Advances in Welding and Joining Technologies
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Lecture – 04
Fundamentals of Welding and Joining- Part IV

Now, will try to discuss the different atom different modes of the metal transfer generally you observe in the gas metal of welding process. So, first will start with the modes of metal transfer that is what one of that is the short circuit transfer.

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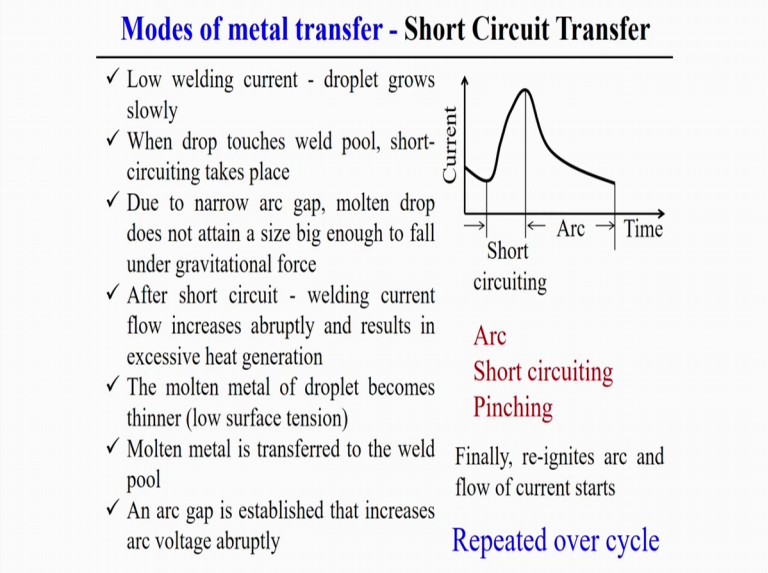

So, basically during the welding process, when the electrode come in contact with the work piece material, and it is just about to contact or gap is very less. So, at that time normally the low current flow through the electrode and then droplet at the tip of the electrode actually flows slowly, because of low welding current. And then when the drop exactly touches the weld pool then that short circuit clears basically, and that short circuit and current flow through this circuit actually changes.

Now, due to the narrow arc gap so, molten drop does not attain the very big size. And therefore, their unit fall the transfer of mole metal droplet may not be due to the gravitational force. That with this once the short circuit established then there is an abrupt change in the current flow.

So, there is a continuous increment of the current flow, and then when there is a current flow that amount of the heat generation also abruptly increases. And that actually results in the decrease of the surface tension force at that point. So, that molten metal droplet becomes more thinner and thinner due to the low surface tension at the high current flow. And from the figure also you can see that, this is the figure shows the typical basically current verses time graph during the short circuit metal transfer.

So, initially when there is a short circuit established, then you can see there is a continuous increment of the current reach the big value so, the maximum current value. So, at that at that point and heat actually reduces the size of the droplets, and then at this point there is an again there is a decrement of the current and each certain values. For example, it reaches these values and the arc actually creates in between these in between this period of the time.

Such that molten metal's become more and more thinner due to the high generation of the heat during this time period. And after that the molten metal is transferred to the weld pool and then once it transfer the weld pool the thinner metal transfer the weld pool, and then the one arc gap establishes between gap is established between the electrode and the work piece. So, what when the when arc gap establishes at that time also, there is a abruptly increment of the arc voltage.

So, short circuit metal transfer can be characterized in such a way that there is basic 3 components, one is that creation of the arc, and then short circuiting and that pinching. Pinching means basically due to the pinch effect it is a detached molten droplet from the electrode. So, that this typical cycle actually repeated over and over so, in this mode of the metal transfer that mean, that is called short circuit mode of the metal this mode of the metal transfer. We can find out in the different gas metal arc welding process we observed this type of metal transfer.

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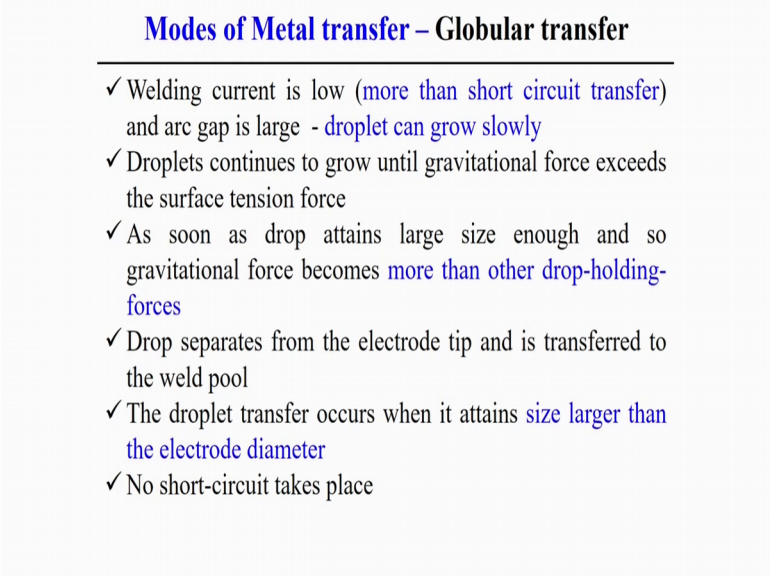

So, this is the one type of metal transfer now, we can see the globular transfer that in this in this form probably that here, also the condition of this type of droplet formation that welding current is typically low, but it is not less than that of the short circuit transfer. And when arc gap is here is also arc gap is more in the sense that it is as compared to the short circuit metal transfer. The arc gap is typically more between the electrode and the work piece.

So, that droplet can grow within that period of the time so, then once the droplet grow, but in this case since we are using the welding low welding current. So, basically the droplet can grow very slowly, but it can continue to grow until and unless the gravitational force exceeds the surface tension force. So, once the gravitational force exceeds the surface tension force, then the droplet actually detach from the electro tape and it comes to the molten weld pool. But, what is the detachment of this droplet from the electrode tip?

So, not only the surface tension force is responsible because, there is also the effect of the other drop holding force. So, it will try to make the balance between the surface tension force and other drop holding forces. For example, in electromagnetic forces and that helps actually play role here, but droplets transfer is merely happens the here due to the gravitational force of the droplet. So, once if be it grows into the sufficient size the droplet detach from the electro tip, and it takes the position within the weld pool. So,

typically the size of the droplet exactly the transfer of droplet occurs, while it attains the size of the size is larger than that electrode diameter. Definitely in this case the globular transfer of the molten metal there is no short circuit takes place in this case.

So, the apart from short circuit metal transfers globular transfer, there is another type of metal transfer, which generally observed in the consumable welding process using the consumable electrode and that is the spray transfer. In the spray transfer what happens? The in this case typically the different from the other two cases, that it is a high welding current density as compared to the globular metal transfer.

So, in this case what happens? The high welding current density and basically; results in the high rate of the melting, and also at the same time the greater amount of the pinch force actually act this type of metal transfer.

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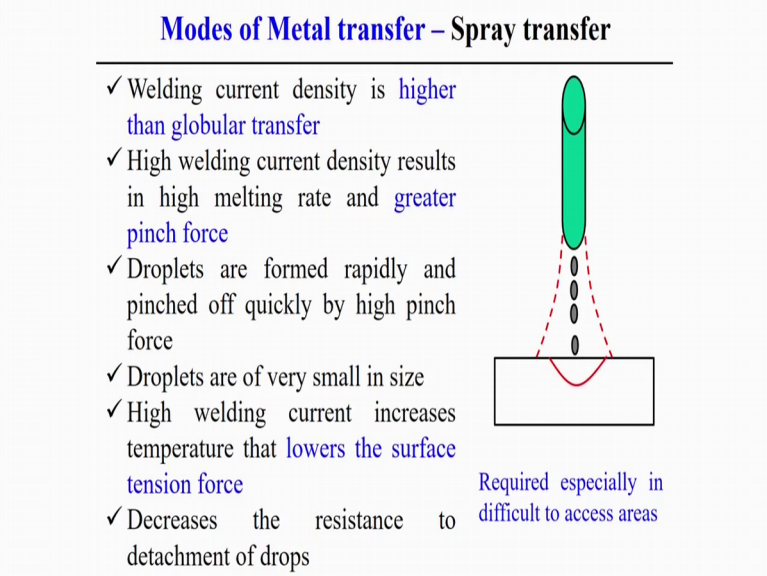

So, droplets are actually formed very rapidly. And so, transfer of the droplets that frequency of transfer of the droplets is normally more in this type of metal transfer, but it is merely correct is the high current density. So, one droplet is formed very rapidly and they at the same time it also pinch off also very quickly, and then it becomes the part of the final weld pool.

So; obviously, the size of the droplet is de definitely less than that of the globular droplet in this case. So, high welding current increases temperatures and then when there is

increment of the temperature that that actually lowers down the surface tension force. And of course, the high current density at the other way heat also favors the in incumbent of the pinch force. So, the com combining the decreasing in surface force and increasing pinch force both together favors the formation of the resistance to the droplet detachment. And that finally, they if we look into the figure actually droplet forms it is very small droplet forms from the electrode, and continuously it transfer to the transfer to the main welding component. So, in this case this type of droplet transfer is specifically important when there is a some intricate part which needs to be weld it.

So, with that in that compound that type of component welding the droplet, the spray transfer is the more preferable situation or more preferable condition in that case. So, definitely we can see that short circuit transfer the globular transfer and the spray transfer. So, all this cases here, we can control that transfer of the molten droplet although it is a very complex phenomena because, there is a so many interactive forces is acting and normally this three forces gravitational force, and the surface tension force and the electromagnetic force.

That actually plays the significant role the detachment of the molten droplet from the electrode tip in, in case of the welding of using some consumable electrodes. So, in that point of view it is although it is very complicated phenomena but, still by change normally changing the current density or other secondary parameter for example, spilling gas involvement and gas explore it that also actually influence the droplet transfer.

So, if you want to discuss all in details about this typical droplets in the arc gas. Metal arc welding processes we need to consider all these parameters, but to some extent it is possible to control the type of the metal transfer depending upon the need of the welding situation or welding of different specific cases. So, apart from all these three types of droplet transfer, there is another topic metal transfer also we modes of metal transfer we generally observe in the detail that is called the Dip transfer.

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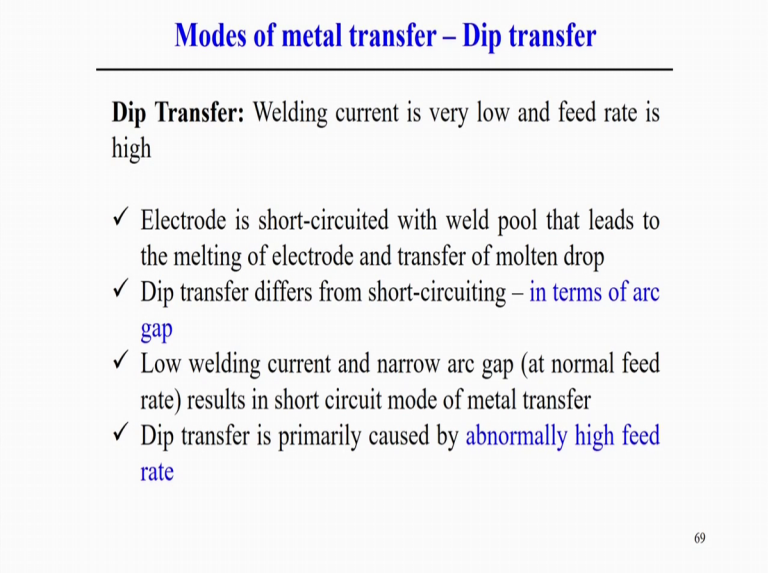

So, Dip transfer is almost similar to that that short circuit metal transfer here also, the welding current is very low and feed rate is very high. So, here also the electrode is short circuited with the weld pool, and that leads to the melting of electrode and transfer of the molten drop. But, Dip transfer this, Dip transfer actually differs from the short-circuiting transfer in terms of the arc gap.

So, here the low welding current and the narrow arc gap and even at normal feed rate is the results in the short circuit mode of the metal transfer, but Dip transfer differs that primarily by the cost by the abnormally high feed rate. So, Dip transfer also takes also similar to the short circuit mode of metal transfer. But, Dip transfer is generally observes when the feed rate is the moving of the electrode is basically is the very high. But, as compared to the short circuit transfer because, short circuit transfer metal transfer generally observes at that normal feed rate, but in this case the feed rate is very high.

So, in that way the different modes of the metal transfer just I have tried to I have tried to give some basic idea of the different types of the mode of the metal transfer, and then there may be the scope of this modes of metal transfer in quizzing considering the effects of the other parameters. For example, the influence of the shielding gas and the angle of the torch that also play important role, and gas flow shielding gas flow rate and the arc length or the arc gap all actually play the role the metal transfer.

So, in this way now I will conclude; that means, for the part of this module or this sector in this way that first.

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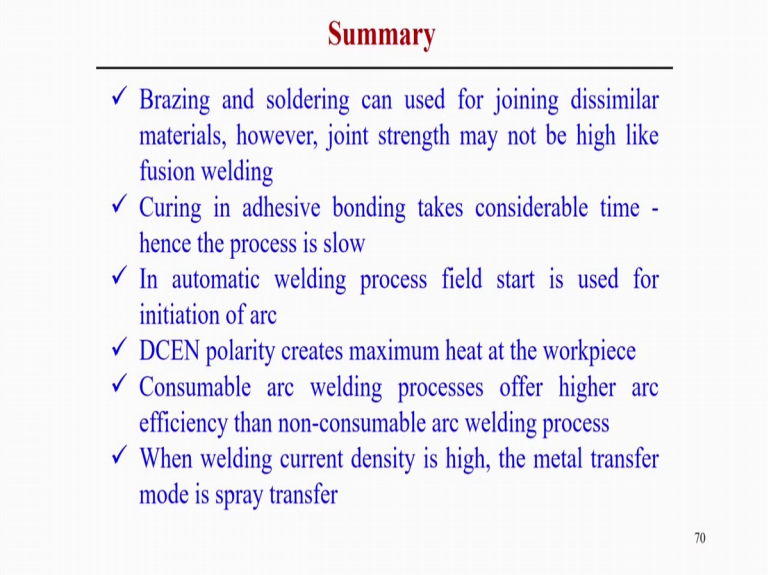

We have discussed in the different brazing and the soldering process and basic mechanism of this processes and their applicability in general of this process, but the significant point related to the brazing and soldering process is that, normally we can use this process for joining of the dissimilar materials. So, in this case, but main obstacles of this using the brazing and soldering process for dissimilar combination of the metals is the mechanical strength of the weld joint.

It is not cannot expect very high mechanical strength for brazing and soldering process, and when which I have to compare to the other fusion welding processes. So, this is one significant point next that we have discussed also adhesive bonding process and their several methods of the adhesive bonding process. The basic principle mechanism of the adhesive bonding process, but practical point of view what you understand from this adhesive bonding process that curing of one of the component of this process that actually takes considerable time.

So, the process is very slow. So, in that sense the adhesive bounding may be most of the cases the adhesive bonding is normally used for the aesthetic purpose. This is but, commercially this cannot be a very alternative towards the fusion welding process, where the mechanical strength of the joint is the main significant. Third point is that when you

try to make the atomization of the any kind of arc welding process then, it is always desirable to use the field start in the 2 initiate or to start the arc as compared to the manual arc welding process. So, that is also one important aspect in case of arc welding process. And third point is that in arc welding process we use the different types of current either ac current dc current, and the even for DC current we have to use the different polarity so; that means, direct current electro negative or direct con electro positive.

Both polarity can be used depending upon the applicability of the process, or whether using the consumable electrode or whether we using the non-consumable electrode. Because, the type of polarity actually resides the amount of the heat generated in the work piece or electrode in which cases it is more or which cases it is less. Normally DCEN polarity, the amount of the heat is generated in the work piece is more and, in this case, the less amount of heat is generated in the electrode material.

So, that is also desirable. So, in that sense DCEN polarity generally use for the non-consumable electron, what in other way also in case of consumable electrode when you using which is preferable to use the DCEP polarity. But of course, there is other factors also to decide the polarity, but in general that melting more amount of the heat generation is or criteria to select the different type of welding process. So, DCEP polarity is more preferable for the when we try to melt the consumable electrode. And ac current of course, always use we use normally when there is a need of the cleaning action in one of the cycle.

So, that at one case that it can AC current can give impact on light, that cleaning of the surface of the weld metal at the same time generation of the heat and creating the weld pool or maybe we finally, make the weld joint. In general, we has if you try to compare the efficiency thermal efficiency in case of consumable electrons or non-consumable electrons. Probably in the using the consumable electron the efficiency in general it is more as compared to the non-consumable electrodes..

Because, in case of the consumable electrodes the generated heat try to consume the amount of the molten metal, and then molten metal finally becomes part of the weld system. So, in that sense, the thermal efficiency is more in case of the consumable electrode. Finally, if you analyze overall the droplet transfer in general we can say that in

case of low current and high current density, in case of low current probably we can use other short circuit types of the metal transfer or globular type of the metal transfer; where metal transfer occurs only due to the gravitational force of the molten droplet be.

It other way if we consider the high current density or high welding current we can expect that the material transfer actually occurs in the spray mode. And the spray mode is may be well controlled or it is more preferable when we try to disrupt a metal, when you try to keep the some intricate part of the compound we want to join and there is a requirement of the metal transfer in that part.

So, in that case spray mode is more preferable mode of the metal transfer in case of the welding process using some consumable electrodes. So, with this I conclude the one part of the module 1. Now, we will try to discuss the next part of the next of the of this module 1.

Thank you very much for your kind attention.