Fundamental of Welding Science and Technology

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Lecture - 15
Physics of Welding

In last class, we were discussing the different types of metal transfer which is generally occur in case of arc welding processes. At the end of last lecture we were discussing about contact type of metal transfer there we have observed there is a direct contact between electrode with droplet and what it is called workpiece. So, there is a direct contact between these three are there and during metal transfer.

So, first we were discussing about bridging types of bridging types of metal transfer. Today I will start another categories of short circuiting types of metal transfer that is called short circuiting types of metal transfer.

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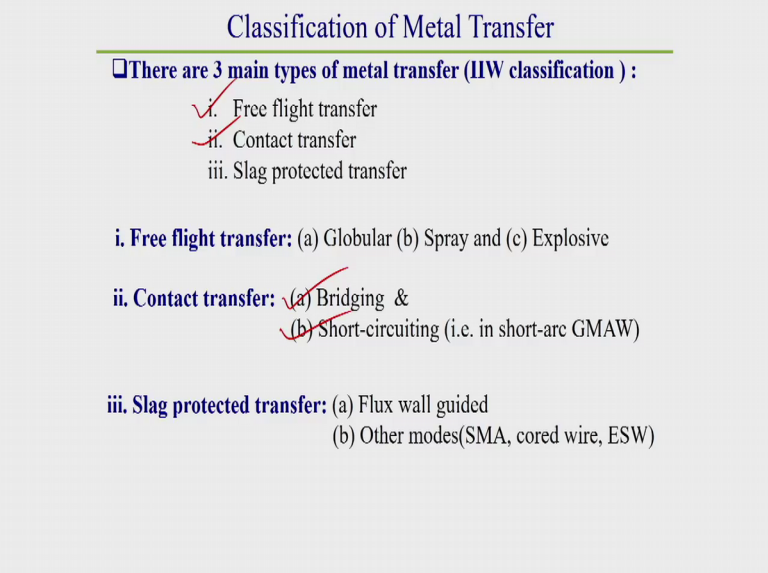

So, we have already completed this replied or contact transfer we are discussing; today one categories of that contact transfer contact metal transfer I have already completed in last lecture. Today I will discuss about that is bridging transfer I have completed today I will discuss about short circuiting types of metal transfer in details; especially which is occur in GMAW pressure that I will discuss in detail today, after that we will go for other categories of metal transfer also.

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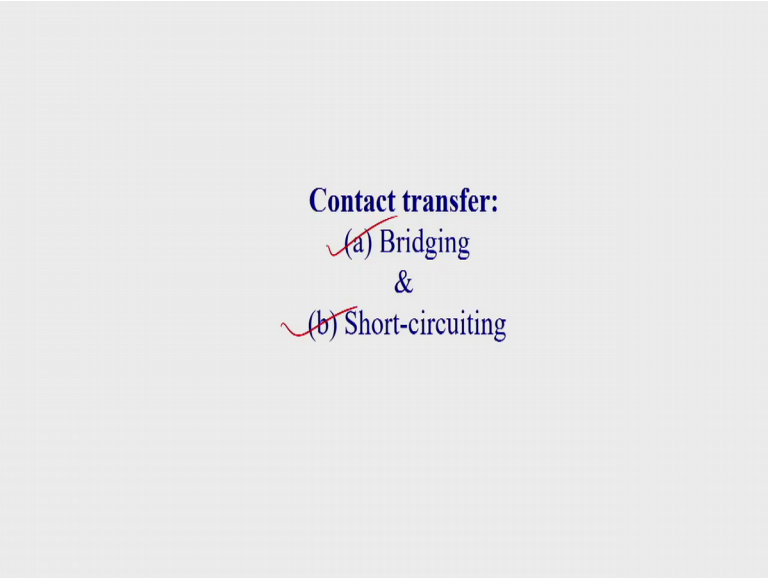

Last lecture I completed this bridging types of contact metal transfer; today I will start on short circuiting types of metal transfer. Now short circuiting metal transfer what happens in short circuiting metal transfer, how its look like?

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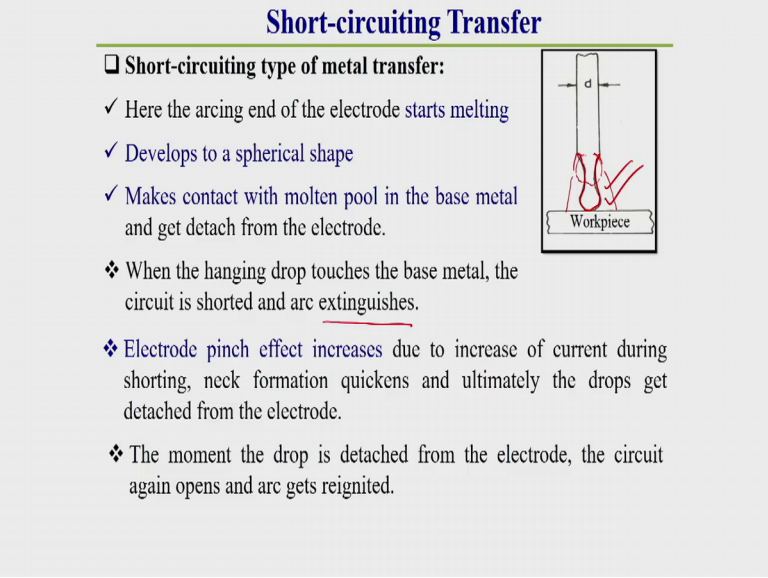

So, this short circuiting metal transfer is a categories is one of the categories of contact metal transfer categories. Here generally what happens? Here the arcing end of the electrode that melting arcing end of the electrode generally start melting; then its developed to a spherical shape makes contact then after this spherical shape this is

generally contact with this workpiece; make contact with molten pool in the workpiece and get detached. Once its contact with this workpiece generally; during the time due to some electromagnetic forces and surface tension forces is detached from the electrode to workpiece.

So, when the hanging droplet all the base metal generally if this droplet; if this hanging droplet touch these base metal then what happens? The circuit is shorted and arc in this case circuit is shorted then where this arc generally extinguishes. So, due to short circuiting here arc extinguishing is taken place.

In other categories like reflectors where we have observed there is no arc extinguishing is occur. So, generally once arc extinguishes then here resistance in between electrode end workpiece generally decreases out. Because current flow through air gap and where current flow through electrode material flow difference is there.

If there is a direct contact between electrode material workpiece then current can easily pass through electrode to workpiece. So, what happens? Once it touches with this workpiece then arc extinguishing, but here the resistance current flow resistant generally decrease a lot. Due to this less resistance in between this electrode and workpiece what happens?

Here current flow increases due to this increase of current flow generally there the pinch effect also increases; due to this pinching effect information is taken place due to this information finally, detach from the electrode to work pieces.

So, the moment the drop is detached from the electrode the circuit again opens and gets reignited. So, once again the next short circuiting metal transfer start in this where generally this short circuiting metal transfer taken place. Now here generally in case of short circuiting metal transfer the rate of metal transfer is varying from 20 to 200 drop per second.

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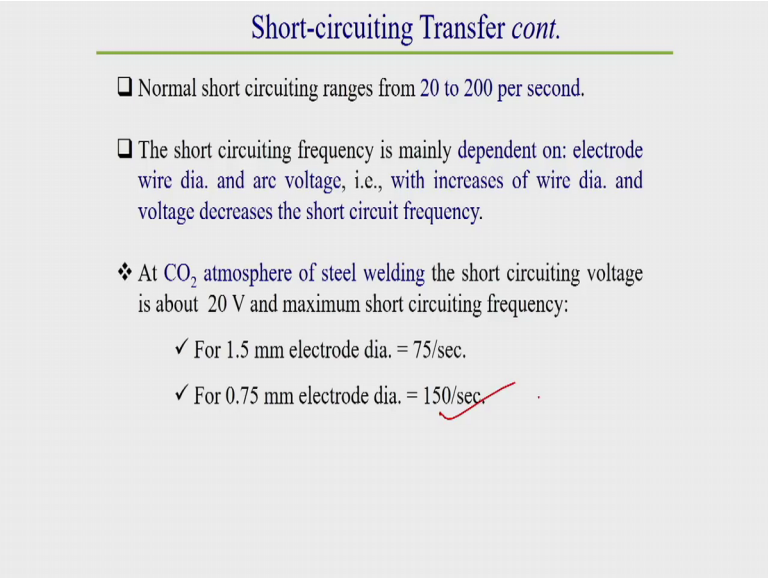

It can vary it depends on welding current then it depends electrode material electrode diameter and different generally parameter its heat shielding medium also its effects. Now, the short circuiting generally frequency is mainly depends on though the different parameter have effect of short circuiting or any types of metal transfer.

But here one things you should keep it in mind short circuiting transfer mainly depends on that short circuiting voltage and what it is called? Electrode diameter; though the electrode material shielding medium also have effect what is effect is pronounced once the electrode diameter varies and that arc voltage varies.

Generally it has observed in case of a CO 2 atmosphere of steel welding; the short circuiting voltage generally it is observed is around 20 volt and its maximum short circuiting frequency generally highly depends on its electrode diameter. It has observed that for a electrode diameter of around 0.75 millimeter; generally it can supply a drop transfer rate of around 75 drop per second. That means, if it is if diameter is 0.75 millimeter then it can supply a drop transfer rate that is equal to 150 drop per second.

If the diameter is generally increases; that means, 0.75 to 1.5 millimeter diameter electrode drop transfer decreases around half of that whatever observed in case of 0.75 millimeter diameter electrode. So, in case of 1.5 millimeter diameter electrode; we can get a drop transfer rate is around 75 drop per second.

It was observed that short circuiting drop transfer frequency highly depends on electrode diameter. It was observed that for CO 2 gas shielding medium for say 0.75 millimeter diameter electrode can provides metal transfer rate is around 150 drop per second. Whereas, if diameter is twice of that then this metal transfer rate become half of the whatever observed in case of 0.75 millimeter diameter electrode; that is for a 1.5 millimeter diameter electrode we can get a drop transfer rate around 150 drop per second.

So, what we observe from here? Higher the electrode diameter, lower the drop transfer rate. So, now, we will see the; what is the characteristics of short circuiting types of metal transfer?

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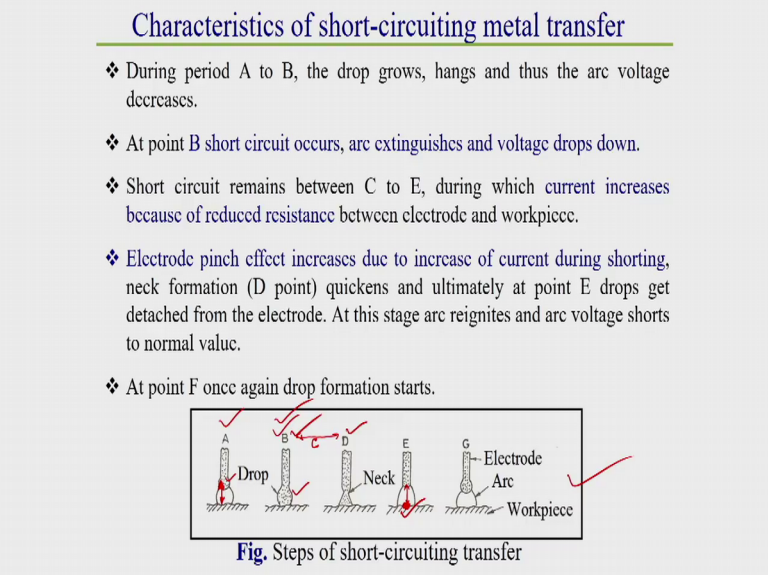

Fig. Steps of short-circuiting transfer

This symmetric diagram represent how the metal transfer from electrode to workpiece during short circuiting types of metal transfer. From this figure one things we can observe that during period 1 to 2 that is A to B; the drop grows hangs and thus the here generally as it grows and hangs gap gradually decreases.

So, due to this decrease of this arc gap generally due to this decrease of this arc gap; what happens? Here the arc voltage decreases definitely that we know arc voltage bends on arc length. So, if the arc length decreases due to increased size of voltage drop; then definitely voltage will be decreases. So, due to this drop grows hangs towards the base material what happens? From position A to B; that means, during the period A to B the

voltage decreases. At point B generally here one things you can observe that when B generally drop short circuit with workpiece.

So, due to this short circuiting of drop with workpiece here generally arc extinguish. So, at point B itself due to the short circuiting arc extinguish. Due to this arc extinguishing and drop gap decreases here voltage drop down a lot because here arc gap does not have any effect or as there is no arc gap that is why due to this arc gap whatever the voltage generally arise that voltage will not be here. So, here generally voltage drop down a lot.

So, after that when the short circuiting generally remains where one things you can observe short circuiting remain for a period from B to D; that means, in between actually we skip the points C because C point in this point generally in between this B and D point there is a point C for neck formation taken place. Here neck formation pronounce in at point D; why this neck formation and this pronounce at point D?

Because what happens neck formation is pronounced or you can say neck formation generally quickens at point D. Because generally from B to D due to the short circuiting of this molten droplet with workpiece there generally resistance decrease a lot. What I have discussed already earlier; that means, electron can flow or you can say that current can flow easily through a molten droplet reason then air gap or arc gap region.

So, that is why as the electron or current flowing due to short circuiting through the molten material what happens here? Resistance decrease a lot due to this decrease of resistant generally here current flow increase a lot due to this increase of current flow what happens? There generally created high electromagnetic forces. Due to this high electromagnetic forces there will be create some pinch effect or you can say radial pressure, due to this radial pressure on B to D the neck formation continues.

Generally at point D this neck formation quickens and ultimately at point E here one things you can observe; at point E it is detach from electrode and drop down to it detach from electrode and it deposited to the weld pool. So, at this state; that means, at point E itself arc reignites here again arc reignites and arc voltage shorts to its normal value. So, here arc voltage again short to its normal value.

Now, at point A F generally at point F just immediately just after E at point A again drop formation start and its continue for continue for next droplet. Now one things you can

observe here whatever the steps I elaborated here this for completing; this many stages it takes only a few microsecond. Because we know that per second there is a short circuiting frequency around 20 to 200 drop per second. Here also if the drop transfer rate is let us 100 per second for one droplet transfer; this wall step represent only a single droplet transfer time.

So, one; so this is this all the step generally taken place within a time of 1 by 100 second; that means, 0.01 second generally this is taken place.

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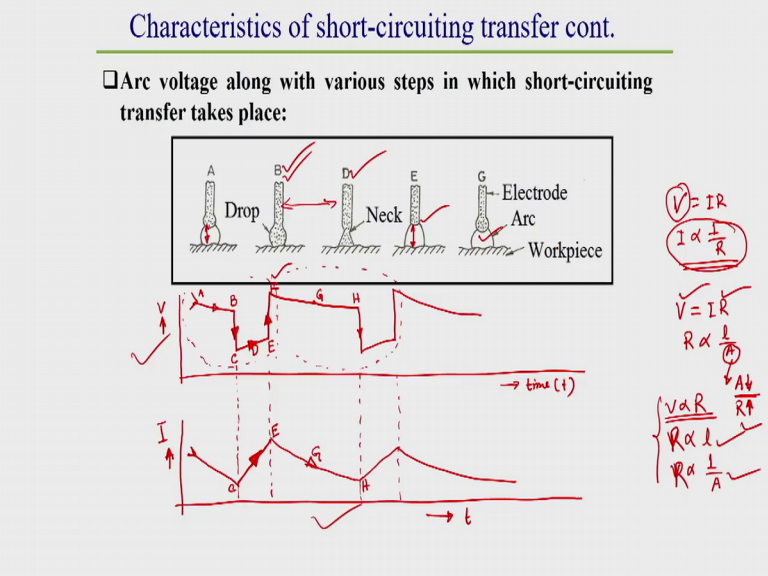

Now, we will see what is the oscillogram or what is the variation of current and voltage generally or oscillogram taken place due to this drop transfer due to the short circuiting types of drop transfer here that I will explain in details.

Now first of all I will show you how the voltage is transferring, then I will show how the current is transferring. Here one things you can observe that in case of let this is the this axis represent voltage; this is the time t. So, how it is varying that I am showing here point wise how the drop transfer is varying that I will little bit show.

Here generally this is the variation of voltage with time due to drop transfer. Here this is point A let this is point A this is generally represent point B; this is the point generally this is point C, this is point; this is point D this is E and this is F. So, whatever the steps I here I am showing this is in this step we in which point what will be the range of pattern

of voltage that is showing by this oscillogram.

So, again here generally we have here will be G here will be generally here will be a is again generally here the drop down; so next step. So, here how it is look like? From here to here we can say from here to here before that also this is one cycle. Similarly this is another cycle, this is another cycle you can say this is another cycle.

So, what happens for part drop transfer how it is varying? That we can observe from here easily. So, here why at point A and B generally voltage drop down? Because here what is what happens here generally arc length decreases whatever I what I have already told you due to this decreases of arc length why this is decrease of arc length taken place.

Because here generally drop formation taken place its grow and its hang; due to that this arc length gradually decreases due to this decreases of arc length here what happens? This voltage drop down taken place; at point B when the short circuiting occurs immediately this voltage drop down a lot that is why immediately the point C come.

So, after that the resistant generally here from C to E during neck formation time due to this construction of the arc there is a marginal rise because what happens? Generally gradually this construction of the arc is taken place due to this constriction of the arc there is marginal rise of resistance is there. Now we see due to this construction if the resistance little bit increase; voltage also will increase. Generally what we know from Ohm's law V is equal to generally I into R here R generally depends on this resistance R generally depends on l by cross sectional area.

Generally what happens? Due to this construction of this arc due to this high flow of current during short circuiting this area decreases; this area decreases. So, if area decreases then R increases, but this is marginal that is why from C to E during neck formation times here what we can observe? Here we can observe that there is a rise of voltage is there why this voltage is there?

This voltage rise is there we due to construction of the work from Ohm's law itself we can observe from here. Because with decrease due to this construction decrease of the cross section is occur; due to the decrease of cross section definitely this resistance will increase marginally due to this resistance increase marginally here voltage rise is also taken place because voltage is proportional R what we observe from Ohm's law.

Now, at point E generally due to this high neck formation; it detach from electrode tip to weld pool. So, once is detach at point E then its generally immediately its regain its original arc length; due to this original arc length here again voltage regain its original value here A from E to that. So, immediately at point E here voltage shoot off and its go to its original value.

Again at point E (Refer Time: 16:36) after that in between E and F there is a point come that is from there again the next cycle of drop formation start that is point F; after that this drop again start growing due to this growing of this drop here again the voltage drop down taken place. Because here again the arc length decreases due to this decrease of arc length voltage is also directly proportional to l; voltage is generally inversely proportional to A, from this because V is proportional to R that we know voltage is depends on resistance.

So, here resistant generally depends on what resistant generally depends on l as well as inversely proportional to A; due to this characteristic here the voltage is varying in this pattern ok. Now, we will see what is the variation of current in this short circuiting of metal transfer. What we observe in case of free flight metal transfer there generally variation of current is almost constant; that means, there is almost no variation of current is observed.

But in case of short circuiting types of metal transfer here generally we can observe a irregular variation of current is there; irregular variation of current is there what does it means? One things you can observe from here easily this how this variation of current is observed here in between different point.

Here also we can observe generally this current variation is look like this; this test of variation of current is also there. What we observe that what I have already told you point C to D; that means, here from here to here; what happens due to this contact resistance C to D due to this contact of droplet with workpiece here generally resistance decrease a lot from this location.

So, due to this low resistance what happens? Here generally more current is flowing. So, more current due to this more current flowing here generally current variation is look like this from here you see current is rising a lot; that means, here current is rising pattern; current here one things you can observe here generally current is rising here.

So, after that generally what happens? At from point F to G again current is decreases why this current is decreases because arc gap is there because instead of short circuiting molten material they are generally arc gap is there. So, in this arc gap what happens current generally decreases. So, this is the pattern of current flow during what its call during short circuiting types of metal transfer.

Why this pattern is coming? That we understand point C to E due to this short circuiting current flow increases. So, once this neck detach from that electrode its regain its original arc length. So, its regain its original arc length once it regain its original arc length here voltage increases.

So, once voltage increases generally what happens? Resistance also increases over there, due to this increase of resistant generally what we know? We know for a particular voltage we know for a particular we know that V is equal to I R. So, if V is equal to constant; so, we can write that I is inversely proportional to 1 by R. So, I is inversely proportional to 1 by R means if resistance increases then what happens? What we can say? Then current decreases that then current decreases.

So, due to this air gap regain of air gap here resistance increases. So, due to this increase of resistance from E to H; E to H generally they are generally decrease decreasing of current is occur. So, due to this decreasing of current generally here is from E to F from there is E to H generally there is a continuous decreasing of current is occur.

So, this is the pattern of current variation during short circuiting types of metal transfer. So, this is the current variation and this is the voltage variation characteristic curves with time for short circuiting types of metal transfer.

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Now, we will go for slag protected types of transfer that this is the last categories of metal transfer. Here what we have observed? Here we have observed there is generally two different categories one is called flux weld guided metal transfer another generally call other mode actually. Other mode occurs in case of electrode slag welding techniques flux core arc welding techniques and like SMAW welding; Shielded Manual metal Arc Weldings.

In case of slag protected welding process what happens; this arc here generally whatever the arc is generated whatever the arc is generally generated in between the workpiece and electrode covered by some slag. Now here one things this slag protected transfer occurs where flux is used. Flux means generally in case of submerged arc welding generally process in case of submerged arc welding processes separate container is there that is called hopper actually from this hopper generally there is a continuous feed of this flux is there.

Generally this flux when its burn then this burn flux is called slag; this arc in case of that flux core or flux separate flux of fly welding technique generally this arc is covered by this molten slag or flux. So, due to that this arc is not visible by naked eye; generally by naked eye you cannot see the arc from outside. For that reason here to a study this types of metal transfer generally X ray is used by X ray method generally you can capture the drop transfer characteristics.

Here what we observe that inside this slag cover here the drop transfer is more or less similar to what happens in case of GMAW process. That means, in case of MIG welding process whatever the different characteristic metal transfer occur like free flight, short circuiting here also more or less similar types of mode of metal transfer generally occurs.

Generally this is occurs in case of submerged circular this types of slag protected transfer generally occurs in case of submerged arc welding process. This types of slag protected transfer you can observe in flux core arc welding techniques, SMAW welding process then electro slag welding forces. Generally in case of these different types of slag protected arc welding process generally in case of different slag protected arc welding process; we can observe slag protected metal transfer.

This metal transfer is also more or less similar to MIG welding process which is observed by the X ray techniques; here also you can observe some sort of short circuiting metal transfer or some sort of free flight types of metal transfer generally here is also observed.

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Now, we will go some other types of metal transfer; generally this these are the metal transfer which is observed this is some other types of metal transfer. Generally this these are the metal transfer which are under the categories either in globular transfer or under the categories of free flight transfer.

But what happens this types of metal transfer occur with some specific reason that is why this metal transfer I keep separately. Like what happens you can get a another types of metal transfer that is called rippled metal transfer. This metal transfer is a free flight metal transfer; that means, here generally drop fly in between the arc gap; here there is no short circuiting occur.

What happens here the drop size is generally is more than its electrode diameter; that means, it is approximately two times of the diameter of the electrode. That is why this rippled transfer generally is a globular types of transfer that I will explain in design what is the reason of this types of metal transfer.

Then another categories of metal transfer is called pulse types of metal transfer. This types of metal transfer here generally we get a spray types of free flight metal transfer, but here generally by some specific characteristic machine generally this types of metal transfer we can observe.

And other categories that is called metal transfer from additional filler wire this is generally what happens this types of metal transfer occurs in case of non consumable types of electrode. Because once we discussing about metal transfer we should know for every cases; for every cases whatever it is means or whether it is a consumable electrode or non consumable electrode, where how the metal transfer is taken place that we should know.

So, that is why here I will show you how the metal transfer is taken place for non consumable types of electrode if there is use a the if there is used a separate filler wire that also I will discuss. So, first of all I will discuss about refill types of metal transfer. Generally refill types of metal transfer is observed in case of GMAW process especially when we use a shielding gas as carbon dioxide. In case of carbon dioxide once we use carbon dioxide it has some specific property by which generally this types of metal transfer taken place; how it is that I will explain one by one.

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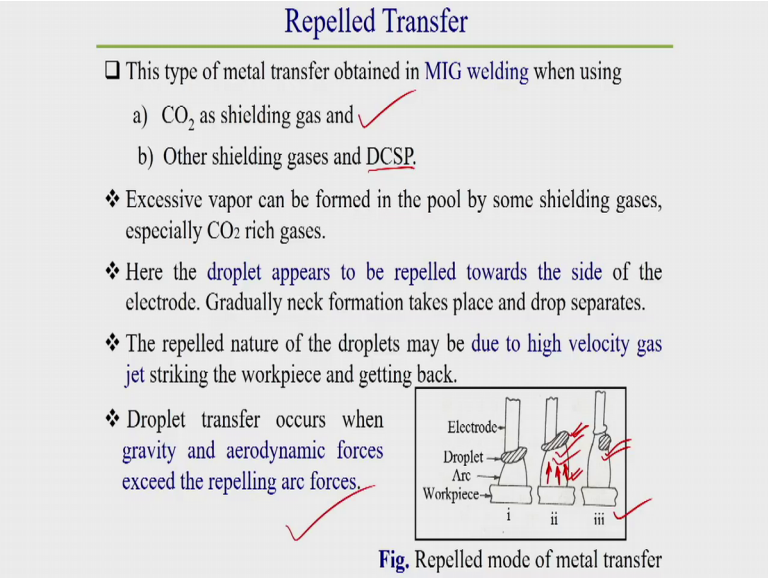

And it is this types of refill metal transfer also you can observe case of C O 2 gas here this refill metal transfer is observed both DCEP and DCEN; that means, both straight polarity and reverse polarity get. Other gases also you can observe this types of metal transfer once you use DC generally EN as a electrode polarity; that means, for reverse polarity; if you use then you can observe this types of metal transfer.

Why and how it is occur? A excessive vapour can be formed in the pool by some shielding gases. Especially in case of C O 2 rich gases excessive vapour can found; this excessive vapour generally provide some repulsion types of force over the surface of the molten droplet which generally protect the molten droplet drop down to molten pool; its generally act against the gravitational force.

How it is generated? Once CO 2 gas is used as a shielding medium or CO 2 gas if it is formed due to this metal gas reaction generally due to this excessive CO 2 gas its getting back or striking over the surface of the workpiece its generally what happens? Getting back and it generally provide some opposing force against gravity over the surface of the droplet actually not weld pool; so over the surface of the droplet. Due to this force of this gases this drop cannot detach from electrode to what workpiece easily.

So, due to this forces what happens? Here the droplet appears to be refilled to the side of the electrode. So, due to this repulsion force we can show a not the due to this force of these gases refilled towards the side of the electrode like this here the in this figure it is

showing. When it is detaching from this electrode to workpiece because if this generally if the gravitational force and aerodynamic force whatever it is acting here generally here; if the gravitational force of this droplet and aerodynamic force of the droplet exceed the refilling force.

Whatever the refilling force created generally; whatever the refilling force created due to this getting back generally gases. Whatever the refilling force is generated if the gravitational force or aerodynamic force of this droplet exceed this refilling force that that time this drop transfer from electrode to workpiece. This drop generally transfer in side only of the arc which is shown in this figure and this is figure iii.

So, how its occur? That idea you can get from here easily its occurred due to this refill nature of the droplet may be due to the high velocity gadget is striking the workpiece and getting back. So, its create some refilling force this; this high velocity gadget generally create some refilling force to the droplet which is generally against the gravitational force and aerodynamic force.

If this gravitational force and aerodynamic force of the droplet exceed that refilling force; then generally it separate from electrode and its drop down to workpiece. And this drop generally transfer occur side only and as it is a refilled in nature that is why this is called refilled types of metal transfer.

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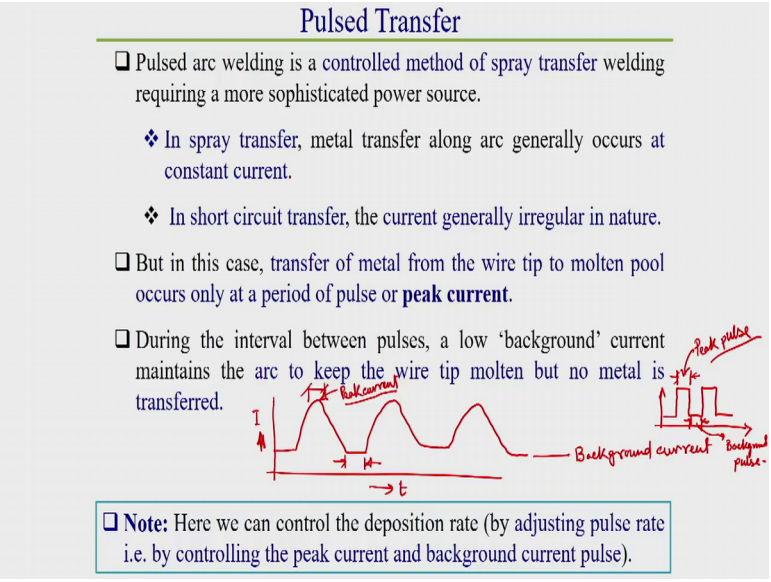

Now, we will see what is pulsed mode of metal transfer? This pulse types of metal transfer is a controlled method of spray transfer that means, here we can control the rate of metal transfer depending upon the pulse rate actually.

For this generally a metal transfer here generally there is require some sophisticated types of power sources ok. In case of short circuiting types or free flight of metal transfer what we observe? Generally in case of free flight metal transfer or a spray metal transfer we observe that current is almost constant over the drop transfer time.

What we observe in case of short circuiting? There we observe that current is varying irregularly in case of short circuiting types of metal transfer. But in this pulse mode metal transfer here the current variation is predefined fashion here some specific pulse is used; that means, here some pulse rate is used to control the deposition rate of molten droplet. So, that is why this is generally called pulse mode of metal transfer; here generally this pulse mode of metal transfer how its look like here generally this current distribution is pulsing in nature.

How this current variation is look like in case of pulse transfer pulse mode metal transfer; that I am little bit showing here generally let this is your current I and let this is time t; how it is varying? Here I am just showing some sort of things; here generally this pulse rate; that generally what happens at this is generally called peak current; peak current and this is generally called background current; background current which I have already discussed in case of pulse mode power source there I have discussed about this thing.

Here also again I am showing here in peak current pulse or whatever the current pulse is there in peak current this is generally called peak current pulse. And this background current also generally here this is generally called background current pulse. So, here I am just showing in curve in nature that can be represented as like this also then it will be more clear and easily be understandable like this.

It can be like this here generally if this peak current is keep for a particular time then that is called peak pulse; peak pulse and in this background current generally if this background current is keeps some a specific time this is called background ground pulse ok; this is called generally background pulse in peak current metal transfer is taken place. So, number of peak current per second whatever the number of peak will be there; that

number of droplet will transfer from electrode to base material.

Generally in bag here background current keep in such a fashion so that arc will not extinguisher. Here always keep it in mind here arc is remain ignited state during the welding operation; here generally arc is not extinguishes like alternating current or short circuiting current. Generally short circuiting types of metal transfer or alternating types of metal transfer what happens here arc does not extinguishes; in case of short circuiting metal transfer arc extinguish.

But here arc is not extinguishes in because here generally arc remain ignited. And this electrode tip remains in molten state and background current also though at that background current metal transfer does not take place, but what happens? At background current arc is at ignited state and the electrode tip is also in molten state, but here drop transfer does not taken place that we should keep it in mind.

So, what happens? This by this method generally we can control the rate of metal transfer because if we said the number of peak per second 60 then here we can get what happen? 60 drop per second. If we keep the number of peak per second is 100 then here we can get the 100 drop per second. So, as per our requirement here we can control the what happens we can control the metal deposition rate by controlling the pulse rate.

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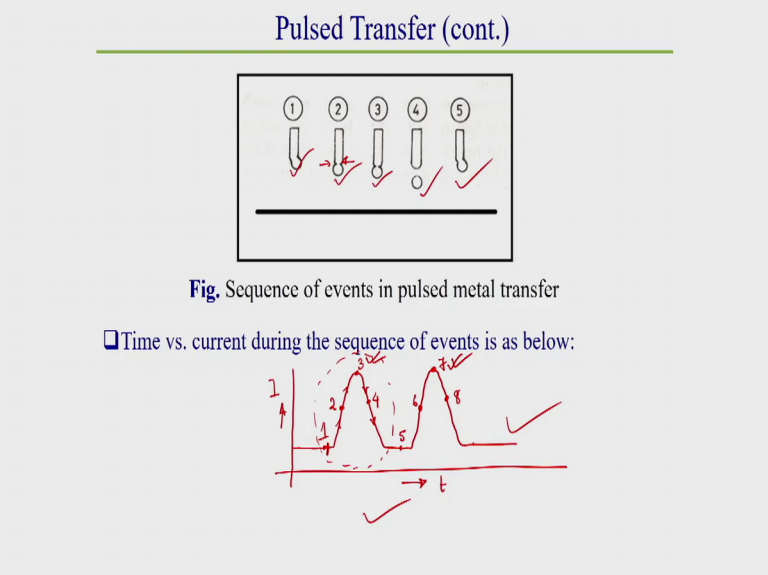

Now, here also we will see what are the different step for metal transfer; that means,

oscillogram how its look like? Here generally how the oscillogram is look like? That is showing in this different step generally at a step 1; the drop start forming, a step 2; the neck formation is taken place a neck formation is start step 3 neck formation quickens or we can say an neck formation increases rapidly. And at point 4, this drop detachment taken place and again at point 5; next drop formation start.

So, how it in case of current due to the different step how the current variation is look like that I am showing here that also I am showing here; how the current is varying in for this different step. See whatever I have told you; we which is the point 1, which is the point 2 and which is the point 3 that I am showing.

What I have told you this is point 1 because in this point 1 the drop formation is start. So, what happened at background current this represent the background current here generally drop that molten tip is in molten state that means drop formation is start. So, at point 2 generally once the current rise; that means, once the current rise that neck formation is started at from 2. Because after background currents if the current rise then the neck formation a start here one things you can observe from here the neck formation is start.

At point 3 generally; at point 3 generally what happens? That neck formation quickens here generally neck formation tremendously increase and at point 3 generally drop separated at point 3 immediately just after point 3 this point 4 comes. Generally what happens? At point 3 itself the drop separate from electrode and it start following actually; one it. So, after that point 4 comes here that again the current decreases again the current decreases and goes to what its called background current.

The next droplet is start, but here generally drop transfer does not taken place after that again here will be point 6 here will be again 7 that is peak current; peak current here again the drop transfer taken place. And after that immediately point 4 comes when the drop transferring from electrode to workpiece; this point 4 after that sorry not 4 this is 8; 8 means subsequently; that means, next step. So, next drop transfer start and next cycle start next cycle is start from here.

So, in this way generally what happens? For E every peak generally provide generally a drop. So, what happen whatever the number of peak per second will be there that many number of drop we can get per second. So, depending upon this pulse rate this is called

pulse rate actually pulse rate means how many peak or how many pulse we are providing per second that is called pulse rate.

So, depending upon the pulse rate we can control the metal droplet deposition rate or droplet transfer rate depending upon the pulse rate we control that droplet deposition rate or droplet transfer rate ok. So, this is generally a controlled metal transfer techniques this metal transfer; what I have already told you here we get a spray types metal transfer which is a free flight types of metal transfer. This spray transfer whatever the different categories of a spray transfer I have told you previously.

So, different types of spray transfer we can get changing the peak value of currents; that means, if we increase the current value then we can get the different mode of a spray transfer also. Like it can be axial or projected type it can be streaming type depending upon the peak value of peak current of this pulse mode current.

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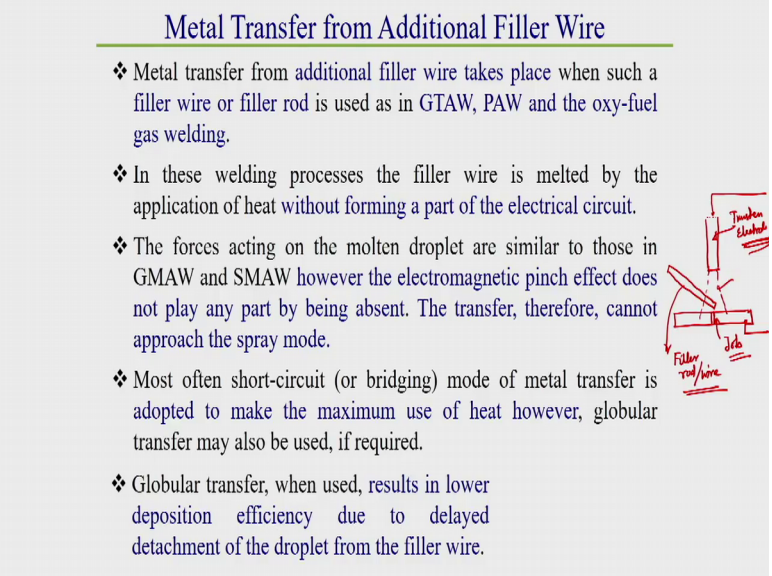

Now, we will see how the metal transfer is taken place once we use a extra filler material. If you use a separate filler material then how the metal transfer is taken place that also we should know. What happens here a extra filler material once it use what does it means? Generally in this case; in this case generally a non consumable types of electrode is used here this is let us tungsten electrode; tungsten electrode and this is generally the job.

So, generally this is either for this is here and here cable; that means, current or current or current cable is connected to this workpiece and the electrode, but this tungsten electrode is non consumable type this is this types of things. So, here generally to deposit the filler material over the job here to deposit the filler material welding region of the job or workpiece, there can be some separate filler wire.

This filler wire this is generally called what it is called? Filler wire filler rod or you can say filler wire or wire this generally heated by this arc and what happens? Due to this heating of this electric curve this filler wire melted and it deposited over the welding region then welding is taken place this is. So, this filler wire where one things you can observe this types of metal transfer.

So, here also some types of metal transfer is taken for how it look like; what types of metal transfer we can observe in case of this filler wire non consumable types of welding techniques; that also we should know. Here one things you can observe that here in this case generally this filler is heated by the arc.

This filler wire here is not a part of electrical circuit what I am telling you understand there is no connection of this filler wire with this electrical circuit; where electrical circuit is connected with this tungsten electrode and in case of a and with this job there is no electrical circuit connected with this filler wire.

So, here this is heated by this arc only. So, here are what happens? Here generally whatever the different forces acting like gravitational force, surface tension force; that means, gas pressure force whatever the other forces are there all the forces acts, but what happens here effect of electromagnetic force is not here because what happens here in the through this filler wire there is no flow of current. So, here generally electrode magnetic force does not created over this wire.

So, here generally that pinch effect whatever the radial force generated in case of consumable electrode that types of pinch effect here is absent; that things you just keep apart from this pinch effect; rest of the all other forces whatever the forces I discuss about consumable types of metal transfer, consumable electrode metal transfer all types of forces generally here is acting.

Here one things you should know what types of mode of metal transfer generally here

taken place. Here generally mode of metal transfer either globular types or it can be short circuiting types. Here spray types of metal transfer is not possible why spray types of metal transfer because spray types of metal transfer generally taken place for higher current range.

For higher current range neck formation force or recurrence of pinch force is increases or electromagnetic force increases. Due to this increase electromagnetic force generally rapid formation of neck and rapid formation of droplet is taken place that types of effect is not here.

So here rapid formation of droplet generally absent here; so that is why here spray types of metal transfer here we are not able to get actually this spray types of metal transfer in case of this. But in case of this non in case of this additional filler wire metal transfer.

Here generally we can get globular types of metal transfer or short circuiting types of metal transfer. Here one things you should keep it in mind once the metal transfer here taken place as short circuiting types or bridging type; then what happens here maximum heat will be used. Why because what happens? Here generally drop is forming and directly reaching the workpiece and directly depositing to the weld pool region.

So, here generally heat loss is very less once we go for globular transfer; globular transfer when use result in lower deposition efficiency because due to delayed detachment of the droplet from the filer wire. What I have told you? Because generally here as there is no neck formation or pinch effects are there that is why what happens here rapid transfer of droplet is not available.

So, that is why here generally due to this delay detachment of the droplet; if you use globular types of metal free flight metal transfer then what happens? There is a chance of less deposition efficiency; that is why generally here short circuiting or bridging types of metal transfer is preferable, where we can add up to make the maximum use of heat.

So, then only short circuiting mode of metal transfer is adopted because to make the maximum use of heat here; then heat generally we can use maximum amount of heat that is why in case of filler wire rod metal transfer instead of globular types of transfer short circuiting or bridging types of metal transfer mode of metal transfer is preferable that is more efficient than globular types of metal transfer.

Now, we got the idea about all the different types of metal transfer whatever the metal transfer generally use in case of consumable as well as non consumable types of electrode. So, I have already discussed about different types of metal transfer in details, their characteristics, how the what are the different forces acting over metal transfer by this metal transfer from additional filler rod by this I have completed the all categories of metal transfer its characteristics in detail.

Next class I will start what are the effect of different process parameter or what are the defect of different parameter on metal transfer. And after that actually I will discuss about what are the different melting rate of metal transfer in details 4 different types of welding process. Apart from this at the end of this physics of welding I will discuss about the efficiency. So, what are the different the efficiencies used in case of welding process.

So, that I will say after that I shift to discuss different categories of weldings there principle, their working principle, their application, advantage, drawbacks, their different process parameters; in subsequent lecture we will discuss about this ok. So, next class I will discuss about effect of different process parameter on metal transfer and melting rate.