Introduction to Abrasive Machining and Finishing processes

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Lecture - 10
Vibratory Bowl Finishing, Rotary Barrel Finishing or Tumbling

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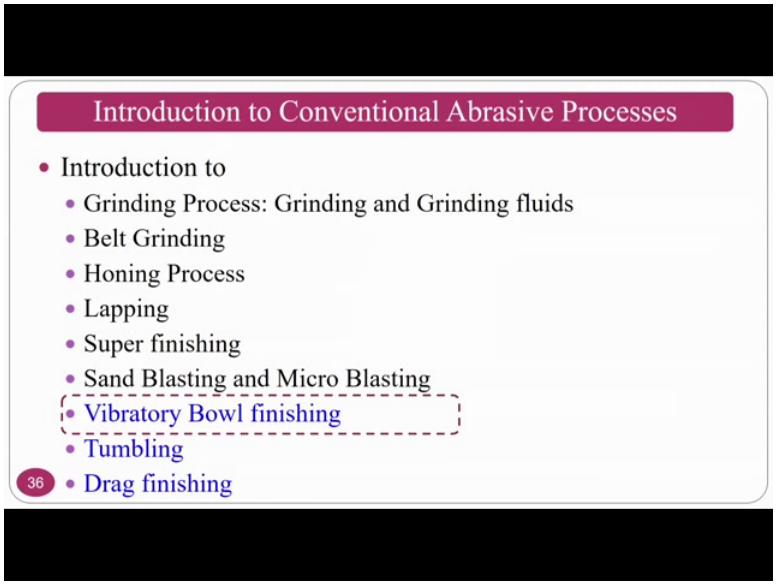

So, the next one which you are going to study is the Vibratory Bowl Finishing and later we will see other processes also.

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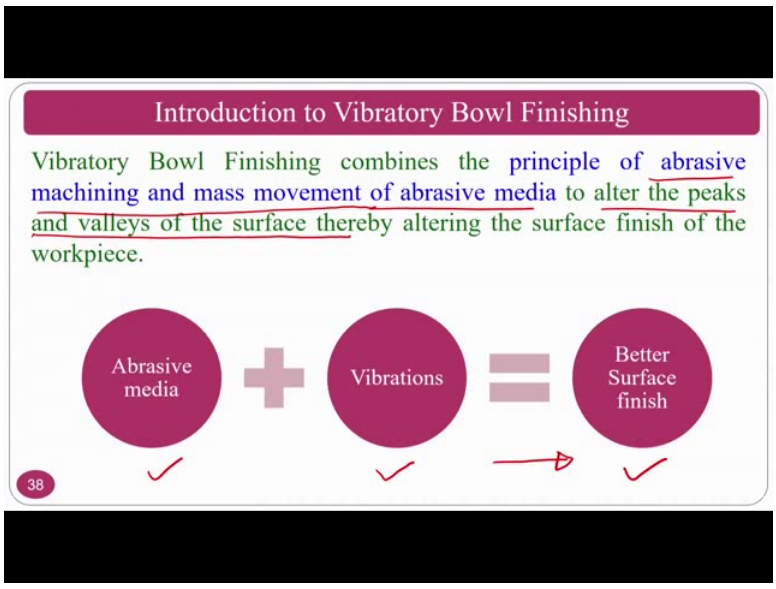

So, in the vibratory bowl finishing, we will combine in the abrasive machining as well as the mass moment of abrasive media. So, abrasive bowl finishing is a mass finishing process where just you dump some of the parts in a batch I mean to say 50 parts or 30 parts are as per your requirement some of the parts you have 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 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 share the work piece speaks at the same time sometimes it will burnish also. So, there is two options it can shear off the surface peaks at the same time. It can do also the burnishing in if the peaks are very very small. So, abrasive medium we will use and vibrations you will use and you get a better surface finish in the in the vibratory bowl finishing process.

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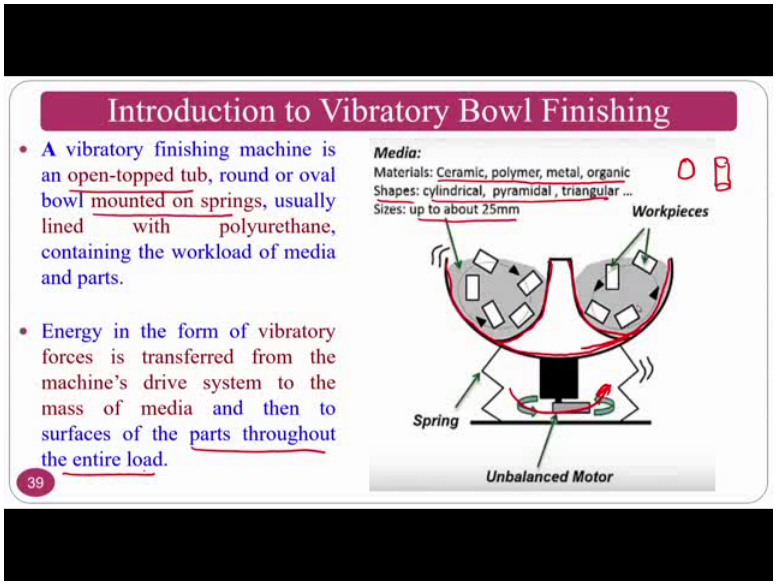

If you see here the vibratory bowl finishing machine is a open-top, top round or oval bowl mounted springs, usually lined with polyurethane containing or normally this particular coating inside will be polyurethane coating because polyurethane is a soft polymer. So, even though it will the work pieces are even though the work pieces are order, 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. The shapes like cylindrical, pyramidal, triangular, size up to 25 mm the these are the medium will be used like ceramic particles you can be used or metal particles you 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 laboratory bowl finishing process. Energy in the form of vibratory forces is transformed from machine 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 these abrasive particles continuously indent or continuously try to shear with respect to a 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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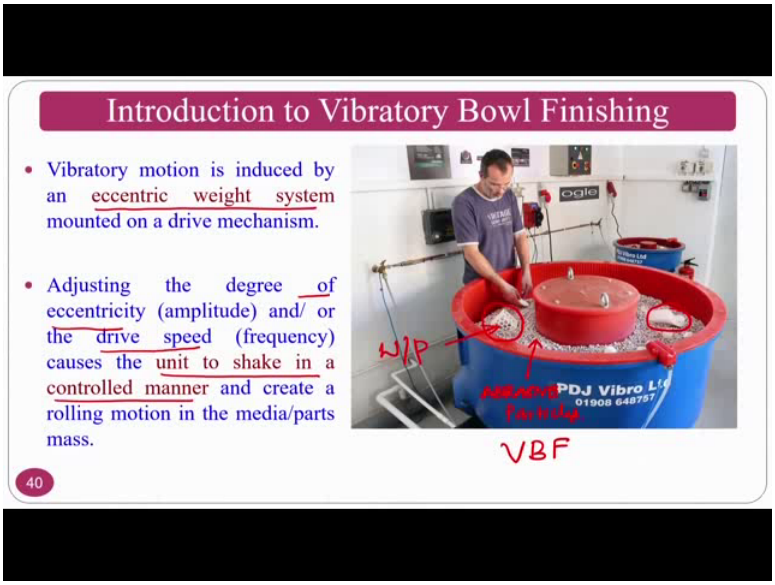

So, this is how the vibratory bowl finishing process setup look like. So, these are the components some of the components are placed and these are the abrasive particles

abrasive particles and these are the work pieces ok. Vibratory motion is induced by an eccentric weight system mounted on the drives drive mechanism.

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

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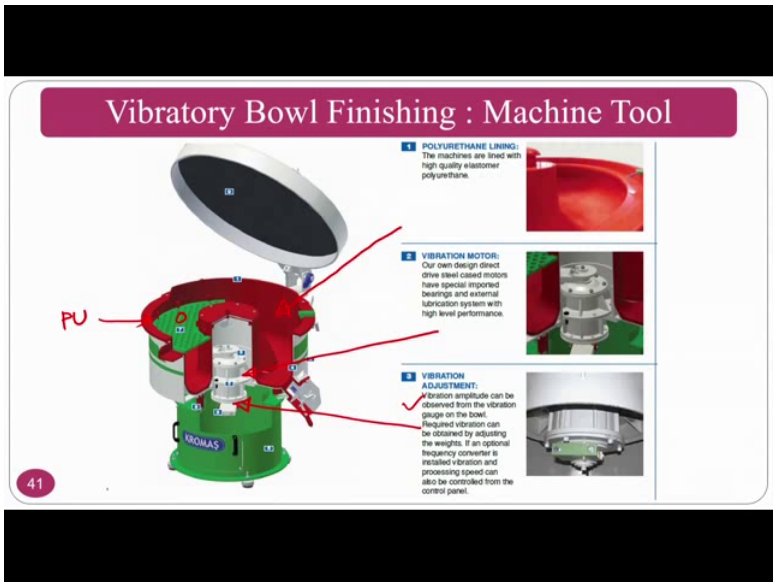

If you see in this one machine tool, so this is what the polyurethane; here is polyurethane is there the second part is here and the third part is slightly below this one ok. So, the polyurethane lining this is normally lined with a high quality elastomer polyethylene because if I have a particles these work pieces should not get hard 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, it is have a drive that is caused by the motors and especially important bearings and external lubrication systems with a 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 are load and other things you can go for this adjusting or the vibration adjustment system.

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And 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 where are 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 busted for added strength.

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

On top of it you will go for many other coatings and other things. This is separators normally separators meet are normally used to separate out the particles. This media separators are made up of long lasting polythene, media separated broken undersized media and made stainless steels separators can be changed, is this 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 and the other things and you require this suspension system and noise isolation you should go for a noise isolation like a very closed system s o 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 fine, and 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 look on 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 descaling operations. And removal of rust and brazing residues can be done. The and burr removal if you have any birds after machining operation like drilling or milling this type of things, if you have any burrs now you can remove these particular things. And generation of radii material removal and size reduction if what all I want to generate some radius; that means, that sharp edges are there you need to very difficult to handle.

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 the improvement of burnishing preparation; that means, that you for t 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 little case and polishing of plated parts and silverware, you can use at the same time developing of lubricated surfaces like honing. If you see the lubricating surface crosshatch patterns are generated here also you can generate this type of surfaces.

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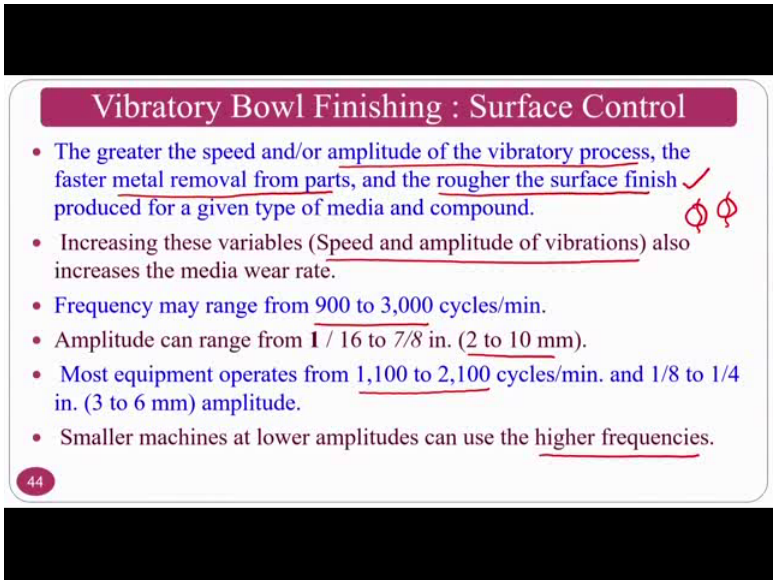

Vibratory bowl finishing surface control if you at all want to control the surface. The greater the speed or the amplitude of the vibration process in these circumstances the material removal will be very fast and the surface roughness that you are going to get is very rough surface. So, if at all I 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 vibration also increases the media wear rate.

That means that the particles that you are using this will also break ok. Frequency may range from 900 to 3000 cycles per minute, the amplitude can be ranged from 2 to 10 mm. Vibrational amplitude and the most equipment operates from 1,100 to 2,100 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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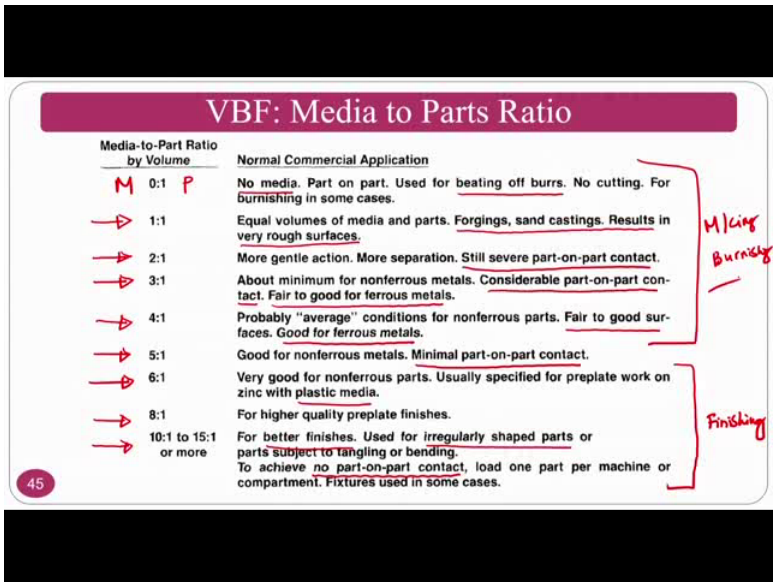

Media to Parts Ratio if you see there are varieties of parts so; that means, that medium to parts. So, if it is 0 is to 1; that means, that only parts are there so there is no media in that circumstance part to the part touch will be there and used for beating of the birds and the no cutting action will 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 particles 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 very rough surfaces.

If you go for 2 is to 1; that means, that the 2 times of the abrasive particles with compared to the work pieces. It will gives the still severe 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 or 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. So, 5 is to 1 if at all you want to go for this one minimal part contact; that means, that abrasive particles will dominate here. So, you will get a good surface in terms of a non ferrous materials 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 means, 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 the 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 machining or burnishing we can go for these particular regions. So, that means, that you have to always decide what you have to do or what you want to do. I 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 media then you can get very good surface finishes.

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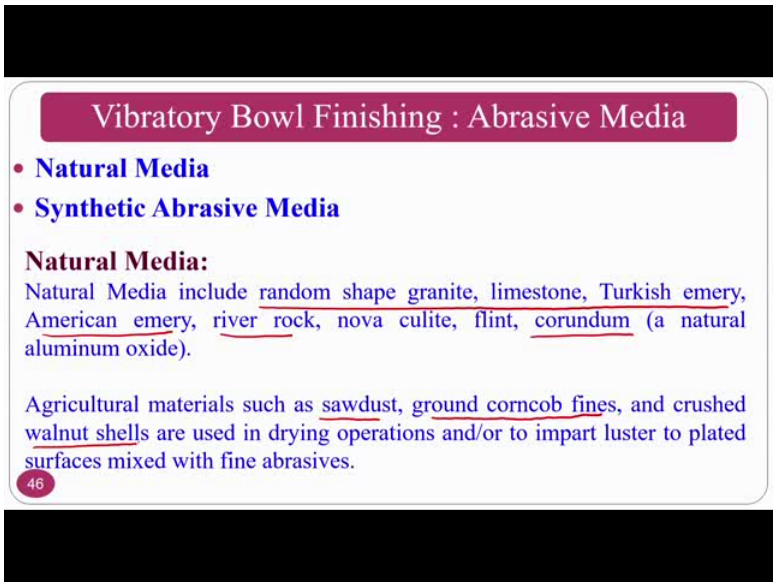

So, the abrasive media normally there are two types of abrasive media. One is a natural media another one is synthetic abrasive media. In the natural media it include random shapes of granite, limestone, Turkish emery, and American emery, these are the river rocks, nova, flint, corundum. These are the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

Agricultural materials such as sawdust ground corncob fines and crushed walnut shells are also used for these particular purposes so, these are all economic. So, the walnuts or these type of nuts whenever you eat the water 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 bowl milling of this walnut shells or you can crush it and you can use it for some of the applications like texturing all 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 aluminium oxide medium. That are nuggets are manufactured at the grade for the cutting and 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 capability than natural stone; that means, that silica and other granite whatever the particles are there their hardness is very less;

compare to your aluminium oxide for that purposes the capability of this alumina oxide is much much better compared to your granite walnut flakes and other things.

The dense non porous rounded random shaped pieces have a crystal structure at the surface that combines the cutting ability with the burnishing quality. And hard forms of media can produce smooth finishes below 2 microns 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 about 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 floor or aluminium oxide polyester resin and a catalyst. Because you always required some catalyst to functionalization to have a proper bonding between your abrasive particle at the same time resins ok.

Resin is a different chemical composition aversive particle is a different elemental composition to get good adhesion between these two you need to always go for some catalyst. The media moulded into specified shape then a pre tumbled to the flash ok. Urea formaldehyde plastic media this contain abrasives urea formaldehyde resin and acidic catalyst.

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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 forming problems ok. So, if at all you want to do this thing what we will have to do? You have to take the abrasive particles and urea formaldehyde then acid catalyst.

You just to 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 two pager causes by which shape you want to fabricate. The high density polyester media see is molded from the blended polyester resin containing a 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 the high density polymers are blended along with the catalyst. And you will have the material removal will be very fast in this curve in this circumstances because your particles are very high at the same time your polymer is also very high strength polymers.

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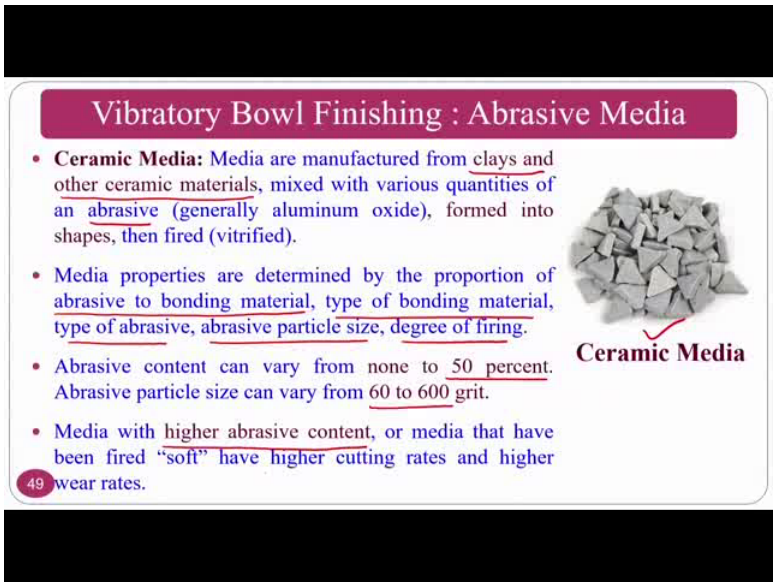

So, in the abrasive medium if you see the ceramic medium; ceramic medium media is manufactured from clay as well as other ceramic materials which are mixed various quantities. That is abrasive particles are mixed with this clay; basically if you see the grinding wheel specifications rectified bonding will be made up of clay.

So, the similar things you can do here also. So, you take abrasive particles you make the raw material clay and you mix it and you mold it as per the different shapes. That if you see here triangular shapes are given here and these type of things you can do instead of a big grinding wheel you can make a small 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 then 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. So, these 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 workpiece 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. The 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 so 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 these particular particles during manufacture of this particular beats triangular beats 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, the 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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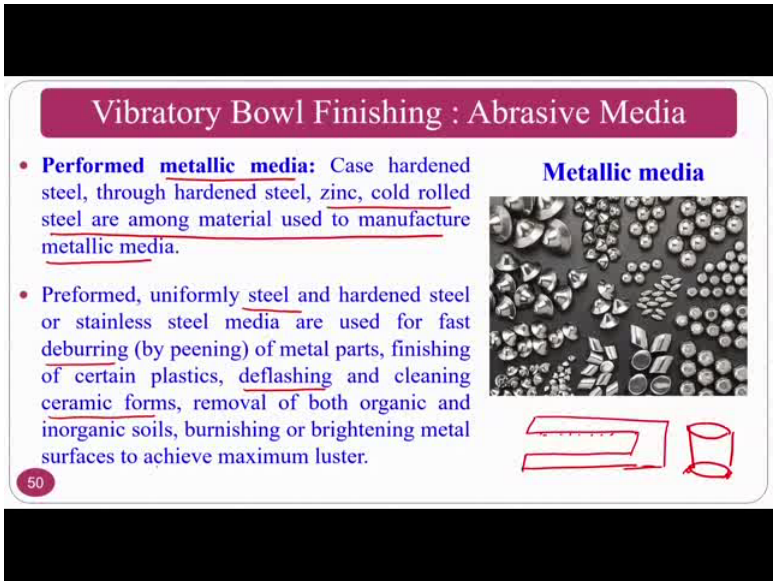

The medium, normally now we are moving to metallic media. We have seen the polymer media, natural media, synthetic media, among the synthetic media. We have seen the

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 the metallic media; that means, that hardened steel is commonly used for this metallic medium. Performed uniformly on the steel hardened steel stainless steel media are used for deburring applications. As I said if you have a structure assume that I want to make a this whole this type of channel in a surface.

So if we have a burrs here so these are the burrs. 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 burrs on this one. So, unremoved chips will be there these are nothing, but the burrs. So, you can use for the deburring operation.

Metallic parts of certain plastics de flashing also you can apply. And cleaning of ceramic forms removal of both organic and inorganic soils burnishing are 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 these metallic particles are very shining.

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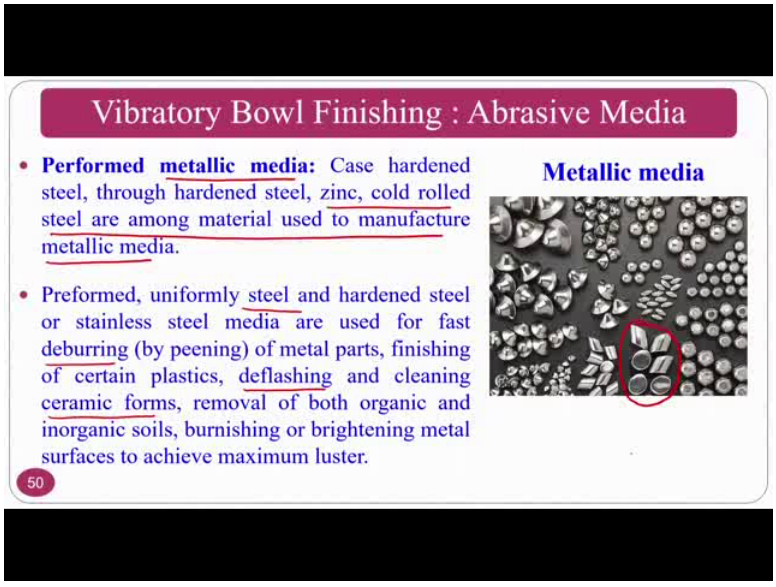

So, this will have good surface roughness whenever this goes and heats; what will happen? Burnishing will takes place or the deburring will takes place. And the surface

also will glow; that means, that brightness of the surface will increase and it will increase the good quality of the product, it looks eccentrically very good.

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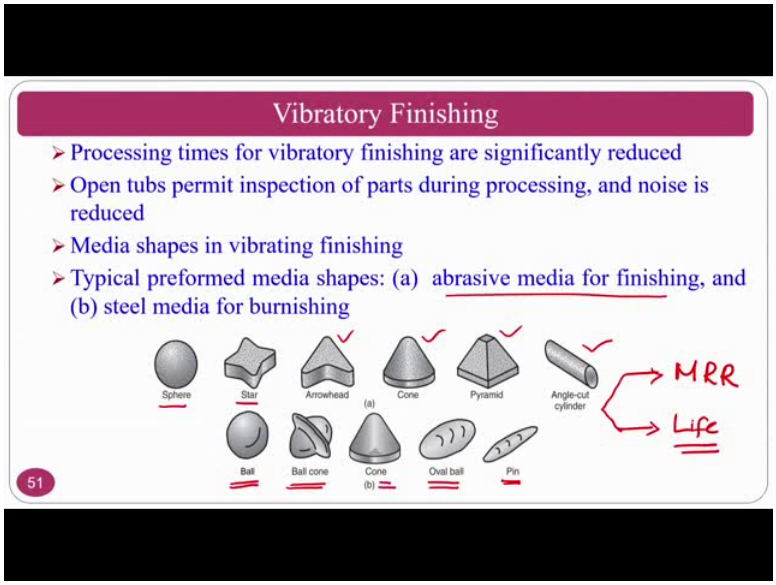

Vibratory Finishing process this process times for the vibratory finishing or significantly reduced and open tubs permit the inspection of the parts during the process. The advantages of this process is that it is the open tub so that you can see from the top. If you are closing also you can have a transparent one like perspex one or something so that you can have a visual inspection.

And media shapes are 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 operation so, that the surface will be heat so that the peaks will deform and burnishing action will takes place. And these are the shapes so spear shapes, star type of shape, and arrow type of shape, the cone pyramid angle cut cylinder.

Then you will have a ball, ball coal both are combined another coal 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 two aspects whenever you want to design these particular shapes. One material removal; How much material removal if I go for particular shape? And the second thing is life of this particular shape or particular grinding particle ok.

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 1,000,000 parts, can it come for 10,000,000 parts. And at the same time can it remove in half an hour can it remove in one hour like that. You have to think in these two aspects whenever you want to decide the shape of these vibratory finishing abrasive particles.

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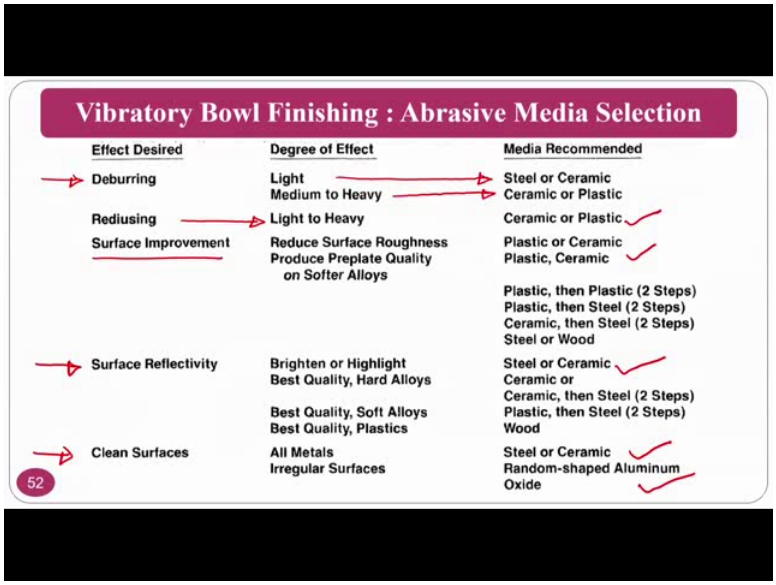

Abrasive media selection if you see if at all I want to go for the deburring operation. So, light deburring then steal or ceramic can be report and the medium to heavy if I want then ceramic or plastic can be referred. So, the radiusing applications assume that reducing application if I have the sharp. So, I want to reduce these two 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.

So, surface improvement the reducing of 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 means, that shiny surface if I want to generate. For that purpose steel or ceramic you can go for the brightened or high highlighted. 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 steal our ceramics are random shaped aluminium 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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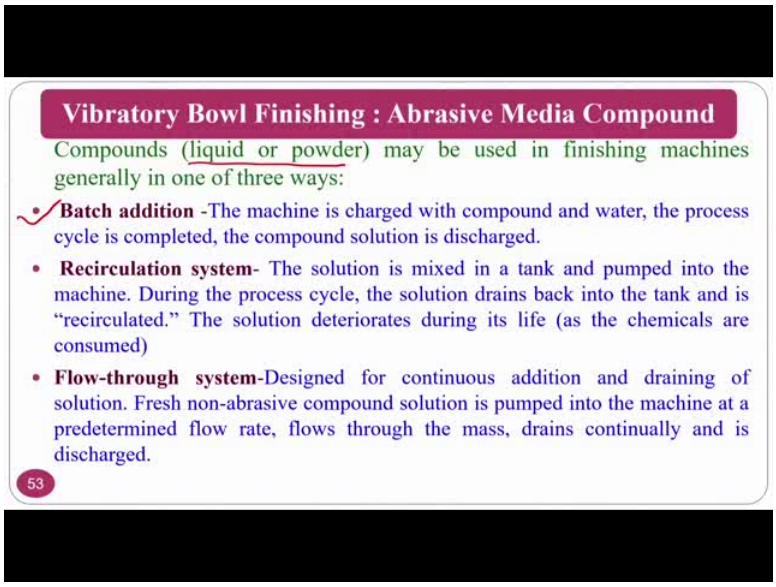

So, abrasive media compound; the compound are normally liquids or powders that are used may be used in the finishing machine generally one or three ways. So, batch tradition so a compounds will be added the machine is changed with the compound and water the process cycle is completed.

The compound solution is discharged normally what will happen if the machine is charged with a compound that and water. So, in these circumstances if we 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 in to the machine during this process cycle the solution drain backs in the tank. And recirculated the solution deteriorates during the life.

So, at the same time flow through the system designed for continuous addition and graining of the solution. Fresh non abrasive component solution is pumped into the machine at the predetermined flow rate. This flow mass drains continuously and is discharged, means that what I mean to say is that abrasive media compound this, whatever this particular slide is that 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 5 3 methods; one is a batch addition compound are along with a 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 1 hour or something that is called batch. And recirculation system you can use continuously will through or continuously will pump this liquid and continuously you 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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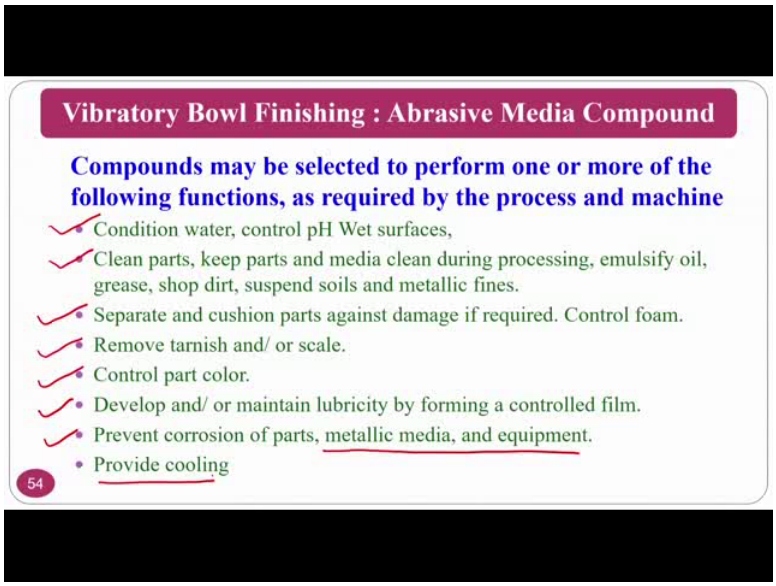

Compounds may be selected to perform some of the functions like condition water and pH of the wet surfaces. Normally whenever you want to do the finishing of this bio implants and other things, you have to control the pH on the surface. For that purpose you have to use the compound, and the cleaning 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 deformed into the valley then it will be create a lot of problem whenever you go and used for the application, certain applications and other things. Separate the and cushioning parts against the damage if required and the control form. Normally what I mean to say is it cushioning the parts again is sometimes no parts and

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

Remove the tarnish or the scales if there is any scales formation is there because of the abrasive or because of the part to part contact or something then you can remove this one. At the part control colour, so the colour of this thing also you can improve. Suppose if at all I want to put certain colour so you can add along with this compound. So, that assume that I want to add a green colour just add the green colour along with this compound. So, that the particles also will become spectacle or the same level components also maybe become some green colour.

Develop or maintain 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 possibilities there for that you can pull it. That is why water, plus lubricant, plus some of the other things all the rheological additives will be added for this particular thing so, that you can overcome some of the problems that are in the vibrational bowl feeding finishing process.

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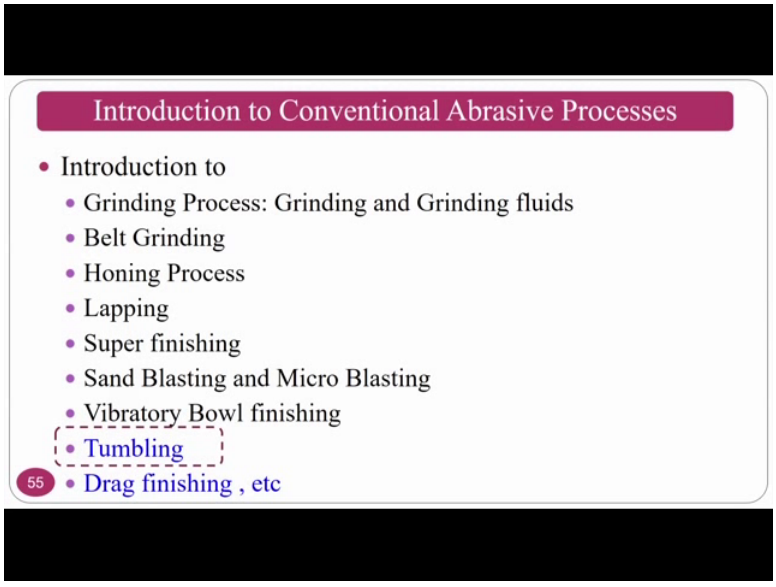

So, next one we are going to see is a Tumbling process; if you see the tumbling the other name for tumbling process is a Rotary Barrel Finishing process.

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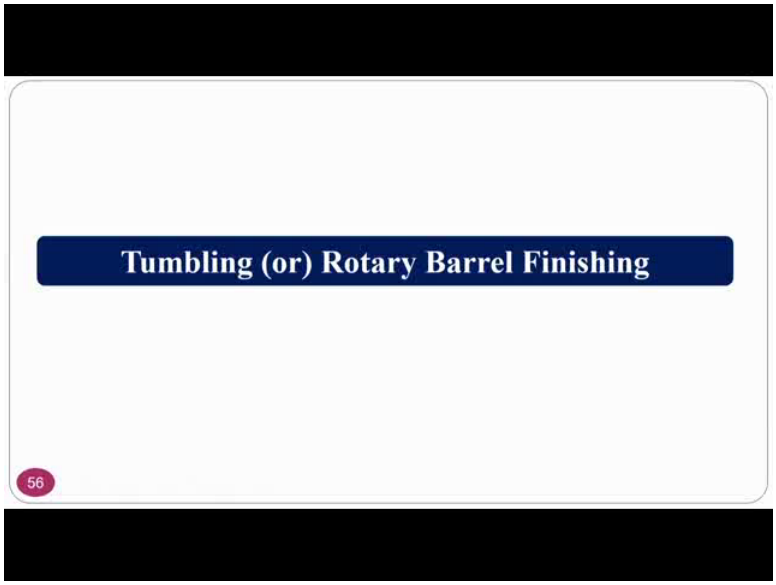

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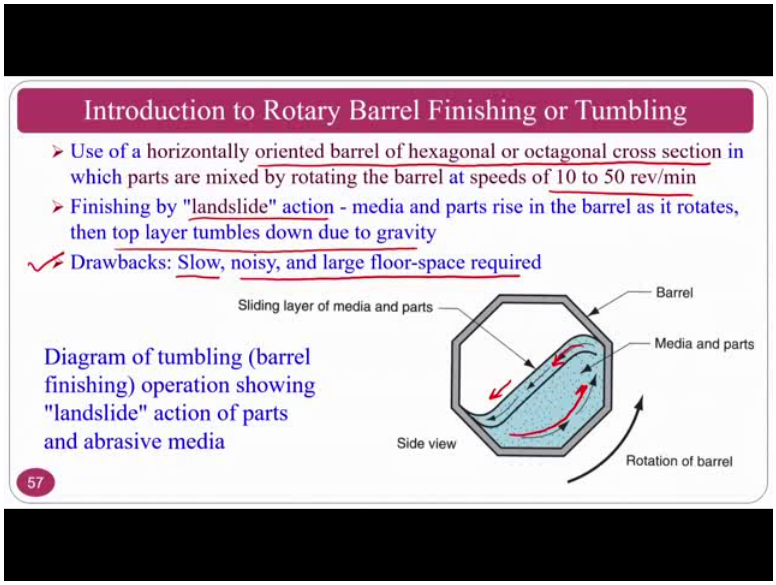

In the introduction to the rotary barrel finishing process or the tumbling process, it is uses the horizontal oriental barrel of hexagonal or octagonal cross section, which parts are mixed to rotate the barrel; the barrel at the speeds normally 50 to 10 to 50 revolutions per minute. Normally this finishing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

you will have a land sliding media and parts are raised the barrel are rotates, top layer tumbles down due to the gravity.

Normally you can see here land sliding type. So, these type of things it is moving once it reaches to here the barrel what will happen? It is moves; this is looks like a landslide these are medium parts and others are mixed here you have abrasive particles like vibratory bowl finishing process to add here and you will rotate the bowl ok. Whenever we rotate the bowl what will happen which are the at the top level it will slide 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 spaces 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 these multiple machines and just you can control from outside.

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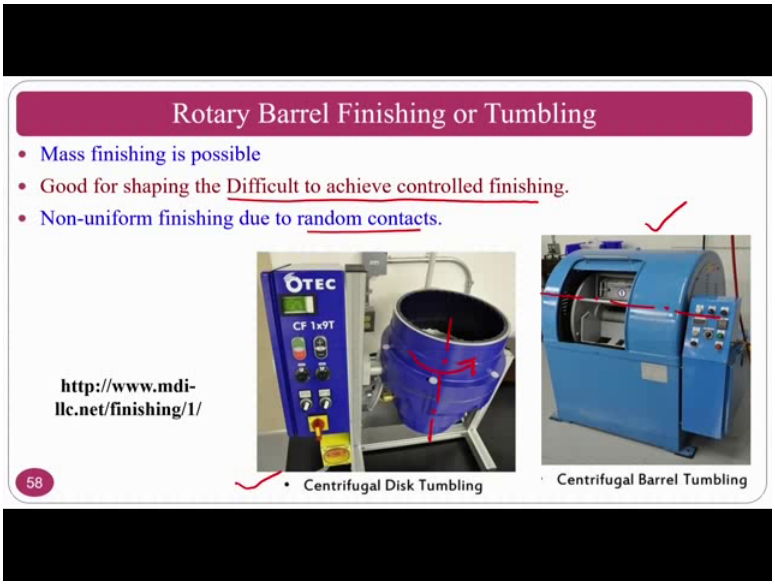

So, Rotary Barrel Finishing you will have normally for the mass finishing applications at the same time good for shaping to difficult to achieve control finishing processes. At the same time non uniform finishing due to random contacts. Because your abrasive particles will have a random touch or randomly impinge on the components. That is why you will get a random surfaces the first variety of this one is centrifugal disc 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. One is vertical type where in it will 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 land sliding and other things will be common for the horizontal that is centrifugal barrel tumbling process land sliding is common. So, centrifugal barrel tumbling as I said the axis is horizontal.

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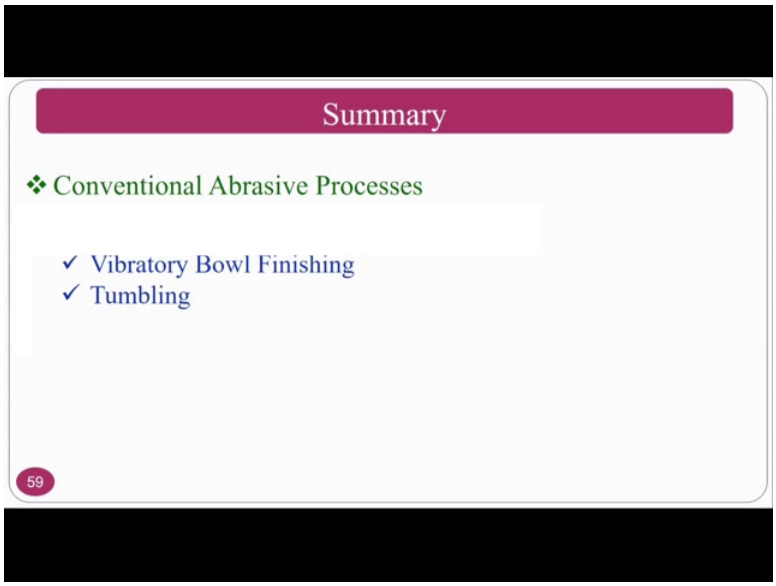

So, the Summary of this particular class we have studied vibratory bowl finishing and tumbling. And we will see some of the conventional finishing processes or conventional abrasive machining and finishing processes in the next classes. And what all we are going to see in the upcoming classes.

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One of the processes Drag Finishing process, which can take over some of the drawbacks of tumbling process. In the tumbling if you are seen in the previous slide you have a vertical one. If you rotate it what will happen all the parts which are there on the periphery of the tumbler. What will happen? It will rotate at very high speed; which are that the centre it may not rotate, it may not travel much distances.

That means, a spectrum of surface roughness is will vary from the outside surface to the inside surface. So, this is the drawback for that purpose there is a another process to overcome this one to get a uniform surface, that is called Drag Finishing Process. That we will see in the next class.

Thank you for this particular class.