Joining Technologies of Commercial Importance

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Lecture – 16
Brazing

Hello, I welcome you all in this presentation with the subject joining technologies for the metals.

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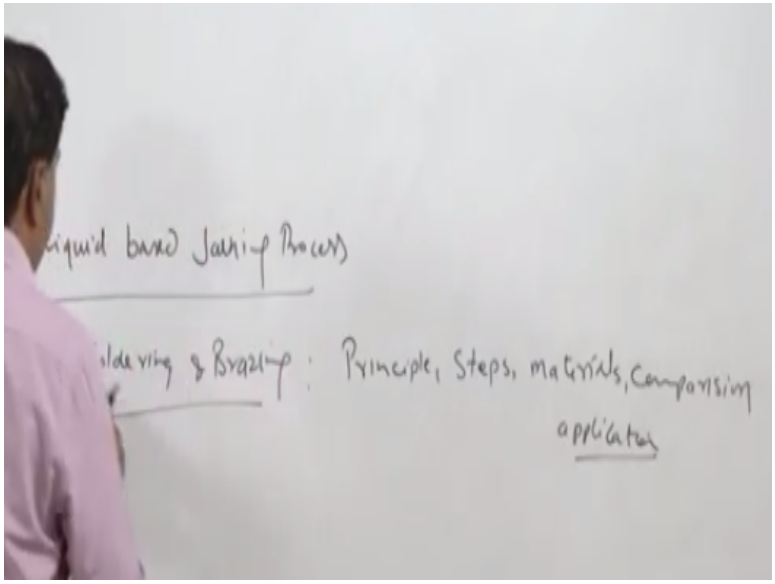

In this presentation, I will be talking about basically the two, the solid-liquid based joining processes. These are commonly known as soldering and brazing. So related with these two processes, we will be taking about the basic principle of these processes steps, the materials which are used like the fillers and the fluxes. Thereafter, comparison between the two like soldering and the brazing and along with the application of the two processes where these are used.

So as name suggests, these processes fall in category of solid-liquid based joining processes.

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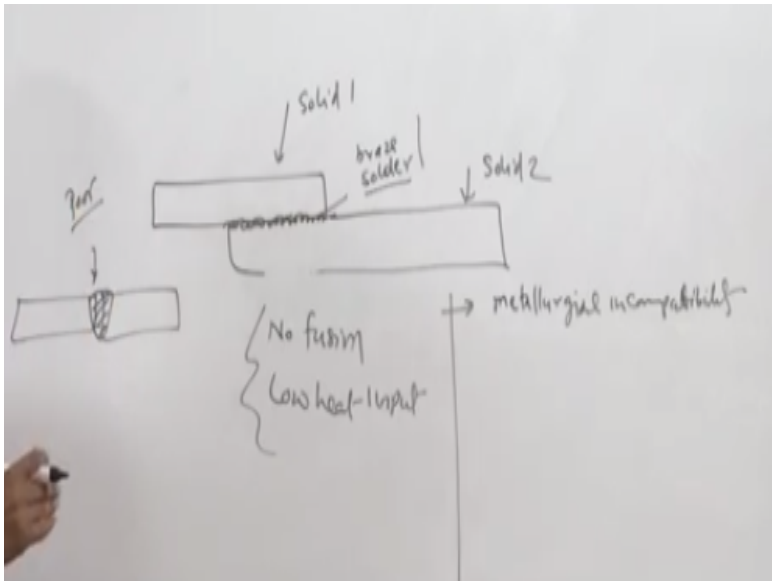

Why are these called so because the base metals to be joined are kept in solid state means, they remain in solid state like 1 and solid 2. While the material which is used for developing the joint between these two is brought to the molten state, which is called either called braze material or solder as per the kind of the process to be used. So brazing material are the solder.

That is why, so here in this case only heating is involved, there is no fusion of the base metal and heat which is required for a melting the filler metal is also very limited. So the heat input is low in these processes. So these are the two very attractive feature and because of these only it offers many advantages. Like absence of the fusion and very low heat input requirements for developing the joints between the two systems.

And this benefit is exploited in number of situations for example, for all those cases where the components like 1 and 2 have the metallurgical incompatibility. So if, after the fusion if the two forms unfavourable things and which lead to the formation of the very poor joint strength, like if 1 and 2 are fused to together and if they are metallurgically incompatible, the kind of joint which is formed is very poor in terms of the strength or ability to sustain the service conditions for long.

So it will not survive or it may cracked immediately, it may get damaged immediately as early as the joints developed. So these kind of situation wherever the joint is to be made between the two systems or the two components in solid state, which are metallurgically incompatible with each other.

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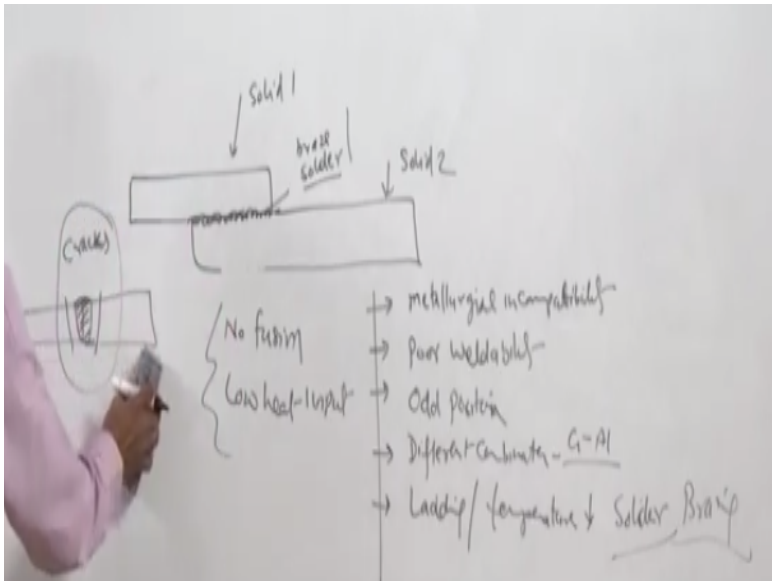

Another is those metals which have the poor weldability means they can be fused but when the joint is made, the kind of properties that we obtain are poor like this, the two components to be joined having the poor weldability when they are fused either it will result in lot of ferocity in the weld or cracks in the weld or in the heat affected zone.

Heat affected zone is either is very soft and or very much hard and lot of welding related issues are involved in the joining of the metals such kind of metals using the fusion welding processes then they will be considered as a poor weldability and better to join them using the solid liquid based processes like brazing and soldering.

Another is odd position welds, like if the molten metal cannot sustain during the odd position welding, then it is always good to make a joint using such kind of processes like brazing and soldering, which will allow just the heating of the base metal and melting of the filler metal for developing the joint between the components, then there is like completely different combination is to be developed like entirely different combination is to be brought in.

For example, like glass and aluminium or completely any other thing which the physical and the mechanical characteristics of the two systems are completely different, they can be joined together using these brazing and soldering processes. Another suitable area wherever the loading conditions during the surveys as well as the temperature conditions to be experienced by the joint is very limited, very less, there these kind of the joints like shoulder joints and the brazing joints are found to be very useful.

So these are the benefits which are exploited due to the unique feature which is associated with the brazing and soldering that it involves just a heating of the base metals and melting of the filler metal for development of the joint. Limited heat input ensure that metallurgically incompatible poor weldability metals can be joined effectively for development of joint.

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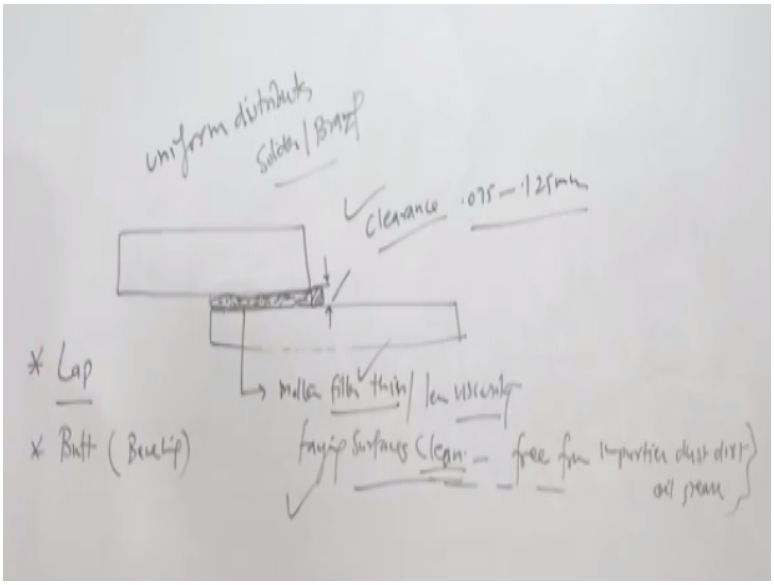

As far as the process principle is concerned and the process is concerned here, what we will do the components mainly the two types of the joints are made, the most common one is the lap joint configuration and sometimes even butt joint can be made for those cases, but for making the butt joint, sometimes beveling is in which especially tried so that the required joint strength can be achieved.

For as far the lap joint is concerned, the plates of the sheets to be joined are kept in lap joint configuration and particular gap between the plates and the seats to be joined is maintained, which is called clearance. This clearance plays a very big role for successful brazing and soldering and this is kept like 0.075 to 1.25 mm1 queue because this gap ensures that whenever the brazing or soldering material is brought to the molten state by the application of external heat.

This molten solder or brazing material will be sucked in inside the gap between the faying surfaces of the component to be joined and by the capillary action. So capillary action will be effective only if the two conditions are there, the molten filler is very thin of less viscosity one and the faying surfaces means the surfaces of the component being joined are very clean being surfaces are clean enough.

So these must be the surfaces must be free from impurities like dust, dirt, oil, grease etc, so proper cleaning is needed of the surfaces to be joined and the gap is maintained once the plates prepared properly, proper gap is maintained, heat is applied once it has become hot, the filler metal is applied, filler metal either brazing or soldering material will be brought to the molten state, so it will be sucked in by the capillary action between the components.

It will be sucked only if it is thin enough and less viscous and having very clean surfaces if the proper gap is maintained. So gap, thinness of the material as well as proper cleaning of the faying surface are very crucial for uniform distribution of both solder as well as brazing material. If it gets uniformly distributed, then the proper joint stress is achieved. If it is left some of the places.

Then that area will be left unjoint and the joint strength will be poor in that case. So proper surface preparation is very crucial for developing the good weld joints.

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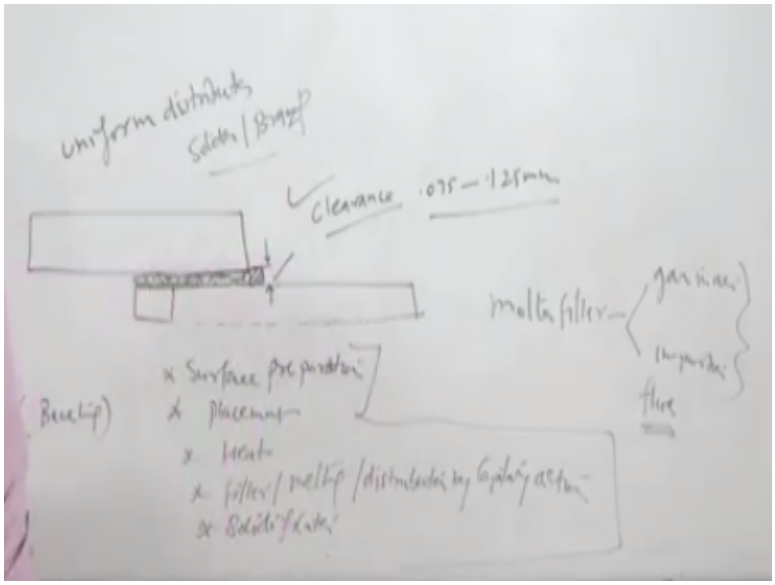

So here as far as the steps are concerned, first the surface preparation with the proper cleaning preparation. The second is the placement with the proper gap. Third is application of the heat, then the filler is brought to the molten state melting and then distribution by the capillary action and there followed by the solidification. Once the solidification is completed, the joint is prepared or joint is ready.

But we know that despite of the proper cleaning, if some of the impurities are left the

surfaces, the molten filler will be able to interact with the gases in air or like impurities present on the surface. So these two things must be taken care of properly and for that purpose, the impurities and the kind of compounds which are formed by reaction between the filler and the atmospheric gases like in form of oxides, the fluxes are used.

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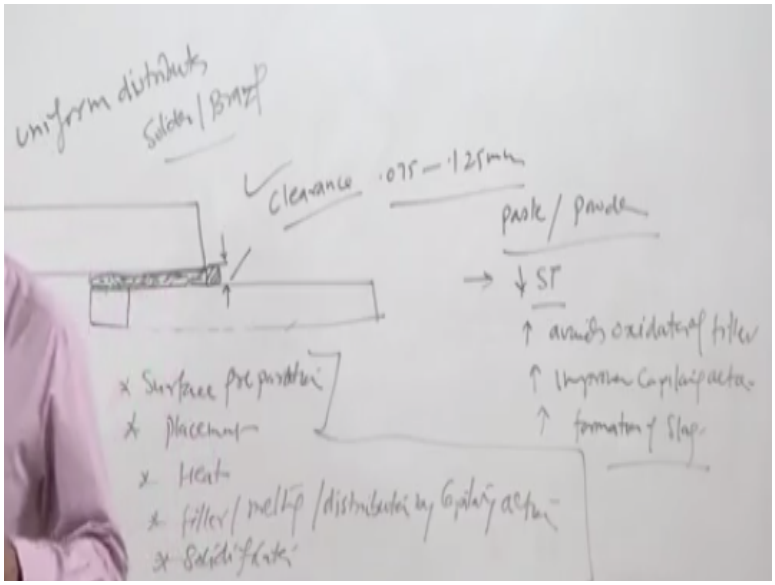

So fluxes are also applied or placed before hand when the filler metal is placed so that the flux also melts along with the filler metal and it works effectively in number of ways. so the application of the flux namely may be in form of like paste, powders which is applied and then this flux after melting does number of things like it lowers the surface tension of the filler metal, it avoids the oxidation of the filler.

And so surface tension is reduced it, helps in making the, means improves the capillary action in better distribution and the flux also interacts with the impurities to form slag so formation of a slag by reaction with the impurities. So flux will be reacting with the impurities and the slag.

Flux will be reacting with the impurities to form slag, and this slag being lighter is removed from the surface. So this is about the butt joint configuration. We know that this is about the lap joint configuration and we know that if the butt joint is to be made for a particular application then for that purpose different some special arrangement must be made in order to achieve the desired joint strength.

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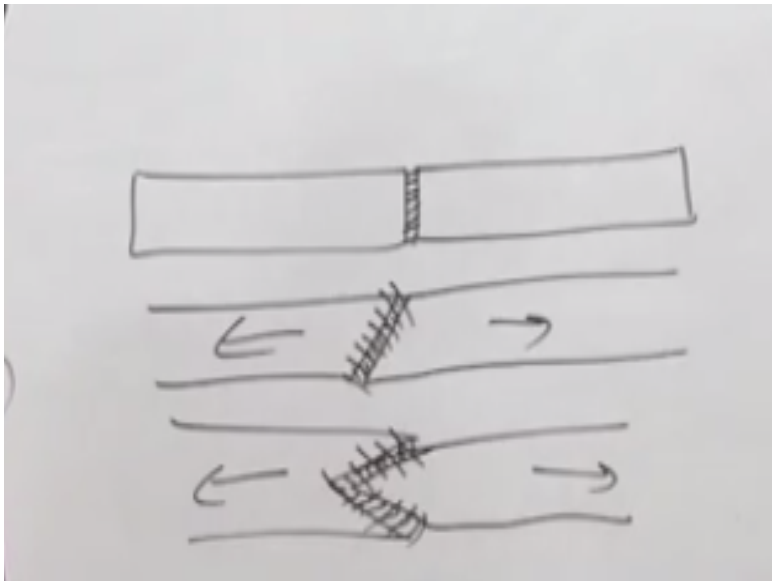

And for that say if this is sheet to be joined, in simple butt joint configuration this area will be very less in order to offer the joint strength. So in such situation, normally bewailing of the surfaces is carried out. So the surface area increases and then we will see that the filler is placed between the faying surfaces for developing the braze or solder joints. Alternatively, another kind of configuration of this kind also can be made wherein the opposite corresponding surface will be like this.

And between these, we can place the braze or the filler joint. So these are the butt joint configuration will be able to carry the tensile load as well. So in order to offer, in order to increase the joint area, the bewailing or a special, or single or double bewailing arrangements can be made in order to increase the joint area, so that the load capacity of the joint can be increased.

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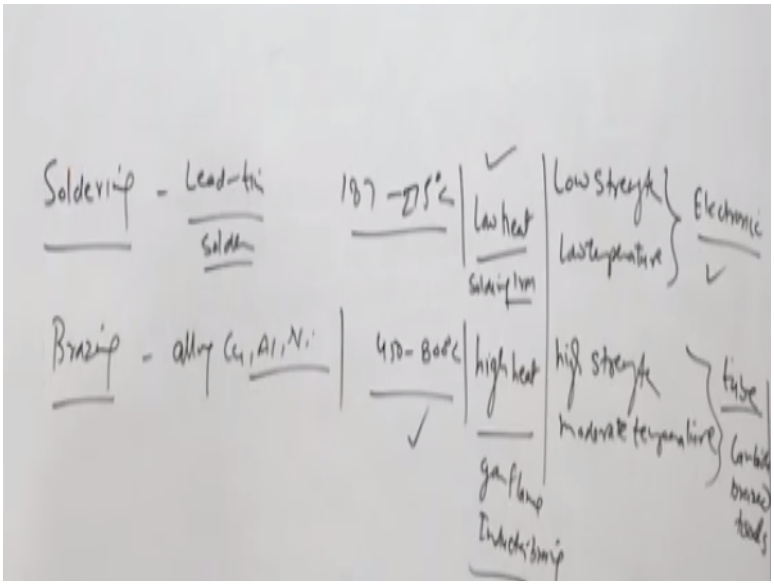

Now there are various points based on which we can compare brazing as well as solder joints. For example, solder joints are solders, soldering is a perform like say this is for soldering, obviously the solder mainly the led and tin based alloy is used and for the brazing purpose like alloys, copper, aluminium and nickel systems are used. They offer somewhat these systems melt at a higher temperature say 450 to 800 degree centigrade.

And this one is used for the lower temperature conditions like 187 to the 275 degree centigrade. So the lead and tin are the low temperature systems and means the solders, this is called solder low temperature systems melts at by low temperature, these melt at very high temperature. So for the brazing purpose we definitely need higher heat input as compared to the soldering which requires low heat input.

Because of the difference in the melting point and since the solders, they have the low melting point. So these offer very strength as well as the low temperature tolerance capability means they cannot work at a higher temperature with increase in a higher temperature, they get soft and strength is reduced. So the joint load caring capability is very adversely affected. So these are good for very low light load service conditions at low temperature.

And these are good enough for the means high they have high, they offer high strength and reasonably moderate temperature service conditions under which these can work. So these are used for like say developing the joints for the tubes or like carbide brazed tools and these are mainly used for the electronic applications where the loading conditions where the joint is primarily made for the flow of current, not for the any load carrying capacity, not for

increasing, not for carrying the load.

So the solders are primarily used for the electronic applications while the brazing joints are used where moderately higher load carrying capacities required or the higher service temperature conditions also can be sustained by the brazing joints. So these are the kinds of some comparison points. Apart from these, we will see that the different points on which these can be compared is, these are the heat source so that is it.

So based on the heat source requirement, very light heat source like soldering iron is sufficient for this purpose, because very limited heat is required for developing the weld joints but very high heat is needed for the, larger amount of heat is needed for the brazing purpose. So we need the special sources of heat, may be like the gas flame or induction brazing, the otherwise brazing methods.

So these brazing methods basically for the brazing there are ways by which heat can be applied at the faying surfaces, so that the brazing material can be brought to the molten state. Similarly, the different sources of the heat can be used for the soldering purpose and according to the method being used for application of the heat either for brazing or soldering, the methods are described accordingly like.

So some of the methods I will be talking here along the filler materials, which are used for the brazing as well as soldering. Now we will see here in addition to this comparison there are certain negatives also related with these processes and the negative aspects related with the brazing and the soldering primarily includes from the inherent feature related with these two processes.

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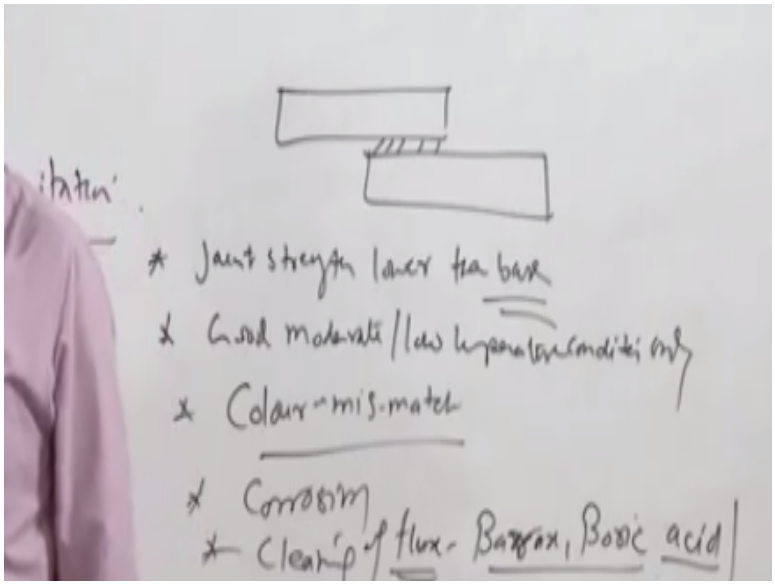

So the limitation who one includes that the strength, if you see the base metals are kept intact in the solid state while the filler is brought to the molten state. So the strength of the joint, so the joint strength is lower, always lower than the base for than the base metal. So the limited strength is one weakness of the brazing and soldering process. Another is they cannot sustain the higher temperatures, temperatures like so good for moderate and low temperature conditions only.

They cannot sustain the higher temperature. Sometimes the brazing and filler material, the solder and the brazing materials becomes of the different colours. So the colour mismatch in the braze and solder joint is another problem because it adversely affects the esteem value of the joint and sometimes the dissimilar metals promotes the corrosion. Additionally, it becomes important for cleaning of all fluxes whatever has been used.

So the flux cleaning like the fluxes like borax and boric acid are commonly used the fluxes and these must be cleaned after the soldering or the brazing so that if these are not cleaned properly after the soldering then because of their corrosive in nature with these fluxes are corrosive in nature. So they will be promoting the corrosion of the joints as well as of the base metal.

So it is important that the fluxes after the application are cleaned and removed properly after developing the joint. Now we will see some of the specific metal systems which are used for developing the weld joints as well as the kind of the arrangements which are arrangement which is used for like for the brazing and soldering purpose.

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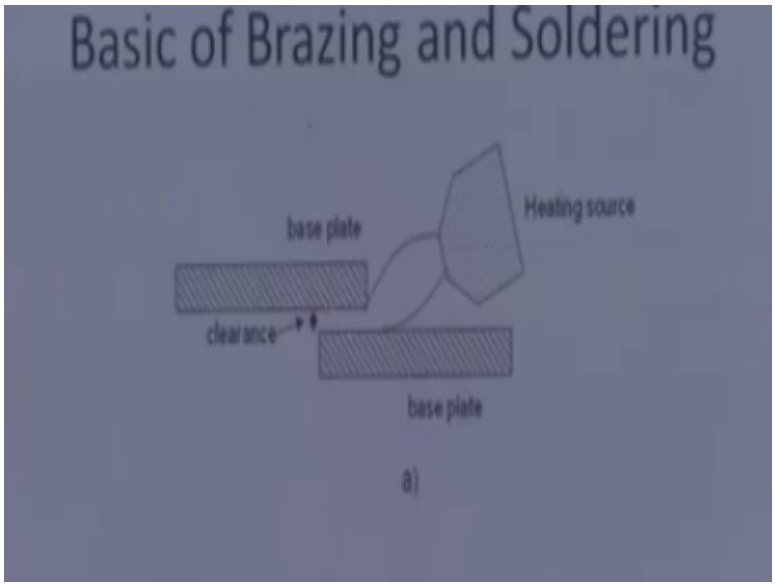

The plates are kept like this with a certain gap and the heat sources are applied and thereafter the flux and the filler is places, once it is brought to the molten state, the filler spreads between the faying surfaces and after the solidification it results in the joint formation of the joints.

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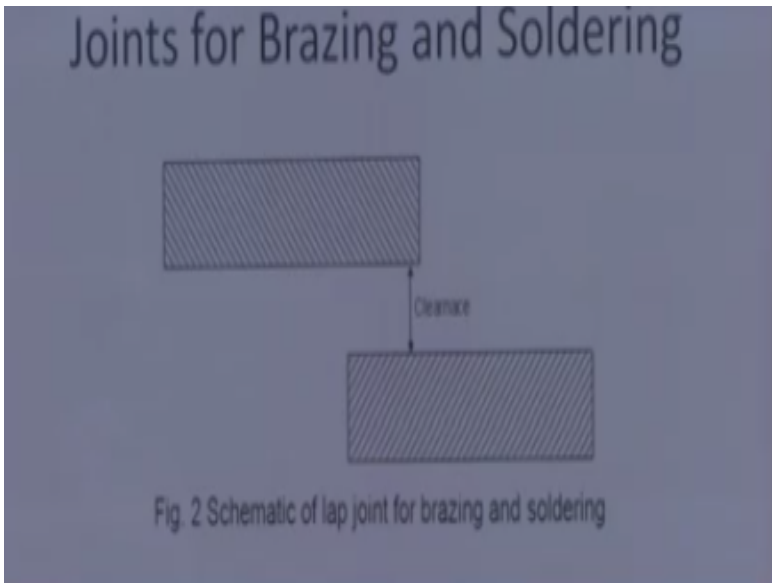

So the clearance is extremely important for having the capillary action in order to ensure the uniform distribution of the filler material between the faying surfaces.

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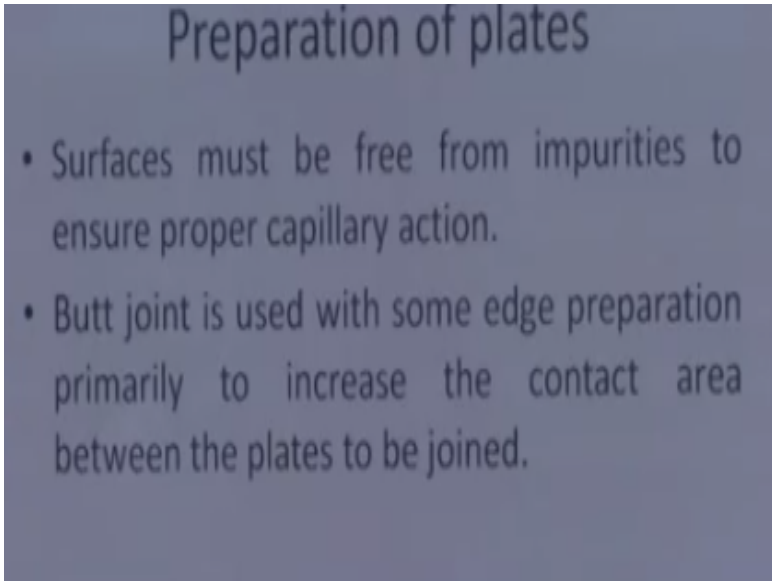

Preparation of the plates is important to make it free from the impurities. So that proper capillary action can be ensured and for making the butt joint some edge preparation is important in order to increase the contact area between the plates to be joined so that the joint can be made of the surface end strength.

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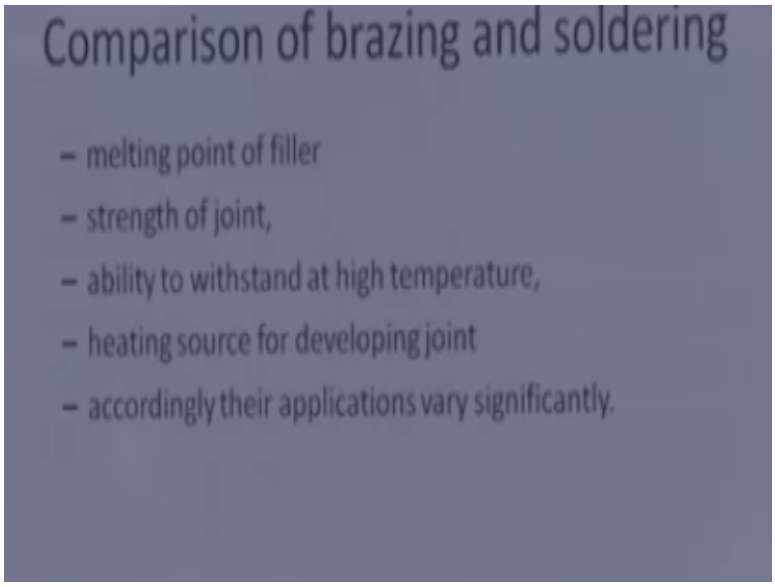

These are the different points based on which the brazing and soldering can be compared like melting point of filler, it is lower for the soldering and then the brazing strength of the braze joint is much higher than that of the shoulder joints and ability to withstand at high temperature is good for the brazing as compared to the soldering, better for the brazing joints as compared to the soldering joints.

And heat source requirement is more higher capacity heat sources needed for brazing purpose

as compared to soldering purpose and according to their load carrying capacity or ability to sustain the higher temperature, these two processes find applications in the different areas.

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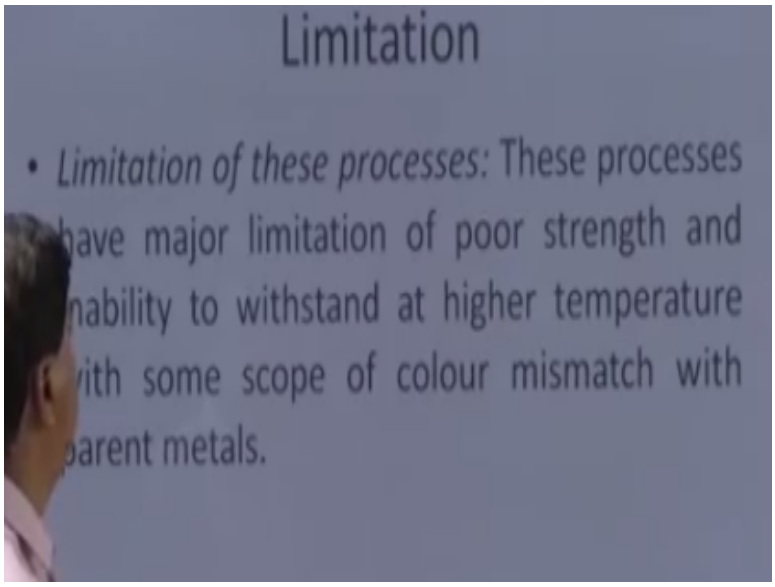

So, this is the comparison purpose, limitation of these processes. These are poor in a strength inability to withstand at higher temperature and sometimes colour mismatch is also another problem, which is encountered.

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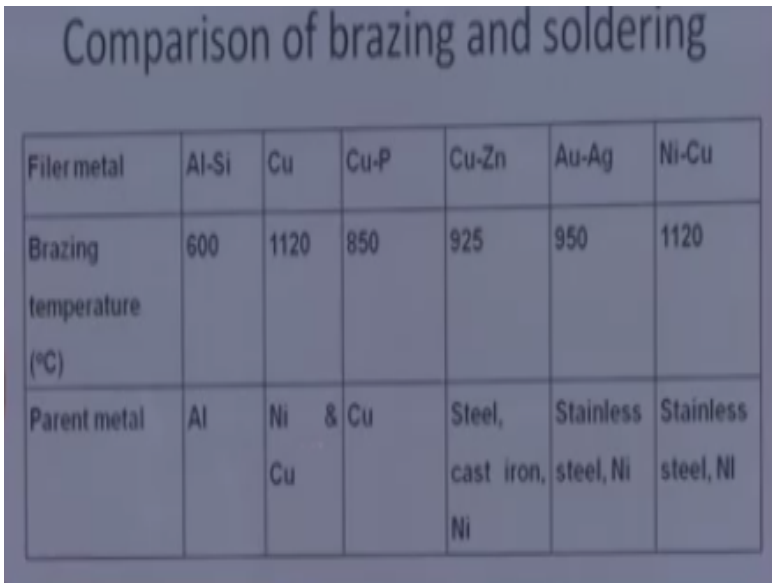

These are the kinds of materials which are used for the brazing purpose, brazing temperature and corresponding filler materials, which are used like for the nickel copper systems, it is 1120 degree centigrade, stainless steel and nickel systems are brazed. And Au and Ag system 950 is the temperature of brazing and stainless steel and nickel systems are blazed like steel and cast iron, copper zinc systems, copper phosphorous, for copper systems, copper for

nickel and copper systems, aluminium silicon for aluminium system.

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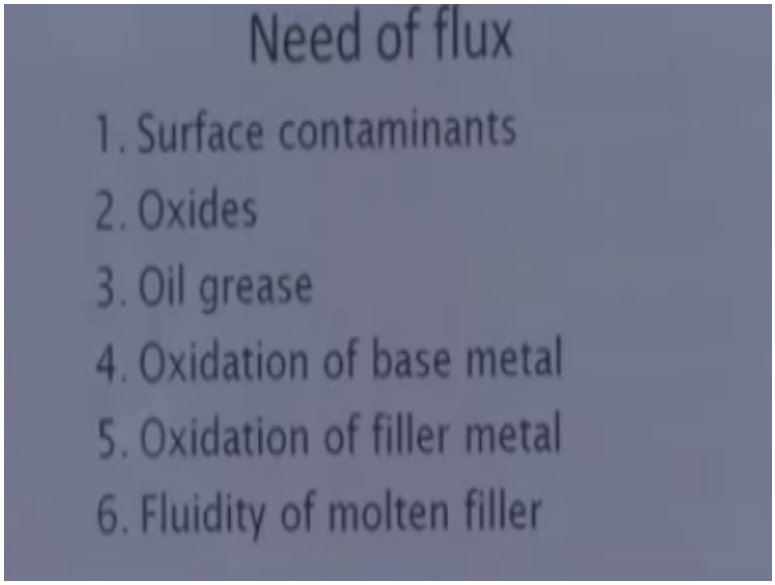

These are the different purposes for which fluxes are used. It takes care of the surface contaminants, oxides, oil grease, oxidation of base metal, oxidation of the filler, and fluidity of the molten metal. The oxidation and the grease and oxides and contaminants are taken care of while the fluidity is improved by the filler.

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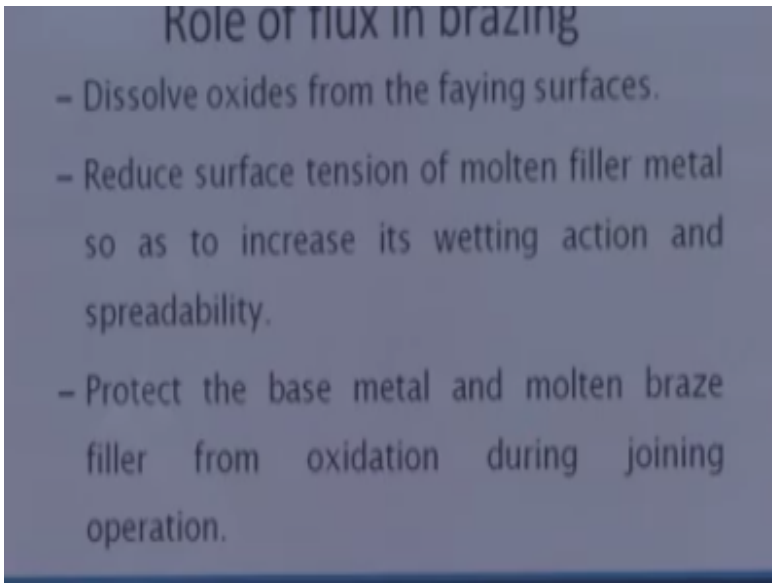

The fluxes help to dissolve the oxides from the faying surfaces, reduce surface tension in order to improve the fluidity and these protect the base metal and the molten braze filler metal from the oxidation during the joining operation.

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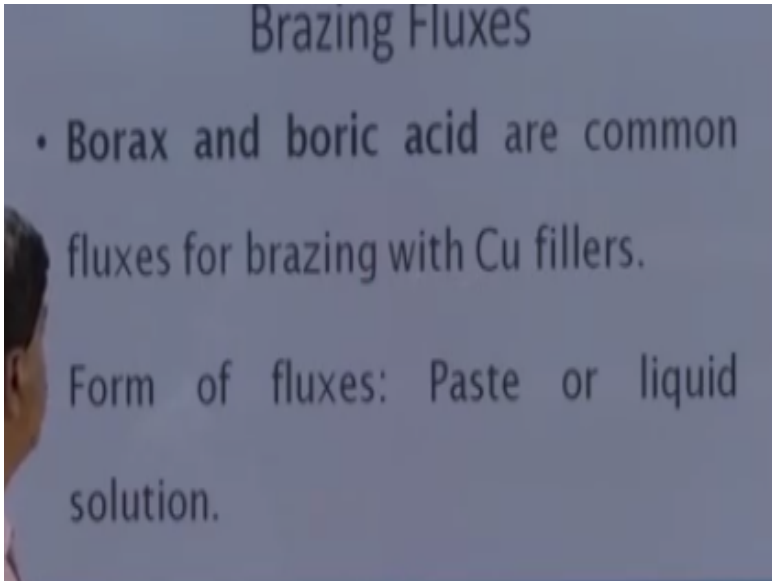

The common fluxes which are used are borax, boric acid and these are, the fluxes commonly used with the brazing for the brazing purpose with the copper fillers and thus these fluxes can be used in form of paste or the solutions or the powders, they can be applied over the surface. So now here I will conclude the presentation.

In this presentation, basically I have talked the basic principle of the solid-liquid base processes like brazing and soldering and the conditions under which these processes can be used effectively, the basic principle of these processes and the kind of material systems which are used for the brazing operations. Thank you for your attention.