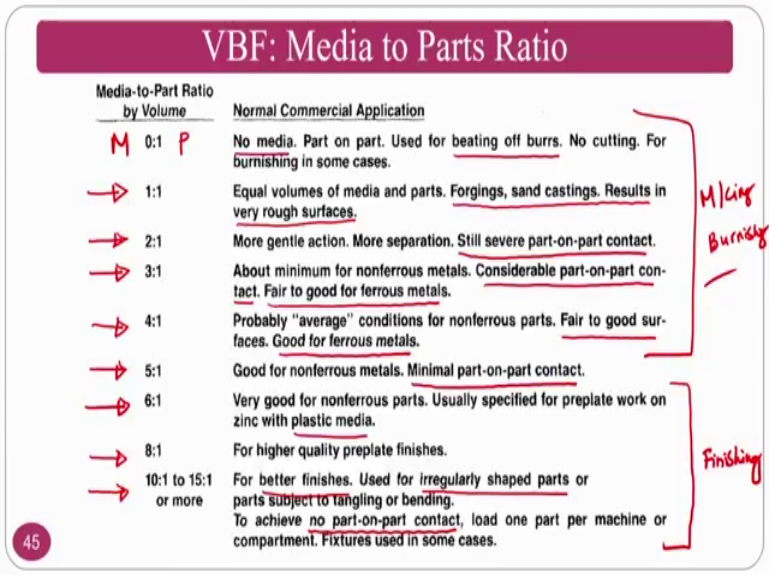

Media to parts ratio, if you see there are verities of parts so; that means that medium to parts. So, if it is 0 is to 1; that means that only parts are there. So, there is no media in that circumstance part to part touch will be there and used for beating of the burrs and no cutting action will takes place and burnishing will takes place. If at all I want to get a burnishing operation on top of a work piece, then you have to go for 0 is to 1. If at all I want to go for 1 is to 1; that means, that 50 percent of abrasive particle and 50 percent of the work piece materials or work piece components, equal volumes of media parts and sand casting results in very rough surfaces. So, in these circumstances the abrasive particles will generate the very rough surfaces.

If you go for 2 is to 1; that means, that 2 times of the abrasive particles with compared to the work pieces it will gives the still severe part on part contact will be there. So, it is also not preferable whenever you go for 3 is to 1 then it will considerable part to part contact still will be there and fair to good for the metallic surfaces like ferrous material

iron based metals will be very good. 4 is to 1 you can go for good for ferrous surfaces and normally what you are going to get is fair to good surface you are going to achieve.

5 is to 1 if at all you want to go for this one minimal part to part contact; that means, that abrasive particles will dominate here. So, you will get a good surface in terms of a nonferrous matals also. 6 is to 1 you will get a good for the non surface non ferrous part parts at the same time you can go for the plastic media also. So, that mean that if you are particles volume is very high you can go for the plastic media so, that you will get a better surface finish.

And 8 is to 1 at the same time above 8 is to 1 like 10 is to 1 to 15 is to 1 you will get a better surface finishes and irregular shapes parts also will be used and you can achieve there is very good finishes and you can ensure that there is no part to part contact and load on one part machine component and will be very less. That means, that if at all you want to go for finishing applications, then you have to go for this region and if at all you want to go for machining or burnishing you can go for this particular regions.

So; that means, that you have to always decide what you have to do or what you want to do assume that I want to do the machining only or delaminating only on surfaces or something then you have to go for 1 is to 5 or 5 is to 1, 5 percent of 5 times of abrasive particles to 1 times of work pieces. And if at all I want to go for finishing then you have to go for 8 is to 1 or 10 is to 1 or 15 is to 1 or in the range of 10 is to 1 to 15 is to 1 you can go, then even you can go for plastic type of medias and you can get very good surface finishes.

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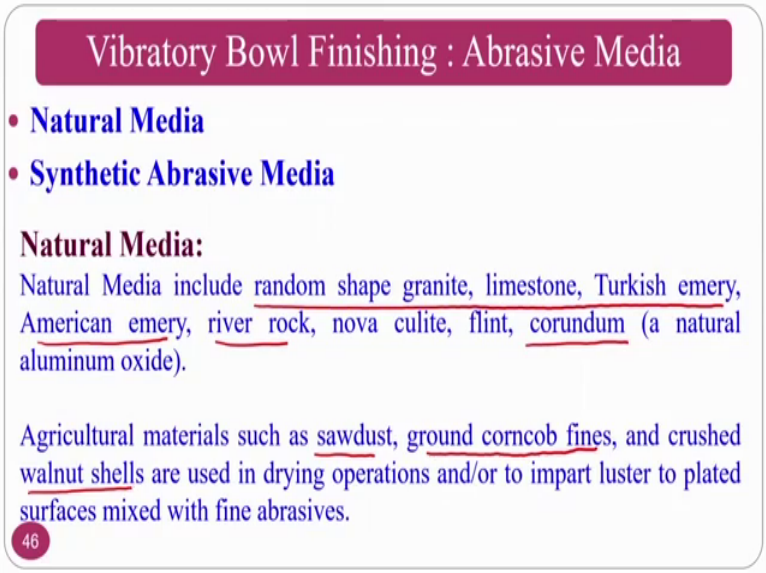

So, the abrasive media normally there are 2 types of abrasive media. One is a natural media; another one is synthetic abrasive media. In the natural media it include random shapes of granite limestone Turkish emery and American emery, these are the river rocks, nova flint, corundum these are the natural aluminum oxide. These are the things that are available in the nature you can go for economic price or you can get from the nature also.

Agriculture materials such as sawdust, ground corncob fines and crushed walnut shells are also used for this particular purposes so, these are all economic. So, the walnuts or these types of nuts whenever you eat the walnuts the shells are waste for you. So, you can go for developing the abrasive particles these are very brittle also. So, you can go for ball milling of this walnut shells or you can crush it and you can use it for some of the applications like texturing on or removing the burrs or texturing on very soft materials and other things you can go for this one.

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In synthetic abrasive media so, what we have to see is fused and sintered aluminum oxide medium that are nuggets are manufactured with the grade for the cutting and the grade for the brightening application if at all people want to get the surface finish and good appearance also for that purpose you can go for sintered alumina and other abrasive particles. The media have greater abrading capabilities than natural stone; that means, that silicone other granite whatever the particles are there their hardness is very less compare to your aluminum oxide for that purposes the capability of this alumina oxide is much better compare to your granite, walnut flakes and other things.

The dense, nonporous, rounded, random shaped pieces have a crystal texture at the surface that combines the cutting ability with the burnishing quality and hard forms of media can produce smooth finishes below 2 micron so; that means that you can use this particular process for pre finishing applications for advanced finishing applications also ok.

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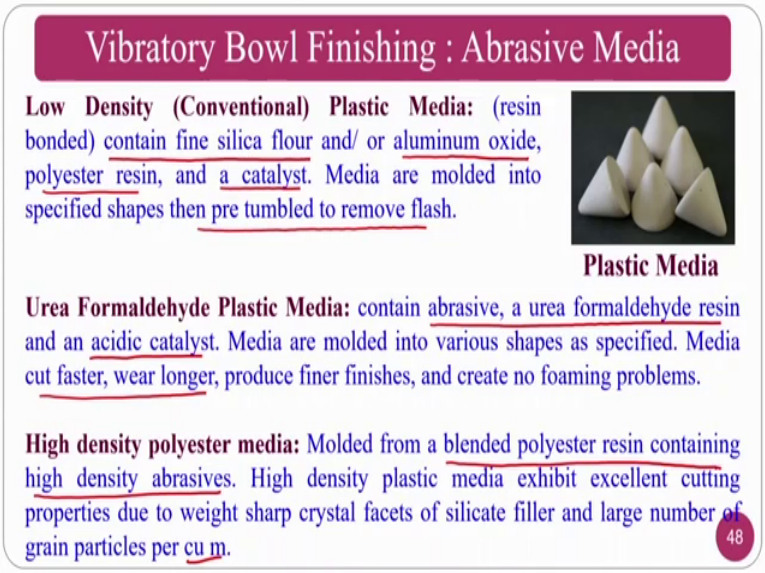

So, the abrasive medium if you see the plastic media also can be used here as I said normally if at all you are going for above 10 is to 1 to 15 is to 1, you can go for this type of plastic media.

So, low density plastic media normally resin bonded where contain a fine silica flour or aluminum oxide, polyester resin, and catalyst, because you always required some catalyst to do have the functionalization to have a proper bonding between your abrasive particle at the same time resins ok. Resin is a different chemical composition abrasive particle is a different elemental composition to get good adhesion between these two you need to always go for some catalyst. Media are molded into specified shape, then are pre tumbled to the flash ok.

Urea formaldehyde plastic media this contain abrasives, a urea formaldehyde resin and acidic catalyst. So, this will contain abrasives and urea formaldehyde and acidic catalyst media these are all molded to various shapes and specified. So, that you can get cutting the faster wear longer and produce fine finishes and create the foaming problems ok. So, if at all you want to do this things what will have to do, you have to take the abrasive particles and urea formaldehyde then acid catalyst you just mix it and you mold it to a particular shapes and your shape should be such a way that it will do cutting faster and should not wear earlier ok, these are the 2 major causes by which shape you want to fabricate.

The high density polyester media see it is molded from the blended polyester resin containing high density abrasives, high density plastic media exhibit excellent cutting properties due to weight sharp crystal and silicate filler and large number of grain particles per unit area will be there ok. In that circumstances what will happen you will have high density of abrasive particles and high density polymers are blended along with a catalyst and you will we have the material removal will be very fast in these circumstances, because your particles are very high at same time your polymer is also very high strength polymers.

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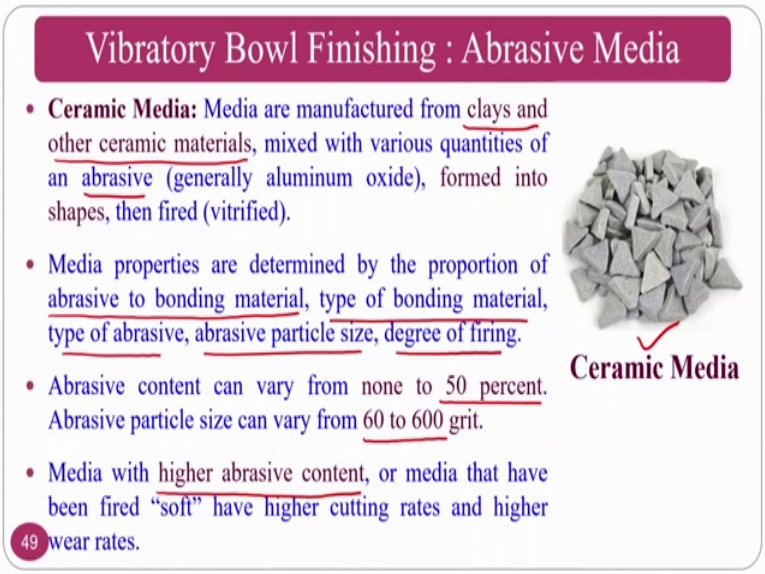

So, in the abrasive medium if you see the ceramic medium, ceramic medium media is manufactured from clay as well as other ceramic materials which are mixed various quantities that is abrasive particles are mixed with the this clay. Basically if you see the grinding wheel specifications vitrified bonding will be made up of clay. So, similar things you can do here also. So, you take abrasive particles you make the raw material clay and you mix it and you mould it as per the different shapes that if you see here triangular shapes are given here and this type of things you can do instead of a big grinding wheel you can make a small particles and you can do the.

Here the surface area is very high. So, the wear rate will be very low the media properties are determined by the proportion of abrasive to the bonding material normally if abrasives percentage is more what we have seen is a dense structure. So, if the

structure is dense for these particular particles so, you are going to get higher material removal. If the dense is structure is open structure; that means, that number of abrasive particles are less than the material removal rate will be very less.

The type of bonding material and type of abrasive and abrasive particle size and degree of firing ok. So, this also play a major role in terms of material removal the bonding material. If the bonding material is very good bonding; that means, that bonding is proper. So, material removal rate will be very high type of abrasives; that means, that whether I want to go for alumina, whether I want to go for diamond, whether I want to go to silicon carbide, whether I want to go to boron carbide, these type of abrasive particles also will decide because the work piece has certain hardness and your abrasive particles will have certain hardness. So, hardness ratio plays a major role if the hardness difference is very high; that means that the hardness ratio is very high so, the material removal rate will be very high.

Abrasive particle size, if the abrasive particle size is 10 microns in one case, in other case the abrasive particle size is 100 microns. So, 100 microns cutting edges are very very big. So, material removal rate; obviously, increases the indentation will be increases at the same time degree of firing if the firing of this particular particles during manufacture of these particular beads triangular beads is very high the strength of this particular particles will vary and according to that the material removal also will vary. The abrasive content can vary from 50 percent, abrasive particles can vary from 60 to 600 grid size; that means, abrasive particle size media with higher abrasive content or media having been fired for soft will have the higher cutting edges and wear rates will be very high.

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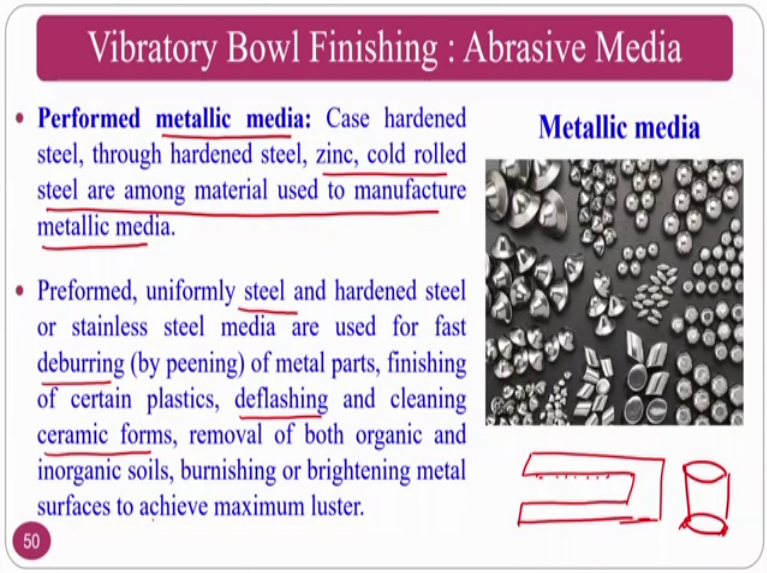

A medium normally now we are moving to metallic media, we have seen the polymer media, natural media, synthetic media, among the synthetic media we have seen the polymers synthetic medium, then the ceramic synthetic medium, then we are coming to the metallic medium. These are performed for metallic media in case of hardened steel through hardened steel, zinc, cold rolled steel are among the materials used for manufacturing a metallic media. That means, that hardened steel is commonly used for this metallic medium performed uniformly and the steel, hardened steel, stainless steel media are used for deburring applications.

As I said if we have a structure assume that I want to make a this hole or this type of channel in a surface ok. So, if you have a buds here. So, these are the buds what will happen, if I want to remove all these things you have to use this type of particles assume that whenever you do the drilling operation from one side to another side what will happen you will have a buds on this. So, unremoved chips will be there. These are nothing, but the buds. So, you can use for the deburring operation metallic parts of certain plastics deflashing also you can apply and cleaning of ceramic forms removal of both organic and inorganic soils burnishing or the brightening of metal.

That means that sometimes these all particles if you see here these are all the particles are I mean to say this metallic particles are very shining. So, this will have good surface roughness, whenever this goes and hits, what will happen? Burnishing will takes place or

the deburring will takes place and the surface also will glow means that brightness of the surface will increase and it will increase the good quality of the product it looks aesthetically very good.

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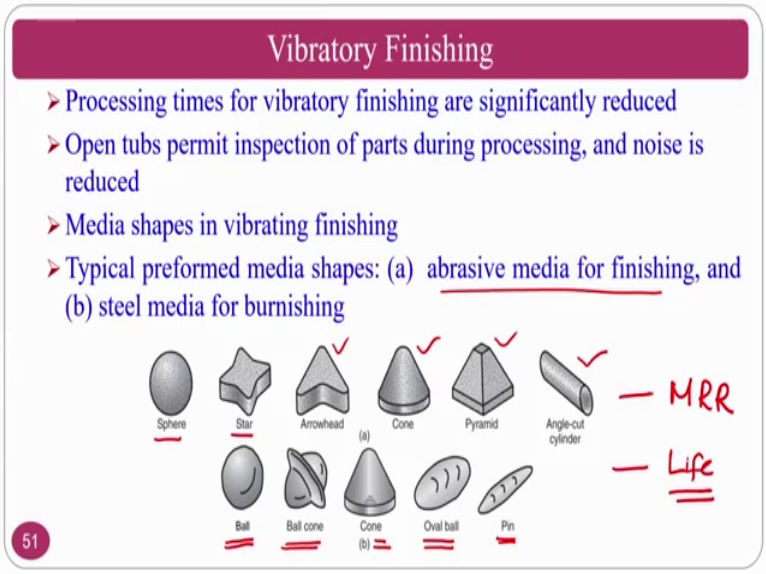

Vibratory finishing process, this process times for the vibratory finishing are significantly reduced and open tubs permit the inspection of the parts during the process the advantages of this process is that it is a open tub. So, that you can see from the top if you are closing also you can have a transparent one like perspects one or something so, that you can have a visual inspection. And media shapes in the vibratory finishing or typically performed shapes are abrasive media for finishing, at the same time steel media for burnishing as I said the steel media will be used for the burnishing operations so, that the surface will be hit. So, that the peaks will deform and burnishing action will take place.

And these are the shapes so, it is sphere shapes, star type of shape and arrow type of shape, the cone, pyramid, angle cut cylinder, then you have a ball, ball cone, both are combined another cone is there oval ball will be there and the pins these are the different shapes that you are going to use. And you have to think 2 aspects whenever you want to design this particular shapes, one material removal how much material removal if I go for particular shape and second thing is life of this particular shape or particular grinding particle ok. Or if at all you want to use this particular thing what will be the life can it

come, for 1000 parts can it come, for 1 million parts can it come, for 10 million parts and at the same time can it remove in half an hour, can it remove in 1 hour like that.

You have to think in these 2 aspects whenever you want to decide the shape of these vibratory finishing abrasive particles.

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Abrasive media selection, if you see if at all I want to go for the deburring operation. So, light deburring then steel or ceramic can be referred and the medium to heavy if I want then ceramic or plastic can be referred. So, the rediusing applications assume that rediusing application if I have the sharp. So, I want to reduce this to like this. So, in that case like this I want to reduce for the rediusing applications light to heavy you can go for ceramic or plastic those.

So, surface improvement the reducing the surface roughness producing the quality surface, then you have to go for plastic or ceramic or plastic and ceramic also you can go. Surface reflectivity; that means, that if at all I want to reflect the surface that mean that shiny surface if I want to generate for that purpose steel or ceramic you can go for the brightened or highlightened for the best quality and other things you can go for ceramic type.

The clean surfaces if at all I want to go for the all the metals then I can go for the steel or ceramics or random shaped aluminum oxide also you can go for the irregular surfaces ok. This type of thing one has to select the abrasive medium.

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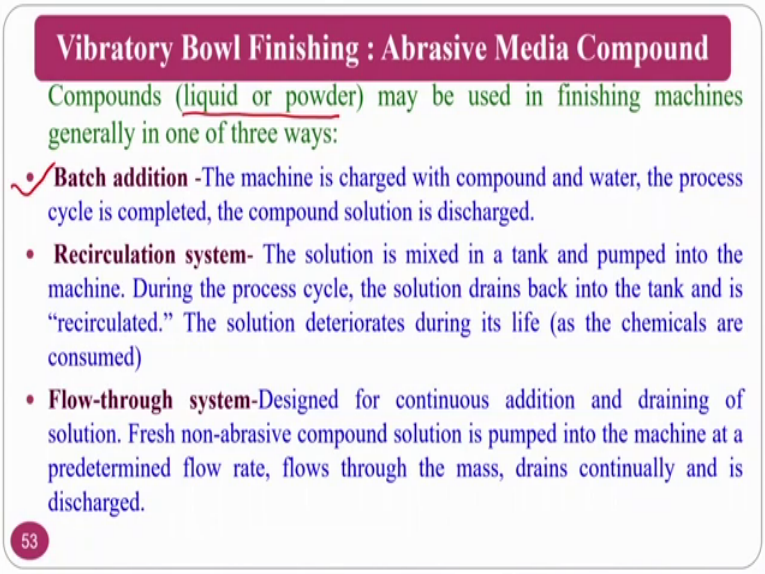

So, abrasive media compound, the compounds are normally liquids or powders that are used may be used in the finishing machine generally one or three ways. So, batch addition. So, compounds will be added the machine is changed with the compound and water in the process cycle is completed the compound solution is discharged. Normally what will happen, if the machine is charged with the compound that and water so, in these circumstances if you once the process is completed then it will be discharged.

If you see the recirculation system and the solution is mixed in the tank and pumped into the machine during this process cycle the solution drain backs in the tank and is recirculated this solution deteriorates the during the life ok.

So, at the same time flow - through the system, designed for continuous addition and training of the solution. Fresh non abrasive compound solution is pumped into the machine at the predetermined flow rate this flow mass drains continuously and discharge; that means, that what I mean to say is that abrasive media compound this whatever this particular slide is there you have to continuously give this compound. So, that if there is a abrasive chips are there to be drained at the same time if at all, I want to

give some lubrication to the parts while doing the finishing operation you can go for 3 methods, one is a batch addition compound or along with the liquid you can add.

Assume that I have a mineral oil along with the water if I want to add you can add now after one hour or something that is called batch and recirculation system you can use continuously you will throw or continuously you will pump this liquid and continuously you re circulate it by using the filter system. At the same time flow through the system that is the continuously you add and you dispense it or this type of compounds ok.

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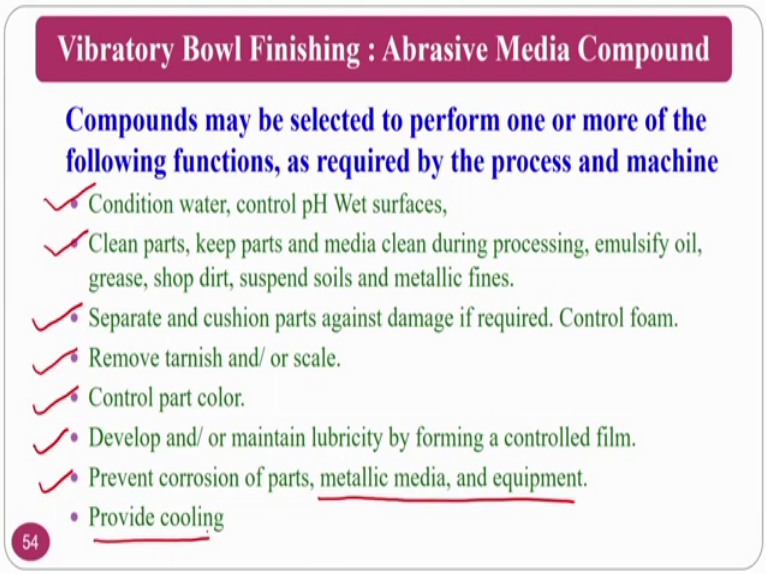

Compounds may be selected of to perform some of the functions like a condition water and pH of the Wet surfaces.

Normally whenever you want to do the finishing of this bio implants and other things you have to control the pH on the surface for that purpose you have to use the compound. And the cleaning the parts and keep the parts continuously cleaning because the if at all some surfaces are sheared or burnished then you have to do the cleaning operation. Assume that the peak d form into the valley, then it will be create lot of problem whenever you go and used for the application certain applications and other things.

Separate that and cushioning parts against the damage if required and the control foam, normally what I mean to say is it cushioning the parts against sometimes you know parts

and parts are hitting inside because it is a random process which is a mass process or a batch process. So, if at all I am pumping this type of liquid or the compound what will happen, there will be always there will be a cushioning between the components.

Remove the tarnish or the scales: if there is any scale formation is there because of the abrasive or because of the part to part contact or something then you can remove this one and the part control color. So, the color of this thing also you can improve suppose if at all I want to put certain colors. So, you can add along with this compounds so, that assume that I want to add a green color just to add the green color along with this compounds.

So, that the particles also will become (Refer Time: 46.03) and same level components also may be become some green color, developed the maintained lubricity by forming at the same prevent the corrosion parts metallic media and equipment and provide the cooling. Normally the most important thing that you can do is there will be a temperature generation depend on amplitude that you are giving, depend on the velocity that at which you are rotating there will be a lot of temperature, generation, possibility is there for that you can pull it. That is why water plus, lubricant plus, some of the other things all rheological additives will be added for this particular thing so, that you can overcome some of the problems that are in the vibratory bowl feeding finishing process.

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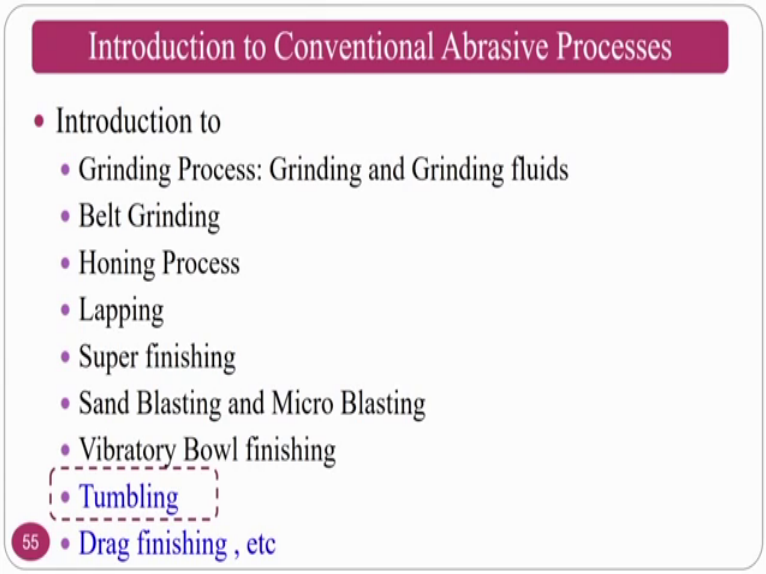

So, next one we are going to see is a tumbling process.

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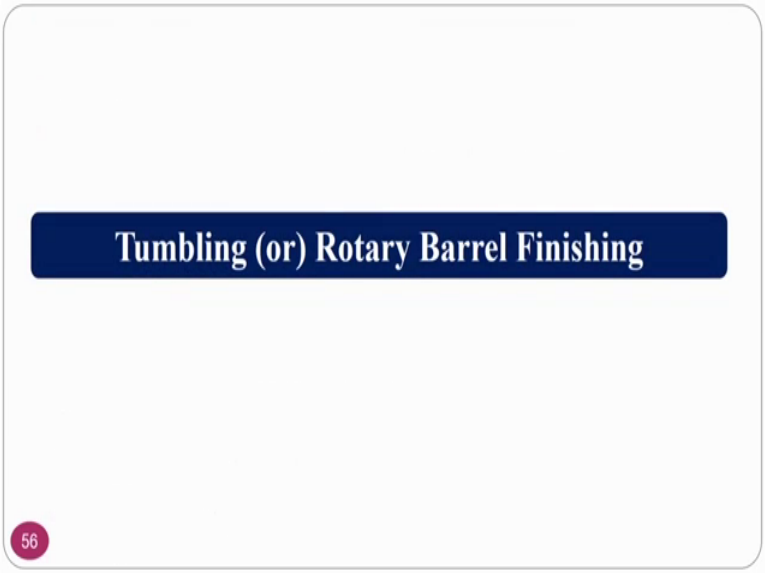

If you see the tumbling the other name for tumbling process is rotary barrel finishing process.

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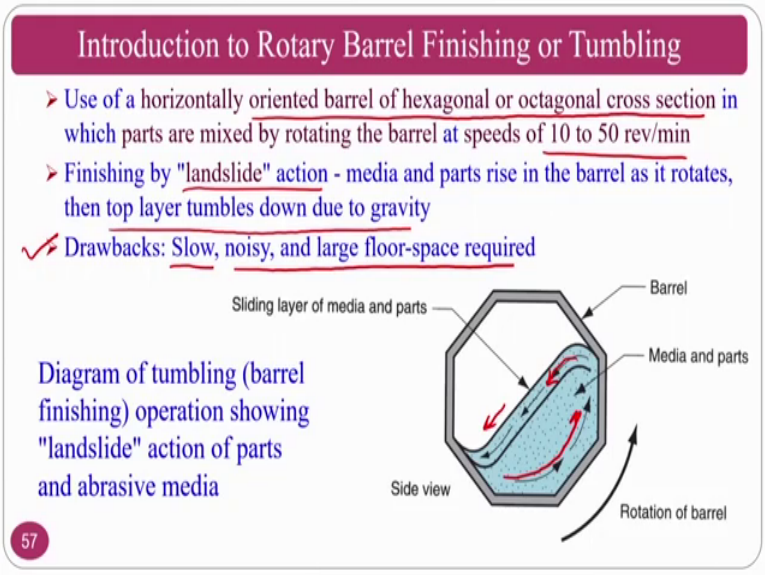

In the introduction to the rotary barrel finishing process or tumbling process it is uses the horizontal oriented barrel of hexagonal or octagonal cross section, which parts are mixed to rotate the barrel this speeds normally 10 to 50 revolutions per minute, normally this finishing will be done by landslide action. In the previous one, what will happen? Vibratory bowl feeder will be there and it will be rotated like this. In this one you will

have a landsliding media and parts are rise in the barrel and rotates top layer tumbles down due to the gravity normally you can see here landsliding type. So, this type of things it is moving.

Once it reaches to here the barrel, what will happen? It is moves this looks like a landslide, these are medium parts and others are mixed here you have abrasive particles like vibratory bowl finishing process if you add here and you will rotate the bowl ok, whenever you rotate the bowl what will happen which are the at the top level it will slight to the bottom so, the it will action is like look like a landslide. And the drawbacks of this particular process is that it is very slow noisy and large floor area space is required basically it will create lot of noise in the manufacturing area. So, you can have a room separately where noise proof and other things you can do from the outside and you just run this multiple machines and just you can control from outside.

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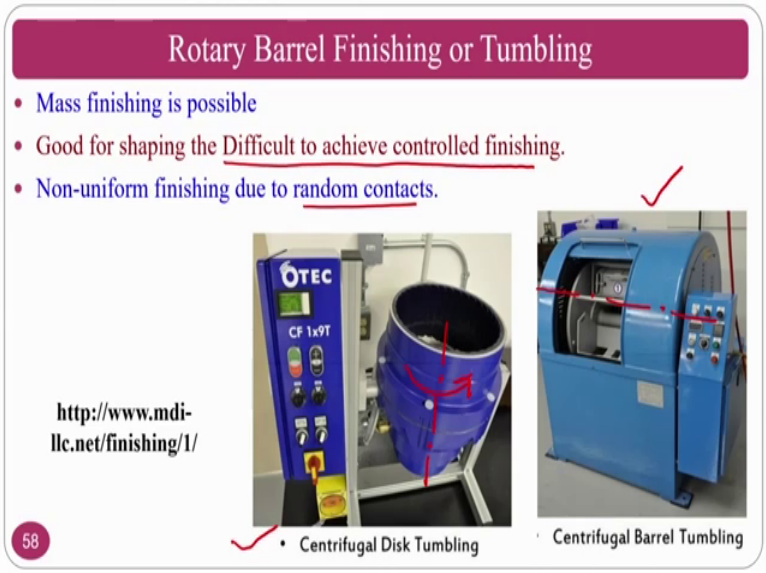

So, rotary barrel finishing you will have normally for the mass finishing applications, at the same time good for shaping to difficult to achieve controlled finishing processes. At the same time non uniform finishing due to random contacts because your abrasive particles will have a random touch or randomly impinge on the components that is why you will get random surfaces. The first variety of this one is centrifugal disk tumbling process where it is a vertical axis; this is a vertical axis about which it will rotate. So, that all parts and abrasive particles will be rotated the other version is you will have a

horizontal type ok. One is vertical type wherein it rotate about vertical axis another one is horizontal. So, some of the components are very good for the vertical some of the components are used for this horizontal, normally landsliding and other things will be common for the horizontal that is centrifugal barrel tumbling process, landsliding is common. So, in centrifugal barrel tumbling as I said the access is horizontal.

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So, drag finishing in the drag finishing before going to that you should know, what is the drawback of the process that you have seen in the previous class.

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So, in the previous slides if you see there tumbling process ok. In the tumbling process the basic drawback is there are 2 varieties of tumbling processes are there these 2 have certain problems. So, before going to it we will see what is the problem. If you see the axis of this one this is the axis. So, vertical axis it will rotate about a horizontal axis you have seen in the horizontal axis there is a land sliding mechanism whenever you just put the parts as well as abrasive particles inside whenever you rotate about it is original horizontal axis, what will happen? The finishing action will take place by the landsliding action ok. So, in the vertical also the similarly what will happen, if you rotate in a vertical axis so, the abrasive particles and implants or the components which are there will rotate and the shearing of the peaks will takes place and there is a chance of burnishing also.

The abrasive particles will continuously hit or shear there is 2 mechanisms one can shear another can the burnished that mean that it will deform the surface peaks, but if you see the basic drawback of this particular process if you see in the vertical one I will explain you in the vertical process. So, the abrasive part particles assume that my implant one implant is here about this is a what is the axis, another implant is assume that it is here.

So, in this circumstances the abrasive particles assume that it is uniformly distributed. So, the distance object 1 and object 2 covers will be this is radius whatever it cover, this will be the radius whatever it cover, that mean that number of abrasive particles cover by the component 1 that is assume that this is C 1 and the C 2. So, component 1 will be very high compare to component 2; that means, that the finishing action taken on the component 1 will be better compared to the component 2, in that circumstances how to overcome this tumbling process.

In this process if at all I want to modify it then what one can do is you can go for the mechanism wherein you can have local rotations or local component holders. So, that you can do the finishing process uniformly on this components so, that process is nothing but the drag finishing process.

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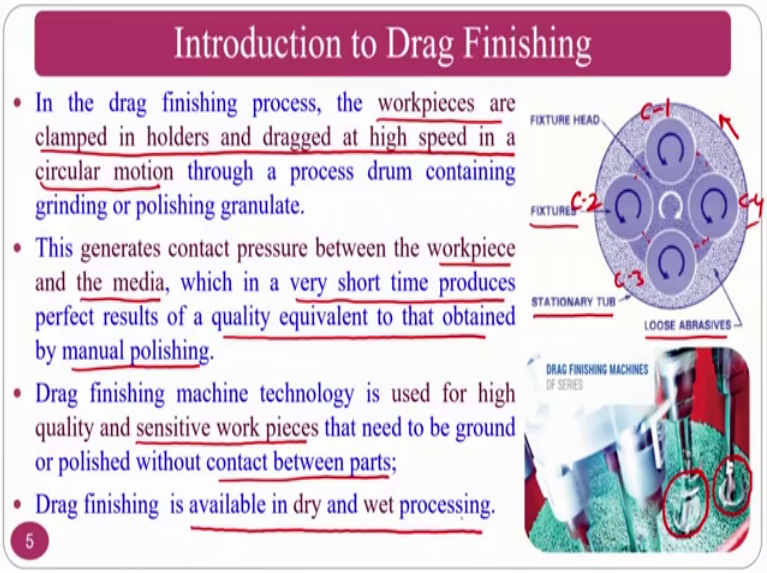

If you see the drag finishing process you are holding the implant or you are holding the component assume that my component is here and at the same time my component is here and this components also assume that my component is held like this assume that implant or the this one this will be also rotated at the same time the bowl is also rotated. So, abrasive particles will have relative motion between these 2 and approximately you will get a good surface finish compared to tumbling process that because you are controlling locally. In a tumbling process what is happening it is a global process so, you are placing at once the components and you are putting the abrasive particles then you are rotating it.

So, the particles are the components which are there at the centre will have slightly less dynamic compared to the compound which are there and the periphery of the tumbler ok. In that circumstances to overcome this one instead of global we have converted into the local one so, that you can do a better surface finishing operation on this one.

Assume that if you see here stationary tub is there loose abrasive particles are there and fixtures which you are holding the component and fixture heads is there on the top, if you are rotating all if you see all are at the same pitch circle all the components are located at the pitch circle. So, all are rotated by keeping the abrasive particles stationary or you can also give the abrasive particles also motion by giving your stationary tub you can also give the rotary motion to the stationary tub also, but in this particular slide

whatever you all seeing is your tub is stationary and your components are rotating. So, this will give you better surface finish compared to your tumbling process, that is the advantage of this particular process compare to your tumbling process.

The drag finishing process the work pieces are clamped to the holders and drag at high speed in a circular motion through which process drum containing a grinding and polishing granules ok. That means, that abrasive particles are there in a tub wherein you have placed a holder or a fixture of abrasive fixture of the component and you are rotating it rotating it uniformly all the things so, that you will get a uniform surface finish. If you are going to rotate the tub also in this case if the stationary tub is also rotated then also there will be a chance of non uniformness until unless if you do not maintain this pitch circle ok. So, you should if you can if you want uniform surface you can go for a stationary and rotate the components.

This generate contact pressure between work piece and the media; that means, that abrasive media in which in a very short time procedures perfectly results in the quality equivalent that are obtained in the manual polishing process. These are all automatically polish things ok. So, if at all you want to polish this whatever you are seeing here, these are the knee implants that are fabricated by ASS 316 cell or titanium or some other materials normally if at all you want to do you can go for manual polishing also hand polishing or something for that, you in order to avoid this what will happen you can go for automatic machines.

In a polishing hand polishing, what will happen? If you are happy today, you do the proper; if the operator is not happy tomorrow, what will happen? So, the emotions also play a major role on the polishing action, I am not saying the always or something then there will be a change in the nano level ok. In micro level it may not have that much difference, but if the operator is not happy or if the pad is not proper or if the fluid is not proper or something many conditions will come there may be a human errors will come into picture so, to avoid human errors automatic systems will give the better surfaces.

The drag finishing machine technology used for high quality and sensitive work pieces like sensitive work pieces like knee implant and other things and which all which need to be ground or polished without any contact between the parts this advantage here is your parts are fixed ok. So, your components are if you see here component 1, component 2,

component 3, component 4 these are all fixed. So, there would not be any contact between the components among the components there would not be any hitting or any damaging and all those things in the tumbling process what will happen all are placed so, there will be heavy chance that the components will collide each other. This is also one of the drawback of the tumbling process that you can overcome in the drag finishing process. The drag finishing process is available in dry and wet processing; that means that you can do this particular process using a dry type of abrasives or wet type of abrasives also.

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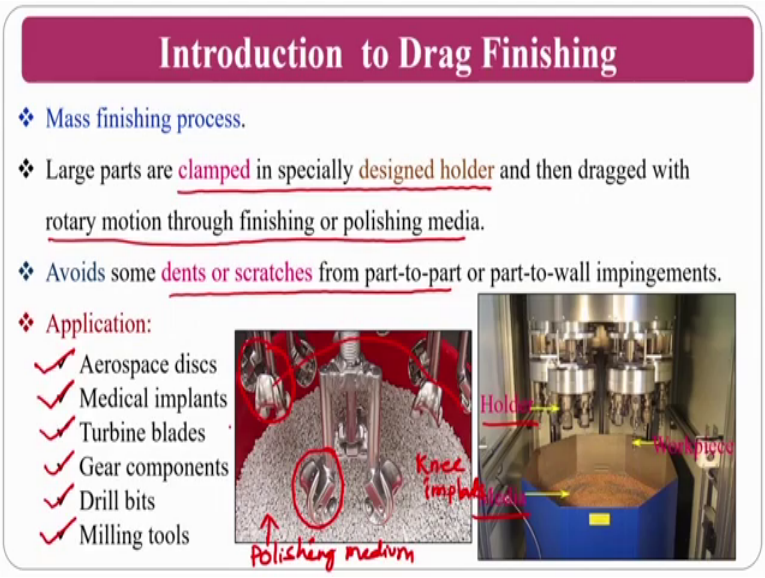

So, this is the if you see this is the mass finishing process such as tumbling process and if you see the large point components are clamped specifically designed holder and then dragged in a rotary motion through the finishing of polishing media. So, this is the polishing media and these are the knee implant implants ok. So, you can see here also media is there holders are there.

And in these circumstances you should always keep your polishing media stationary if you keep stationary because some of the components are in this periphery, some of the components are in this periphery, thus pitch circle is very less. So, if you can give the same rotational speed in that circumstances, what will happen? If you keep the medium or the polishing medium constant or without rotation, what will happen? All the components will get uniform surface roughness. Though it avoid dents and scratches

from part to part or the part to wall to impingements this also have another advantage that in the previous tumbling process the abrasives and the components will also hit the surface. Assume that in this case my component is here assume that my component is here there is no chance that it will hit this particular surface this is a surface.

There is no chance at the same time this components also there, but these are all looks like they are near to the surface wall of the drag finishing process, but it is not so, ok. That means, at the same time you can even see the wall is also here also it is made up of polyurethane polymer. So, that if it is hit also nothing will happen so, but better condition is that it should not hit for that purpose they will maintain certain distance from the wall ok.

What are the applications of this particular process? If you see the applications of this process it can use aerospace industries, medical implants, basically whatever you are seeing is a medical implant, you can use for the turbine blades in the aviation industry and the gear components in automobile or aviation or many places wherever the gear components are used you can also use the drill bits.

Because drill bits have fluids which are which contours are completely different from tool to tool and other things, at the same time you can also used for the milling tools, milling tools also will have some helical nature and other things. So, in order to finish nook and corner of these complex surfaces you can go for the drag finishing operation.

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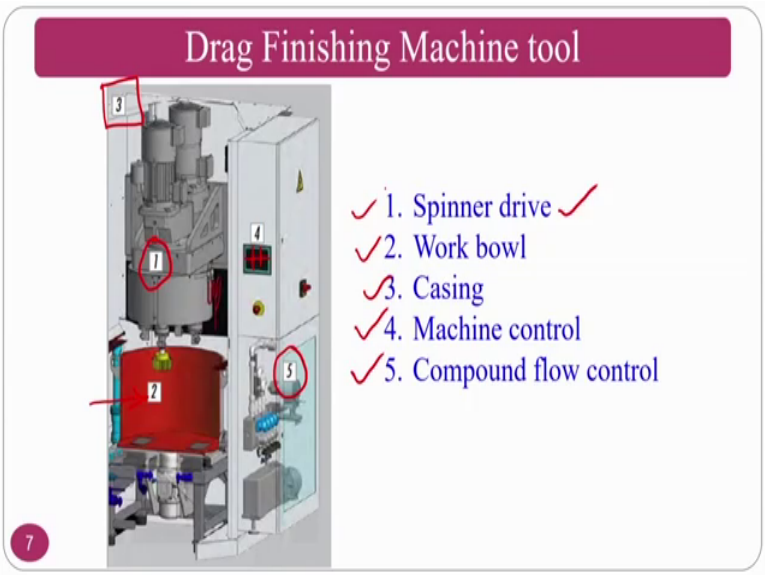

If you see the drag finishing operation normally if you can hold it is a spinner drive one is a spinner drive. Normally you can see the spinner drive and working bowl this is the working bowl 2, if the third one is complete casing and the fourth one is machine control, normally whatever you want to do the control like switch on, what is the speed that I want to give and the what at what rpm I want to rotate the component, at what rpm I want to rotate the medium and other things.

Compound flow control is another one. So, whenever compound is the nothing, but abrasives and wet compound or a dry compound wherever the component, what you want to use? You can use in this particular drag finishing process.

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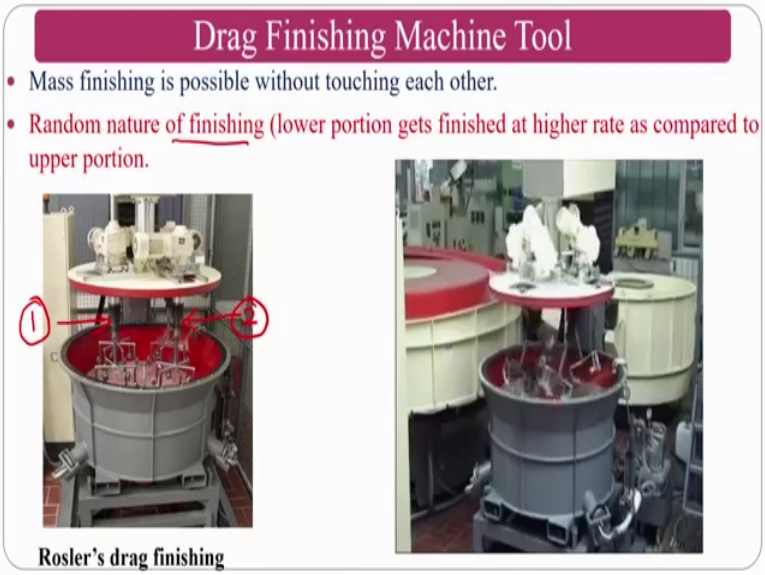

If you see in this one which is a mass finishing and random nature of the finishing lower portion gets higher rates and all those things this can be overcome by this drag finishing, as you can see here implants are a set of implants are held here whenever I am just giving you 1 and 2 3 4 also there. So, you can rotate about it is own axis so, that the your components are finished. If you see the video the continuously the abrasive particles are interacting and you can see the zoomed version also how the abrasive particles are interacting with respect to the implant ok.

These implants are continuously rotated by the motors which are there on the top you can see the motors are there on the top and these are rotated so, that the abrasives which are there will are, this may be bonded abrasive, this may be unbonded abrasives and

other things ok. So, if you like this the components critical components like milling cutter, knee implants, drilling cutters or many other aerospace turbines and other things can be finished using the drag finishing operation.

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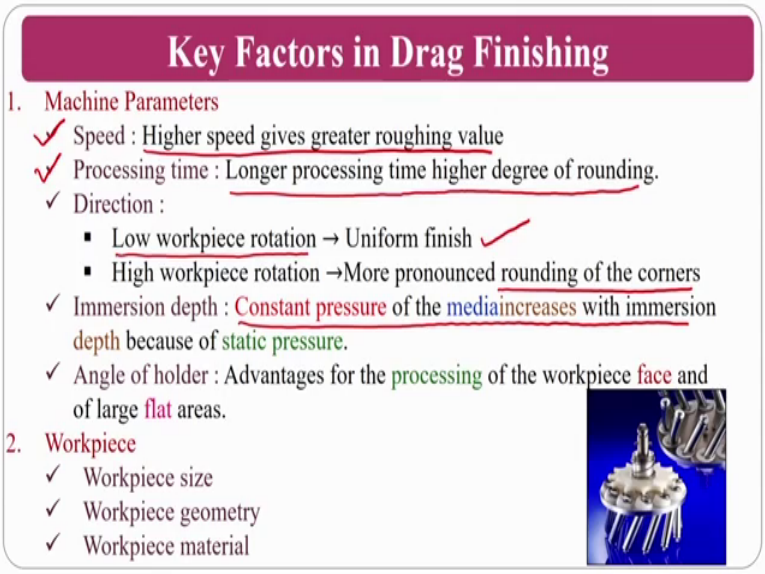

The machine parameters if you see which is nothing, but the speed high speed gives the greater surface roughness value; that means, that if you are using a very high speed normally surface roughness may be very high, but because interaction force will be very high. At the same time processing time if the processing time is large in high degree of roundness will be there; that means, that if at all I want to generate a roundness assume that there is a very sharp edge is there which I do not want as if this is the thing where the sharp edge is there assume. So, if I want to hold it for certain operation then it will hurt to the hand. So, I need to give some roundness to this type of cutting edges ok.

So, these sharp edges to be round for that purpose if at all I want to go you can you should always use the higher processing time; that means, that higher finishing time and the directions low workpiece rotation normally you will get a uniform surface finishing and the high workpiece rotation more pronounced rounding of the corners. If at all I want to use for low workpiece rotation then you will get a uniform surface roughness; if at all I want to go for high workpiece rotation, then the interaction at the edges because the edge is sharp if this is the edge so, the surface area is very high here compared to the lower portion. The surface area if I just do the sectioning I am just explaining with one

fixture this here it is prone to give radiusing rather than here the material is very high ok. So, that is the problem with this one. So, if we at all your requirement is roundness then you have to go for the higher work piece rotation.

Immersion depth constant pressure of the media increases with the immersion depth, because of the static pressure. So, you can go for immersion depth different immersion depths if at all I have a set of components where I want the uniform surface roughness then your immersion depth should be constant. Angle of holder you have seen the vertical type of motion or vertical type of holding you can also give certain angles depend on your shapes of your components.

The work piece, work piece size plays a major role work piece geometry and work piece material normally, if the size of the work piece is high what will happen? Finishing time will takes place a finishing time will be high, at the same time geometry is complicated then reaching to nook and corner of the complexity or the complex shape will be will take more time in that circumstances it also take more time at the same time work piece material if the work piece material is harder work piece material, then the finishing time will takes place more if the finishing time. If you want to list so, then you can go for softer type of work piece material.

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The key factors the other one is media H granules normally polishing and finishing of HSS tool you can use, HSC granules the gentle edge rounding normally 50 to 20 microns

finishing of HSS tool carbide tools will be used here and K type of granules gentle edge rounding process will be used and at the same time you can achieve less than 15 microns finishing of HSS tool. SIX granules and QZ granules these are the other type of granules where if you what all you want to have the more pronounced edge rounding up to 30 microns that is roundness radius of the curvature that you want finishing of the carbide tools and the other things you can go for SIX granules QZ granules are more pronounced for edge rounding over 30 microns finishing of carbide tools you can use.

You can see the H type of granulates, HSC granulates, K granulates, SIX granulates and QZ granulates are these type of the granulates that you can use for this type of drag finishing applications.

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The first application that normally people look at it is deburring operation as you can see residual burring are far from the manufacturing process on the edge surface impair the workpiece quality. Basically existing of the burrs if you see the figure 1 and I am just dividing it, this is figure 2 in figure 1 if you clearly see there are burrs on the surface, there are burrs on the surface ok. So, if you what all you want to see here just I will show you this type of protections are there here if you see just I will delete it this things again if you see here you can clearly see that there are some burrs especially in the region of this region you can clearly see in this region the burrs.

This burrs impair the quality of a component or if at all you want to put this particular component in the practical application these burrs impair the performance of this particular component. So, by choosing the right media you can do the drag finishing operation and you can clearly see in the figure number 2 how these burrs are removed ok. So, if you see the surface it is properly finished and this is a beauty about the drag finishing process if you want to use drag finishing. So, all these burrs are finished using the drag finishing process the removing of burrs if from a existing component; that means, that pre machine assume that in this condition people might have use the milling cutter because what I am because there is a scratch marks like this. So, or the feed marks are like this looks like it is a milling process or any material removal process which comes or hamper some of the edges remain the unremoved material will be stayed there that is called burr and these burrs are removed by using the drag finishing process.

Now if at all you want to use the component figure 1 component if you use the performance and figure 2 also if you used what will happen figure 2 component which is there in the figure 2 will give you good performance compared to figure 1 because you have properly done the deburring operation.

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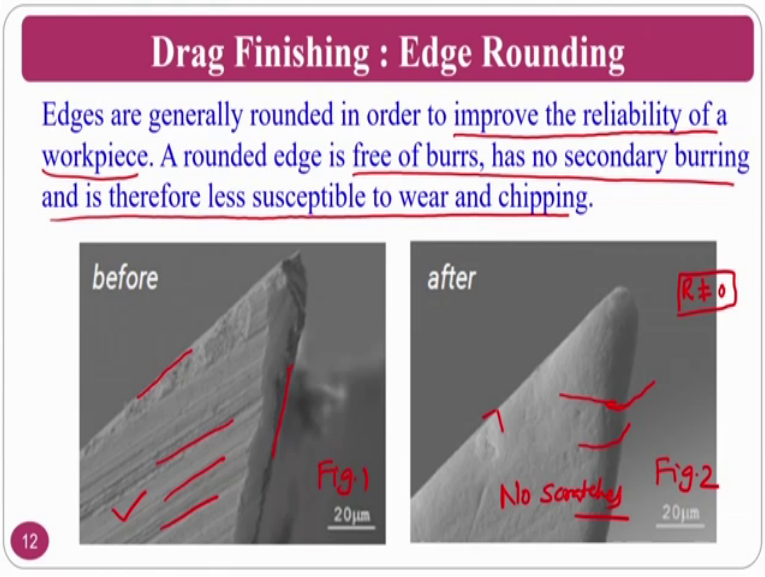

Drag finishing operation also uses for the edge rounding edges are generally rounded in order to improve the reliability of the work piece in order to improve the reliability of the work piece.

If at all I want to use this figure 1 and figure 2 if you see here figure 1 has lot of scratches, at the same time lot of burrs and the surface roughness of this particular surface is also very poor ok. So, rounded of edge free burrs has secondary burring and therefore, less susceptible to wear and chipping; that means, that if you are going to use figure this particular component what will happen this will have higher wear rates in the practical at the same time this edge is very sharp and this is the edge which is very sharp.

And at the same time this also edge is very sharp whenever you use in particular condition or particular practical application this edge will just cut off as early as possible. That means, that catastrophic failure may takes place for that purpose in order to avoid that 2 things that is edge rounding can be done, assume that you can see here edge rounding is done, at the same time you have removed all the scratches which are there on the surface these are the scratches are there no scratches are there.

So that is a beauty, at the same time if you see the what is people sometimes this is also called as edge radiusing also some of the applications like cutting tool and other places you require sharp edges obviously, but normally nothing in this world is 100 percent sharp it is cannot be 100 percent sharp. So, for that purpose you will always will have a sharpness radius that is the thing, but where ever 2 surfaces are going to meet those will have certain radius that is nothing but the sharpness radius always the sharpness radius never be a 0 or something ok.

So, it will always will have certain value if the sharpness radius is increases, increases in cutting head what will happen, then there will be a problem you should have always choose certain sharpness radius. This whatever I am talking about the cutting tool sharpness radius and other things are nothing to do with this particular slide, but this particular thing that drag finishing hear that is edge rounding and other things is most important from the handling of the component.

If you want to handle figures number 1 then you will may hurt your hand, if you want to handle figure 2 you will have a very smooth surface. So, there would not be any hurting of your hand or any damage to the operator.

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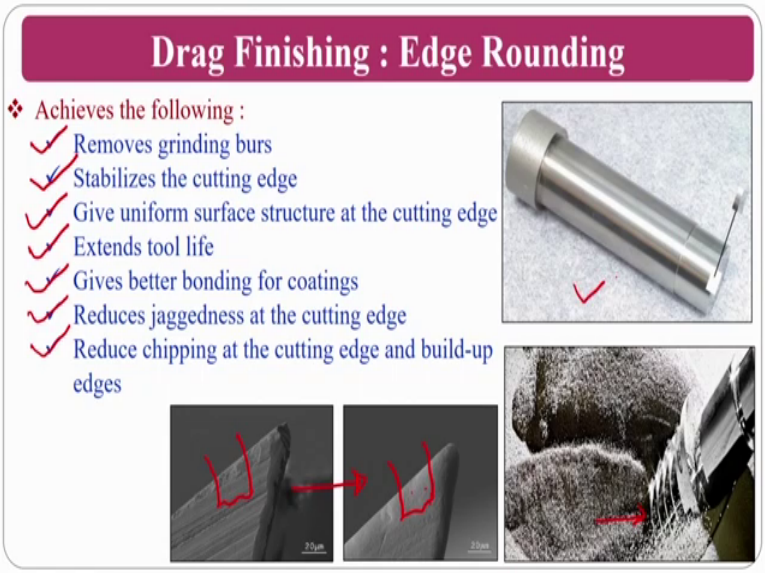

So, drag finishing again if you see the edge rounding. So, it removes the grinding burs, stabilizes the cutting edges normally the cutting edges will be sharp. So, you it can do some roundness. So, that it will have a stability because if it is too sharp the tool life will be very low; that means, that immediately the catastrophic failure takes place and along with this edge if it may have chance that it may take out some of the material from the flank surface of the greater surface other things.

Gives uniform surface structure at the cutting edge and extends tool life because if you are less radius or the cutting edge radius is slightly higher what will happen the area contact with respect to work piece will be very high. So, you will have good life, but there may be a chance of vibrations that is a drawback of it. Gives better bonding for the coatings assume that you have a better surface compared to this surface if you have this surface what will happen you will have a.

Whenever you are hitting these surfaces what will happen, it can generate super hydrophilic surface. So, that you coat it properly reduces the jaggedness at the cutting edge. So, there is any disturbances or something are there on the edge edges it will reduce reduces the chipping at the cutting edge and build up edge formation and other things ok. If at all the chip moves on this particular surface what will happen, it will have lot of assistance assume that on the surface if the chip want to move with this surface is

very smooth and there is no high frictional forces at the same time you can also finish these type of complicated surfaces and this type of surfaces is also.

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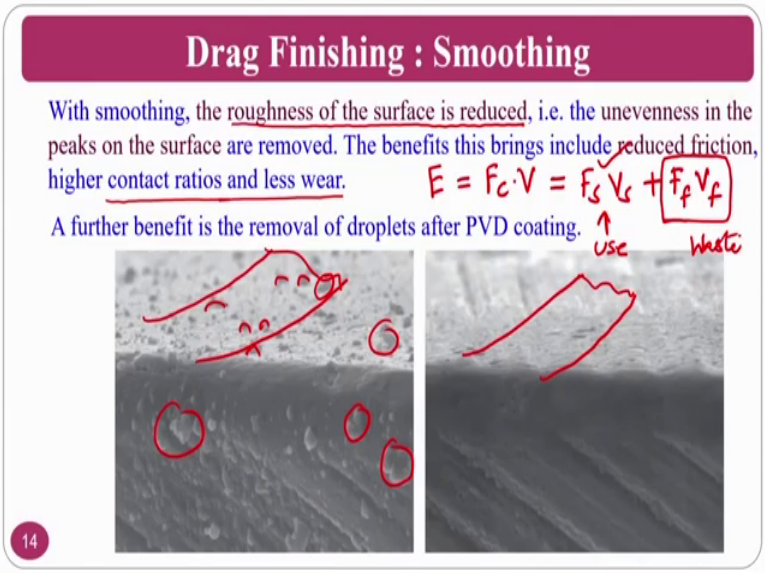

The smoothing operation is another advantage of this particular process if you see with the smoothing roughness of the surface is reduced; that means, unevenness in the peaks of the surface are removed the benefits of this one brings a reduced friction at higher contact ratios and less wear further benefit is you can remove the droplets after the PVD coating.

So assume that if you want to remove the droplets assume that this is a PVD coating that is done on a particular surface as previously what is an edge founding is there; that means, that are edges are, at the same time the advantage of that particular process is you can make it super hydrophilic surface. So, that you can coat using the PVD process that is physical vapor deposition process or chemical vapor deposition process. Normally whenever you do it then again the problem will come, what is the problem?

The droplets are some of the features nano features or micro features will be on the surface assume that if I have the chip is moving on this PVD coated cutting tool what will happen this. Particular portions will hamper the cutting chip velocity if it will abstract the chip velocity for that purpose you should always go for the drag finishing process. So, that the surface will get smooth and your chip will move as per the requirement and your frictional forces will be very less; that means, that you are wear

surface chip movement will have very less friction if you do that drag finishing operation and removes the what are the droplet type of structures, nano structures, micro structure that are formed on the after the PVD coating. If you can remove by the drag finishing process; that means, that you are frictional forces can be reduced.

If you see here in the metal cutting normally input energy is nothing, but F c into V cutting velocity into cutting force which is equivalent to shearing velocity and shearing force plus frictional force and frictional velocity. So, if you can reduce the frictional velocity and frictional force what will happen; that means, that you are shearing component will be very high; that means, that this particular thing is known as useful and this is waste.

So if you can reduce the friction on particular surface on a cutting tool your few frictional force as well as frictional velocity if it goes down what will happen the means that your shearing ability of the your cutting tool and useful energy will be maximum, for that for that purpose you have one option of finishing is drag finishing process.

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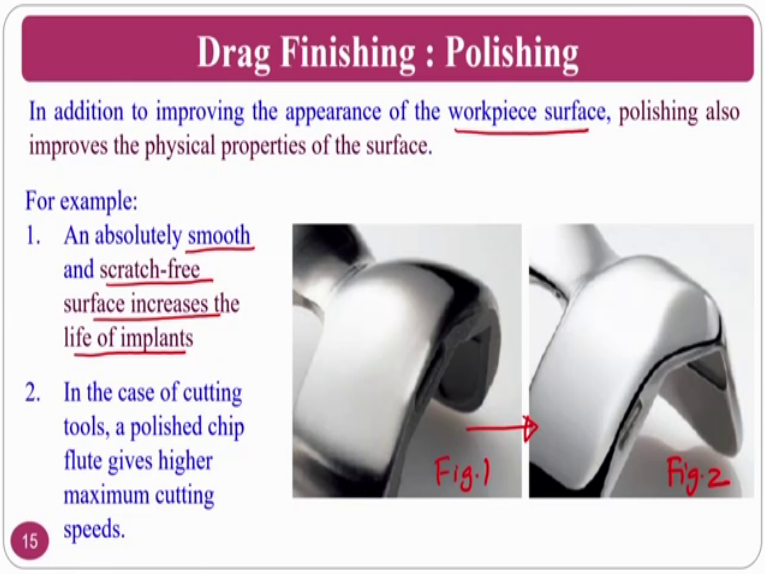

Again the drag finishing process also can be used for the polishing applications, in addition to improving the appearance of the work piece surface policy also improve the physical properties of the surface; that means, that it will improves the aesthetic appeal at the same time it will reduce the surface peaks.

So for a max absolute example absolutely smooth scratch free surfaces of can improve the implant life this is figure 1 again, figure 2 you can improve the surface roughness at the same time you can improves the good aesthetic appeal, good look also will come, the brightness will also come on the surfaces ok. If you see figure 1 to figure 2 the surface roughness is decrease; that means, that the finishing is improved; that means, that polishing action has worked here shining also is improved; that means, that aesthetic appeal suppose if at all somebody want to purchase, then what will happen ok.

If they want you as soon as they see this both figure 1 and figure 2 obliviously the person likes to go to figure 2 because aesthetic appeal is very good, at the same time the life is also very good and many more advantages will be there, the frictional losses assume that knee implant is there ok, that there will be a relative motion always will be there, whenever you walk under all if the frictional forces are very high then always the patient will have lot of problem.

And if at all if you go for a nano finishing application of this knee implant of this particular the block body fluid flow easily at the same time interacting muscles ask your blood cells that the bone cells and other things will have proper interaction. In case of cutting tools polished chip flutes higher maximum cuttings normally you can also use for cutting tools polishing applications also.

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So, if you see the polishing of these things, this is before polishing application after internal grinding and after polishing. If you see the transformation from 1 to 2 this is a tremendous transformation of the quality of that particular component. So, you can get a very good quality component ok. So, at the same time tool holders you can do these type of complex surfaces by drag finishing operation and thread cutting taps also you can do the this particular mass finishing operation, you can go for many work pieces at a same time. Achieve the following, this can achieve the improves the surface quality at the same time reduces the roughness and improves the chip flow also; that means, that as I said if the chip flow is increase; that means, that material removal per unit time will increase; that means, that your production rates are increased so, that you can be competitive in the market.

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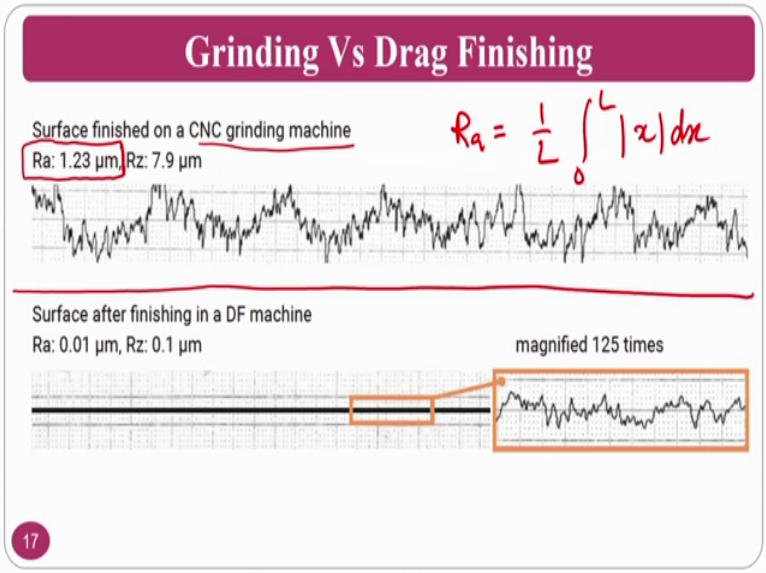

If you see the surface roughness surface roughness in the grinding process this is the CNC grinding process the average roughness value is approximately 1.23 microns and R z is 7.9 micron; that means, that R a is 1 by L, 0 to L ok. So, you can it express, at the same time let me explain you in physical terms average surface roughness about the central line and assume that this is my central line average roughness it will tell and R z tells about maximum peak to minimum value this is nothing, but R z and average value of about the central line will tell you the R a value ok.

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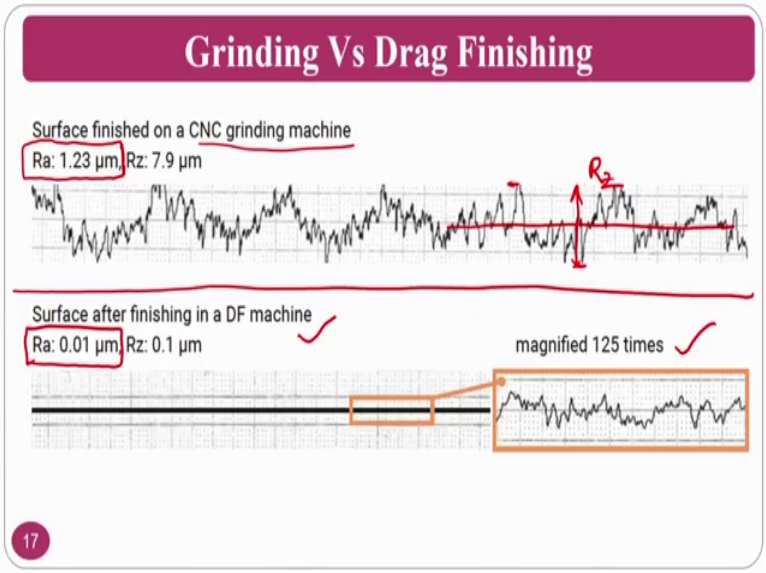

So, if you see after the drag finishing process it looks like a very straight line if you zoom about 125 times or something then your surface is looking like a grinding process; that means, that you are absolutely getting a very good surface finish about 0.01 micro meters. See the improvement one 1.23 micro meters to 0.01 micro meter the surface improvement is taken place in the drag finishing process compared to the grinding process; that means, that there is a enormous improvement of surface finish if you are using the drag finishing process.

At the same time this is a batch finishing process or a mass finishing process depend on how much components you are using what is the size of your tub and other things ok. So, this is a beauty about the drag finishing process. So, I will move on to the another area in the next classes.

Thank you for your kind attention.