Advanced Machining Processes
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Module - 05
Lecture - 13
Electric Discharge Grinding , Electric Discharge Diamond Grinding , and Wire Electric Discharge Machining

Welcome to the course on advanced machining processes. Today we are going to discuss on wire EDM process, electrodischarge grinding process, and electrodischarge diamond grinding process. So first we shall start with electo wire electrodischarge machining process. Last class we have discussed about the EDM process electrodischarge machining process.

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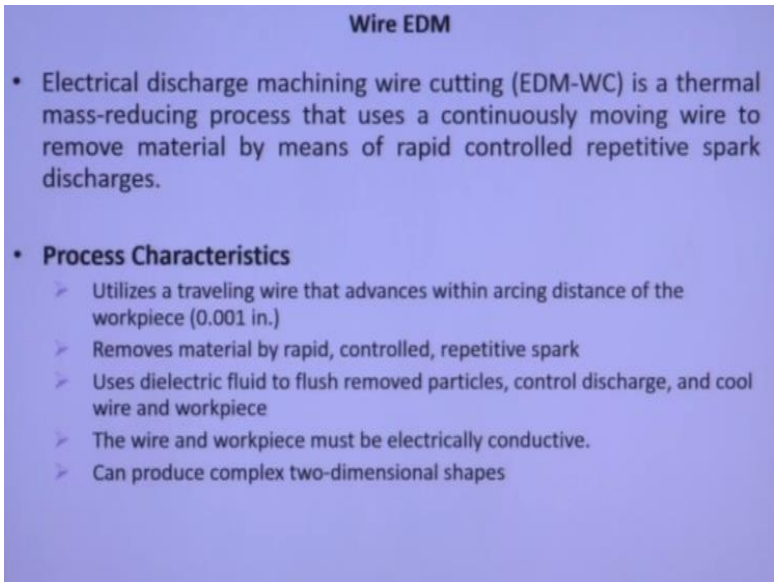

So we have discussed the working principle of this electrodischarge machining process. This wire EDM also works on the same principle of EDM process, everything is the same but here in wire EDM process instead of tool electrode a wire is used as an electrode okay. So there is a travelling wire is there which is which serves as an electrode.

The definition is that electrical discharge machining wire cutting EDM-WC is a thermal mass-reducing process that uses a continuously moving wire to remove material by means of rapid controlled repetitive spark discharges. So there is a moving wire is there. So sparking occurs in between this wire and the workpiece surface. So by using this process any kind of complex freeform surface either 2D or 3D can be machined. So any complex freeform surface on 2D

surface or 3D surface also can be machined. Mostly different kinds of dies and moulds are actually generated or fabricated or machined by using this wire EDM.

Because there is a very small diameter wire which passes through the workpiece so in between this wire and workpiece this interelectrode gap very small interelectrode gap less than 25 micron is maintained. So any complicated surface can be generated by moving this wire so this wire you can tilt in x direction, you can move this wire in y direction. You can move you can tilt this wire in back and forth, left and right.

So any kind of complicated surface can be machined by this wire EDM process which is not possible by normal die sinking EDM process. So this process characteristics utilizes a travelling wire that advances within arcing distance of workpiece so this interelectrode gap is maintained as 0.001 inch. Removes material by rapid, controlled, and repetitive spark. So spark occurs in between this wire and the workpiece. So uses dielectric fluid to flush away the removed particles, control, so it controls, this dielectric fluid control the discharges. Also this dielectric fluid cools down the wire as well as the workpiece .

The wire and workpiece must be electrically conductive. Obviously this wire because it works on the same principle of EDM this wire and workpiece should be electrically conductive. So it can produce complex two-dimensional shapes. So three-dimensional shapes can be generated by moving this wire into a on a by moving this wire and workpiece on a Cnc Xyz table.

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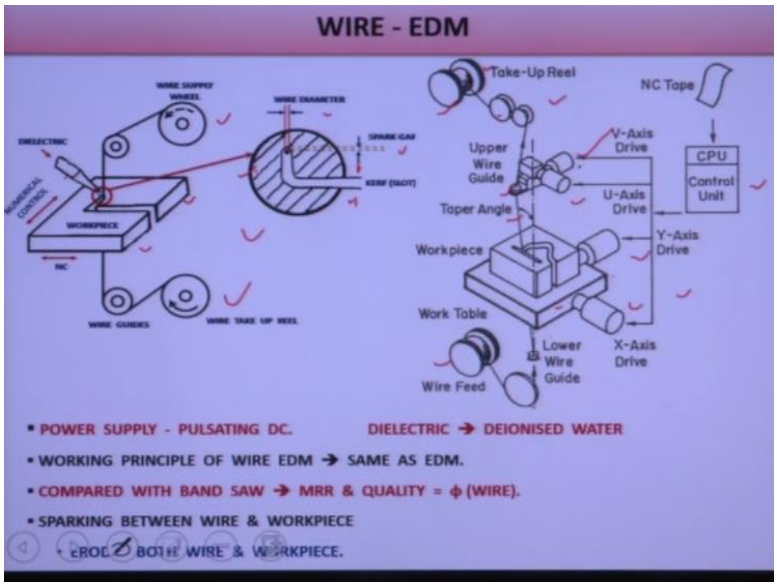

So this is the schematic diagram of wire EDM process. So this is the workpiece here. So there is a 2 wheels are there. There is a travelling wheel is there. So this is the wire supply wheel and this one is the work wire take up wheel. So this is the 2 wheels are there. So this is the wire supply wheel and this one is the wire take up wheel and there is a wire guide system is there and there is a nozzle.

So through this nozzle actually this dielectric actually flows in between these wire and workpiece where you are doing the machining operation. So there is a Cnc control table, work table is there. On that Cnc control table you keep your workpiece. So here you can see the exaggerated view of the machining zone. So this is the kerf which is generated, kerf means this wire diameter so whatever material you are removing so this diameter this width of that cut is more than your diameter of the wire. So this spark gap, so in between this wire and workpiece, so this is the spark gap here and this is the wire diameter here.

You can see this means width of cut is more than your diameter of the wire. So this is the schematic diagram of the wire EDM setup. Here one more thing I want to say that in normal EDM process you do not need to make a hole into the workpiece surface, but in wire cut EDM process to make a contour surface on the workpiece so first you have to move, you have to move the wire through the workpiece so initially there is a hole, one hole has to be made into that workpiece, a through hole has to be made so that this wire can pass through the workpiece and when it passes through the workpiece then you can start cutting.

So initial one hole has to be made which is not required in normal die sinking EDM process but it is required in wire EDM process. So here you can see there are 4 axis motion. So this is the x axis, x axis motion of the table and this is the x axis motion, this is the y axis motion of the table. Also there is a tilting mechanism, is there. So you can tilt the wire in forward and backward direction. So you can consider this one as the U drive and you can tilt the wire in left and right motion, left and right direction so at you can tilt the wire at different angle.

So different kinds of shapes can be generated by tilting this wire in forward backward direction or left and right direction. So the limitation of the or capability of the wire EDM setup can be represented by the maximum tilting angle it can move the wire, it can bend the wire. So this is the work table here. It is connected to the Cnc machine. So any complex shape can be generated. So this is the taper angle. So there is a wire guide system is there. This is the take up wheel, take

up reel and this is the wire feeding system. So wire is bigger size wheel is used reel is used. So from this reel actually your wire is coming, very small diameter wires are coming.

So it is moving through a wire guide system and then it is passing through the workpiece then there is a wire guide system is there, then wire tensioning system is there and then it is coming to the take up reel. So this X and Y and U and V-axis drives actually they are controlled by Cnc controller. So there is a controller unit is there so that can be controlled. So here this dielectric is used as deionized water. So deionized water is used as a dielectric fluid.

So power supply also here pulsating DC pulse DC power supply is used in wire EDM process. So working principle of wire is same as the EDM process. Whatever the working principle here also same working principle of EDM this sparks generate in between this wire and the workpiece, but here this wire diameter is very less.

It is up to 0.15 millimeter to 0.3 millimeter so that is a very small diameter wires are used. Small diameter wires are chosen because you can make any complicated shape and your (()) (9:17) will be very less. So that is why small diameter wires are chosen, but if you choose very small diameter wire then your current carrying capacity also will reduce. So there is a optimization what should be the diameter of your wire.

So you have to choose your wire based on your application. So it is compared with the band saw. So in case of band saw this thickness of this saw actually determines what should be the kerf or width of cut generates into the workpiece surface. Here also you can see here diameter of the wire actually generates how much will be the kerf or kerf on the slot generated on the workpiece surface. So here sparking between the work and wire and workpiece generates.

So you know this in EDM process because of this sparking there is a erosion in workpiece as well as in the tool also, in both the electrodes there is a erosion is there. So wire also means after sparking there is a erosion in wire as well as in the workpiece surface but the same wire actually it is not same wire is not used so it is not reused because this wires are very cheap okay. But also it is not used because this after sparking because this wear means erosion occurs in the wire also this diameter of the wire or cross section at different cross section, diameter of the wires at different cross section also changes.

So its diameter becomes nonuniform. So using this nonuniform diameter wire if you do the machining you will get different kinds of kerfs, different kerf shape into the workpiece surface. So you will not get the same kerf shape or you will not get the uniform workpiece surface by

using that already used wire. So this wires are not used. After machining these wires are actually discarded. So main difference is that here deionized water is used and also here this nozzles, one nozzle is actually kept. Through this nozzle actually deionized water actually flown in between this wire and the workpiece surface. Also it should be very good idea if you can make along the axis of the wire if you can you can flow the dielectric fluid so it will effectively flush away whatever debris are there it will effectively flush away the debris.

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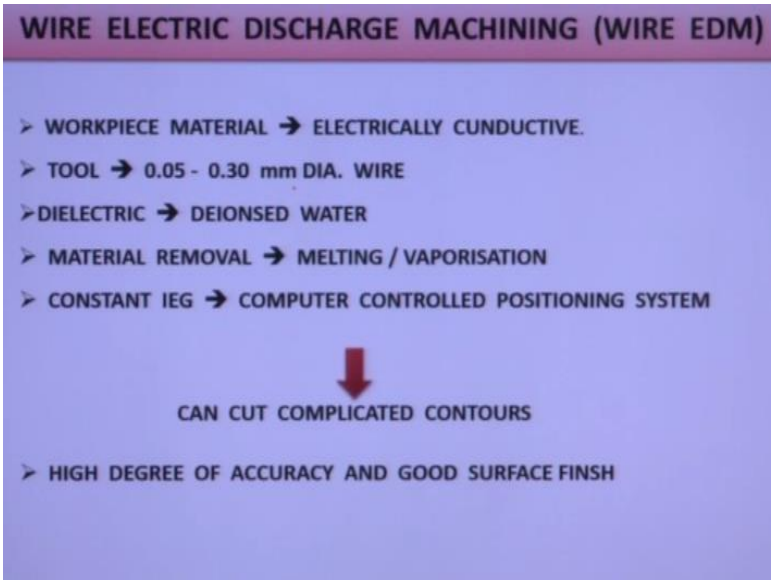

So workpiece material as an EDM process here also electrically conductive workpiece material can be used. So this tool here or electrode here, tool diameter is 0.05 millimeter to 0.3 millimeter diameter which is very less diameter. Based on your application if you are machining very accurate and also if you are machining very fragile or thin or accurate machining is required. So very fragile on a fragile workpiece and very accurate work machining is required in that case you will reduce the diameter of this wire.

But if you reduce the diameter of your wire so your material removal rate will reduce because your current cutting capacity of this wire will also reduce. So it may happen that this wire will frequently breaks, will frequently break if you are using higher current through this small diameter wire. So based on your application, based on your material so you have to choose your wired diameter. Generally it is kept 0.05 to 0.3 mm, very small diameter wire is used. So dielectric here, only deionized water is used for wire EDM process.

It has certain advantages, we shall discuss all these thing. So material removal also because of this sparking occurs in between this wire and in the workpiece and very small gap that is 25 micron is maintained by a positioning system, positioning control system. So very small gap is maintained 25 micron. So sparking occurs in between this wire and the workpiece so this material removal takes place because of this melting and vaporization of this workpiece material. So it is the same concept of EDM process. Constant interelectrode gap is maintained by computer controlled positioning system. So this positioning system is very much important. So because of this positioning system very small diameter interelectrode, small interelectrode gap is maintained that is 25 micron. So can cut complicated contours, any complicated contours can cut by using this positioning system. So we can get high degree of accuracy and good surface finish by using this wire EDM process.

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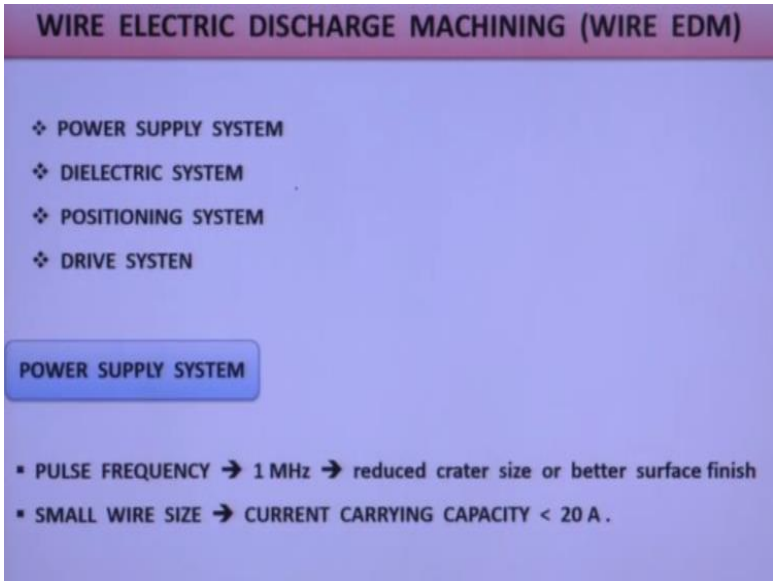

So in this wire EDM process there are 4 units of this wire EDM process, wire EDM machining setup, so you can see here.

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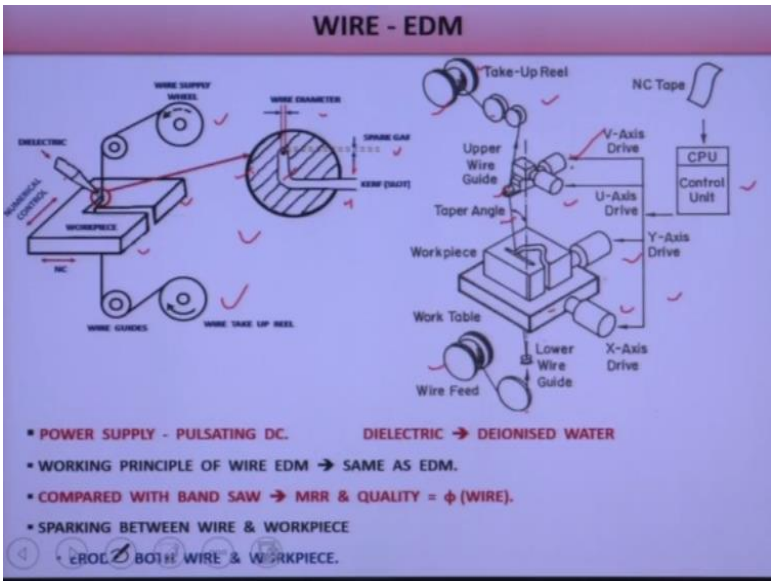

So first one is the your power supply DC power supply, pulse DC power supply is the first one. So DC power supply then air positioning system is there second one, then dielectric system is there and then wire drive system is there. So these are the 4 important components of wire electrodischarge machining process.

So this pulse power supply system it is a DC pulse power system. So only difference between this EDM and wire EDM process because here we are using very small diameter wire as an electrode okay so we cannot expect a very big size crater. So we need a very small size crater. For getting this small size crater we have to use high frequency of the current, high frequency current. So current in the range of 1 MHz is used, frequency of the current in the range of 1 MHz is used.

So this is the pulse frequency. So because of this high frequency of this current your crater size actually reduces and your accuracy and surface finish improves and also this crater size is very small. Also this erosion of the wire also will be very small because of we are using high frequency current. So wire will not break frequently.

So small wires are used current carrying capacity it is less than 20 ampere. So you cannot go beyond 20 ampere because whatever diameter, very less diameter we are using as a wire so we cannot give more wire more current to the wire so in that case this wire will break because due to the high heat generation.

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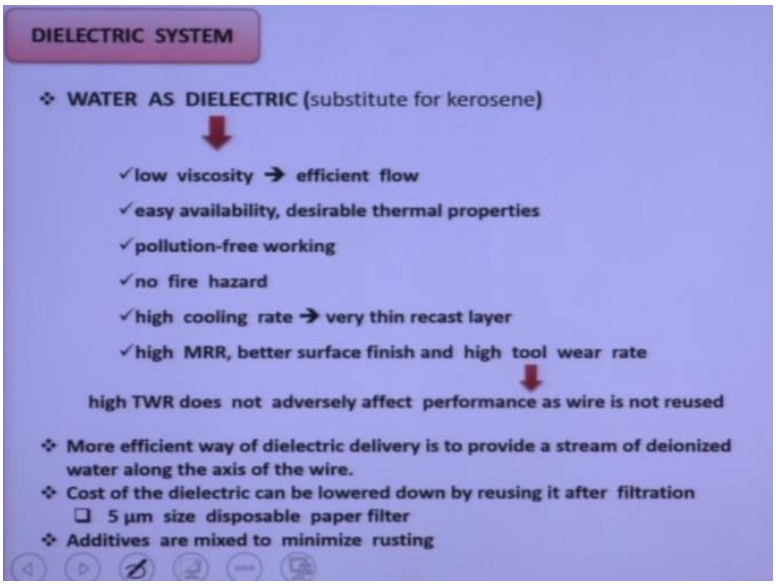

Now second part component of the wire EDM system is the dielectric system. So already I told that deionized water is used as the dielectric in case wire EDM system, wire EDM process. So it is substitute. So kerosene is substituted by deionized water so because very small gap is maintained in between this wire and the workpiece so that is 25 micron so these dielectric fluid should have a high viscosity sorry low viscosity, it should have a low viscosity. If it has a low viscosity it can easily pass through the interelectrode gap.

So efficient flow, to maintain a efficient flow of this dielectric water which has a very low viscosity compared to other dielectric fluid is used in wire EDM process. Also it is easily available and it has a very good desirable thermal properties, because huge amount of heat is generated and that heat if it is not removed from the interelectrode gap immediately what happens this wire it will also become heat up because it happens both from the wire and also both from the wire and workpiece so if it is not removed very fast, very quickly what happens, this wire will break after some time. So that is why it should have very good thermal properties so it will cool down very easily.

So it should cool down very easily and should have easy availability and also it should have pollution free working. So this dielectric should not pollute the working environment or working area, this dielectric should not pollute and it should not have any fire hazard. So because total thing is not immersed into the dielectric so there should not be any fire hazard, there should not be any fire hazard in case of wire EDM process and also high cooling rate is one of the important parameter requirement for this wire EDM process. Because of this high cooling rate this

whatever the recast layer generated into the workpiece surface so it thickness of this recast layer also reduces if the heat can be released from the workpiece very quickly after melting and vaporization of this crater so whatever this recast layer generated after each spark, each it also reduces. So very thin recast layer is generated if you are using the deionized water as an dielectric. So using the deionized water we get high material removal rate, better surface finish, also you get high tool wear rate.

So we get high material removal rate on the workpiece, also at the same time tool wear rate also very high. As these wires are not reused so whatever tool wear rate is there so it does not matter because these wires are not reused because there will be uniform, nonuniform cross section of the wire after machining so it is discarded after using it so it is discarded so it is not reused. So these are the properties, important properties of deionized water, advantageous properties of deionized water.

Another but it has certain disadvantage also because this water so it has a corrosion problem, obviously there is a corrosion problem is there if you are using as a water as a dielectric. So this workpiece and other machine tools some parts of the machine tools also will corrode if we use this deionized water.

So to reduce that actually some inhibitors some additives are used. So these additives actually inhibits the corrosion problem by the deionized water. So water delivery system this dielectric delivery system is through the nozzle and external nozzle is used, through this nozzle at the interelectrode gap dielectric is delivered to flush away the debris from the machining zone. So more efficient way of dielectric delivery is to provide a stream of deionized water along the axis of the wire. So if we can flow the stream of deionized water along the axis of the wire so it will be very efficient to flush away the debris from the interelectrode gap.

Cost of this dielectric can be lowered down if we can reuse the deionized water after filtration, so it can be reused, this dielectric fluid deionized water can be reused after filtering it. So 5 micron size disposable paper filter is used to for filtering the debris particles from the dielectric. So some additives are mixed which I already told to minimize the corrosion or rusting problem of the workpiece as well as the machine tool by the deionized water.

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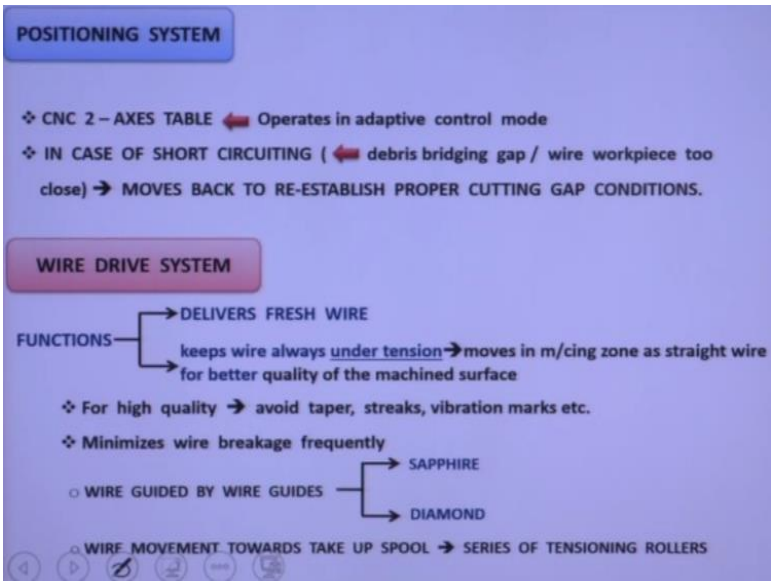

Now third component of the wire EDM process is positioning system. So these wires has to be positioned very accurately because we are going to cut a very complicated surface or contour from the workpiece surface. So using a CNC controlled 2-axes, 2-axes controlled table we can use, we can use a 2D complicated surface we can use.

So this one actually this CNC table actually works in a adaptive controlled mode, adaptive controlled mode is that if there is a because you are cutting the cutting the workpiece in complicated contour so it sometimes actually the tool actually this wire touches the workpiece surface there is a cut of protection circuit is there and also there is servo system is there servo system what happens this servo system actually retracts the workpiece away from the wire and the gap in between the tool or wire and the workpiece is flushed with the dielectric so that any debris which is clogged in between this wire and workpiece can be removed.

So in case of short circuiting debris bridging gap or wire workpiece to close so moves back to re-establish the proper cutting gap conditions. Now fourth one is the wire drive system. So there is a take up grill and there is a releasing grill is there okay. So it delivers the fresh air, a bigger size grill is used. It delivers the fresh air. Keeps wire always under tension so there is a wire tension system is there, it is required so that the wire should be under tension every time. So moves in machining zone as straight wire because for better quality of the machining surface.

If this wire tension system is not there what happens this wire may touch the workpiece surface it may bend, it may touch to the workpiece surface so it may generate taper, streaks, or vibration marks into the workpiece surface. So to avoid that taper, streaks, and vibration marks for getting

high quality machine surface there is a better wire tensioning system and also wire guiding system is required. So it minimizes the wire breakage frequently and wire guides by wire is done by wire guiding system is done by sapphire or diamond rollers are there or diamond or sapphire diamond wire guides are there okay. So this wire guiding system it should pass through the wire guiding system. So wire movement towards the take up spool series of tensioning rollers to the take up spool so there is a series of tensioning rollers, rollers are there to make a straight wire.

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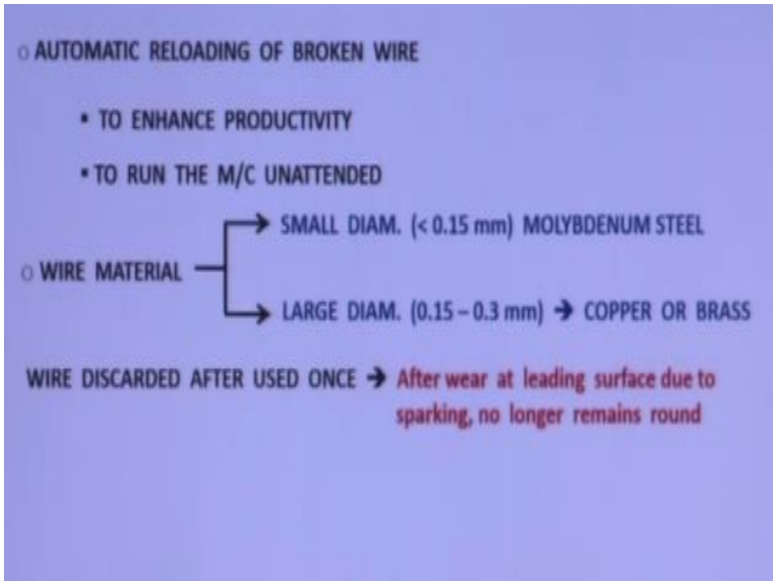

Now it is this wire EDM systems are actually fully automated so it comes with a automatic reloading of the broken wire. So in during machine to make to make the machining process unattended okay so it to make the machining process automatic or unattended by any worker so nowadays actually this automatic reloading of the broken wire is there so it will automatically reload and it will pass through the wire guiding and tensioning system and automatically this machining will start if during machining this wire breakage is there.

So it enhance the productivity and also this it run the machine unattended by any worker. So wire material maybe small diameter wire material, less than 0.15 micron. It is made of molybdenum steel or if it is large diameter wire is used 0.15 - 3 mm okay so in that case copper or brass wires are used. The wire is discarded after use after wear at the leading surface due to sparking no longer remains round.

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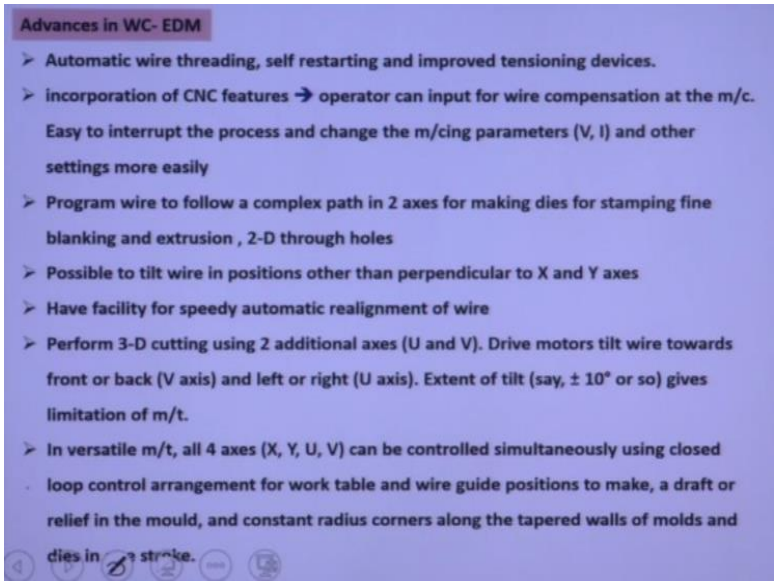

So these are the different advances in wire EDM system, automatic wire threading, self restarting, and improved tensioning devices are there. Incorporation the CNC features to make a complicated contour into the workpiece. So operator can input the wire compensation at the machine. Easy to interrupt the process, change the machining parameter that is current voltage and other settings more easily. Program the wire to follow a complex path in 2 axes for making the dies, for stamping, fine blanking and extrusion, 2D through holes.

Possible to tilt the wire in position other than the perpendicular to the X and Y. Have facility for speedy automatic realignment of the wire and it can do the 3D machining also using 2 additional axes that is U and V that is tilting forward and backward and tilting left and right, this wire can be tilted. So drive motors tilt the wires towards front and back that is V axis left and right that is U axis. Extent of tilt that is plus minus 10 degree will give the limitation of the machine tool.

In a very versatile tool all the 4 axes can be controlled by a controller and it should have a feedback controlled system for the work table, wire guide position to make a draft or relief in the mould for a constant radius corners along the tapered walls of molds and dies. So any kind of 3D surface can be made into the workpiece.

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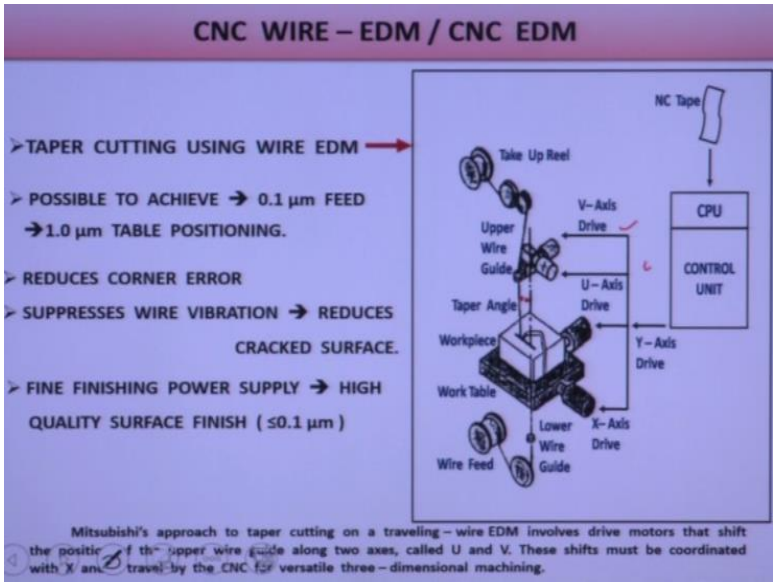

So this is the CNC wire EDM system. You can see here V axis, U axis is there. So taper cutting can be done using this wire EDM, the CNC wire EDM. Possible to achieve 0.1 micron feed and 1 micron table positioning is possible and it reduces the corner wire, corner error. Suppresses the wire vibration and reduces the cracked surface. Fine finishing power supply quality surface is less than 0.1 micron.

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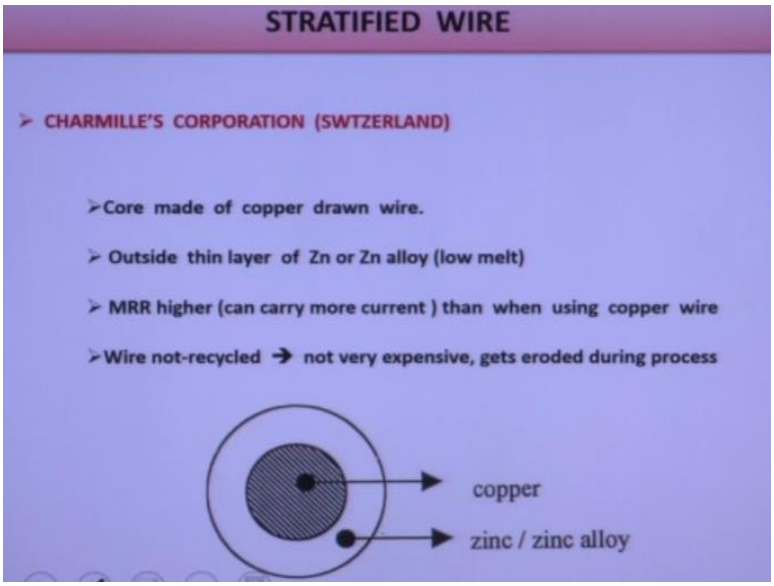

So there is a concept that is called this stratified wire. In stratified wire this core material is made of copper and the outer material is made of this zinc and zinc alloy. So this core material is made of copper drawn wire and outer thin layer is made of zinc and zinc alloy which has a low melting point than the copper. So if we need high material removal rate it should carry more current than

when using the copper wire. So wires are not recycled, so not very expensive and gets eroded during the process.

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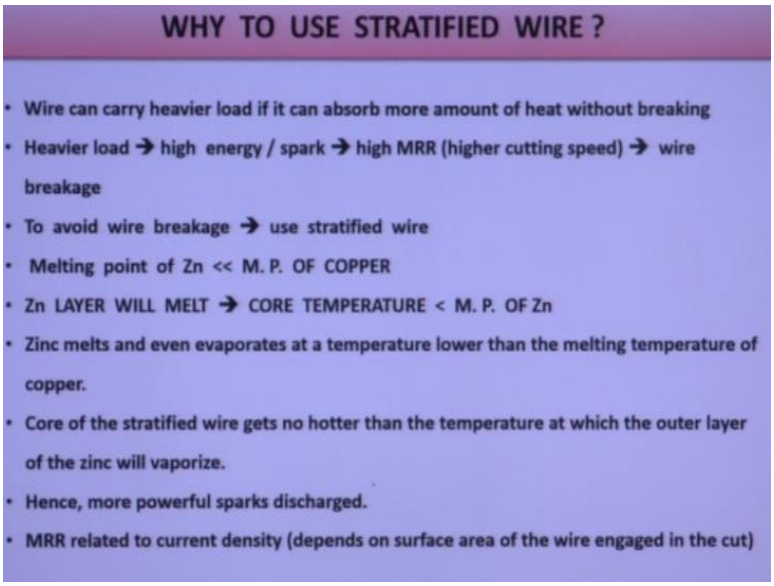

So wire can carry a load if it can absorb more amount of heat without heating without breaking. So heavier load means higher energy per spark. So higher material removal rate, higher cutting speed. So if we if we give more current to the wire so obviously there will be higher energy per spark will be generated. So material removal rate will be high. So in that case there will be wire breakage will be there. So to avoid that wire breakage this kind of stratified wire is used where core material is core of this wire is copper and outside there is a small layer of zinc or zinc alloy is there. The melting point of zinc is very very less than the melting point of copper.

So during machining during sparking actually this outside this zinc layer will melt but core temperature it does not reach to the melting point of the copper so zinc melts and even evaporates at a temperature lower than the melting temperature of the copper. So this core of the stratified wire gets no hotter and does not become hotter than the temperature at which the outer layer zinc will vaporize. So it does not break. Hence more powerful sparks can be discharged.

So MRR is related to the current density as the wire diameter reduces so your current density will be also high okay so you can generate high energy or spark, energy per spark okay. So your material removal rate will be high without breakage of the wire. So Charmille Corporation they actually developed this kind of stratified wire and this kind of stratified wire also they are it is not reused.

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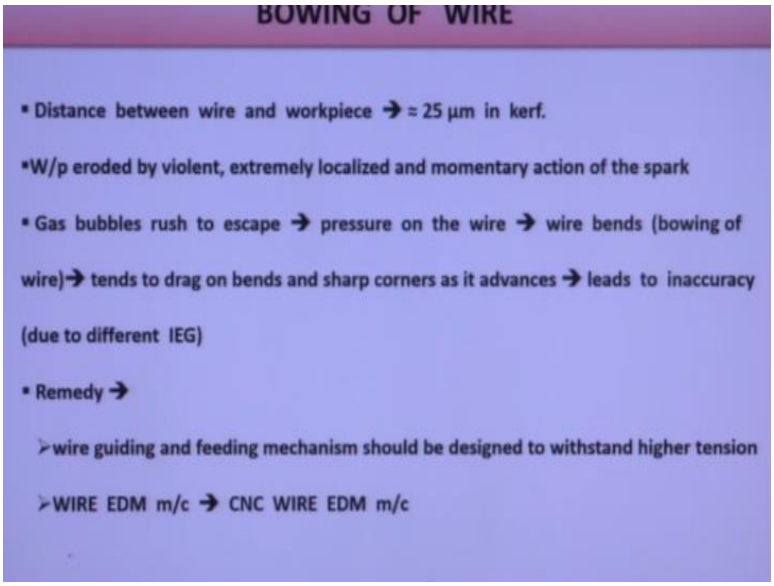

So another concept is the bowing of air wire. So because very small gap that is 25 micron is maintained in between this tool in between this wire and the workpiece and huge amount of so workpieces eroded by violent, extremely localized and momentary action of the spark and gas bubble actually erupted.

So this gas bubble actually comes in between this interelectrode gap. While this gap bubbles are generated this it comes from the interelectrode gap and because of this huge pressure by this gas bubbles it will actually bow it will bend the wire so because of this air pressure, pressure by this gas bubbles, it will pressurize on the wire and wire bends and bowing of the wire happens and it tends to drag the wire on bends and sharp corners as it advances and it leads to the inaccuracy due to the different interelectrode gap.

So this remedy is that your wire guiding system should be strong enough, so you have to make a very strong wire guiding system so that more tension can be given to the wire so that this wire should not bow during machining or during sparking. It should not bend during sparking.

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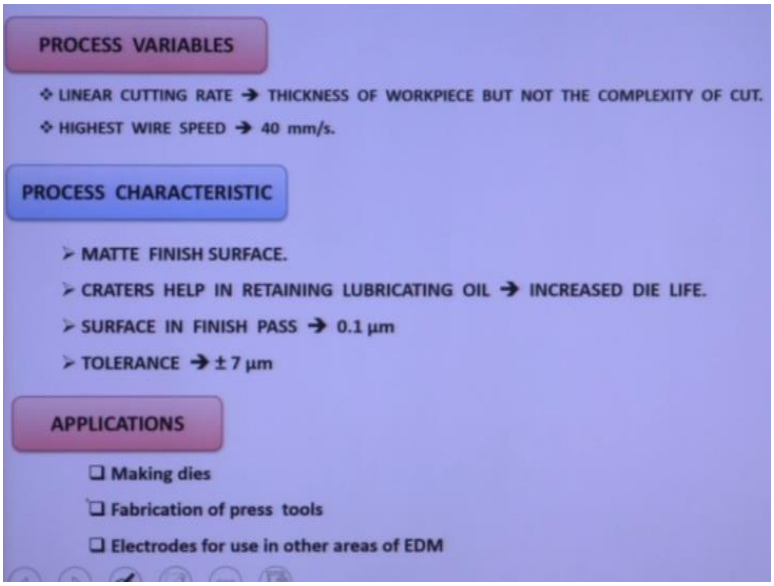

So this process variables, linear cutting rate. It depends on the thickness of this workpiece material but not on the complexity of the cut. So it depends, this linear feed rate of this wire, it depends on the thickness of this workpiece material. So highest wire speed is 40 mm/s. So process characteristics because of this craters generated because of the sparks craters are generated on the workpiece surface, this matte finish is actually generated.

So most of this wire EDM process is used for making dies, 2D or 3D complicated dies. So it needs the lubrication. So for better lubrication this kind of matte finish actually required. So it helps in better lubrication, this matte finish. So it helps in increased die life. Surface finish as low as 0.1 micron can be achieved and tolerances plus minus 7 micron can be achieved.

So these are the applications. It is used for making dies, fabrication of press tools. Electrodes, it is it is used for making fabrication of the electrodes which is used for other EDM process. So with this we shall stop this wire EDM process. Now we shall start okay. So there are some applications of this wire EDM.

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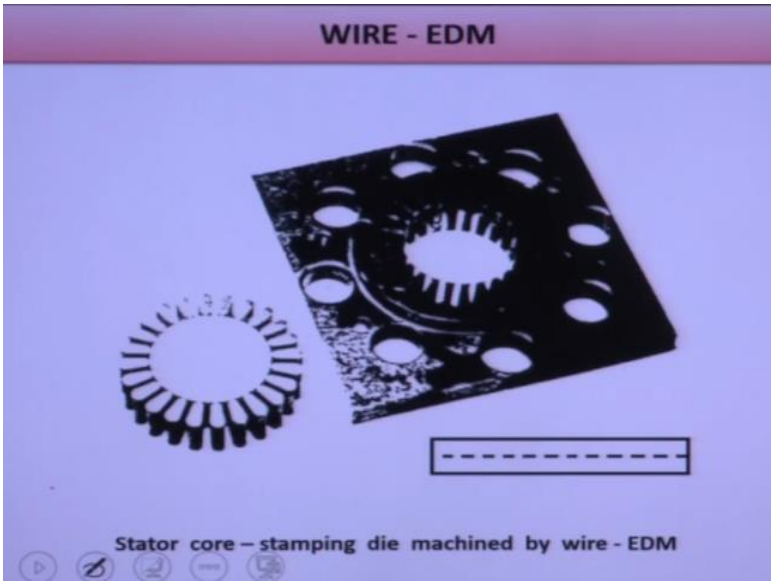

So you can see this kind of stator for the motor is can be made, this kind of complicated surface on a 2D complicated surface can be generated so which is used for this stator core is the stamping die machined by this wire EDM okay, can be machined by the wire EDM this kind of complex contour on a 2D surface can be generated by wire EDM process.

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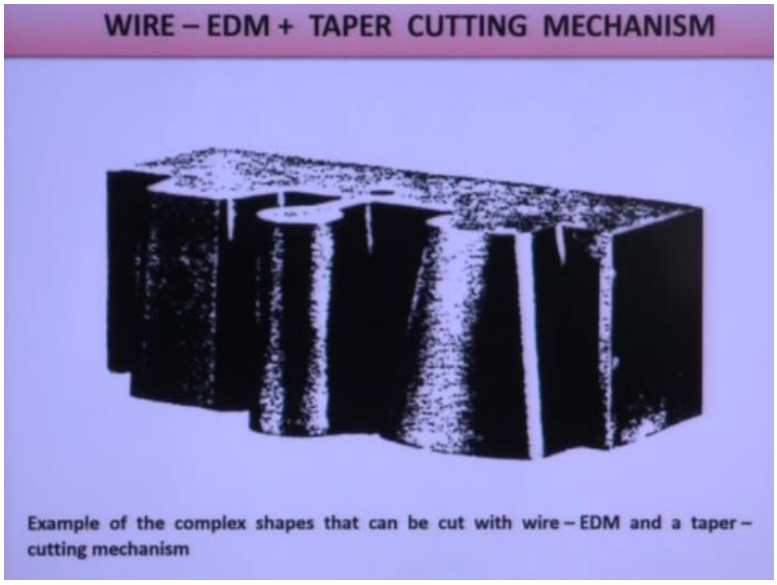

This is the example of complex shape that can be cut with a wire EDM and taper cutting mechanism. So this kind of inclined surface can be generated by a tilted wire in wire EDM process. So now we shall start with electrodischarge grinding. So grinding we know this conventional grinding process there 1 grinding wheel where this abrasive particles are bonded. So this grinding operation can be conventional grinding or hybrid grinding but in hybrid grinding

process one of the nonconventional machining process is also attached along with the conventional grinding operation like electrochemical grinding where normal grinding process is combined with the electrochemical process. So it is called electrochemical grinding.

Like electrodischarge grinding where normal grinding operation is combined with the electrodischarge machining so it is called electrodischarge grinding. Another one is the electrodischarge diamond grinding. So there normal grinding along with the EDM process is combined. That is called electrodischarge diamond grinding process. So these are the different grinding operations, hybrid grinding operations are there.

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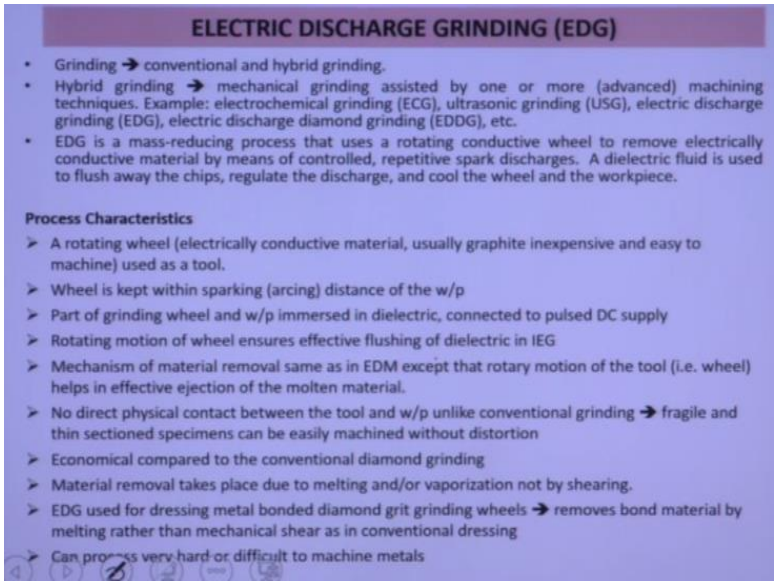

So this electrodischarge grinding also hybrid grinding operation. So it is a mass reducing process that uses a rotating grinding wheel to remove the electrically conductive material by means of a controlled repetitive spark discharges. A dielectric fluid is used to flush away the chips, regulate the discharges and cools the wheel and the workpiece. We know that in normal EDM operation so there is a very problem of the dielectric flushing system.

So dielectric flushing system should be as good as possible so that whatever debris are there that should not clog the interelectrode gap and because very small gap is maintained if some debris actually clogs there will be a short circuiting. After short circuiting it will damage both the tool and the workpiece. So effective flushing is required.

So in case of electrodischarge grinding so a graphite grinding wheel is used. This graphite grinding wheel like normal grinding operation, this grinding wheel actually rotates with a very

high RPM so because of this rotational motion of this grinding wheel and this graphite grinding wheel which is metallic, metallic graphite grinding wheel and the workpiece both are actually this part of the grinding wheel and the workpiece both are actually immersed into the dielectric medium and as the grinding wheel rotates at a high RPM so effectively this interelectrode gap it flushes away by the dielectric fluid. So whatever this debris materials are there it can be removed very easily by using this electrodischarge grinding operation.

So this process characteristics, a rotating wheel electrically conductive material, usually graphite so this graphite is taken because it is inexpensive and easy to this grinding wheel easy to fabricate by using a soft grinding graphite material. So it is used as a tool. So there is no abrasive particles are used like in conventional grinding operation.

So here a total wheel is actually conductive material no abrasive particles are used and this grinding wheel does not touch the workpiece surface. So it is like a electrode in case of EDM process. So this grinding wheel works as an electrode okay. So part of the grinding wheel and workpiece is immersed into the dielectric and they are connected to the pulse power supply. So rotating motion of the wheel ensures the effective flushing of the dielectric into the interelectrode gap.

So mechanism of material removal is same as the EDM except that rotary motion of the tool that is wheel helps in effective ejection of the molten material. So whatever this molten materials are there, so whatever the sparks are generated because of sparks this material is removed by melting and vaporization, whatever this molten material is there. So it is effectively removed or flushed away by the rotating motion of the wheel. So no direct physical contact between the grinding rotating grinding wheel and the workpiece. So any kind of fragile and thin section workpieces can be machined by this process.

Fragile and thin section specimens can be easily machined without any distortion. So economically it is very economical compared to conventional diamond grinding operation. So material removal takes place due to the melting and vaporization not by the shearing like in conventional grinding operation and electrodischarge grinding is used for dressing metal bonded diamond grit grinding wheels. So it is used for metal bonded diamond grinding wheel so for dressing of this metal bonded grinding wheel it is used because this sparking occurs in between this bonded material of the diamond grinding wheel and the rotating graphite tool.

So whatever this bonded material removed so it removes the bond material by melting rather than mechanical shear as in conventional dressing, so dressing occurs. So this bonded material is removed by melting operation okay so this dressing of the grinding wheel metal bonded grinding wheel can be done by this process. So it can process very hard and difficult to machine materials.

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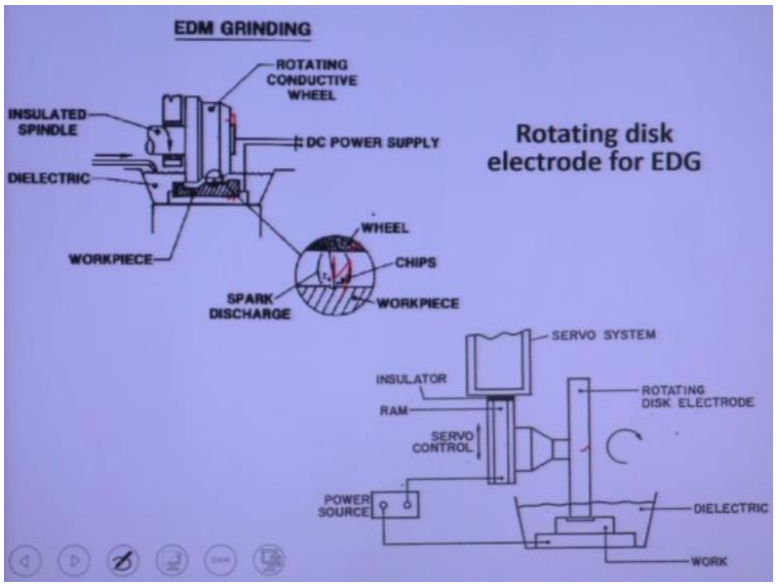

So here you can see this is the rotating grinding wheel, graphite grinding wheel is there. So this is the workpiece and you can see this is the sparking occurs. After sparking these are the debris particles, which is flushed away on the interelectrode gap by the rotating grinding wheel. So this wheel actually it is a graphite. It is a conducting material, conducting material, graphite is used. So you can see here this rotating electrode disk is there.

So it is servo control. If this gap between this grinding wheel metallic grinding wheel and the workpieces clogged using the debris particles okay so in that case actually this servo system actually removes the keeps away these XY table away from the rotating grinding wheel and so that this whatever this debris particles can be easily flushed away from the interelectrode gap.

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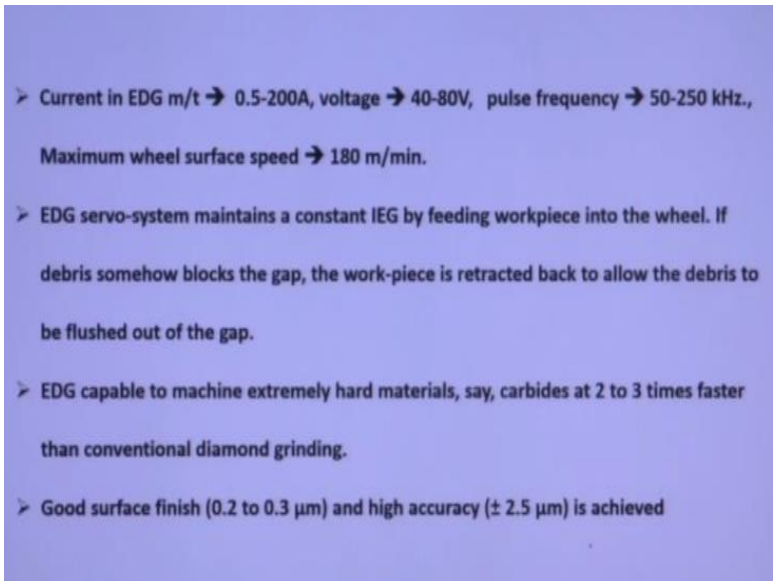

So current used in case of electrodischarge machine is 0.5-200A and voltage used 40-80V and pulse frequency 50-250 kHz. So maximum wheel surface this outer periphery surface is 180 m/min in case of electrodischarge grinding. So electrodischarge grinding servo system maintains a constant interelectrode gap by feeding the workpiece into the wheel. In debris somehow blocks the gap, the workpiece is retracted back to allow the debris to be flushed out of the gap.

So electrodischarge grinding capable to machine extremely hard materials say carbides and its efficiency is 2 to 3 times higher than the normal diamond grinding operation. So it is faster than the normal diamond grinding operation, conventional diamond grinding operation for cutting carbide tools. So it achieves good surface finish 0.2 to 0.3 micron, high accuracy plus minus 2.5 micron.

So now another hybrid process that is called electrodischarge grinding wheel. So in case of this electrodischarge grinding there is no abrasive particles are used, but in electrodischarge diamond grinding operation metal bonded diamond abrasive particles are used.

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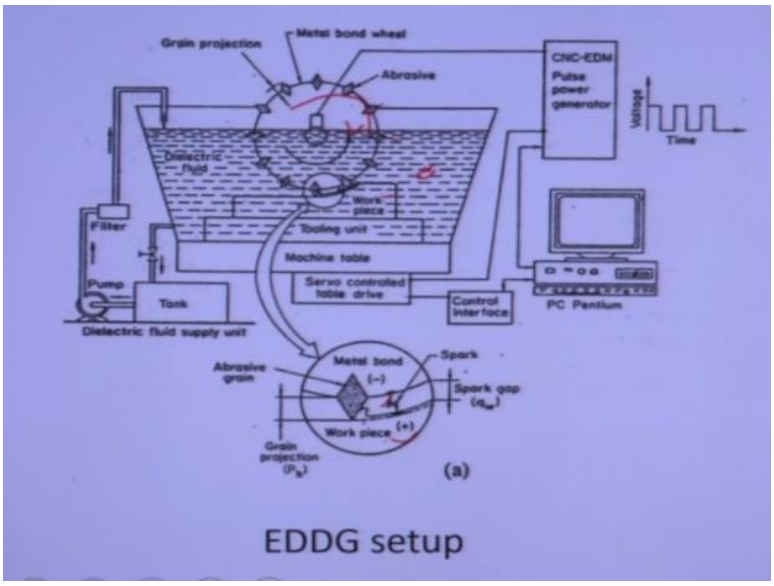

So you can see here this is the metal bonded diamond abrasive particles. So this is the grinding wheel is there which is metal bonding metal bonding metal metallic bonding material is there and these are the abrasive particles at the periphery of this grinding wheel. So these abrasive particles actually maintains, so this is the exaggerated view of the finishing machining zone you can see these abrasive particles diamond abrasive particles maintain the interelectrode gap.

So in between these 2 abrasive particles whatever this dielectric material is there this spark occurs in between these dielectric material here. So this spark occurs here in between this dielectric material here, dielectric fluid here. So spark occurs in between this tool, metallic bonding metallic bonding material and the workpiece okay.

So part of the bonding material and part of the workpiece melts and vaporizes and machining and become very soft. When this soft molten material is there at the same time this abrasive particles are also moving. So this abrasive particles, diamond abrasive particles easily removes that soft molten material from the workpiece okay. So like this actually there are 2 process, EDM process which melts the bond melts the softens the material because of the sparking.

So this material from the workpiece become in the molten condition and becomes soft and abrasive particles easily can remove this soft material okay. So we can easily can understand that this life of this metal bonded grinding, diamond grinding wheel is 10 times higher than the normal diamond grinding conventional grinding wheel. So this part of the this grinding wheel and workpiece is kept inside the is immersed into the dielectric chamber.

So this is the means working chamber, machining chamber. This is the workpiece. So like this this machining is going on and there is a filtering system is there. So it will filter. So whatever this dielectric is there it will filter and it will return back to the tank and easily pump. After filtering it will go to the dielectric means machining chamber again. So this workpiece actually it is fixed on a XYZ table which is controlled by a CNC machine.

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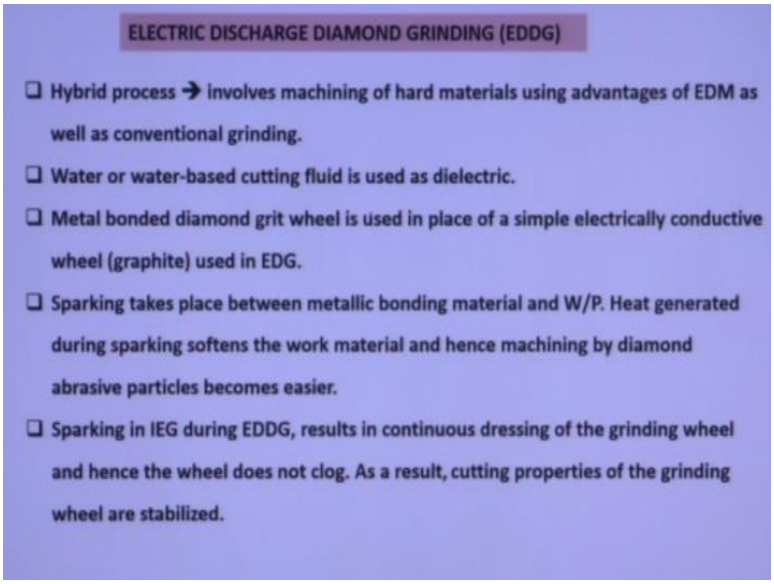

So hybrid, this hybrid process involves machining of the hard materials using advantages of EDM as well as conventional grinding operation. Water or water-based cutting fluid is used as the dielectric. Metal bonded diamond grit wheel is used in place of simple electrically conductive wheel like graphite which is used in EDG process, electrodischarge grinding process. Sparking takes place between metallic bonding material and the workpiece and heat generated during the sparking softens the workpiece material and hence the machining by diamond abrasive particle becomes very easier.

Sparking in interelectrode gap during electrodischarge diamond grinding results in continuous dressing of the grinding wheel. So this sparking occurs and this machining occurs in between this in this workpiece as well as sparking occurs in the in the metallic bonded grinding wheel also. So dressing of this grinding wheel also occurs simultaneously. So there is no dressing operation is required during electrodischarge diamond grinding. So there is a continuous dressing of the grinding wheel hence the wheel does not clog. As a result cutting properties of the grinding wheel are stabilized. Uniform grinding operations are maintained.

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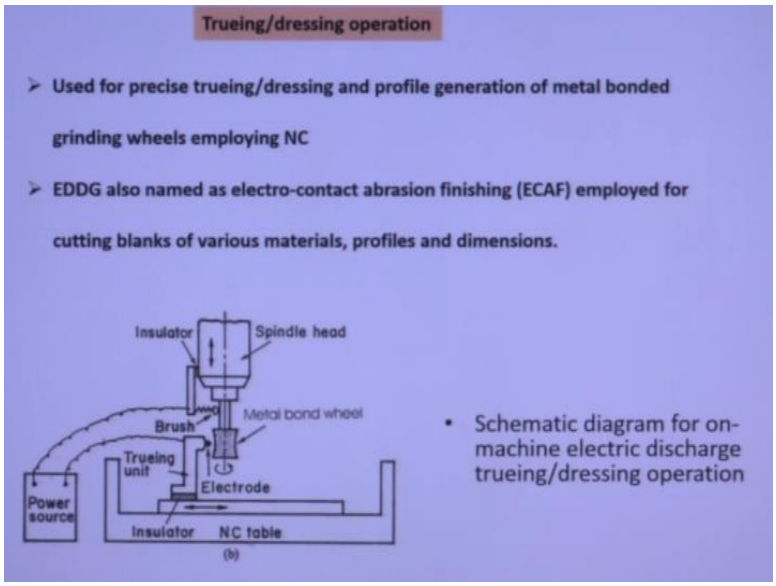

So this trueing and grinding operation using this electrodischarge diamond grinding you can prove, you can do the trueing operation or dressing operation. So used for precise trueing or dressing and profile generation of metal bonded grinding wheel employing this NC concept. Electrodischarge diamond grinding also named as electro-contact abrasion finishing, electro-contact abrasion finishing, ECAF employed for cutting blanks of various materials, profiles and dimensions.

You can see any kind of surface contour surface can be generated on a metal bonded wheel. So this is the metal bonded wheel. So this is the electrode here. So this here this machining is going on on the metal bonded wheel so any kind of contour or curvature can be generated here using this electrode, round electrode okay. So this workpiece is here metal bonded wheel is rotated here and by giving this up and down motion and xyz motion also, any kind of shapes can be generated so by trueing and dressing operation. So any kind of shapes into the metal bonded wheel can be any kind of formed shapes can be generated on a metal bonded grinding wheel by using this electrodischarge grinding operation.

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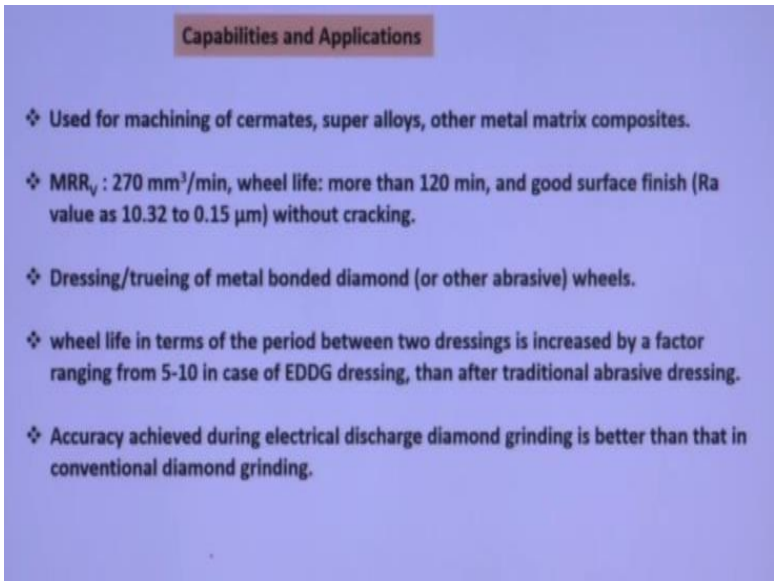

So capabilities and applications used for machining of ceramics, super alloys, other metal matrix composites. Material removal rate in case of electrodischarge diamond grinding is very high. It is 270 mm cube per min. Wheel life is 120 min. Wheel life means dressing between 2 successive dressing operation. So it is 120 min and good surface finish is achieved from 10.3 to very high to 0.15 micron based on your applications without any cracks.

Dressing and trueing of metal bonded diamond wheels or other than diamond any kind of abrasive wheels, metal bonded abrasive wheels can be done. This dressing and trueing operation can be done. Any kind of shape, contour shapes can be generated and wheel life in terms of this period between 2 dressing is increased by a factor of 5 to 10 times in case of electrodischarge diamond grinding dressing than after traditional abrasive dressing operation. So accuracy achieved during electrical discharge diamond grinding is better than that of conventional diamond grinding.

Thank you.