Welding Processes
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Buried GTAW and Rate controlling parameters of GTAW
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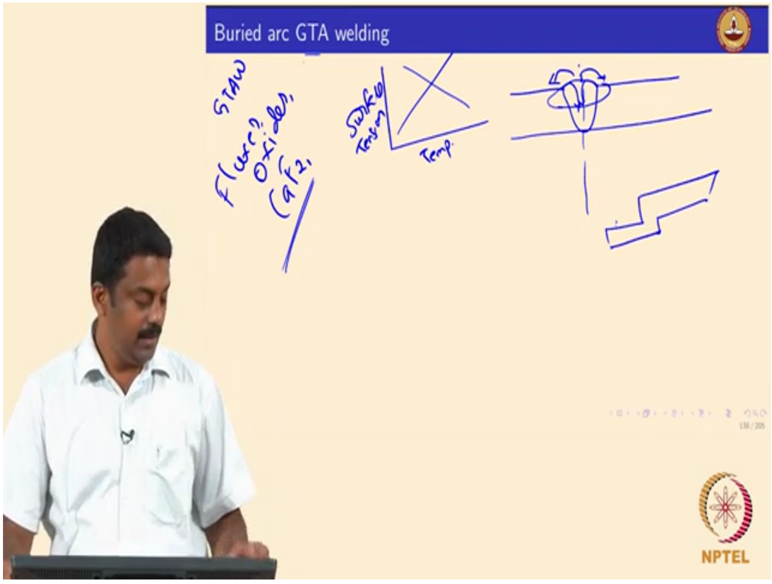

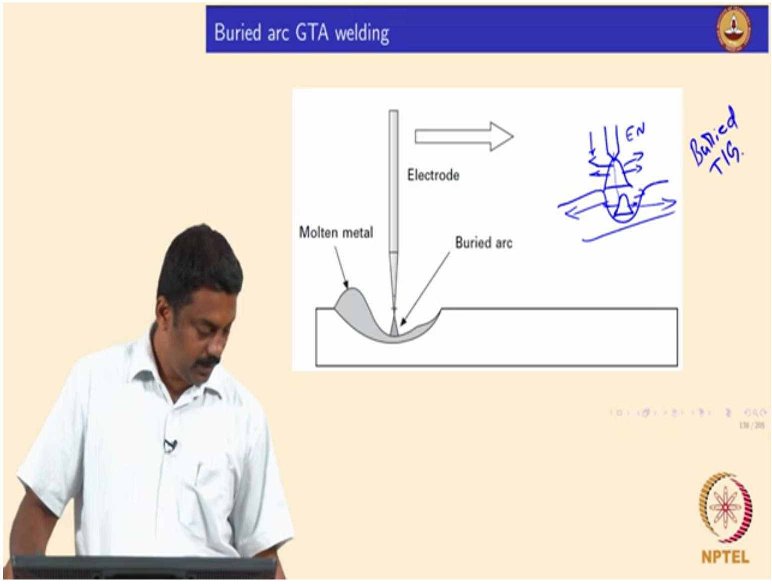

So we move on to the other modifications or advancement that we have made in a GTA, gas tungsten arc welding is the buried TIG, it is colloquial attempt is buried TIG, so we also know from the physics that the GTAW is very energy inefficient process okay again we will in this class will see when we calculate the melting efficiencies, will identify why is it TIG is not efficient because what are heat is generated is not transferred fully is not it, so because the cathode is heated up, cathode is heating, all the heat to emit the electrons, but nothing is extra going except the electrons from the cathode.

So we have a lot of heat loss in this process and also the convection, conduction radiation would also transfer the arc to the atmosphere, the heat to the atmosphere, so in order to improve the efficiency we need to shield the arc is not it. So the people thought of that why cannot we just use the plasma jet, which generate the arc core to make a cavity in such a way that you make a weld pool and then slowly move the electrode down to the weld pool and then these plasma jet can pull the, can push the pool in such a way that the entire arc can be submerged and buried inside the pool. Okay.

So this can be very effective so, for example, so in this case, so the conventional GTAW, you always have the electrode with distance from the liquid surface. Okay, so in that case suppose if in conventional way thought we get that thing back. Okay, so in conventional process so you have tungsten electrode and this is your molten pool is added, and you have an arc right. So in that case, so the heat transfer to the atmosphere is an enormous because you also have an conduction, conventional radiation heat losses from the arc and whatever the cathode is emitting it is also like you know if use electron negative the only electrons would be acting to heat at the workplace.

That is why the efficiency is not there, so in order to shield the arc or not to maximise the heat transfer from the arc to the pool, so what you do, so we slowly once the arc is struck, we push the electrode in such a way that the plasma chat can pull the molten metal and then make a cavity by the plasma jet and then slowly immerse it in such a way that the entire arc can be surrounded by the molten pool. Okay, so in that case, the heat transfer can be maximised is not it.

So the convection radiation can happen to the molten pool, so it would transfer the heat subsequently to the base material and then melt more right, so by the plasma jet what is there in this end of the arc is used to create an sort of an cavity in which the electrode can be push inside and then arc can be shielded by the liquid metal and the heat transfer can be efficiently made, so in that case, the penetration depth can be increased significantly.

So only tricky here is the plasma jet velocity in such a way that it is not cause an explosion of the pool and by carefully controlling movement of the electrode once the arc is tracked with the proper knowledge of the plasma jet velocities and we can create a stable buried TIG process okay, so in that case, the efficiency, the heat transfer efficiency from the arc the pool is increase tremendously, and by doing so we can increase the efficiency and we can increase the penetration, yes, it is clear, buried arc, yes.

So this is also commonly used for thicker section, steel welds to minimise specially if you are using without any filler because it is very difficult to add filler in this case, so if you want to increase the depth of penetration and increase productivity, obviously, so you can use the buried arc process. Okay, good.

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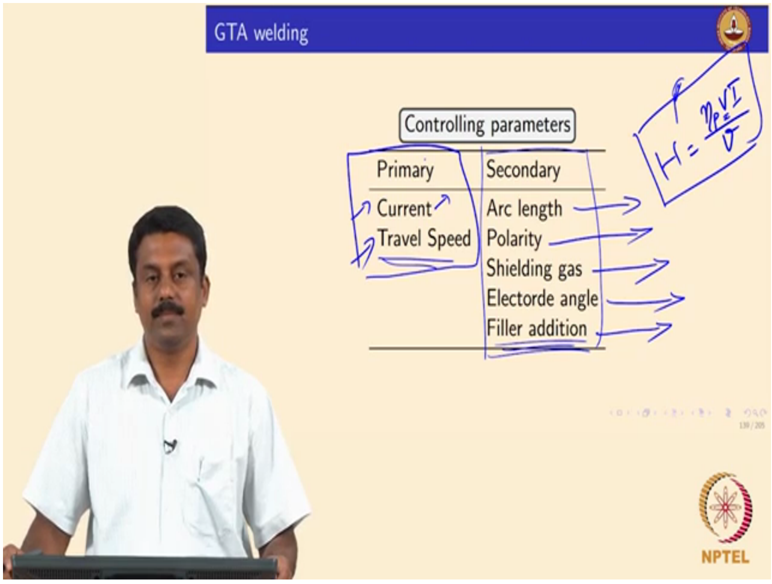

So next advancement is like you know the pulse TIG and pulse GTAW and then you can also have pulse plasma and you already. I thought you about the how the pulse is going to work right and if you look at all this processes, there are some rate controlling parameters is not it, so by understanding, by controlling this parameters we can effectively control the bead geometry, microstructure and thereby mechanical properties. Okay, so in all the advancement what you have has seen and even in conventional process the rate controlling factors, the important factors are of course current and the travel speed is not it, so current determines heat is not it, the equation.

So that is why always go back to that deviation what you have made, so that determines the heat generation is not it, and then travel speed, so obviously that is dynamic situation, so you have transient heat source and the speed also controls the amount of arc energy transfer to the work piece for given time and given are okay.

So these two are the primary parameters and we also looked at how the current can be pulsed and role of alternating current, changing polarities and how that can improve the stability of the arc and in next slide is the influence of travel speed in the heat, well looking at the heat transfer and the heat input calculations and there are some secondary parameters that can also influence the size, for example arc length.

So arc length is very critical, so arc length is very critical because arc ignition is determined by the D, the distance is not it, so when you are doing it in an arc ignition by electric breakdown, will look at breakdown voltage right as a function of pressure and then the distance right, so it influences the arc ignition and the arc length can also be fairly play around to change the heat energy.

So why if you change the arc length, so what happens to the voltage, so voltage increases, is not it but if you increase a voltage, you also change the heat input is not it, the heat input how do you calculate again, what is the heat input equation? Efficiency, voltage, current, by welding speed, so in this case, the V, the voltage if you change, you also change the heat input and if you change the arc length, the voltage also changes because you also change the distance okay.

So you also change the distance that means that the voltage should change, but there is a critical limit because if you keep on increasing the distance at some point of time you also cause the arc of instability because ultimately arc is stable by sustained discharge is not it and discharge has to be sustain over a distance, you cannot keep on increasing the voltage, so then you would end up affect instability of arc.

So we cannot play around with the voltage, the arc length that is why when during welding, when you are doing the arc welding process, the rate controlling is always current. Okay, so voltage is derived product right, so you cannot really play around with the voltage because voltage is the by product, the current is rate controlling. Okay, so the arc length you can play around, you can change but the voltage will also change when you send the arc length right and you cannot change it significantly to improve the heat energy, the arc energy, then you would affect the arc stability right and then polarity.

Polarity can significantly change the heat transfer, we already looked at changing in polarities if the electrode negative. Okay, it is the most conventionally use polarity for GTAW is not it, if electrode negative, you transfer the maximum heat to the work piece because electrons are transferred from the cathode which is electrode, which is negative terminal to the work piece which is positive terminal, so the polarity can significantly change against the heat transfer.

In the shielding gas we also looked at in a very details shielding gas is not it, the effect of shielding gas is the argon, helium how the heat transfer is change, arc stability change as the function of composition of shielding gases, how we can play around the composition to get the weld bead characteristic changed and then we also looked at electrode angle is not it, the influence of electrode angle on the depth of penetration, because if you change the electrode angle and you also change the cathodes part is not it.

So the cathode parts part is change and then you also change the arc envelope dimensions right, and then filler addition that can also be effectively used to change the weld pool temperature. Okay, so whether if you are using cold wire or hot wire and if you are dipping it into the weld pool, weld pool temperature can be changed, but it is not really rate controlling, but when you have a GTAW with the filler then you can also play around with the filler additions rate to change the weld pool temperature.

So these are all the important rate controlling parameters when you are doing GTAW, so two process primary parameters are current and travel speed. Okay, and other things are all stationary, the secondary parameters are length, polarity, shielding gas, electrode angle, filler additions, so generally we keep secondary parameters constant for a given application and we play around current and travel speed right, it is clear.

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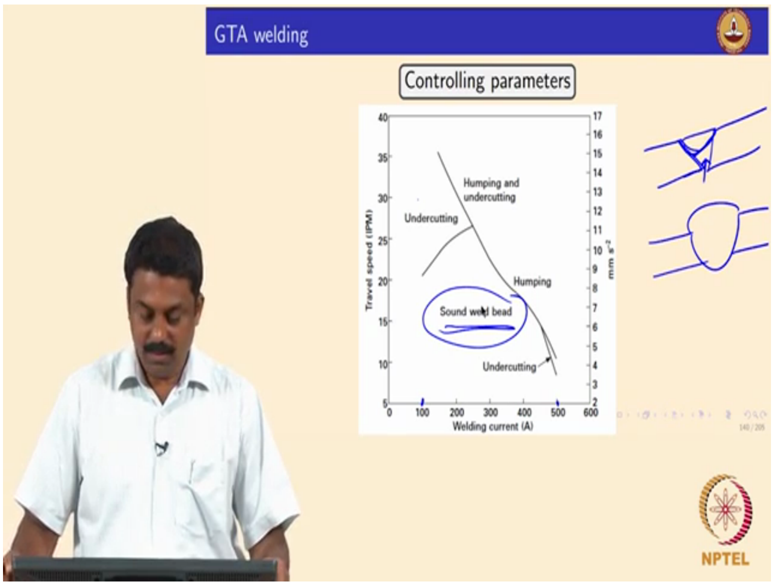

Okay, so basically, so you play around current and travel speed by keeping secondary parameter constant to achieve a good weld, so such a process map we can generate, which can tell so what current and what travel speed can give us very sound weld bead right, for a given secondary parameter as well as the metal thickness and composition, if travel speed is too low and the weld the current is too low, we may end up not forming any weld at all.

Okay, so suppose if you have low current and high travel speed, so you may have undercuts, undercuts means the weld is not fully filled, is not it, so suppose you have a driver something like that and if you have very low current is not it and a high travel speed, so it may not have weld at all, you may have something like this and you will have serious undercuts right.

So if you have a very high current, very slow speed you melt more is not it, so you will end up making humping, which is also not needed, so by increasing current tremendously at a slow sound immediately the melt volume, the amount of material you melt is increased, so you will end up melting more and forming humps.

So you need to play around with this primary parameters speed and welding current very good sound weld bead yes, it is clear, so that is how we always get, will generate such a process maps for a given secondary parameter and the material composition thickness and we can get such a process maps to identify, so what welding current and travel speed will it operate and this information they are already there.

Suppose if you are buying a most advance microprocessor controlled power source and they have all inbuilt parameters in this energy power source board because they, we pay for that right, so the commercial power source manufacturers they do all these experiments for us and then you select one program, for example I want to weld say 2mm thick austenitic stainless steel in bid and paid configuration in autogenous mode then you can choose the voltage and current and the travel speed in such a way that, the weld is made with good characteristics right, so with these we finished GTAW.