Welding Processes
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Variants in resistance welding Part 01

We will start from last class what we left as we looked at some of the problems that are associated with the resistance spot weld.

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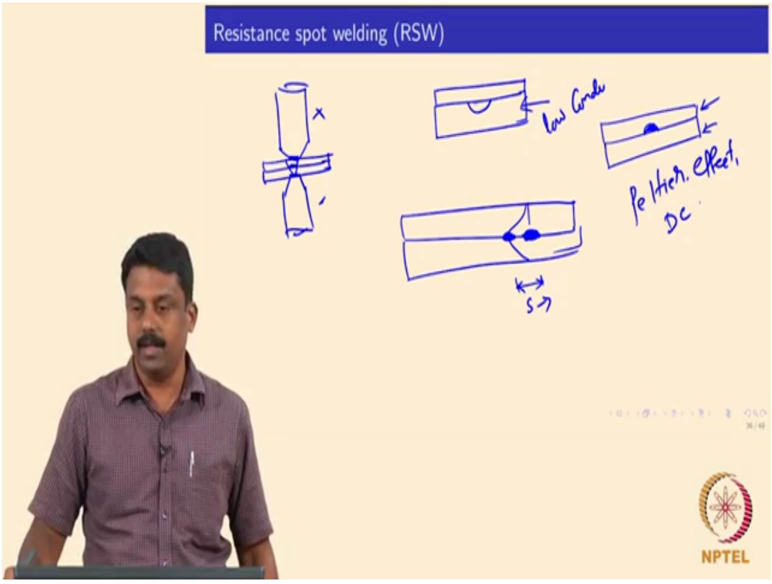

Suppose if you have a dissimilar thicknesses, so if material has a very high thermal conductivity or electrical conductivity and if you are using a case where thicknesses is not different. So suppose if material has different conductivity or the same conductivity which is higher and you are welding a two sheets, if a material has higher a conductivity so obviously the mass of the larger thickness would conduct the heat much more effectively that means that you may not make the welds at all in the thicker sections, you will end up making weld only at the thinner sections because heat is contained, there is no mass effect to transfer the heat effectively from the thick section welds sheets.

On the other hand in contrary, suppose if material has low conductivity then what will happen? The heat is contained, so it is not effectively contained and whereas in this case the heat can be conducted because of so approximately two weld, so material has low conductivity obviously you will end up making the welds only at the thicker sections so these are some problems you may expect when you are doing dissimilar thicknesses and the same effect can also be seen if you are welding a similar thicknesses material with different composition the same effect you also see.

Suppose one material has high conductivity, whereas another material has low conductivity so obviously so you will end up making weld only if the material has the low conductivity because heat can be conducted in other side and these effects are very predominant and when you are doing dissimilar welding, either it is similar thicknesses or dissimilar materials. So this you will always have a problem in a commercial production where thicknesses may not be same all the time.

So you will have to look at the material composition if the similar material how you can optimize it, one way of optimizing it is do not change the electron diameter accordingly so that you deduce the you optimize the thermal conduction to make the welds in the same size in both top and bottom plates or you can also change the electrode material accordingly, so one electrode can be made into high conductivity copper and other one with the alloyed copper so that you can contain the heat, is it clear? Okay, so these are some of the problems.

The other problems we looked at is the shunt effect, shunt effect happens when you place a weld very close to each other, so the S the distance between two L it is very critical so if you look at the cross section of the resistance spot weld, so if you have one weld you placing it here, another weld if you are placing it very close to each other then what will happen when the electrons when they travel from the electrode to the other electrode and they would always find the least resistance path, so instead of travelling it may also go through the weld which is already made.

So obviously instead of making a weld here you will end up heating the weld which you already made, the shunt effect is very common so that is why the distance S between the weld is very critical. So we will have to identify the distance between the weld, what is the critical levels so that we can minimize the shunt effect.

So the other effect we saw was the Peltier effect, Peltier effect so it is opposite to the Seebeck effect and in resistance spot welding you always have dissimilar junctions. So if you have copper electrode and then you are welding a shield sheets two sheet shields, so you always have some junctions, for example you have a one dissimilar junction here and the other one over there. So here the ion copper junction ion copper junction is ion ion junction.

So suppose if you are passing a DC current and EMF so between two positive and negative terminals where the electrons will travel from the cathode to anode and when you have a dissimilar junction and you are passing an EMF the dissimilar junction would never be in same temperature so that is opposite of Seebeck effect, so Seebeck effect says that when you immerse in two dissimilar junctions in two different temperatures there is EMF generated that is what Seebeck effect.

So the same concept would also work you have dissimilar junction you pass an EMF and these two dissimilar junctions would never be in same temperature, one will be hot and one will be cold. So that can happen when you are reaching DC current direct current to weld resistance spot welding and you have an EMF sent through at dissimilar junctions, so obviously these junctions may never be in same temperatures.

So obviously one end you may end up heating it more than other end, so the weld may not be uniform you may always have when dissimilar heating end up changing the weld nugget size endogenously. So this Peltier effect is common when you are using a DC current to weld direct current to weld so that is why in most of the cases in resistance spot welding we always use alternating current, where the polarity switch in a cycle so in alternating current polarity switch so we can overcome the effect of dissimilar junctions being hot and cold, is it clear?

So these are the quite common problems we see regularly that is what we discussed in last class and we will move on to the next section to see the other variants of resistance welding.

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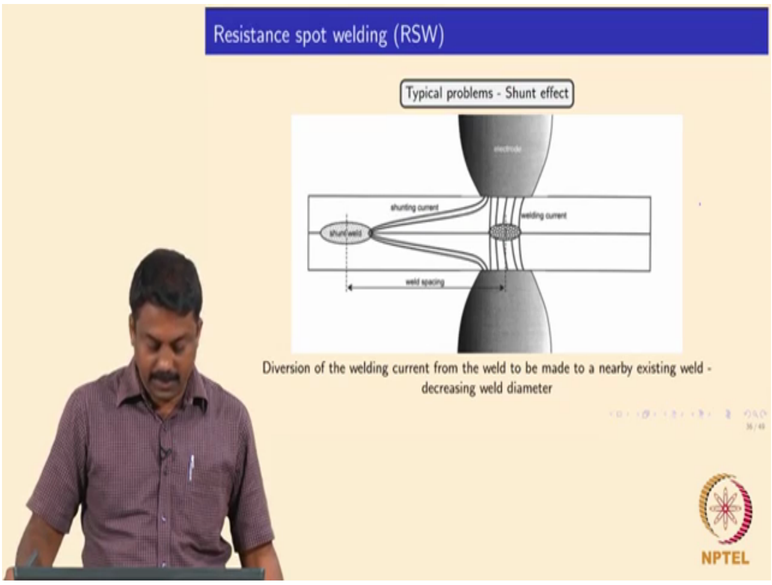

Okay, this is clear right? Shunt effect? Shunting current.

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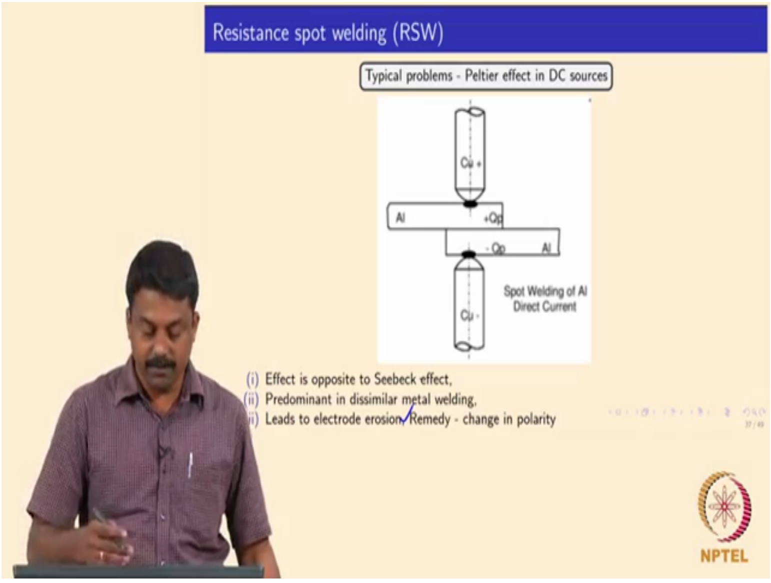

And then the Peltier effect, right? So you will expect an electrode erosion very severe electrode erosion and because of the dissimilar heating.

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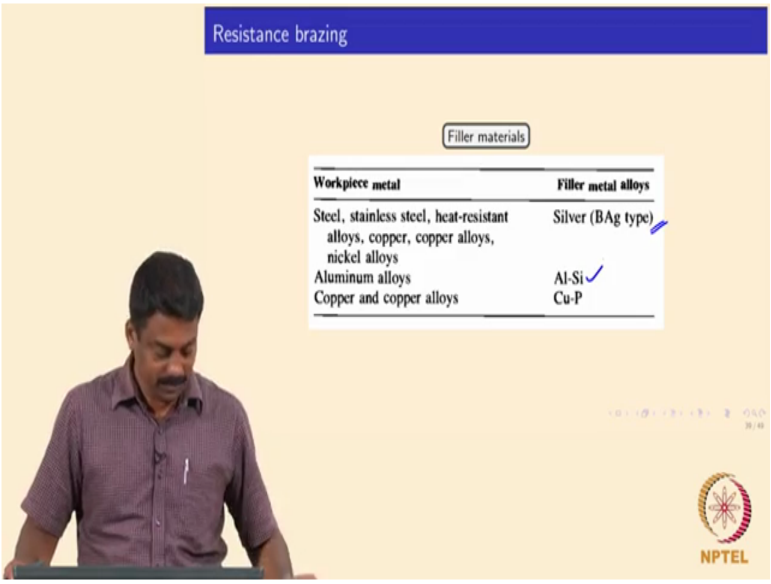

And then this class we will move on to the next unit in this section and which are actually derivatives of the resistance heating process. So we use various modifications of Joule heating and then we also add extra material so that the joint geometry as well as joint property can be improved significantly and we can also extend the range of material that can be welded by resistance heating.

So one such method is resistance brazing, resistance brazing the concept the heat generation mechanism the physics is the same as resistance spot welding so where we have two overlapping joints made using two electrode by passing an alternating current, Joule heating is carried out by contact resistance and then you can do nugget formation. In most of the cases as we explained the material should be compatible, so if you look at the if you recall the table that I showed you a a, b b the compatibility of the material suppose if you are welding aluminium to stainless steel it is e it is very difficult to weld because of the cracking that is actually happening when you are doing dissimilar weldings because resistance spot welding you always have a load acting on it and the weld joint.

So in order to overcome that problem, so we can also add extra filler material in between the overlapping sheets that is the possibility and this filler material can be compatible with both sheets you are welding. So if you are using a filler material and this filler material can melt can make a joint between the two (())(8:47) interfaces. So in this setup it is same for example you have an electrode and the overlapped joint but before making overlapping we keep some filler material in between these joints.

So most of the cases the fillers are flux coated wires so that it can act as a butter layer so generally we call it as butter layer just to add butter to on a toast so that it goes in your stomach without any problem. So we also add some butter layer in between the faying interfaces as a filler and these fillers can be flux coated mostly silver or low melting constituents, solder alloys or sometimes even we can also use a similar material sheets of for example steel aluminium you can place a nickel I am just giving you an example.

So this filler can be placed in between the sheets and then you are basically creating more interfaces, more contact resistance. So you will end up melting the filler and the filler can wet the surfaces and then it can also diffuse to the surfaces and this filler can be compatible for both the sheets and by doing so so you end up making joint when the filler solidifies and then you can also make it use it for a large parts because the filler can melt and make a complete scene for example a longitudinal section.

Whereas in spot welding these are done in different geometries, different diameter, so if you are keeping a long filler and then you use a long electrode and melt it you may make a very good joint, you need not melt the interfaces of the base material, you just melt the filler and the filler solidify and then weld solidification, now it can make complete weld across interface, it can be used for smaller parts, for bigger parts.

So in bigger parts in this process generally we use the graphite electrodes for example here the graphite electrode and then we have large work pieces and the filler is kept in between and the electrodes are (())(11:25) each other to each other and then apply a load, pass the current and this flux melts then makes the joint complete. In this process in most of the cases we do not completely melt the base material.

So the filler melts and then we may end up melting at the interface and then the diffusion would complete the weld joint, so that is why this process is mostly known as resistance brazing because the work piece is not molten completely. So filler generally we use is low melting alloys say for example steels stainless steels, heat resistance, alloys, copper generally we use the silver base silver type the braces, the melting point of the silver base solder are slightly higher temperature, so you need to use more current in order to identify in order to melt the fillers so that you can deposit.

But we replace (())(12:37) with the silver and then the cosmogenic problems can be overcome. So the silver paste or a silver filler with the flux coated silver wires are very commonly used for brazing applications, brazing and soldering applications and these silver base solders and braces they can also withstand higher temperatures because melting point is slightly higher than (())(13:02) base solders. So for brazing applications now we commonly use silver fillers in order to keep interfaces like I showed you, molten and then make a joint, so that is why you do not have modern the filler wires for the solders and brazers are slightly expensive because of the use of silver.

So for a good brazing so we can also use silver paste otherwise we can also think about copper alloys, so copper alloys melts in a similar temperature we can also bring down the melting point of copper by adding phosphorus so the copper phosphorus system they are also used for basic applications, you can develop a filler with the copper alloy place it and then apply current and load the filler melts and make a joint.

So the aluminium alloys aluminium silicon filler is very commonly used not only for welding also for brazing applications and if you choose aluminium 12 percent silicon, so why aluminium 12 percent silicon? (())(14:14) composition so melting point will be much lower than aluminium alloys, the other aluminium compositions, so you can use aluminium silicon filler so that melting point can be lower and you can heat it up until an melting point of the filler and then you can make a brass braze joint, is it clear? Any question so far? Good.

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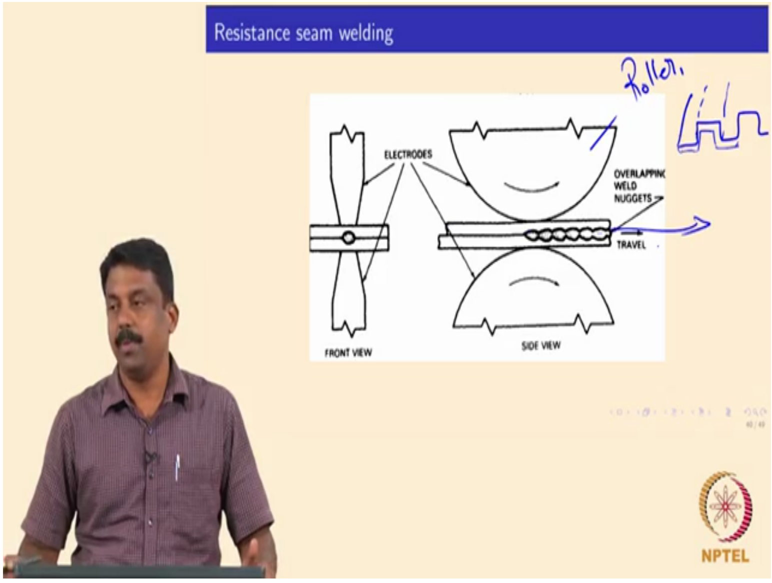

So we will move on to the subsequent to resistance brazing a resistance seam welding, the resistance seam welding so instead of using in a single point electrode we use a roller electrodes, so roller electrodes it is the concept everything is the same so instead of using it in a single point contact we will have a wheel which act as an electrode and the material which is to be melted it is actually sent to these rollers and then you pass a current and load is applied like a same way what you do it resistance spot welding, only here is because material is continuously sent through the rotating rolls and you will end up heating the interface continuously like a seam and then you will end up making in a continuous seam welding through the length of the sheet which is actually fed to the rollers and this is very commonly used for welding long sections, long and thin sections.

For example in most commonly application of this roller resistance seam welding used to make fences or corrugated sheets, roofs. Have you seen the roofs of corrugated sheets? Something like this, so these sheets sometimes may contain that couple of two rolls, two sheets or four (())(16:18) two (())(16:19) they call it, so they may also have in a different sections and these are all welded using resistance seam welding.

Similarly the next window frames, so if you have long fences made of flat sheets you can buy them so these kind of corrugated sheets and those are all made using resistance seam welding, where you will have a rotating electrodes and then the flat sheet is sent through the electrode and you may also have additional work rolls which would actually bend or change the shape of the sheets and then once it fed to the electrode rolls then you pass a current so obviously when the sheet is moved towards the other side then you may end up melting the interface continuously, is it clear? Then you will make a continuous seam welding.

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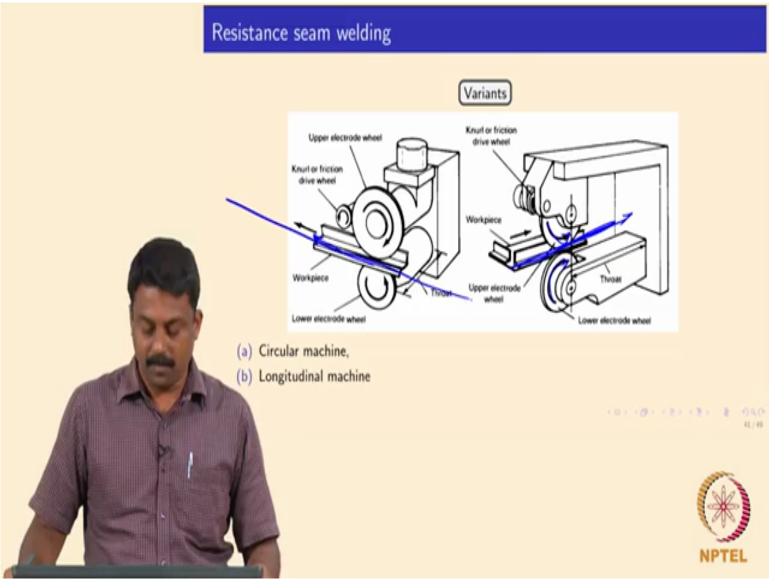

And this process is also commonly used for pipe making or tube making, okay. So tube making also very commonly used, so instead of making in a flat rolls you may also have a bending rolls, the bending roll would bend the sheet and then using a induction coil you may also have a current passed at the interface and contact resistance subsequently would melt and then make a joint.

So the seam welded tubes and pipes are also used are also made using resistance seam welding and if you look at it, it can be circular configuration or longitudinal configuration, so whereas in a circular configuration you can make a continuous seam of weld, so if it is fed rotating like this you can send the continuous sheets along these rolls and you can make as long as possible the seams.

So the sheets of the alloys can be overlapped and then send it through the roll and then the weld can be made continuously or it can also be made into the reciprocal way. For example the wheels can be rotated and then it can be welded and subsequently we can also rotate in other direction and you can also make subsequent welds. So this is circular machine and this is longitudinal machines where the motion control can be reciprocated in such a way that we can also do in an alternative way, so that is also possible.

So objective of this is to extend the resistance spot welding into much longer weld with a seam like seam means continuous longitudinal weld made over a large dimensions, is it clear?

So these are also commonly used for making engineering applications mainly on thin sheets and if you want to build a component out of thin sheet which already (())(19:27) and the seam welding can be used.

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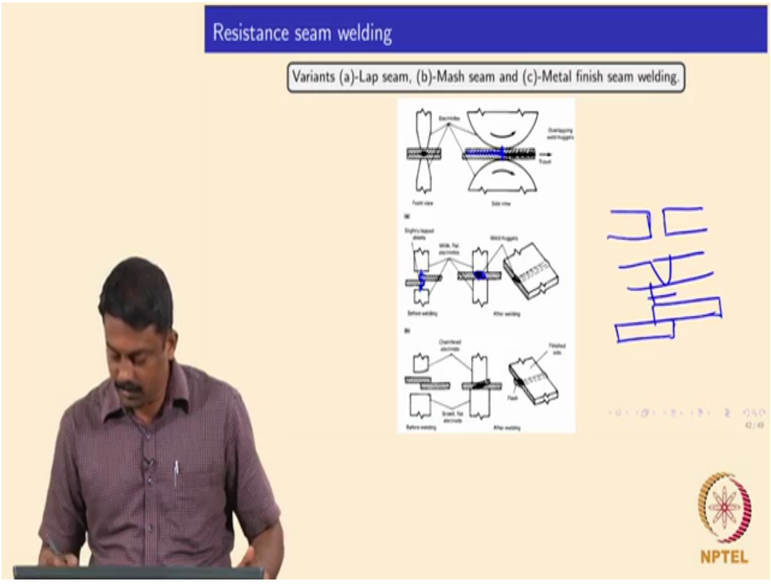

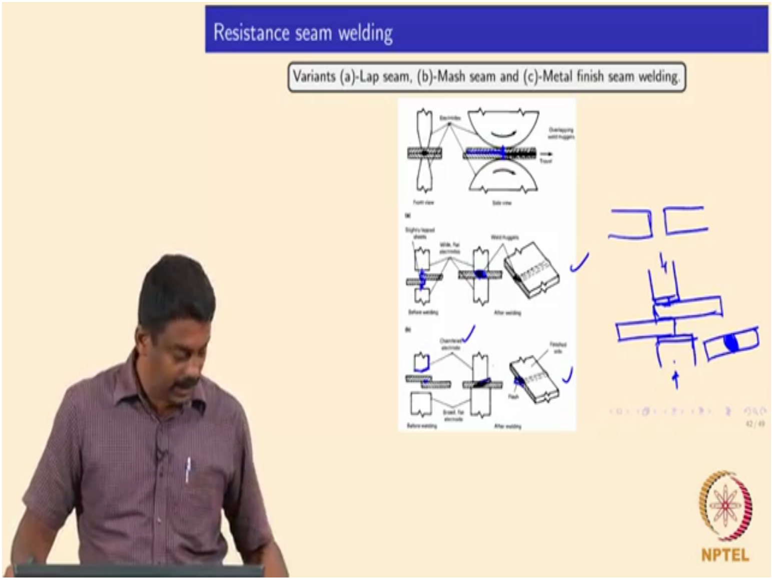

Some of the variants of resistance seam welding. For example lap seam welding I showed you already in the first image of resistance seam welding, in lap seam welding so basically you have overlapped joint and these overlapped joint the sheet is sent in between the rolls and the rolls are electrodes, so (when the electrodes) when the rolls pinch the sheets so obviously it is at a given time T it is like a spot weld, so at a given time it is like a spot weld, where you make a weld but it is actually continuously moved.

So you melt it and then it is continuously moved and subsequently the other area will come into contact in the electrical circuit with least (())(20:17) so direction for the electrons and you will end up heating by the contact resistance or the interface and then you will make continuous seam, is it clear? And then we can also add the advantage of mechanical forces that we may also subject these interfaces to enhance the weld quality or weld material properties.

Say for example in this case this mash seam, so mash seam is done we will have instead of overlapping so you may also have a (())(20:51) fillet configuration and then you keep the sufficient force in such a way that you may also have a mashing effect once you heat up the liquid interface above the melting point so you can also apply a mashing so that you may end up creating a joint sort of closed to the butt weld.

So butt weld is basically you have a joint something like this, so when you have you can make a weld so you will have weld made something like this. So similar configuration you may also achieve in mash seam weld so where you keep material in slightly in a filler configuration and then you have an electrode (I will take this off) so top electrode and bottom electrode. So push it, so once they are in contact with the work piece you pass the current, you melt the interface and this become really softened and then apply mashing load in such a way that and this two becomes one with a weld in between, so this is similar to what you do in a butt weld configuration and this is known as mash seam welding.

And you may also have finish welding, so in this case so this is like it is sort of you have an overlap as well as shearing action takes place during welding, so one of the electrode is slightly tapered so this case and then you again the process is same as resistance spot welding you bring the electrode in together and then at the contact resistance heat up the interface and upon achieving required weld directions the melt pool and then you do on a mashing action so that so you take away the access material and then shear it out as a flash.

So advantage of this process over this process is in this case the edge preparation is not really necessary. So in this case so you will have to make sure that the edges are prepared well and if it is oxidized and it will end up trapping inside the melt pool because the flash is not removed, flash is contained inside the pool. So the edge preparation should be very good in such a way that the surface the oxides or any other contaminant those are removed properly in mashing welding.

So whereas in metal finish welding the electrode is kept slightly shampered in such a way that so when you are doing welding the access the surface it is actually it is coming out as a flash. So the surface preparedness the efforts can be minimized in metal finish welding because the previous surface is removed as a flash. And this process, this methodology is also commonly used in various resistance base processes. So we will move on to the other processes where we can also look at it.