Welding processes
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Advances in gas metal arc welding – Controlled dip short circuiting processes

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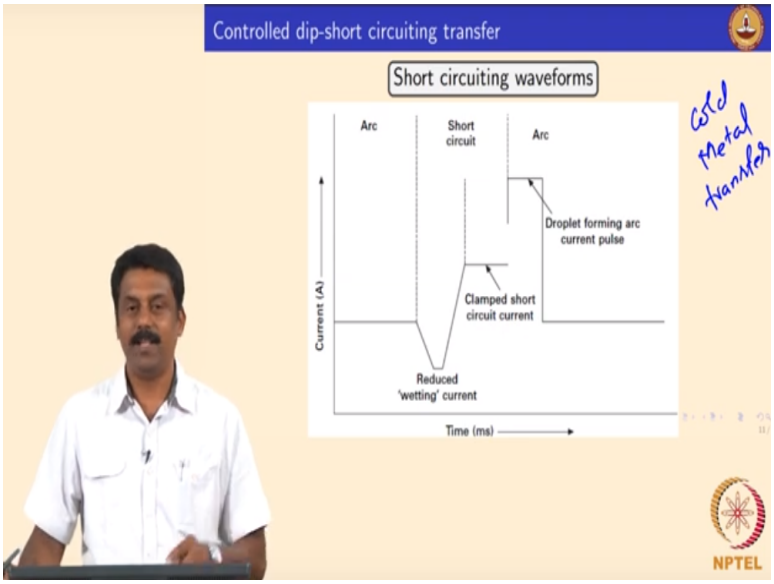

Move on to the second advancement, second advancement is bit more complex than pulse GMAW right, so when you are going short circuiting transfer which is rear is to achieve a stable transfer, so when you are looking at short circuiting when you at last lecture when I was talking about metal transfer the moment you have a short circuiting happens the voltage becomes very low or zero is in not it, because it is continuous the circuit is completed voltage decreases significantly the moment was anything happens but the current is still flowing the same amount what you are transferring that means said when you are a forming a droplet.

When the current is there continuously flowing you also enormous amount of Lawrence force and magnetic force which I considered to a very tiny area it is get accumulated because of the resistant of the liquid it much lower, so it is getting accumulated in the droplet at the moment the Lawrence force the accumulated so obviously it would exploded the droplet is in not it, because we have an a bridge form between the two solid and liquid bridge is forming which has an extremely poor article conductivity.

So the accumulations of charge carriers at the droplet would lead to there an enormous amount Lawrence force and magnetic fields and then obviously the moment you have an short circuiting happens and the accumulation of force will lead to the explosion of droplet and then that can lead to similar turbulence in whirlpool obviously will through whatever you melt to various places and that cause as better, so now we will have to identify some mechanism so that we avoid such an a instable process and metal transfer characteristic so there are various ways we pulled out some to this.

So one such mechanism is to identify the at which short circuiting happens, the moment we identify that we can reduce the current and such a way that the current is minimize to solo and the droplet can be transferred in tag just base of his tension, so you have a droplet is going down, so the moment also short circuiting happens you identify the voltage drop you know that when the short circuiting happens the voltage becomes very low zero and then immediately you reduce the current and then the other thing the system current is low voltage is equal to zero and it is just a droplet, so suppose if you pulled the droplet bag the surface tension of the whirlpool would puled the droplet.

So by doing so we can achieve very stable transfer but then the trick is you have to identify at what moment this short circuiting happens, so that we can run the current off right it is clear, so that so the modern advancement took place in GMAW by modifying the current voltage wave forms so one such wave form is given here in this slide which is a commonly used to achieve a short circuiting transfer at extremely low Doppler temperature, so Doppler temperature means close to melting point that way it is known as this process in known as cold metal transfer, so first I will show the video then I explain the form and then again we will look at the video to understand, so first we will see the video how does the process work.

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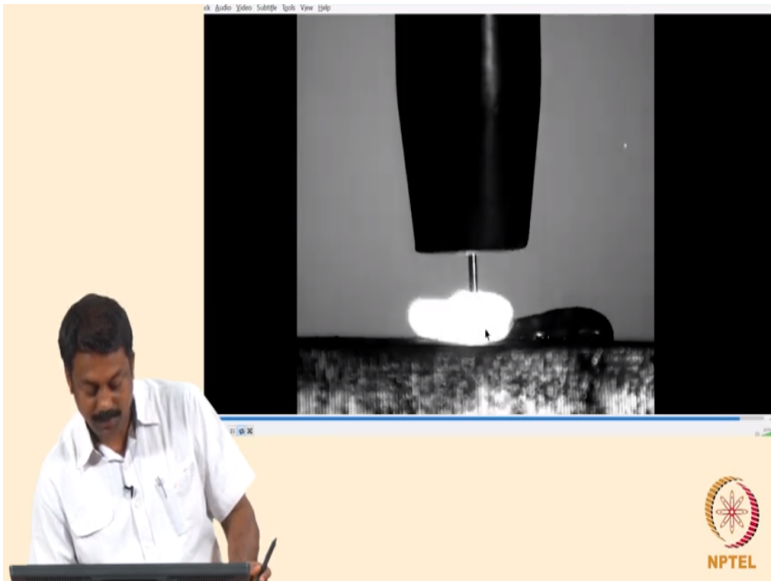

So you see the various process is what is that happening, so we see that the wire is moving back and front and we have a short circuiting event and we have arcing event and the short circuiting event and the arc completely extreme users the droplet is transfer again the wire is moving out and then arc is formed again and then this cycle continuously carried out and the droplet is transferred and you see melt and pulled, so in order to achieve we need extreme synchronization.

So we will have to controlled the wire feed rate we will have to control the arcing period we will have to control the moment at which the short circuiting happens and then we will have to measure the moment at which the it happens and then we play around the wave form in such a way that droplet is transferred without any explosion, so it is clear right the action we have arc we have the back and front moment of the electrode this short circuiting event and then the metal transfer by collapse of the droplet to the well pulled.

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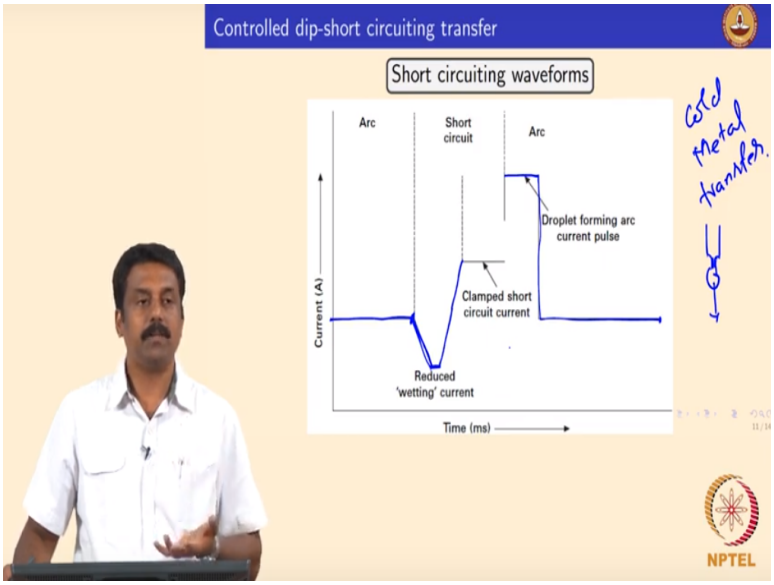

So what it is happening here is the objective is we will have to transfer the droplets without explosion that means that moment short circuiting happens will have to minimize the current but, we cannot completely minimize the current because then when you detract if so may be surface tension is not sufficient so the droplet may come with the wire, so now what we do, we will so the first we will have the arc the first video the arc is formed the arc the moment arc is there obviously you melt you form the droplet and then the wire is brought down toward the pole the moment you established the short circuiting by the forward motion of the wire.

The current is decreased and then the moment the wire is completely made in contract is whirlpool the current is decrease that means that arc completely extinguished us, so this continuous from here so until this point arc is there and during this process, the wire is also is brought down the moment the short circuiting happens the arc current decreases in such a way that arc completely extinguishes, and during this process it also getting even the current is also decreased and then now in this position the electrode dip is completely touching the whirlpool and then we retreat the wire.

We retreat the wire and during this process we slightly decrease the current in such a way that we form a Lawrence force and then neck would make a pinch of the droplet and then when you are detracting further this droplet would be transfer to the whirlpool it is clear yes or no, so the trick is here is the mentor arc current the arc is there and during this process the wire also coming

down and gradually we decrease the current when you are moving it up and arc is still there the moment short circuiting happens we identify that from the voltage drop and then we decrease the current to extremely low level to keep the droplets stable and then the wire is detracted and during detraction period in case a current slightly higher.

So that the Lawrence force and the surface tension of the droplets would do the transfer from the dip to the whirlpool it is clear and then this cycle continues the current is extremely low below even arcing current the arc is completely gone, so arc is there until only this and the droplet is transfer the voltage is zero and the current is very minimum because we are just switching of the current when this short circuiting happens, so that when the droplets is transfer it transferring it technically a molten droplet, so by doing so the arc energy we supply the extremely minimized to much lower level than that even in pulsing GMAW, so technique droplet is transferred at the melting point of the droplet, so that means that the droplet is transferred in much more colder stage than any other GMAW process that is way this process is known as coal metal transfer,

So the metal is transferred and the droplet temperature is more or less melting point droplet, so this has a very high advantageous in terms of heat input we give, so if you take an average of the I mean of this circuit it will much lower than the pulse GMAW you knew I mean as well as the droplet is transfer without any arc, so you not super heating the whirlpool you also super your heater heating zone, so you can avoid a various metallurgical reaction that are happening into the super heating for example if you want to avoid intermetallic formation in you are welding dissimilar weld.

So in that case it want you can do is you can minimize the heat and then we will have to make sure the whirlpool temperature is not heated up otherwise you will have a diffusion of an elements it may cause the intermetallic formation for example you are getting iron and aluminum weld, so those kind of application this causes extremely suitable because the heat is there in whirlpool is so minimize is such a way that we avoid all these detrimental metal reactions and it also achieve a similar productivity because the cycle it is same as a pulse GMAW.

So we make sure that there every pulse every short circuiting one property is transferred and we can play around with the detraction and the forward motion of the electrode and the short

circuiting events would determine the number of the product transfer per cycle it is clear this what happens in the video.

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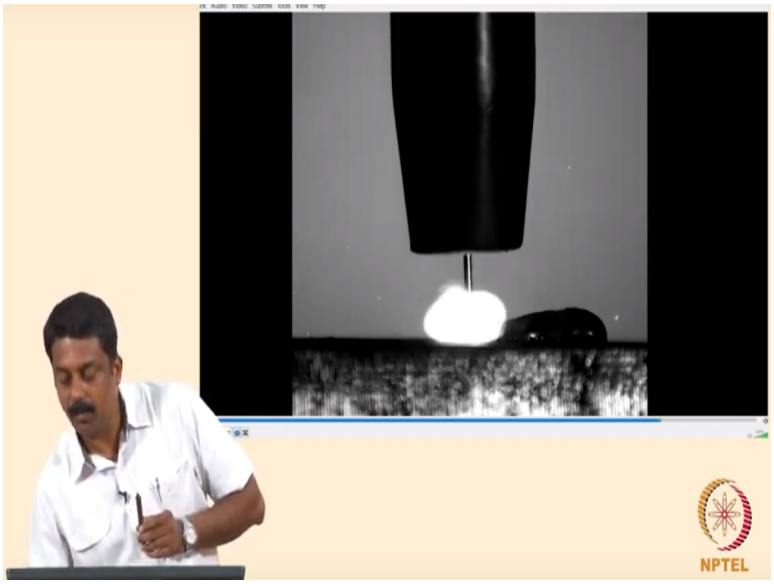

So we will see video again, so first so this is the time at which the current is slightly increase of the short circuiting you see that when the current is increasing you form a neck, so I will just show this pen here so you will form a neck and then this neck, so it is now detected the ire is going up so now the droplet is detached, and then subsequently any two moss and then wire is ground up now and then current is increase in such a way you form or not, and then arc stage remains and upper keeping some sometime and then again the wire is going down.

So again the wire is going down short circuiting happens voltage current is now minimize to extremely low level and then droplet is transferred when though wire is coming out during the surface tension of the whirlpool and then slightly increase current which can also aid the droplet transferred right now this cycle continue the number of droplet transferred is a function of number of short circuiting events we can have a cycling of the process.

The process is clear for you the step is the arcing period short circuiting period and then a transferred period subsequently the detraction period during arcing period the current is maximum during short circuiting event the current is zero and during detraction transfer period current is slightly higher and subsequently we go back to the arcing period so this is known as

the controlled dip short circuiting transfer characteristics so now so there as two or three companies.

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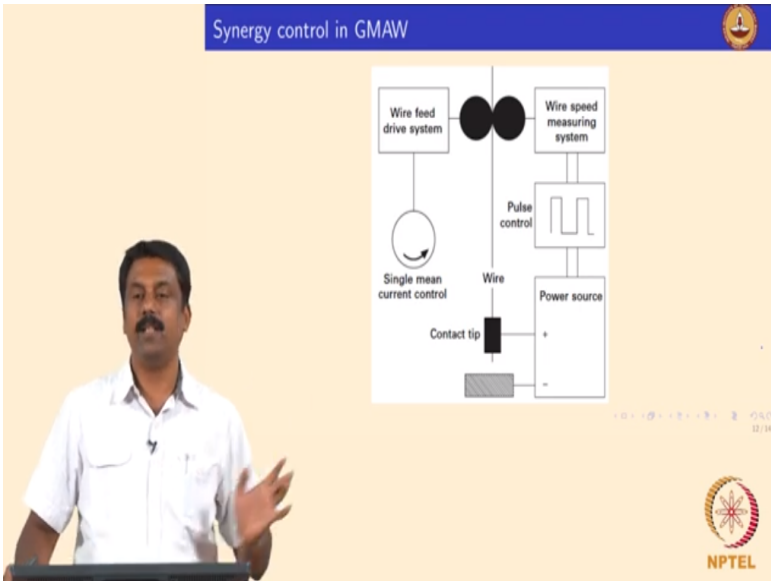

They sell the power source with the capability of transferring in controls or short separating dip transfer as we will move on to the last slide in the GMAW this unit is how do you achieve all these development what we have done GMAW, so we will have a smart works because the moment you say I want a pulse transfer then the power source would calculate the wire feed rate calculate the melting rate it has to calculate the frequencies it has to get the process windows of transfer the similarly when you wants to transfer the control or separating transfer and it has to calculate.

The speed at which it has to move wire take the wire back at the forward moment retraction it has to calculate the short circuiting in time and it has to calculate the current at which it has to form the arc so all the information it should be calculated and then when you select welding process and it has as simple as possible, so the famous Einstein quotes so everything should be made simpler but with complicated means because when you look at the actual in process the welding engineers the welding technicians they are all simple persons and you cannot tell them to okay you know make the current zero.

When the short circuiting happens and in case the current moment when wire goes up no one would by that power source, so it has to be inclusive and it had to be as simple as possible all this

signs what you see here it should be implicit in the power source itself and it should be control with a single nobe also, so that is how we developed the synergy technology.

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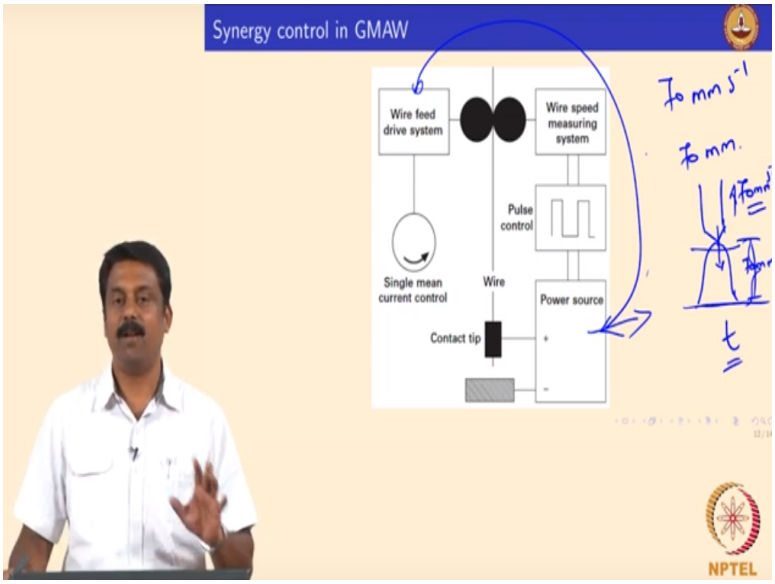

So synergy talks about synergy is between all the parameters which controlled the welding performers for example we looked at wire feed rate which is important because you have to maintain a constant arc length in some cases are you also need to calculate a short circuiting time so how do you calculate short circuiting time will have to move the melting rate and then arc length, so if you know arc length and melting rate then you know at want time short circuiting can established, supposed if you have an 70 mm per second that is your melting rate the arc length is 70 mm okay, so what I am after arc ignition short circuiting can happen.

So for example so you have 70 per second that is wire feed rate and then arc length is 70 mm if you wire feed rate 70 mm you will always maintaining a 70 mm of arc length, suppose if you increase the wire feed rate 80 mm then what will happen then you are moving the wire towards the whirlpool, so now we can calculate from the melting rate, so what will be my wired feed rate in such a way that I would established a short circuiting at a time T because we will have to feed more than your melting rate and if you know the arc length then you can see what time T short circuiting can be established it is clear but then we need all the information.

So the system would contain the information about the melting rate, melting rate calculated based on the compositions the stick out length and stick out length has to maintain by the power

source, so the wire feed systems so talked to the power source in such a way that in a pulsing case it always supplies the whatever it can melt, so that you maintain a contact arc length you supply the same melting rate as a wire feed rate, in short circuiting transfer mode we will have to make sure that we will have to established the short circuiting after time T, so then it ask to feed up increase the sire feed rate about the melting rate.

So power source so talked to wire feed rate no I am melting 70 mm per second you give me 80 mm per second, so that I can established short circuiting after what about time and then the moment short circuiting and this power source would identify my voltage is going down voltage is zero, so now I need to reduce the current and then it can reduce the current with the delay with a slight delay and then you tell the power divide filtrate again so the device pull the wire back, and then the wire feed rate pull the wire back and then the by the time it goes it has to measure how much it has travelled so that the moment it achieve it set an arc length you ignite the arc by giving the arc current, so this are all now integrated.

So in synergy mold what it is you select a data base for a given material and the filler diameter these two are information we need to calculate the melting rate, melting rate is alpha I plus beta L pi square by pi R square, alpha beta is can determine from the composition and the welding parameters like shielding gas and there electrode polarity, if you know that we can calculate alpha and beta that is a V column I, V I and anode current that is all process specific and Y diameter determine the pi R square and the L is determine by the process source itself what stick out it will has to.

So what we will have choose now to achieve a pulsar in your wave forms we will have to give what a wave forms what wire feed rate you want that it these two parameters you give the power source it calculate everything suppose if you want to do pulse GMAW, so it has to from I mean and calculate IP and TP, from I mean it calculate from melting rate and the melting rate can be calculated F can be identified the frequency of pulsing and accordingly melting rate can be calculate from IM and it can maintain constant arc length pulsing.

So only two information we will have to give, information about your main current information about wire feed rate if you do this two the synergy controlled the power source would take care of the inter welding process because all the data base is established from the physics what I

explain from the melting rate calculations from the heat transfer from the arc to the electrode tape.