Fundamental of Welding Science and Technology

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Lecture – 22
Gas Metal Arc Welding (GMAW)

In last lecture, I was discussing about GTAW that is Gas Tungsten Arc Welding process, actually GTAW welding process in which generally a non consumable electrode was used. But today I am going to discuss about a welding techniques whose name is actually GMA welding that is called generally Gas Metal Arc welding process. Here generally instead of using a non consumable electrode here a consumable electrode is used.

So, you here is there is a huge difference between this TIG welding and; that means, GTAW welding and GMAW welding there was, their physics was some somewhat other type here the physics will be somewhat other types. So, here generally I will discuss in details about GMAW process; that means, Gas Metal Arc Welding process. So, today's lecture actually is on gas metal arc welding process.

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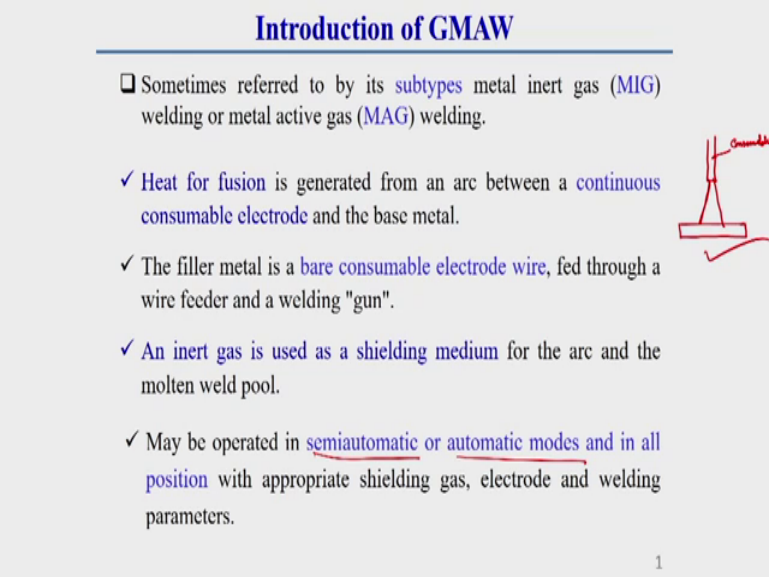

Generally, this is sometimes referred to by referred by it is subtype; that means, this is also sometimes referred to as subtype in the sense sometime it is called as MIG welding or MAG welding, this is generally subtype of this gas metal arc welding process there is use some active gas that is why this welding technique also named as MIG welding or

once a MIG welding means Metal Inert Gas welding or sometime it is termed as MAG welding MAG welding means metal active gas welding.

Because one of the shielding gas which is used to protect the molten pool and arc if that gas is active in nature then that is called metal active gas welding or if there is used there is used inert gas as a shielding medium or shielding gas then that is called metal inert gas welding technique that is MIG welding techniques.

Here generally heat for fusion is generated from an arc that arc generally generated between a consumable electrode and the workpiece; that means, here whatever the arc is generated that arc is generated between workpiece and workpiece and this is electrode this electrode is consumable electrode consumable means it generally continuously fed by some wire feeding mechanism it is consume; that means, it is melt and it deposited as well as it generally generate arc and it generally conduct the current for generating arc to do the welding operation that that; that means, here the arc whatever it is generating between this workpiece and what it is called a electrode this electrode is a consumable electrode.

Here this electrode is a filler material, this filler material is a bare consumable electrode wire it is fed by some wire feeding mechanism through a welding torch this welding torch also sometimes referred as welding gun here in this welding technique there is used a inert gas. That inert gas which protect the molten pool; that means, molten weld pool as well as this arc from the atmosphere contamination actually that is why this welding techniques name as gas metal arc; that means, a gas term is used here because here a gas is used to protect the molten pool as well as arc from atmospheric contamination.

Generally in SMAW welding process what we have observed generally to protect the arc from atmospheric contamination. Generally there is used flux as well as flux when it is burn it produce some gas. So, there is somewhat different mechanism or somewhat different types of protecting medium is there, but here the protecting medium weld pool as well as arc is inert gas or sometimes there is use some active gas also.

Now here this welding technique may be operated in semiautomatic as well as automatic modes and it can be used in all position; that means, by this welding techniques also we can used in positional purpose also like this welding we can use horizontal the vertical

flat overhead. So, different different purpose of actually this welding techniques we can use

But for this positional welding we have to generally choose appropriate shielding gas electrode and welding parameter. So, once we go for positional welding for that generally there we should select our welding parameter such a way. So, that it should suitable for that positional welding ok.

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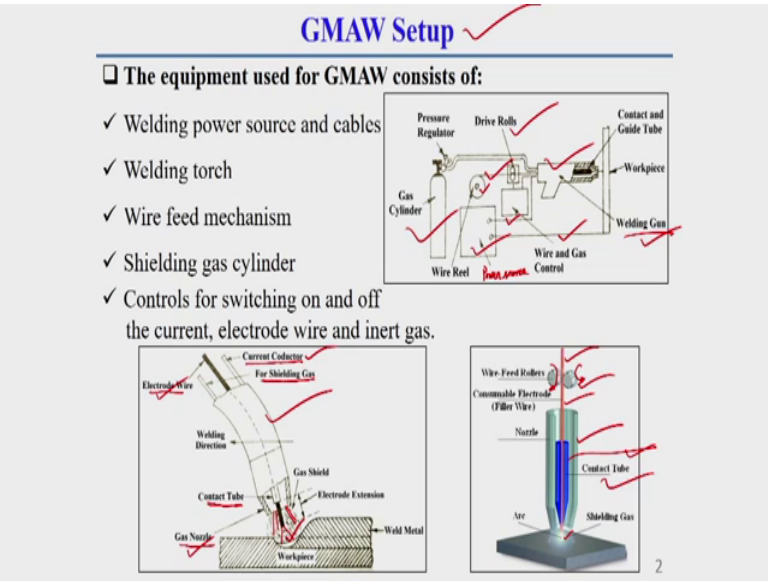

Now, in one by one actually first of all I will discuss about GMAW setup; that means, whatever the sequence I followed in previous welding techniques in previous lecture similar sequence here also I will follow; that means, first will be that introduction then whether it will be what is the setup of this thing, then what is the principle of this process, then what are the different welding parameters like this then advantage, disadvantage and its application like this actually I will discuss here also the with this similar sequence I will also follow here the similar sequence of discussion.

Like first of all I will discuss what is the GMAW setup, here the GMAW setup consists the following five important equipment what are those equipment here generally this right side figure this figure represent the GMAW setup one things you can easily observe here there is used a power source this is called power source. So, what is the name of this is called welding power source.

So, power source is there; so for this power source there is required cable because by this cable generally it is connected to electrode as well as it is connected to workpiece, so, that is why here required this cable. So, here this first equipment of this thing is power source, second one you can easily observe that is there is required a gas cylinder because gas cylinder why gas cylinder is required what I have told you here generally there is used a shielding medium to protect the arc as well as what it is called molten weld pool from atmospheric contamination.

So, for that reason here generally used some sort of inert gas or sometimes there can be used active gas also. So, so that is why a cylinder is required that is called gas cylinder, this gas cylinder then another thing is there is a continuous feed of electrode is there is a continuous feed of electrode actually is there.

So, there is required wire feeding mechanism; so there is required wire feeding actually this is a wire is role in a wire reel from this role what happens this wire or this electrode wire continuously feed through the welding gun or welding torch this is called generally welding gun. So, another one equipment of this welding process is welding gun, then there is also used some control mechanism this control mechanism actually is required for switching on and off of the current as well as a electrode wire and inert gas.

So, this control system generally used to control what happens gas flow rate that is inert gas or controller or regulator are there. So, there is different controls are also there, there is also a control is there to switching on and off of the current is that types of control is there. And there is some other control also is there for feeding of this electrode wire from this reel, that is generally you see this is generally drive roll actually or some motor or some that motor mechanism generally used to feed that thing.

So, there is some also some control is required, so there is different control also is there to control this what it is called current electrode wire and inert gas. So, this is the generally what happens? So, here what are the equipment are there is a power source, then there is what it is called gas cylinder there is generally wire feeding mechanism, there is wire feeding mechanism, there is a welding gun here you see is this is called welding gun or this is sometimes called generally this is sometimes called welding torch also because this through this why it is called welding gun?

Because through this generally there is a continuous flow of electrode is there ok, it is generally this welding gun supply both arc as well as it generally help to generate arc as well as it generally supply what it's called inert gas. So, what happens this is sometimes called welding torch or you can say it sometimes called welding gun also because why it's called torch because it's generally help to generate arc, as well as it helps to supply a continuous flow of what if feed of continuous feed of what it is called electrode consumable electrode, that is why this is also sometimes referred as welding gun.

And you see this welding gun once we just see little bit bigger way this welding gun this is this is shown here. Here one thing you can see very easy way that what are the different cable, different nozzles system and what its way how the arc is generated everything is available generally here in this little bit bigger way if you will see. Here you see there is electrode wire is there, this electrode wire feed by some wire feeding mechanism some roller or an some motor system is there.

And here in this torch or gun there is a contact tube you see there is a contact tube, in this contact tube generally one cable is connected to supply the electric current to what it called electrode to supply the electric current to electrode and how this is connected this contact tube connected to what it is called the power source, this is generally here is use some wire, this wire I am just showing here some current conductor or some cable is there by this cable this contact tube is connected with power source.

So, here generally current conductor is connected to this contact tube to supply the current tube electrode actually, this I will explain in right figure more clearly and there is another tube or hose is there this hose generally is this is the for shielding gas. Generally this is a pipe system is there through this generally the shielding gas coming from what we say current coming from this gas cylinder.

So, what happens once the welding is start? Here one things you can easily observe that what happens in the middle of this thing there is generally developed this arc and why this gun; that means, by this gun or you can say that this welding gun or in front of this welding gun there is generally used some nozzle, generally nozzle through this nozzle generally this gas emitted out from this gas nozzle to weld pool what happens then you see this is the gas shielding which there this is the gas shielding which generally shield both this arc as well as weld pool.

So, what happens here? Generally this weld pool as well as arc protected by shielding gas which is supply from the gas cylinder through nozzle to weld pool; so then this weld pool generally protected from atmospheric contamination. So, this is once we just see this gun by section then we can get a very clear picture from here how its look like.

This is generally nozzle, this is a nozzle which is a hollow cylindrical types of shape, hollow circular cylindrical shape generally this inside this here you see this blue one is called contact tube. This is generally contact tube a conductor contact tube is there this generally through, this generally electrode is continuously feed to weld pool then it's there is a close contact between this contact tube and electrode.

This contact tube is connected by this current conductor to power source in this contact tube generally current cable is connected and what happens through this contact tube the current is coming from power source to cable then cable to this contact tube and contact tube to its electrode, here electrode means in this consumable electrode. This electrode is continuously feed how it is feed because what happens here this in front of this electrode there is generally arc is there.

So, due to this arc this electrode is melted and due to this what happens? It is continuously deposited to the weld pool and what happens and this electrode is continuously feed by wire feed roller. Here you see this is a wire feed roller this they can be group type, this can be plane types of roller also here it is generally I am showing a group types of feed roller which rotated like this if it is rotated so what happens it continuously supply this electrode to weld pool actually.

Now you see through this nozzle generally this hollow nozzle this shielding mesh coming out and it's shield; that means, it's cover both arc as well as weld pool from atmospheric contamination. So, what happens? There is a chance of oxidation or other effect due to this atmospheric contamination is will be will is protected by this shielding gas. This shielding gas sometimes what I have told you, this shielding gas sometimes used as inert gas sometimes it is used as what it is called active gas. That is why what happens sometimes it's referred as metal active gas welding, then sometime it is referred as metal inert gas welding ok.

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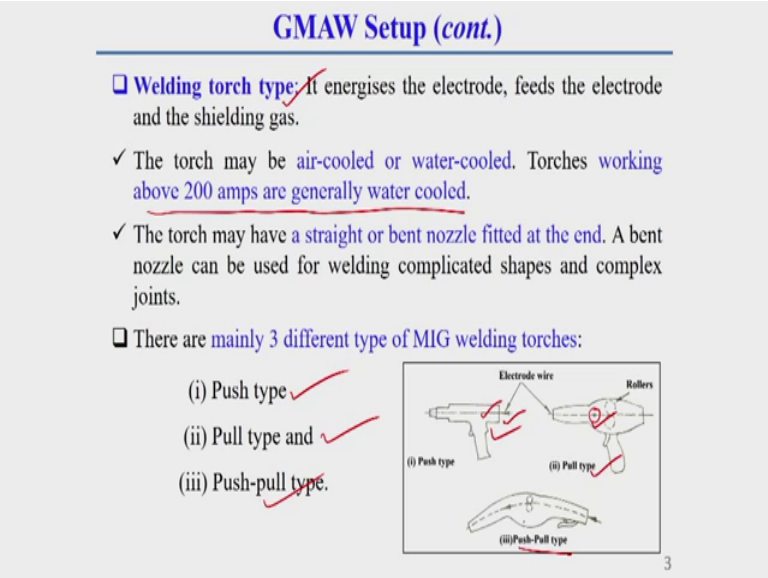

Now, we will go to the details what is this gun whatever gun or torch we have seen this torch have different types actually. This torch is the main part of this welding process because what happens it energize the electrode, feed the electrode and it also supply shielding gas to weld pool that is why this torch is very important part of this welding process.

Here one things you should keep it in mind generally this torch can be sometimes air cooled or water cooled because there is a continuous supply of current as well as there is a continuous generation of arc is there due to that there is a chance of generation of heat. For that reason happens if the current energy is high enough, then what happens there can be generated more heat. So, if there will be more heat then what happens there is a chance of overeating of this torch and other thing is there

That is why depending upon the range of current this what it's called this torch can be air cooled at as well as water cooled. Generally if the current range is above 200 ampere, then what happens this types of welding torch generally cooled by some water system; that means, water cool system. So, it is generally that types are so above 200 amperes currents on we go for using this types of welding process, then there is required generally water cool system to cool the gun or torch.

This torch generally may be straight or it can be bent type this nozzle generally which is fitted in front of this torch because this bent nozzle or this nozzle help to supply the gas

to weld pool proper way actually, so this nozzle in front of this torch can be bent type or it can be a straight type. Generally a bent nozzle can be used for welding complicated shape and complex joint so if the joint is little bit complicated or complex and if the shape of the welding is little bit complicated shape the then what happens they are bent types of welding torch is preferable.

Here on things you should keep it in mind that this welding torch, so depending upon this cooling system there is two different types of welding torch you got that is one is called air cooled welding torch another one is called a water cool welding torch. So, depending upon this feeding mechanism used in this welding torch this depending on this feeding mechanism, this welding torch also further categorized into three different categories one is called push type, another one is called pull type and third one is called generally combination of this push and pull types welding torch.

Generally in case of push types MIG welding process or push types this welding torch, here pushing of this electrode you see through this gun there is a pushing of electrode is there, so what happens this it push the electrode to continuously feed to weld pool. So, here some pushing mechanism is used, Whereas in case of pull system here you see here some roller system is used which pull the electrode actually and it continuously feed to what it's called in weld pool.

So, cooling mechanism is used here generally used push mechanism in first case. Now, this third categories here both this pulling mechanism as well as pushing mechanism is used in third categories you see, here you can feed this electrode by pushing as well as by pulling mechanism. So, that is why this is generally called push pull types of welding torch.

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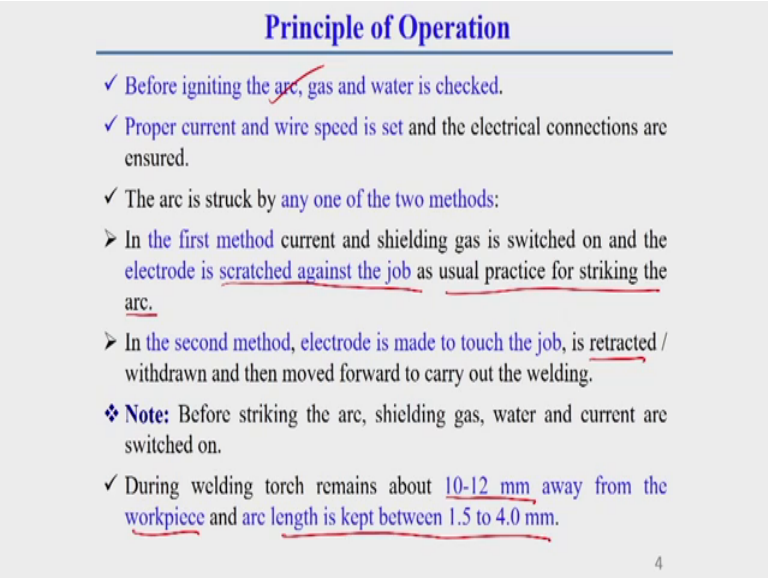

Now, we will go what is the principle of this operation? Here principle is of this operation means how it is operated actually. So, what are the different a step we should follow during this welding process, what is the principle of this operation? That I will now discuss.

So, first of all here one things you should know that before say what are the things first what are the thing required first of all here, generally before igniting the arc, here one things you should know that before igniting the arc gas and water is we have to check; that means, first of all we have to check whether there is sufficient gas or water cool if it is water cool that water is there or not that we have to check. Then we have to set our current and wire speed and we have to generally is check the electrical connection also whether it is proper or not.

So, before starting the arc these are the things we have to check. So, what are the thing we have to check? Whether we have; that means, whether there is sufficient inert gas or active gas in gas cylinder is there or not. Then we have to set the what should be the current range, what should be the welding speed in power source and then we have to check whether this electrical cable everything is well connected or not that we have to check.

Then the arc is generally struck by any one of the two methods. So, arc can be struck by two different method in this welding process, see I have already discussed there is

different types of technique generally used to initiate the arc in different arc welding process there is also some technique is used to initiate the arc. Here generally in the in the first method generally current and shielding gas is first switched on.

So, before striking the arc I have already told you we have to generally switch on both current as well as shielding gas and the electrode generally is scratched against the job as usual practice for striking the arc. So, here generally by as you can say a striking method like message, similar method generally here also is used; that means, some scratched method by scratching the electrode on the workpiece generally here arc is struck so this is the first method.

In second method generally electrode is made to touch the job then it retracted or withdrawn retracted means then is so first we touch the electrode to job then it's retracted and then move forward to carry out the welding operation, so this is the second method. So, one method by scratching method another one method is called by touching or you can say that is a type of a similar to tap method tapping method ok.

So, here one things you should know that is note it down that before striking the arc what I have already told you shielding gas water and current should switched on. So, before striking the arc itself that should be switched on and during welding this torch remain about 10 to 12 millimeter away from the workpiece and their generally here the arc length generally kept between 1.5 to 4 mm.

So, from here you get a fair idea what is the range of arc length generally used in case of what it's called GMAW process. Generally arc length is range which is used that is baring from 1.5 to 4 millimeter approximately and this torch which is used in this arc process here this torch also should have some distance; distance from workpiece to what it's called workpiece to torch that distance also should be 10 to 12 millimeter.

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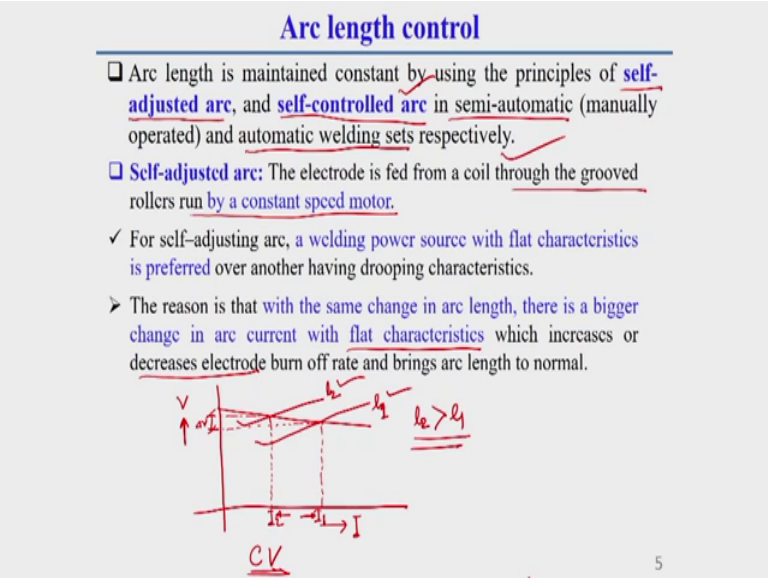

Now, this whatever the arc I was why this is actually why this arc and torch should kept little bit away from this what it's called workpiece because otherwise what happens due to this arc also it can damage and other things or so once we keep this thing around 10 to 12 millimeter, then there is a chance of less damage of this welding torch will not be damaged.

Now, here we should know how the arc is controlled, here generally in this welding process generally what happens arc length maintained constant by using the principle of two different principle generally used here what it's called to make the arc length constant, here generally two different principle is used. This first principle or first technique generally is called self adjusted arc; that means, first principle is called self adjusted arc and second principle is called self controlled arc.

So, by using this two techniques this arc length keep constant self adjusted arc technique generally used in semi automatic welding operation semi automatic you know what is semi automatic welding operation I have already discussed about this in detail in previous lecture. So, and this self controlled arc this principle is used in case of automatic welding techniques. So, what happens? So self adjusted arc used in semi automatic types of welding process and self controlled arc used in automatic types of welding process.

So, so first of all I will discuss about self adjusted arc. So, in the in case of self adjusted arc this is this I have already explained in details when I was discussing in case of power source characteristics there I have already discuss the self adjusted arc, this self adjusted arc also is called as self regulation of arc characteristics. So, what happens self adjusted arc the electrode is feed from a coil through the grooved roller run by constant speed motor.

So, here in case of self adjusted arc there is used a constant speed motor; so that; that means, this constant speed motor with a constant speed it generally supply that electrode. Now what happens if in this welding process if there will be any unbalance or there will be any disturbance, if due to this disturbance if there is a change of arc length will be there if there is a change of arc length is there, then what happens there is generally a principle is used which generally increase the melting rate or decrease the melting rate and it generally return back this arc length to its original shape. So, this principle generally is called self adjusted arc.

Generally these things you can you can observe, generally these things you this types of self adjusted arc once I will discuss this thing little bit graphical way then it will be more clear to you. Just here you see generally in case of power source characteristic what we observe that in case of power source we observe that, there is generally used current voltage.

So, in case of the self adjusted arc this is used in case of flat characteristic power source; flat characteristic power source in the sense the where this power source characteristics is flat in nature. Now in case of V and I a space we observe that if there is a change of change of arc length is there let us what happens if let us there is a change of arc length is there due to due to this if there is a change of voltage is there, this is for arc length characteristic for l 2 length and this is for arc length characteristic for l n length.

Now here we know that generally I this is the voltage of that thing this is the voltage of welding voltage of this thing. So, this is generally power source here generally what are the things are there, here generally l 2 greater than l 1. So, if there is a change of arc length from l 2 to l 1, so there is a drop of voltage is there. So, a small change of voltage drop is taken place and here what happens if this power source characteristics is flat type there is a small change of arc length there is a huge change of current is there.

So, here this is your I 2 this is your I 1, so here there is there will be a huge change of current is there. So, here current change is very high in case of flat types of power source characteristic due to this a small size of voltage there is a huge change of current is there. So, due to this huge change of current there is generally more burning of filler material is there. So, due to this more burning of filler material; that means, if there is a drop of voltage is there.

That means, if the if the arc length decrease if the arc length decrease little bit then what happens; that means, this; that means, this gap between this electrode and arc is decreased, then what happens there is a sudden rise of current is there due to this change of arc length. That current generally value is comparatively little bit higher in case of flat characteristics compared to what it's called constant current characteristics cc or what grouping characteristics types of power source.

So, here what happens due to this high change of current generally what happens there is more heating heat is generated due to this more heat generally there is more melting of filler material is taken place, due to this more melting generally this what that due to this constant speed of this motor what happens this arc length generally increase. So, these are due to this increase of arc length is return back to it's normal position actually.

So, so if there is a change of voltage; that means, drop of voltage is there then there is general automatically either increasing or decreasing the current value here generally what happens this arc length increases or decreases and it's return back to it's original position. This types of principle or this phenomena is called generally self adjusting characteristics of arc. So, this here in case of self adjusted characteristics of arc or self adjusted arc here a constant motor is used and here what types of power source characteristics is used constant voltage power source characteristic used.

So, because the reason is that with the same change in arc length there is a bigger change in arc current with flat characteristics compared to drooping characteristics which increases or decreases the electrode burn off rate and bring the arc length to normal well that is why generally self adjusted arc characteristics or the to control the arc length; that means, is used when the arc source characteristics is constant voltage in nature; so here generally the self adjusted arc principle generally used.

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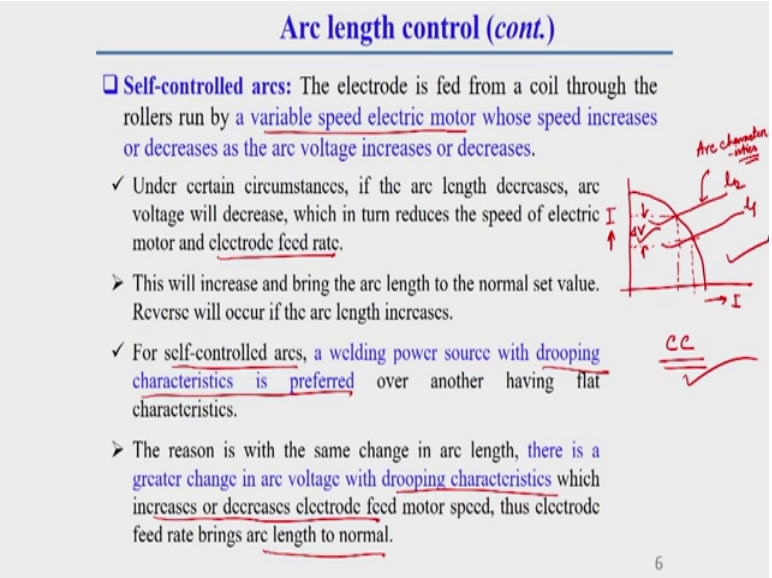

Now, in case of self controlled arc in case of self controlled arc here generally the electrode is feed from a coil through the roller which is run by variable speed here one things you should keep it in mind here variable speed electric motor is used, whose speed increases or decreases as the arc voltage increases or decreases.

So, this motor generally speed automatically changes with the increase or decrease of the arc voltage this you keep it in mind and you know already that arc voltage depends on for a particular types of material or diameter of the electrode for a particular types of electrode and material. Generally arc voltage is mainly depends on that arc gap other things you know; that means, that the voltage drop occurs in electrode tip in workpiece how it is that I have already explained.

So, arc voltage is mainly depends on arc length. So, you see so here in this case once the arc voltage increases or decreases then the electrode; that means, this variable speed motor speed also increases or decreases and what happens due to this generally what happens this arc length regain to its original length. So, so here once I explain this thing then it will be more clear to you this types of characteristic this types of principle generally used once we use constant current types of power source characteristic generally this type of things is used or preferable you can say.

Here what happens in case of constant current power source characteristics or this is also called drooping characteristics you know these things which is look like this here also

this arc characteristics; arc characteristics is look like this let this is for l 2 this is for l 1; that means, for a particular arc length this is called arc characteristic curve you know already these thing characteristics curve this is this is called arc characteristics.

Now here one things you can observe that here with a small change of arc length here comparable comparably more voltage drop is taken place compared to this flat characteristics; that means, for same arc length variation if you use this flat characteristic whatever the voltage drop here you can observe if we use constant voltage types of sorry constant voltage types or flat characteristics power source there the voltage difference will be different.

That means so for same arc length variation you will get more voltage variation or more voltage drop in case of what it's called constant current power source compared to constant voltage power source characteristics. Because in case of constant voltage power source characteristics what we observe there within a small size of arc length there is more change of current is there compared to voltage difference ok.

So, here that is why here you can get a more voltage change that is why this types of characteristic curve is preferable for varying the speed of motor because here generally that is why here a variable motor once we use for control the arc length, then what happens there should there the power source characteristic should be constant current type then it will gives better control of the arc because here generally more voltage change you can observe due to this more voltage drop change, then what happens there this electric; that means, a variable speed motor speed will increase or decrease and it generally return back to it's original arc length.

So, here this is the thing here it is written let us under certain circumstances if the arc length decreases arc voltage will decrease which in turns reduces the speed of the electric motor and electrode feed rate because if the speed of the motor changes, then feed rate also electrode feed rate also will be changes this will generally increase and bring the arc length to normal set value.

So, this reverse is occur once the arc length is increases, if the arc length decreases whatever the phenomena occurs, if the arc length increases then reverse phenomena occur; that means, if the arc length increases then voltage increases voltage increases means what happens due to this voltage increases this a[rc]- speed of the motor will

increases. So, speed of the motor increase means it will supply more wire more wire so what happens due to that what happens whatever the burning will be there that burning as it is remain same, that is why what happens this arc length regain to it's original shape.

There that is why here it is written this thing for self controlled arc generally one things you keep it in mind a welding power source with drooping characteristics is preferred over another having flat characteristics. So, here drooping characteristics is more preferable; that means, the reason is with the same change in arc length there is a greater change in arc voltage with drooping characteristic which increases or decreases electrode feed motor speed thus electrode feed rate brings arc length to normal values normal arc length.

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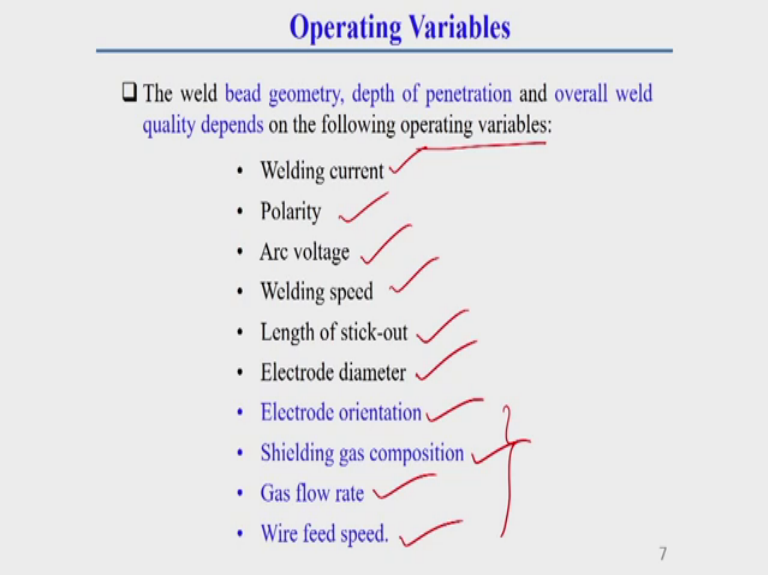

Now, you see we will discuss about what are the different operating variable generally used in this welding process, in this welding process generally this whatever the common welding parameter are there that is common apart from this thing there is some extra parameter also is there this welding parameter related things generally I have already explained in details in physics of welding.

But here generally what is the means what is the means importance of this welding parameter in this welding process that is related things I will explain little bit in this lecture. So, these are the welding parameter which is common welding parameters generally the weld bead geometry, depth of penetration and overall quality generally of

the welding is depends on following operating variable or you can say following welding parameters.

That is welding current one is welding current another one is polarity arc voltage welding speed length of a stick out electrode diameter these are the things which I have explained in details already in physics of welding. So, I will not go in details about this parameters, apart from these things here generally another welding operating parameters which is used that is called electrode orientation.

Then second one was shielding gas composition gas flow rate and wire feed rate. So, here I generally concentrate more in this last four welding parameter because this is this above above one have common effect actually to all the welding process you can say so that I will not explain in detail.

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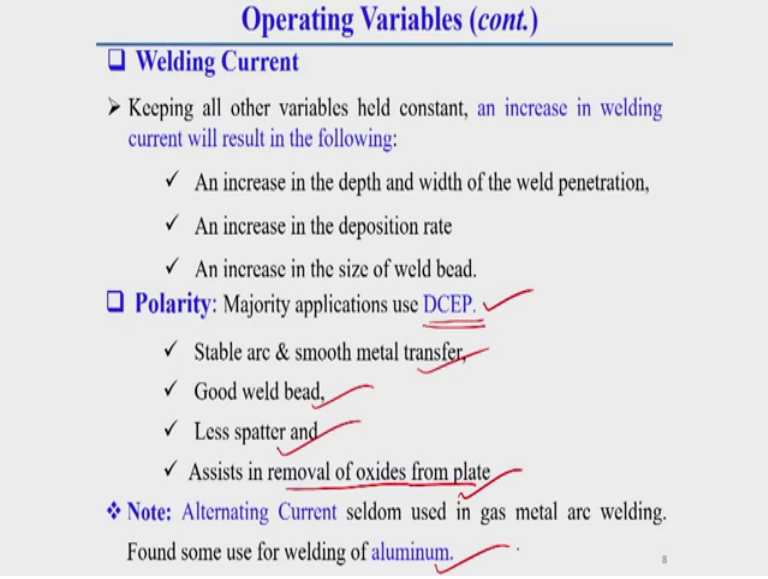

Then also here it is a consumable types of electrode is used here, that is why what should be the welding current and what should be welding polarity preferable for this welding process that I have already discussed multiple time. Then also in this welding process how what is this thing that I should tell that is why I will tell little bit here.

Generally here welding current generally you I know we you know this thing what is the effect of welding current, generally welding current effect means keeping all other parameters fixed if you increase the welding current generally an increase in the it's

generally increase the depth as well as marginally it's increase the width also width of the. So, so here generally depth of penetration increased it's generally increase the deposition rate because if we increase the current burn off rate increase. So, it's increase the more metal to deposit so it's increase the deposition rate and also it's increase the size of the weld bead.

But here the main things you should keep it in mind for as it is a consumable types of electrodes. So, more heat should generate in electrode that is why here DCEP types of polarity is preferable because DCEP means Direct Current Electrode Positive because if the electrode is connected to positive terminal, then what happens then mo[re]- electron bombardment will be taken place in electrode.

So, so more heat generally if it is positive terminal, so 70 percent heat will be generally you know this thing a in case of DCEP generally where the electron bombardment is taken place there generally more heat is generated compared to where the ion generally deposited positive ion generally deposited

So, hence here so due to this electrode bombardment what happens in electrode generally 70 percent heat is generated and 30 percent heat generally generated what it's in workpiece. So, we want here in case of consumable electrode should melt. So, that is why more heat should produce in electrode, that is why generally here the electrode positive polarity is preferable and for this types of welding process if we use electrode as a positive terminal then we can get a stable arc and a smooth metal transfer.

Because here generally from this electrode continuous feed of molten droplet are there; so generally for a smooth types of metal transfer also this DCEP is preferable, then it's create good weld bead it create generally less spatter and as this is DCEP; that means, reverse polarity it's also help to remove oxygen or oxide is used to remove oxide from weld pool, that you know already in case of refractory types of material like aluminum I have already explained in detail like for cathodic cleaning action generally if we occurs if we use electrode as positive terminal that you know already.

So, that is why it's also assists to removal of oxide from the plate, if we use DCEP. In this types of welding process as it is semi automatic or automatic types of welding process that is why in this welding process it is alternating current is really used or

seldom used these alternating current sometime its use once you go for welding aluminum or magnesium types of reactive material.

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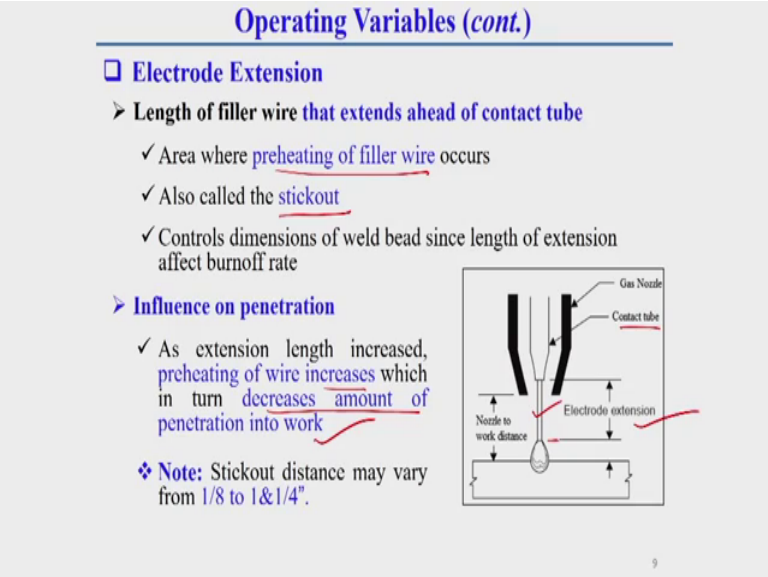

Now, electrode extension this also we know generally electrode extension means this is generally this contact tube. So, from contact tube; tube to arc position whatever the electrode wire or whatever the filler wire which is extended ahead of the contact tube; that means, from contact tube to arc position whatever the filler wire or you can say here it is electrode because it is carrying current as well as it is melting and depositing as well as it act as a filler wire that is why here you can say filler wire or you can say electrode here itself.

So, whatever the electrode or filler wire generally extended ahead of contact tube to arc position, that portion of electrode or a filler wire is called electrode extension. So, generally this electrode once is extended in front of this contact tube generally it act as a what resistance heater because it act as a resistance heater means here generally due to the flow of current through this electrode generally what that what happens there is generated heat because here joule heating types of phenomena is taken place. So, due to this these electrode is preheated you can say, that is why this electrode extension part if this is also sometimes referred as area where preheating of the filler wire occur

So, in electrode extension where generally preheating of filler wire is occur and also this is this is also called length of stickout; that means, stickout length whatever the length

coming out in front of the contact tube because here already preheating of the electrode is taken place. So, what happens within further increase of current or voltage burn off rate increase or decrease more compared to once it is less preheating less preheating.

Here another things you should keep it in mind as this electrode extension; that means, this electrode extension part as it's taken heat from the power source. So, whatever the generally so some sort of heat you can say here is heated which is taken from which should go to actually arc. So, from arc generally whatever the if it will not be heated. So, whatever the power will go to arc so due to the heating of this because some sort of heat is already lost you can say, it is losses to hit this electrode extension part.

So, that is why whatever the arc here it is generated due to this electrode extension that arc generally force is comparatively less if there is less length of stickout is there. So, lesser the length of a stickout, lesser will be the preheating, so lesser will be the heat energy loss pr lesser will be the power loss. So, less more power will be in, so if more power will be in arc then more forceful arc will be generated.

So, that is why some heat is lost due to preheating of this electrode itself. Due to this thing here generally less forceful arc is generated. So, due to this less forceful arc generally whatever the turbulence effect or other phenomena which I have already discussed in physics of welding process that thing generally that force generally decreases, due to that thing here generally less penetration; penetration is decreases.

That is it is written as extension length increase preheating of preheating of wire increases which in turn decrease the amount of penetration in to work, which generally decreases the amount of penetration into the work why? Because generally less forceful arc is generated compared to generally less length of stickout or without a stickout in we can say. Here what is the range of this length of stickout that generally varying from 1 by 8 inch 1 by 4 inch; that means, it's varying from 3 to 30 millimeter that about 3 to 30 millimeter; that means, this length of a stickout varies.

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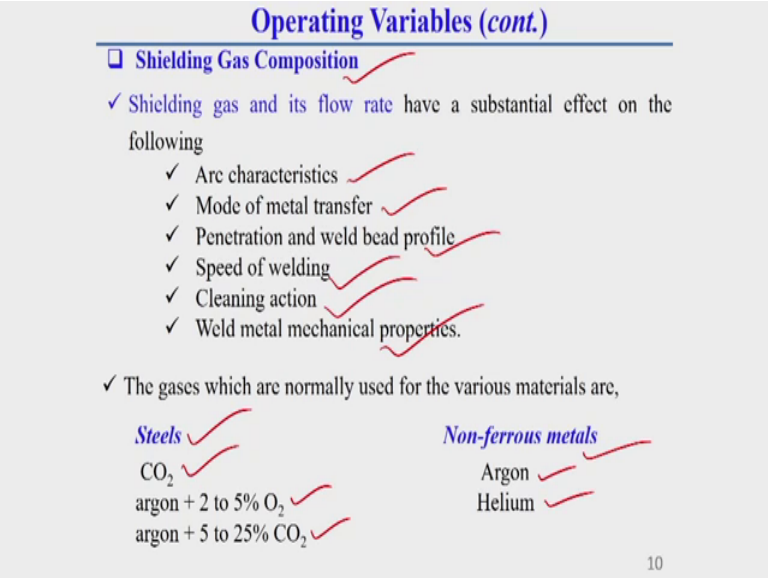

Now, this shielding gas because rest of the thing whatever; that means, volt cu[rrent]-voltage what is the welding speed that already I have explained the similar effect also here it is. So, I will not discuss further here about that things. So, here there major parameters which are generally used here that I will just more preferable here that I will explain; here generally the shielding gas composition is a very important operating variable in this welding process.

Generally the shielding gas and it's flow rate have a substantial effect on the following generally this following generally the shielding gas and it's flow rate have substantial effect on the following, that means it's effect is on arc characteristics, mode of metal transfer, penetration of weld bead profile, a speed of welding, cleaning action, weld metal mechanical properties; that means, shielding gas has a very important effect in overall quality of welding itself; overall quality of welding means it's generally effect characteristic of arc or what I have already discussed it generally affect the mode of metal transfer; that means, whether it is globular or a spray that also I have explained.

So, it has a very huge affect it's effect in cleaning action I have already discussed these things and all so generally organ is preferable for cleaning action than helium gas. Similarly, that then what are the gases generally used in this welding process? Generally if it is a steel material, for a steel material generally carbon dioxide gas this three different gas channel a gas or gas mixtures generally used one is carbon dioxide, another

one is argon with 2 to 5 percent oxygen gas and argon with 5 to 25 percent carbon dioxide gas if it is a steel material generally this types of gaseous generally used, if it is a non ferrous material then there is used argon or helium separately.

Now generally here apart from this three combination of a steel or the generally there is used some other combination of gas mixture also, which is this other two combination of gas mixture there we have seen argon with oxygen either or argon with carbon dioxide either but here can be argon oxygen and carbon dioxide that that; that means, there can be three different gas mixture also.

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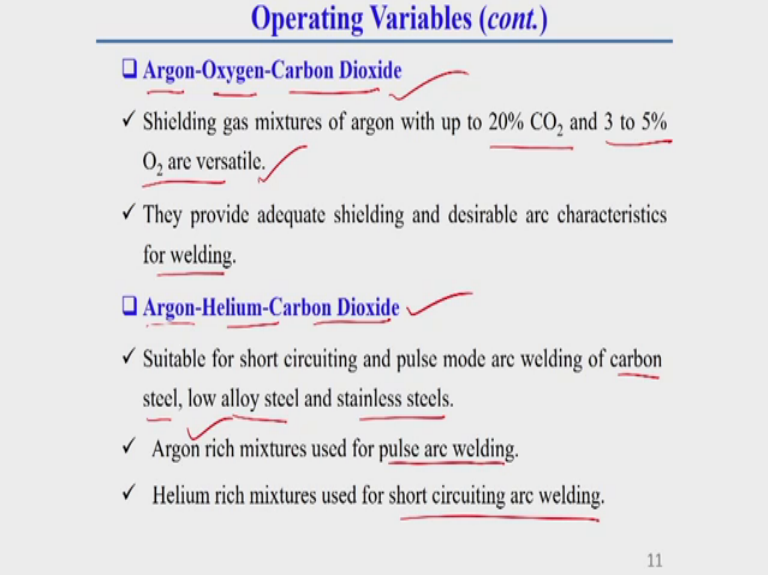

So, that is generally argon one is argon oxygen and carbon dioxide gas mixture another one is called argon helium and carbon dioxide gas mixture. So, argon oxygen carbon dioxide this gas mixture they provide adequate shielding and desirable arc characteristics for welding, that is why this we can use once the what it's called shielding gas mixture of argon with 20 percent carbon dioxide and 3 to 5 percent oxygen versatile. They provide adequate shielding and desirable arc characteristics for welding.

Similarly argon helium carbon dioxide mixture this has also some a specific application, these types of mixture generally used for short circuiting and pulse mode arc welding of carbon steel, low alloy steel and stainless steel. For this material generally if we use this mixture, then what happens there we can get short circuiting types of metal transfer or pulse mode types of metal transfer. For getting this pulse arc types of welding process

argon rich mixture is preferable whereas, for short circuiting types of metal transfer generally helium rich mixture is more preferable.

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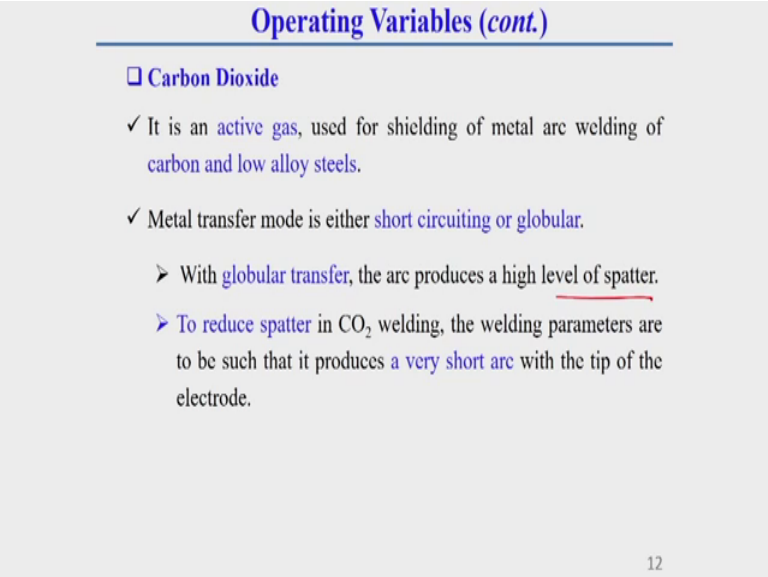

Then carbon dioxide gas generally what happens this is a gas which is active gas which is generally also used in this welding process that is why this welding process also sometime known as MAG welding process; that means, Metal Active Gas welding process. Generally this carbon dioxide though it is active gas, but whatever the quality of welding generally we get that generally fulfill the characteristics required for industrial application or industrial acceptability.

So, what that is why what happens carbon dioxide gas is generally as it is cheap easily available that is why it's so widely used in some industry, especially in shipbuilding industry it has widely used it has wide application. If this is a active gas generally what happens this active gas always produce either short circuiting types of metal transfer or globular types of metal transfer by this gas it's generally difficult to get what it's called a spray types of metal transfer.

That is why with globular transfer generally the arc produces high a spatter that we know. So, to reduce a spatter in CO 2 welding, here what we have to know do we have to generally keep the arc length as short as possible because a if the bigger droplet fall from little bit higher distance; that means, higher gap between electrode and workpiece whatever the spattering will be happen if that bigger droplet is drop down from a a

smaller height then this a spattering will be less. That is why we should select the parameter in such a way so that arc length should be as minimum as possible. So, then what happens we can get spatter types of fuel quality, by using carbon dioxide.

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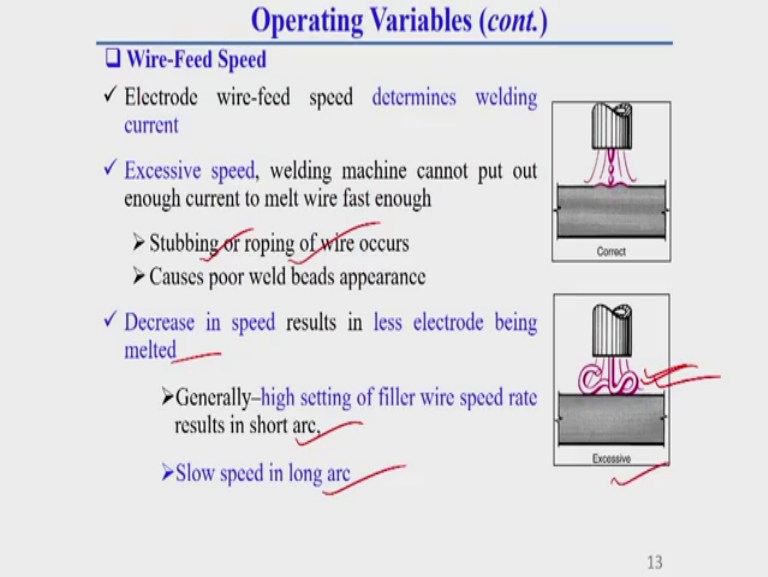

And now another operating variable is called wire feed rate feed rate wire feed rate means to feed the how; that means, at which speed this electrode wire or you can say filler wire is feeding; that means, what is the length feeded by this wire feeding mechanism per unit time that is generally call wire feed rate; that means, how much wire is coming out per unit time. Now you see if the wire feed rate is very high then what happens one types of things will happen, if the wire feed rate is less than another things will happen.

So, here this wire feed rate also have a significant effect generally in case of automatic welding process generally this wire feed rate control the current and the welding current you can say control the welding current. So, if there is high wire feed then what happens there will be automatically there will be high current if there is less feed then there will be less current, but what happens this welding power source also some capability it has also some range to supply the current. So, if the wire feed is feed quite very high, then what happens there is a lack of chances of supply that much of current to melt the filler wire.

So, what happens due to this what happens if the welding current will not be sufficient, then there will be melt rate of the electrode will be less. So, there will be chance of these types of thing; that means, there is a chance of stubbing or roping of the wire can occur actually these types of a stubbing or roping types of thing can occur in this types of welding process because if the wire feed rate is comparatively very high which is not desirable, which is not possible the power source to supply that much of current then what happens there is a these types of phenomena can occur.

Now, here one thing you should keep it in mind decrease in speed results in less electrode being melted, that is why have a general rule is used higher setting of filler wire a speed rate result in short arc, generally slow speed is slow speed in long arc. Generally if the speed of the filler wire will be less then there will be long arc, if the speed of the filler wire is high then what happens there is more filler wire will be there so there will be there will be less what is called shorter arc there will be shorter types of arc and this was stubbing or roping of wire can occur if the power source if the wire feed rate exceed the power source capabilities not then these types of roping can occur.

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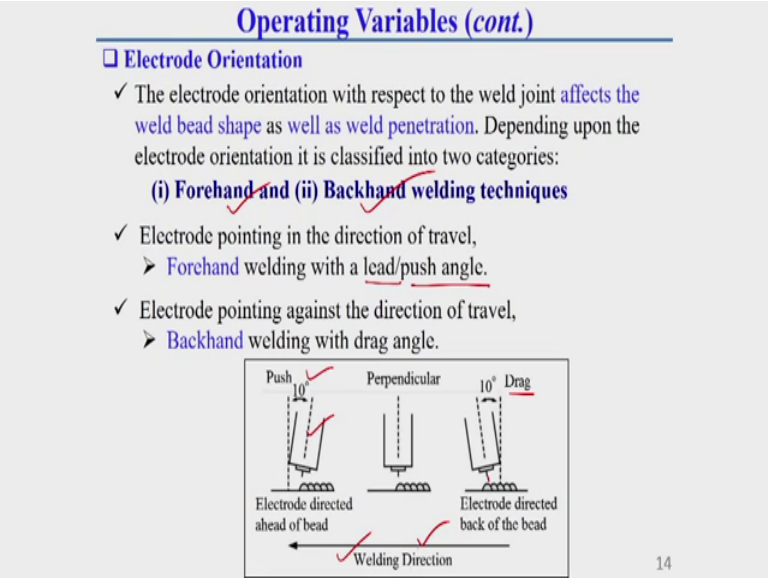

Now, now another important parameter is called electrode orientation this is a very interesting parameter electrode orientation with respect to actually weld joint affects the weld bead shape as well as weld penetration. Depending upon this electrode orientation

generally this welding this welding technique can be categorized into two different categories.

So, this what is this two different categories? One is called forehand welding techniques another one is called backhand welding techniques. When it is called forehand welding techniques; forehand welding technique means if the electrode this is the electrode if the electrode pointing in the direction in the direction of welding or you in the direction of travel then that is called generally this is called forehand welding.

That this techniques actually I have explained already in case of gas welding technique; that means, a oxyacetylene gas welding technique this techniques already I have explained. So, in case of forehand welding techniques here a angle is created between this electrode and a perpendicular line that is called lead angle or push angle this is a very important angle, this angle generally varying from ten to fifty degree ok. So, generally depending upon this position of welding this angle vary.

So, generally they if this electrode pointing against the this if this here you see here this electrode pointing against the direction of the welding speed, then this is called back hand welding techniques here whatever the angle created between electrode axis and a perpendicular plane then perpendicular the welding axis whatever the angle here it is created that is called drag angle ok. So, this is called generally back hand welding technique.

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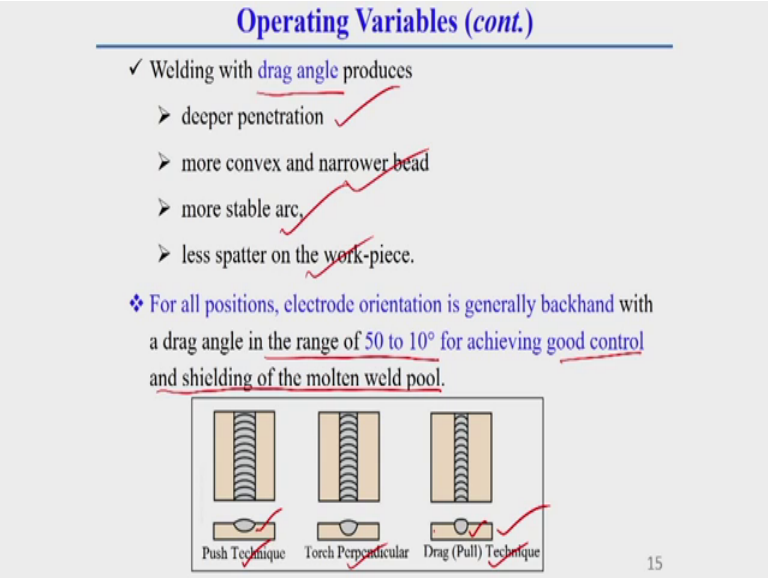

Generally what is the effect of this push angle or back angle on weld bead geometry that also you should know. So, here what we have observed this in case of forehand welding technique this electrode pointing toward the direction of travel and in case of back hand welding techniques electrode pointing against the direction of weld. In case of backhand welding techniques there is created drag angle and which have some good characteristic in weld quality, with drag angle there will be deep penetration, deeper penetration narrower weld bead and more convex types of weld bead more stable arc and less penetration on the workpiece is observed.

This is the actually in case of backhand welding or in case of drag angle types of thing why because here this welding torch is to at he deposited weld. So, what happens here generally these types of different important aspect we can observe once there is a drag angled drag angle incase of welding incase of backhand welding. So, in case of this is drag angle generally we get more penetration and narrower types of here you see if the angle is in case of forehand welding one things you can see, in case of forehand welding here less penetration wider bead is observed and in case of backhand welding here generally more penetration narrower weld bead generally is observed.

So, for all position electrode orientation is backhand with a drag angle in the range of 5 to 10 degree for achieving good control and shielding of the molten weld pool. So, for achieving good control in molten weld pool as well as shielding of molten weld pool for backhand welding we should keep our torch within a range of 10 to 50 degree, then there is a better control of shielding as well as better control of in weld bead also are there ok.

Now in case of if the torch is perpendicular there is generally intermediate types of fuel quality we can get, that is whatever the quality we get in case of forehand welding and backhand welding it’s a intermediate quality we get actually.

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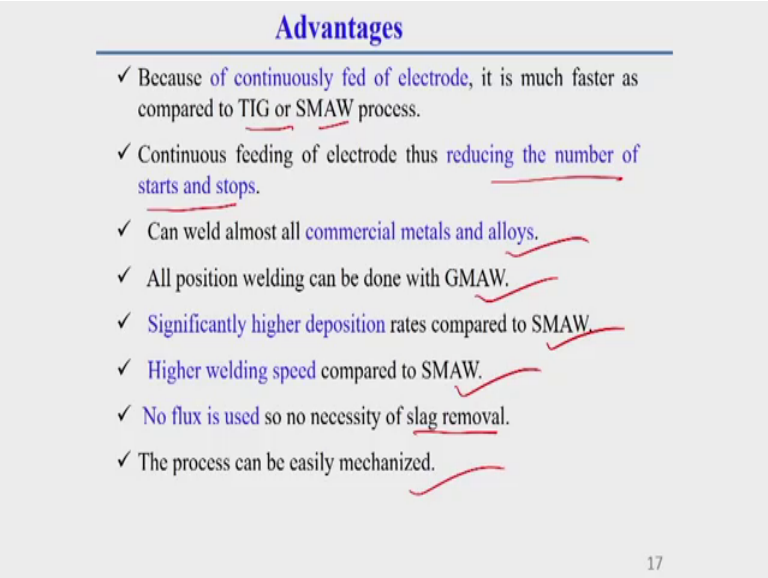

Now, we will discuss about is the advantage of this welding process disadvantage and application, these are the three things remains about this welding techniques. So, first of all we will discuss about what is the advantage as in this welding process there is a continuous feed of electrode is there.

So, it is much faster as compared to generally TIG welding or SMAW welding process much faster process. Continuous feeding of the electrode due to this generally is reducing the number of a start and a stop which is generally observed in case of SMAW welding process there is a generally there is a number of a start and a stop is there but as is it is a continuous types of feeding of electrode is there that is why what happens this a start stop phenomena is comparatively less.

Can weld almost all commercial metal and alloy all position welding can be done by this GMAW welding process this is significantly high in this welding process generally significantly higher deposition rate compared to SMAW process here generally higher welding is speed also as the deposition rate is high. So, we can get higher welding speed also compared to here we are comparing with some other welding process generally compared to other welding is like SMAW welding process, here we get higher deposition rate, higher welding speed.

And generally as in case of SMAW we are comparing as there is no flux is used that is why no necessary of slag removal operation is required. Then this process can be easily

mechanized another thing this process can. So, there is lot of advantage over TIG or SMA, SMAW welding process in this welding technique.

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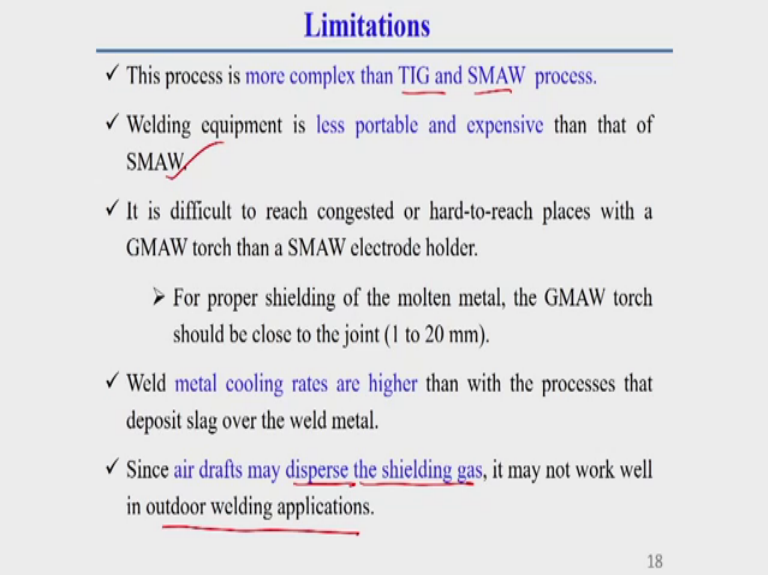

Now, we will see what is the drawback, what is the limitation of this welding process because generally we are conquering this welding process with some other welding process and we are getting whether it is how much advantageous and how much how much limitation also is there that also we should see. This process is more complex than TIG welding or SMAW welding process this is most complex because here there is lot of control system like gas, as well as water cool system, as well as current control feed control.

Ah So, so many things are there so this is generally more little bit more complex than TIG or SMAW welding process. This welding equipment is less portable and comparatively expensive than SMAW welding process. Generally it is difficult to reach congested or hard to reach places with a GMAW torch than a SMAW electrode holder they generally hard to reach places.

Generally wire the welding can be done easily wise stick welding because the stick welding has a stick which you can put easily to this hard to face position, but here generally you have to keep your welding torch or welding gun itself nearer to the workpiece. So, hard to reach places generally it's comparatively difficult than SMAW process. Here generally for proper shielding of these workpiece generally our torch this

welding torch should close enough to the workpiece otherwise proper shielding of the gas will not be occur, that is why that torch should be within a distance of around 1 to 20 millimeter.

So, hard to reach position if that types of a space and other things will not be there then what happens in this case? Generally proper shielding will not be occur, that is why for proper shielding of the molten metal this GMAW torch should be close to joint with that that distance should be within a range of 1 to 20 millimeter. If it is more than 20 millimeter then there will not be proper shielding.

So, there is a chances of oxidation and other things are there, that is why in this welding process generally once hard to reach position or generally consisted area generally these types of welding process where this gun is difficult to reach these types of welding not is not preferable. They are generally SMAW welding process because there is a stick only a stick is to put over there, so there generally stick welding is more preferable.

Generally weld metal cool cooling rate generally here is higher than SMAW welding process. So, here whatever the weld quality we are getting her it's less ductile compared to we can say SMAW process and here another things since air drafts may disperse the shielding gas, this disperse the shielding gas; that means, due to the air draft there is a chance of move of this shielding gas or disperse the shielding gas it may not work well in outdoor welding application, where is a continuous flow of air or other things are continuous flow is of air are there; there is if this welding process is not suitable.

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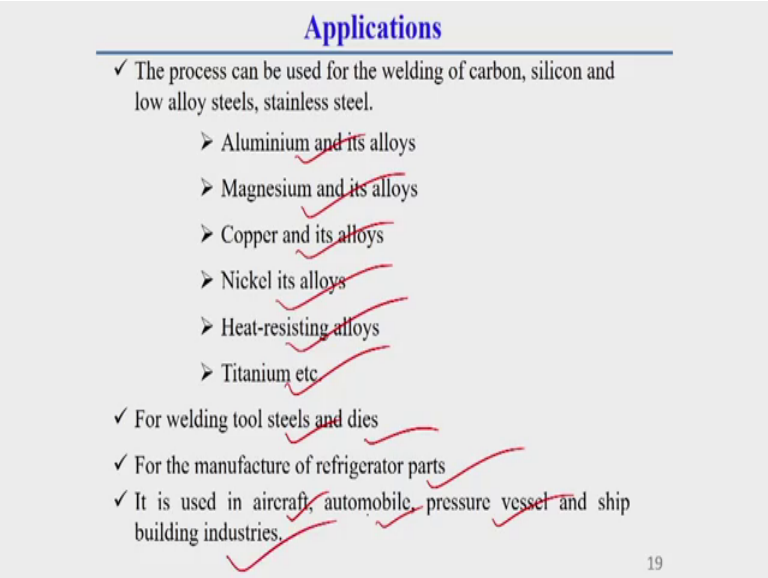

Now, the last point is application of this welding process, this process can be used for the welding of carbon, silicon and low alloy steel, a stainless steel apart from this thing this can be used in following material and it alloy like it can be use aluminium and it's alloys, magnesium and it's alloys, then copper and it's alloys, nickel nickel alloys nickel and it's alloys, then heat resisted alloy titanium so it is generally used in different different types of material.

It can also be used to for welding tool steel and dies for the manufacturing of refrigerator part also it is widely used, it has wide application in aircraft industry, automobile industry, pressure vessel and ship building industry. So, this is all about GMAW process, so in next lecture I will start another welding technique that is called submerged arc welding techniques.