Manufacturing Process – I
Prof. Dr. D. K. Dwivedi
Department of Mechanical and Industrial Engineering
Indian Institute of Technology, Roorkee

Module – 3
Lecture - 6
Shielded Metal Arc Welding Part – 1

Welcome students. This is the sixth lecture on the welding engineering, and this lecture is based on the shielded metal arc welding processes. In this lecture, I shall cover the principals related to the shielded metal arc welding process, the power source and the type of welding current. And there are the different aspects related to shielded metal arc welding processes will be covered in this lecture.

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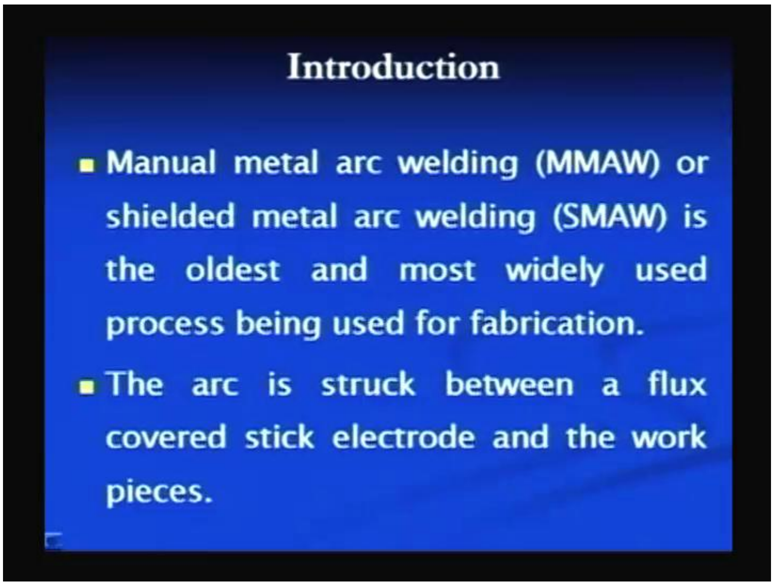

And this shielded metal arc welding process is the process which is most widely used; about 80 percent of the metal is deposited by the shielded metal arc welding process, while the percentage of the metal deposited by other welding processes is only about 20 percent. So, it is important to understand the basic aspects related to the shielded metal arc welding process. You will find this process is used by every person who is involved in the repair in fabrication of the components, which are produced by the joining processes.

Even the roadside welder also uses this shielded metal arc welding processes for producing the consumer goods or the minor repair of the different items related into the construction industry. The manual metal arc welding or shielded metal arc welding, both are the same processes, and these were developed in the very early stages of the welding process development. And here, initially, the bare electrodes were used for joining the metals, and later on the coated electrodes were used for producing the joints.

These coated electrodes help to provide the better shielding of the weld pool to protect it from the environment, and thereby, to produce the better shielding effect and sound joint. Because of this process is mainly controlled manually that is why it is also known as the manual metal arc welding process. And this is most commonly used process in the fabrication industry, and also for the repair purpose same is also used extensively. In this process for producing the joint, heat is used for melting of the base metal and melting of the filler metal which is there in form of the consumable electrode.

So, arc heat is used from the arc which is established between the electrode and the work piece. The arc is struck between the flux covered electrode and the work pieces. So, electrode and the work piece both are made a part of the welding circuit, arc is developed between two. And whatever heat is generated is used to melt the base material which is to be joined and the group or the gap between the plates to be joined is filled by a melting of the electrode itself. So, this process uses the consumable electrode which is normally coated to protect the weld pool and the electrode tip from the atmospheric contamination.

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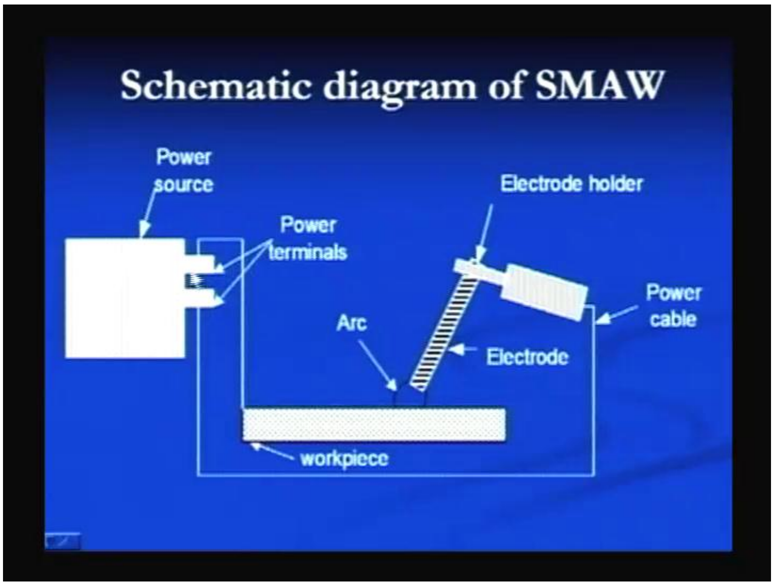

You will see the basic circuit, which is used in shielded metal arc welding process; here conventionally we use one power source and having the two terminals the positive and the negative terminals, and these terminals are connected to the work piece. One terminal will be connected to the work piece, and another terminal will be connected to the electrode; this is the electrode. And when arc is struck between the electrode and work piece, it generates the heat required for melting of the base metal and the electrode.

Here for making the connections between the power source terminal and the work piece, the welding cables are used. These white lines you can say they schematically indicates the welding cables which are capable to supply the high current, and these cables are rated according to their capacity to carry the welding current. Excessive current can damage to these welding cables, and that is why according to the rating of the welding cables, the current should be transferred through them for generating the electric arc in shielded metal arc welding process,

And depending upon the kind of polarity which is to be used, in case of the DC welding or in case of the AC welding, the terminals of the power sources are connected to the work piece. For DC welding if the DCEP or DC electrode positive polarity is to be used, then the positive terminal of the power source will be connected to the electrode. And if the DCEN is to be used, then negative terminal of the power source will be connected to the electrode.

So, depending upon the kind of polarity to be used, the power source terminals may be connected to the electrode and the work piece. And in case of AC, the polarity will go on changing in every half cycle. So, there is a no question that which terminal is connected to the work piece or to the electrode. Here for igniting the arc, initially the open circuit voltage is set in the power source, and the current is set. And then arc is struck between the electrode and work piece to generate the heat required for melting of the base material.

And when melting of the base material takes place, at the same time melting of the electrode tip also takes place. And at the continuous melting of the electrode tip leads to the formation of bubble at the electrode tip, and after sometime when bubble takes a larger shape, it gets transferred into the weld pool. So, those aspects we will see clearly in the next diagram, which will indicate that how the melting of the flux under the base metal takes place and the heat is generated for joining the plates by SMA welding process.

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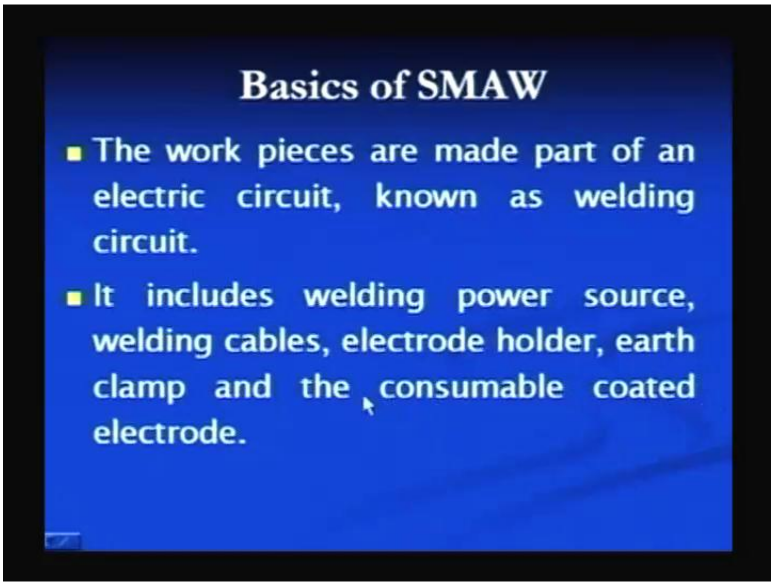

Here as I have told in the previous slide that the work pieces are made part of the electric circuit, and that is why the entire electrode work piece connections are known as the welding circuit. So, you can say the work piece is made part of the welding circuit, and this welding circuits includes the various components like welding power source, the welding cables, electrode holder, earth clamp and the consumable coated electrode.

Power will be supplied by the power sources, and it will be transferred by the welding cables to the electrode through the electrode holder. And to complete the circuit, earth clamp is used which will be connected to another terminal of the power source. And the consumable electrode which completes the circuit and also acts as a filler metal by melting, because the melting of the coated electrode fills the group between the plates to produce the joint.

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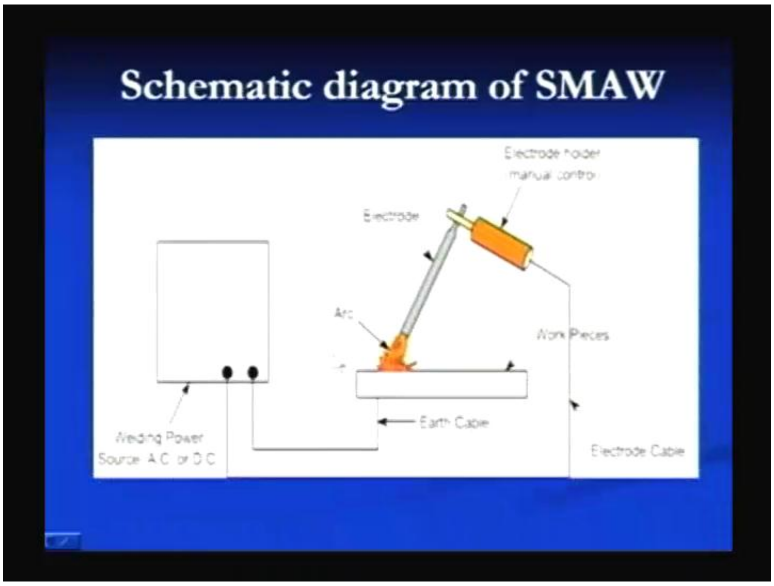

The schematic diagram of the SMAW welding process can be seen more clearly here with the help of this diagram welding power source can be AC. It can supply AC or DC as per the needs of the process, and then the cables are connected to the work piece and also connected to the electrode through the electrode holder. And here an arc is generated, and the heat of the arc is used for melting of the base metal and the filler metal.

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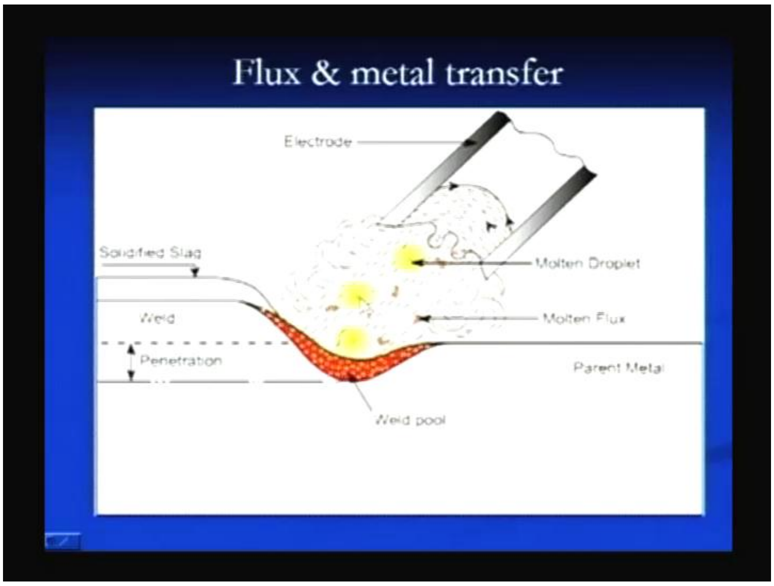

And when heat is generated by the arc which is continuously supplying the heat, this leads to the various reactions in the weld pool zone or in the arc zone area, and that you can see here clearly that this is the electrode coating; the gray portion indicates the electrode coating. This portion is the core wire of the electrode, and this is the shielding gas cover which is formed by the decomposition of the coating material. So, the shielding gas you can see around the weld pool and around the arc, and here this represents the arc area or the plasma region.

And here the molten metal droplets are indicated by the yellow shade, and here the red zone indicates the molten weld pool which is yet to solidify. And this is the portion where weld pool has already solidified, and the coating material which is having basically flux reacts with the impurities present in the weld pool to form slack. And that slack become slight; that is why it floats on the upper surface of the molten metal, and that is why solidified flux is found at the top of the weld bead which is removed one by one from the weld bead.

So, this slag must be chipped off before going for the second pass or before putting the weld joint in application. And here the molten flux which is produced by the melting of the coating material reacts with the impurities present in the weld pool. And also it supplies the inert or inactive gases to protect the entire arc zone including the molten weld pool to protect it from the atmospheric contamination.

So, not only the melting of the core wire takes place by the heat of the arc, but also the melting of the flux coating and its decomposition also takes place. Melting of the flux helps to produce the slag, and decomposition of the coating constituents helps to produce the inert or inactive shielding gases to protect the weld pool from the atmospheric contamination. So, this diagram shows the role of the fluxes, and how the molten metal form the electrode tip to the weld pool is transferred. You can see gracefully these droplets are formed; these will be growing gracefully.

And when this grows to the large extent by the gravitational force, these get detached from the tip of the electrode and transferred to the weld pool. So, this how transfer of the molten metal from the electrode tip and the transfer of the molten flux in the arc zone take place. And here one more important thing is that penetration, the depth up to which the melting of the base metal takes place because of the arc heat. So, this depth you can say this is the level of the base metal, and up to this much distance the melting of the base metal has taken place. And this distance is termed as the penetration; greater the heat input to the base metal, greater is the depth of penetration.

So, the welding conditions which are effecting to the heat input such as welding current, the welding speed and the welding voltage; all these parameters significantly affect the penetration which is produced during the shielding metal arc welding process. Now some other aspects of the shielding metal arc welding processes we will see in next slide.

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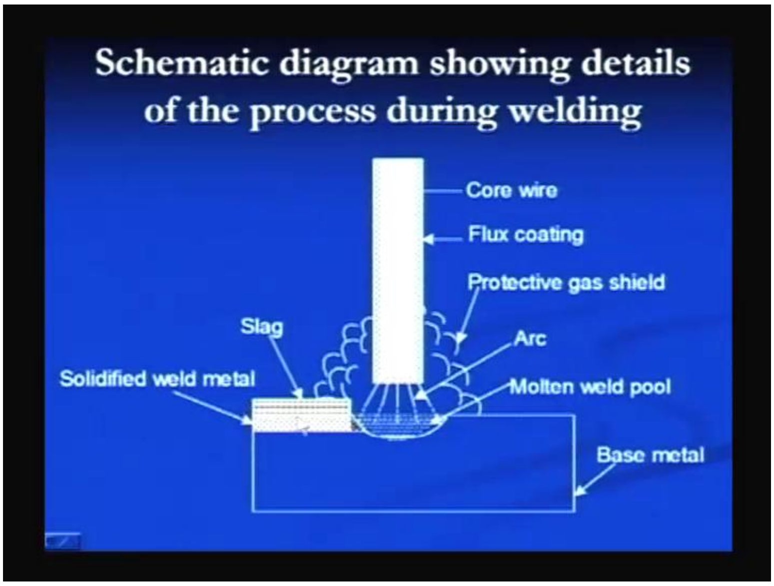

The same thing has been shown schematically in the different way here; you can say this is core wire; this is flux coating protective gas, which has formed the arc zone which is there, and in the molten weld pool in between the slag is covering to the solidified the metal. And the solidified weld metal is indicated here and, this is the weld metal.

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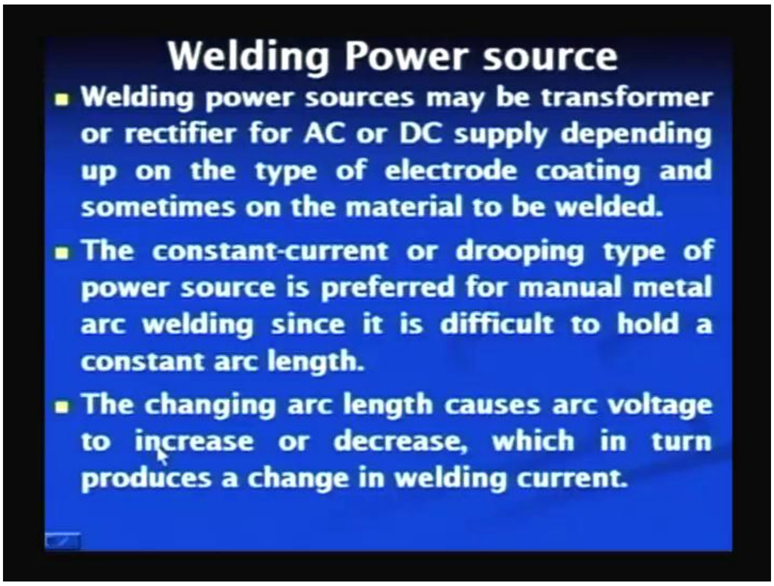

The power source is a very important component of the welding circuit, because it delivers the sub power which is required to produce the joint by melting of the base metal and the filler metal. But in this process the arc is mainly controlled manually; means arc length is controlled manually. And that is why normally with the shielded metal arc welding processes; constant current power sources are used.

Power sources may be in form of transforms, rectifiers, which are able to supply either AC or DC depending upon the type of electrode coating which is being used and the type of material which is to be welded, because the different materials need different types of the current for effective welding. That is why the selection of the AC or DC will depend upon the electrode coatings, and sometimes also on the material to be welded. For example, if the electrode coating is having large quantity of the low ionization potential elements, then it can effectively work with AC; otherwise, the stability of the arc becomes poor if AC is used.

So, the electrode with the less amount of the low ionization potential elements, then arc stability is adversely effected. So, well in case of the DC, this is not a major problem, because the current magnitude and its direction remain constant while in case of AC it fluctuates continuously. And it also passes through the zero region where current magnitude becomes zero. So, the re-ignition of the arc in case of AC becomes difficult if the less amount of the low ionization potential elements are present in the electrode coating.

The constant current type of the power source or the dropping type of the power source is preferred for the manual metal arc welding process, because it is difficult to hold the arc length at a given level, because the arc is controlled manually. So, there will always be minor fluctuations in the arc length. And under these fluctuating conditions of the arc length, if a current is also changing then the heat input will not be uniform, and that will lead to the inconsistence weld bead.

So, if a power source is able to supply the largely constant current even when there is a minor fluctuation in arc length, under those conditions the weld bead will be smooth, consistent and the sound weld is produced. And that is why in manually controlled welding processes like shielded metal arc welding or manual metal arc welding process, normally constant current power source is preferred. Here the further explanation related to the same is that changing arc length causes the change in the arc voltage either with the increase in arc length, the arc voltage will increase or with the decrease in arc length, voltage will decrease.

So, accordingly current is also changing, then that will adversely affect the soundness of the weld joint consistency of the weld meant. So, under such conditions of the changing arc length when arc voltage is also changing, the change in welding current should be less. It should be less, and that is possible only if the constant current of the dropping type of the power source is used.

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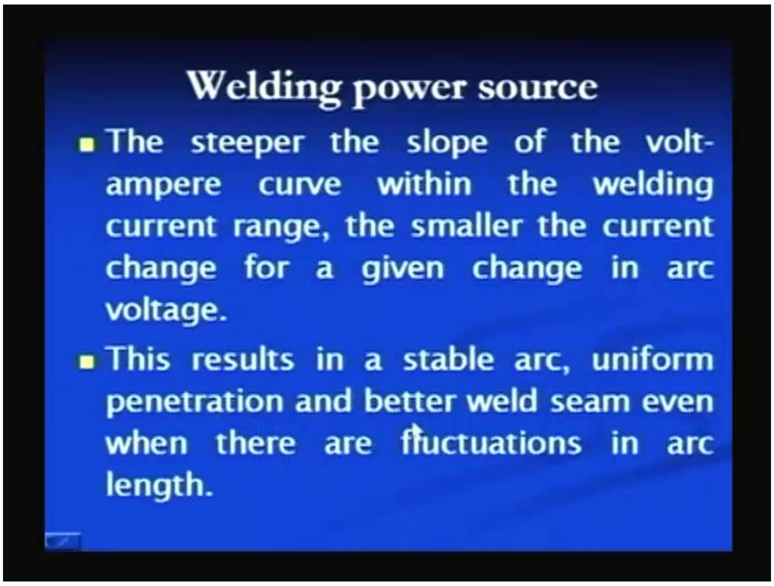

Here for given change in the arc length, means for given change in the arc voltage, how much change in the current will be there? It is determined by the VI characteristic of the power source. If the slope of the VI characteristic of the power source is less, then there will be greater change in the welding current compared to the case when the steeper slope of the VI characteristic of the power source is there. So, steeper is the slope of the VI characteristic of the power source, smaller will be the change in current for a given change in arc length or given change in the arc voltage.

So, it is always desirable to have a steeper slope of the VI characteristic of the power source of the constant current type. So, that the small change in the current is there for a given change in arc voltage, and which in turn results in a stable arc uniform penetration better weld bead seam even when there are fluctuations. So, even when fluctuations are there if VI characteristic of the power source is steeper, then there will be small change in the welding current

And a small change in welding current means heat will be supplied continuously is smoothly without major change, and the uniform supply of the heat of the arc will result the uniform penetration means uniform melting of the base metal and filler metal, better weld bead seam and the stable arc. All these benefits are obtained if the current remains constant.

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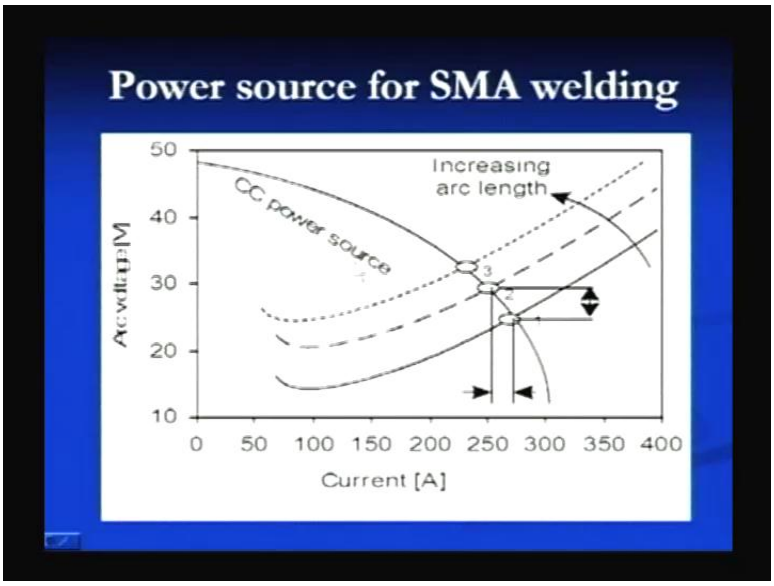

Here power source for the SMA welding process which is mainly constant current type, and its role can be understood easily from this diagram. Here you can see these lines indicate the VI characteristic of the arc, and this line indicates the VI characteristics of the power source. And this slope is negative in nature. Steeper is the slope, lesser will be the change in the welding current for a given change in the arc voltage. And this VI characteristic of the arc indicates these are the three VI characteristic of the arc for the different arc lengths, and these are in increasing order of the arc length.

So, if there is a change in the arc length, say, arc length increases, then operating point shifts from point one to the point two. And in that case, here will be this much change in the arc voltage while change in the arc current is very small. So, this small change in the arc current will not affect the heat input appreciably. If this slope is more steeper, then this change in the welding current will further be small for a given change in the arc voltage. And that is why it is preferred to have the steeper VI characteristics of the constant current type of the power source.

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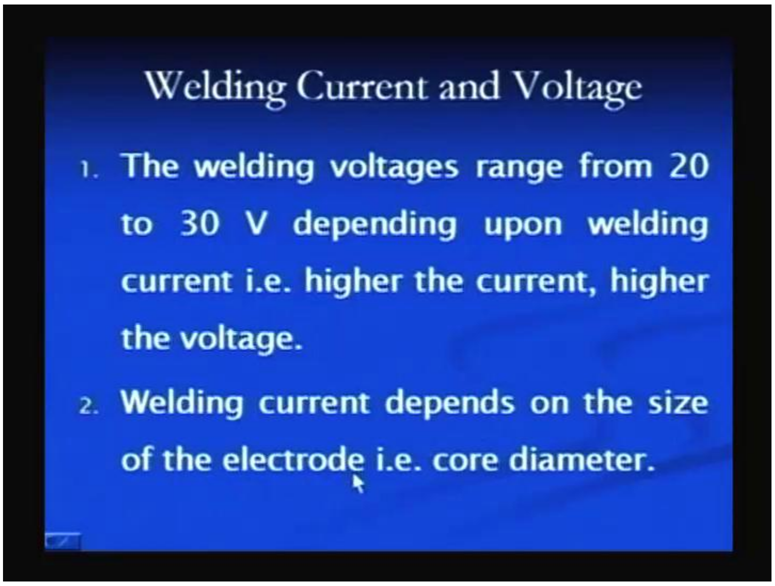

Now how to select the welding current and the welding voltages for the shielded metal arc welding processes, because the welding current and the welding voltage these are the two important parameters that determine at what rate heat will be generated. And it will be supplied to the base metal for uniform and consistent melting. If the welding current is not selected properly or if the welding voltage is not selected properly, arc will not be stable, and we will not get the desired penetration in the base metal; we will not get the desired melting rate or melting of the filler metal.

And we may land up with the very poor quality either with the very poor quality of the weld joint or even joint may not be produced. That is why selection of the welding current and the voltage in the shielded metal arc welding process is very important. And these welding voltages normally range from 20 to 30 volts depending upon the welding current. Normally high current, means higher the current and the higher the voltage. If we have to set higher current for welding of the thicker plates, then we will be selecting the higher voltage. Normally these voltages range from 20 to 30.

And the welding current in turn depends upon the electrode which is being used or that is the core wire of the electrode. The selection of the electrode depends upon the current which is to be used for welding of the given plates. So, if the thicker plates are to be welded then for melting of the thick plates, we need higher heat input. And for generating the higher heat, we need higher current, and the higher current can be used only with the large diameter electrodes.

So, the current which is to be used; so, accordingly for the higher current, the large diameter electrodes will be selected. Because if the higher current is used with the smaller diameter electrodes. Then these can lead to the significant electrical resistance heating which can adversely affect to the coating or excessive electrical resistance heating can damage to the coating even when they have not performed their role of providing the fluxes or generating the inert or inactive gases for shielding the weld pool.

So, the welding current selection is based on the base metal which is to be welded, and according to the current for the current which is to be used for the welding purpose, we select the electrodes. So, indirectly we can say the welding current to be selected depends on the size of the electrode; larger the diameter of the electrodes, higher current can be set. And the diameter of the electrode here we mean the core diameter of the electrode not the diameter of the electrode with the coating.

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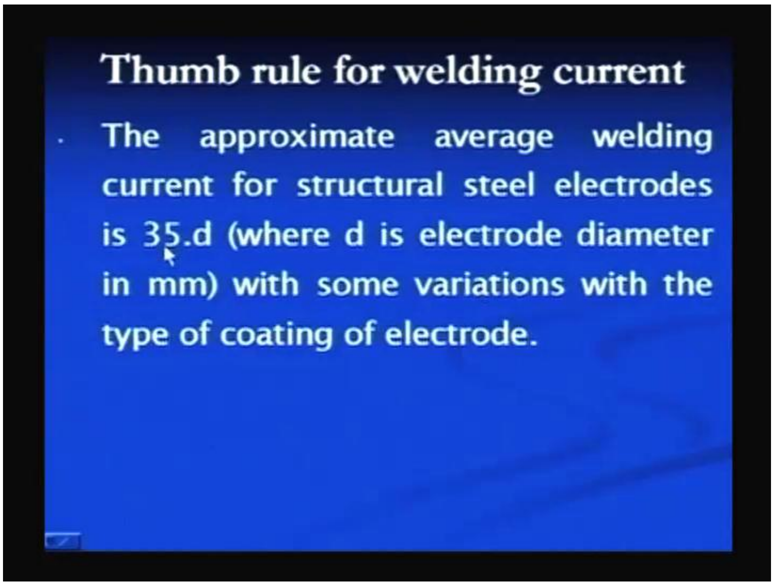

As a thumb rule here some of the things have been established for the selection of the welding current, because this is very old and very extensively used process. The welding current is selected in such a way that the coatings are not damaged, and we get the desired melting of the base metal for producing this sound joint. Approximately average welding current for a structurally steel electrode is found around thirty times of the d, where d is the electrode core diameter it is with some variations with the type of coating; means this is average current value that can be selected, 35 times the diameter of the electrode in mm.

So, it will give you the current value which will be good for a structurally steel electrodes like for 4 mm diameter electrodes, we can set 140 ampere current. But there can be a range also; that range can be 35 to 40 about that time, and to accommodate that only that some variation in the current can be there with the type of the coating in the electrode. So, minor variation in the current range can be there, and depending upon the kind of the electrode coating which has been applied on the electrode. But as a thumb rule, welding current can be set at 35 times of the electrode diameter.

For successful welding by shielded metal arc welding process, it is necessary that the welding current arc voltage and welding speed are selected properly, so that we get the defect free weld joint, because improper selection of these parameters can lead to the number of undesirable effects in the weld bead or undesirable discontinuities and defects in the weld joints.

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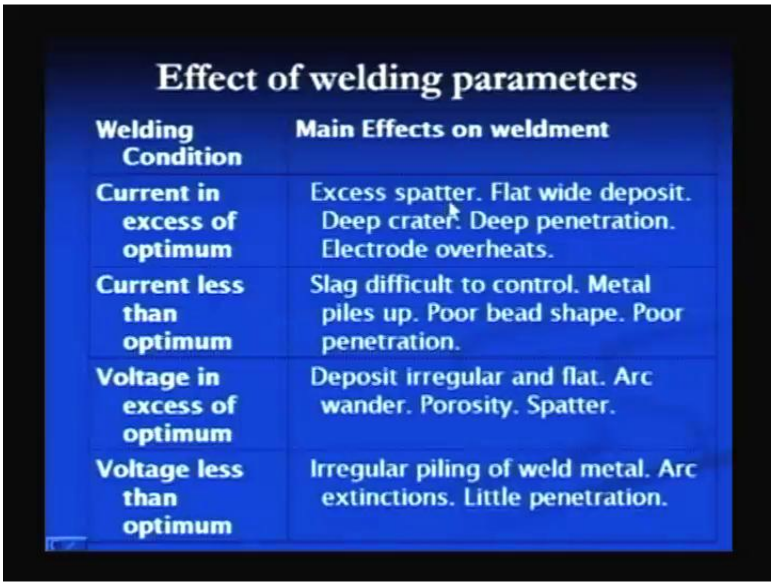
Effect of welding parameters

Welding Condition	Main Effects on weldment
Current in excess of optimum	Excess spatter. Flat wide deposit. Deep crater. Deep penetration. Electrode overheats.
Current less than optimum	Slag difficult to control. Metal piles up. Poor bead shape. Poor penetration.
Voltage in excess of optimum	Deposit irregular and flat. Arc wander. Porosity. Spatter.
Voltage less than optimum	Irregular piling of weld metal. Arc extinctions. Little penetration.

So, effect of some of the welding process parameters and the discontinuities we will see here that excess welding current than the optimum one leads to the excess spatter. Spattering is the falling of the molten metal here and there, and that unnecessarily leads to the loss of the metal which can be deposited in the weld bead. And also sometimes degrades the mechanical performance of the weld joint, because the spattered particles here and there acts as a stress raiser points for nucleation of the cracks, and thereby reducing the tensile strength and fatigue strength of the base metal.

So, excessive spatter is the one undesirable effect, a very flat and wide bead is deposited. So, excessive weld bead width is obtained when current is too much or higher than the optimum level, the deep crater is formed which is to be removed for obtaining the joint which can be used in engineering application, deeper penetration is obtained. This deep penetration will be good in case of the thick sheet or thick plates welding. But in case of thin plates, it can lead to the melt through a kind of undesirable effects, and excessive current can also cause the overheating of the coatings.

Because electrode extension in the shielded metal arc welding process is significant which causes excessive electrical resistance heating if the current is set on the higher side than the optimum one, and excessive heating can decompose the coating material prior to the situation when they should decompose near the arc. So, the electrode coatings may get damaged due to the excessive heating. And if the current has been set less than the optimum one, then also there will be the problems like slag will be difficult to control, the molten metal may start to get piling up. Because of the reduced fluidity caused by the less heat input poor weld bead shape and poor penetration

So, if less current is selected, it will lead to the many undesirable effects like excessive piling up or peaked bead also we can say poor weld bead shape and the poor penetration or lack of penetration. So, a lack of penetration can lead to the improper joining or very poor strength of the weld joint. On the other hand, excessive setting of the arc voltage than the optimum one can lead to the regular deposits, which are flat; arc may wander excessive porosity and a spattering can also be there.

So, the porosity and spatter will adversely affect the mechanical performance of the weld joint, while the irregular deposits will lead to the poor bead appearance. And arc wandering can cause the poor control over the molten metal or the melting of the base metal also. And if the volt is set is less than the optimum one, then irregular piling of the weld metal can be there or arc can also get extinguished or the penetration may also be less.

So, setting of the proper current and the voltage is very important. The higher side setting of the current and the voltage or the lower side setting of the current and voltage; all these four lead to the number of undesirable effect, and which lead to the poor performance of the weld joint. The effect of some other welding parameters we will see in next slide.

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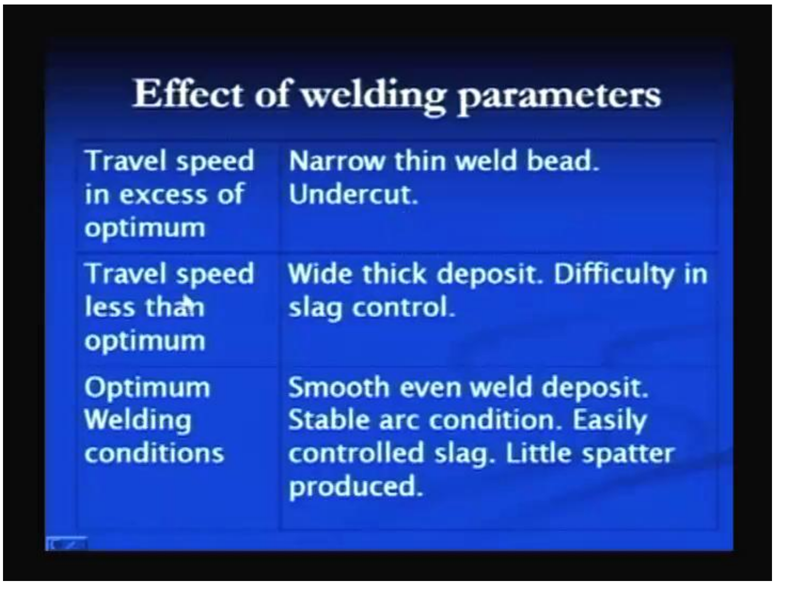

The travel speed is another important factor or important parameter that determines the net heat input to the base metal, because net heat input is calculated from the voltage multiplied by the current divide by the welding speed. For a given heat input obtained from the VI for a given current and a given voltage, how much heat will be supplied to the base metal; that is determined by the travel speed. If the travel speed is excessive, than net heat input will be reduced, or reduced heat input will lead to the narrow weld bead. And it can also cause the undercut undesirable effect you can say the discontinuity in the weld metal

And travel speed less than the optimum one can increase the heat input significantly, which can cause the wide and the thick weld deposit. And the slag may also be difficult to control under the conditions when excessive heat has been supplied to the weldment during the welding. So, the optimum welding conditions will be corresponding to the weld bead when it is smooth even while deposit is formed stable, arc is generated, and the slag is removable or easily removable, and spatter is very less.

So, the welding speed, the welding current and the arc voltage should be selected in such a way that the weld bead is smooth, arc is stable, and a slag is easily removable, and the spatter is minimum one, it is not required. So, it should be as less as possible.

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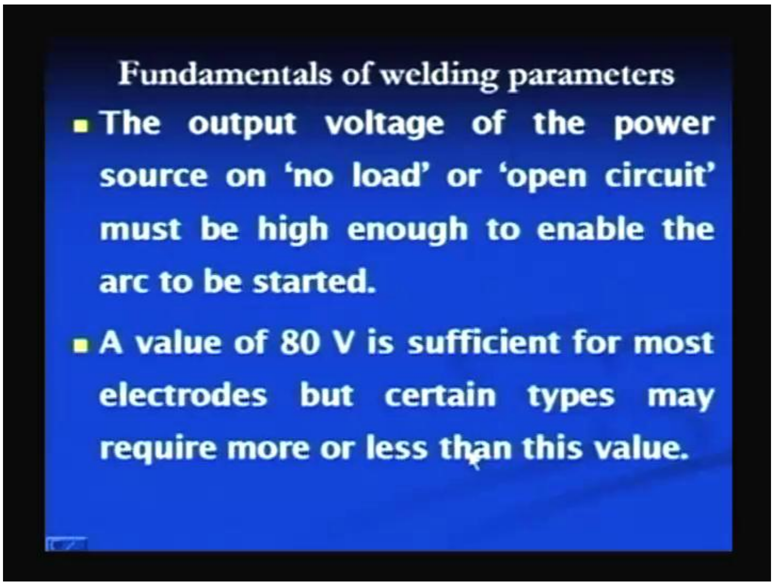

Some other effects of the welding parameters and the selection related aspects we will see now. And output voltage of the power source or which is also known as open circuit voltage must be high enough to start the arc. If the open circuit voltage is not selected properly, then particularly in case of AC welding re-ignition of the arc becomes difficult; that is why it should be selected properly and value of the 80 volt is sufficient for most of the electrode. But this value may be on the higher side or the lower side depending upon the type of the electrode coating or the core wire material of which the electrode is made.

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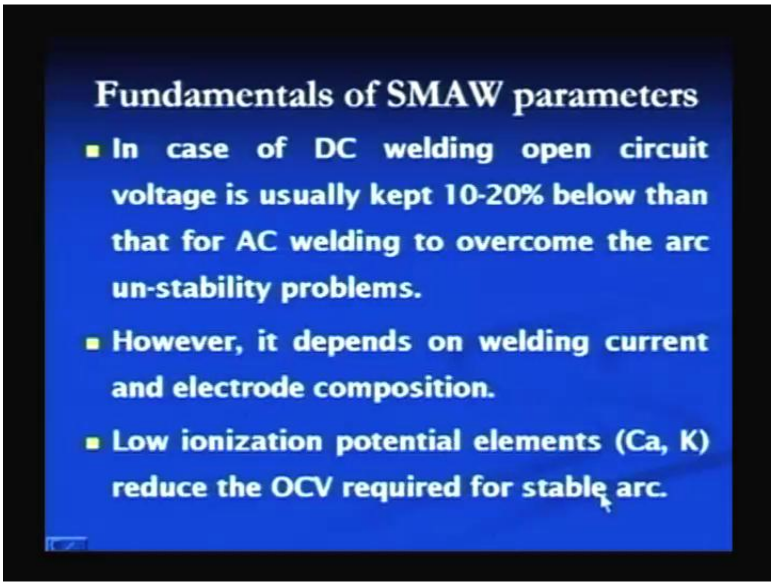

In case of the DC welding, open circuit voltage is usually kept bellow 10 to 20 percent than that of the AC welding to overcome the arc un-stability problems, because in case of AC, your polarity changes continuously in every half cycle. And whenever there is change in polarity, arc is extinguished. So, to reignite the arc it is necessary that open circuit voltage is set on the higher side. On the other hand, the polarity remains same in case of the DC welding, and the current does not change in magnitude and the direction; that is why it allows to use even the lower open circuit voltage.

And this can be 10 to 20 percent less than the open circuit voltage that is required for AC welding in order to avoid the arc un-stability problems; however, selection of the current depends on the diameter electrode composition. And at the same time, the open circuit voltage is also determined by the welding current and the electrode composition. Because as I have said earlier, the higher welding current needs the higher voltage, and in the same way if the electrode is having the low ionization potential elements, it can work effectively even with the lower open circuit voltages. Low ionization potential elements like calcium and potassium if are present in the large quantity in the coating materials, then they will allow to use even the lower open circuit voltage for having the stable arc.

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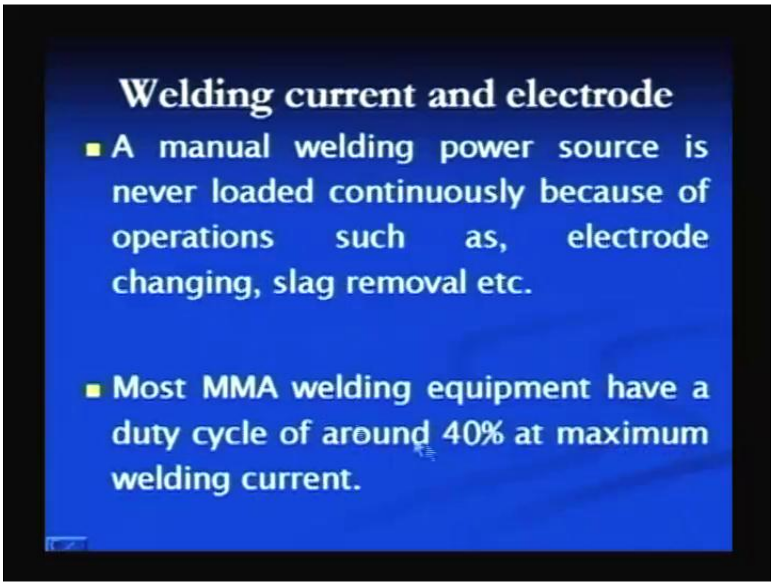

A manual metal arc welding is never loaded continuously, because operation by this shielded metal arc welding process needs the changing electrode and the slag removal. Like in the submerged arc welding or metal inert gas welding process MIG process or SAW process, where we use conservable electrode, which is fed continuously from the pool; we can use the process for long time if the power source is able to supply the current continuously. But the current is never drawn continuously in case of the manual metal arc welding or shielded metal arc welding process, because the electrode has a limited length, and it is consumed continuously during the process. And that is why it is required to change the electrode at regular intervals.

And when electrode is changed, you need to stop the welding process; that is why this process is never continuous, and it is required to stop the process after sometime to change the electrode. At the same time, slag is also formed on the top surface of the solidified weld metal, and that should be removed. So, it is required to stop the manual metal arc welding process at regular intervals, and that is why it never works under the 100 percent duty cycle. But normally the lower duty cycles are used in the shielded metal arc welding process, and these may be in range of 40 to 60 or 70 percent.

Here mostly the manual metal arc welding equipments have a duty cycle around 40 percent at a maximum welding current. So, it is normally expected that the process will be stopped earlier, and the normal duty cycle which is used with this shielded metal arc welding process is around 40 percent when the higher current or the maximum welding current is set.

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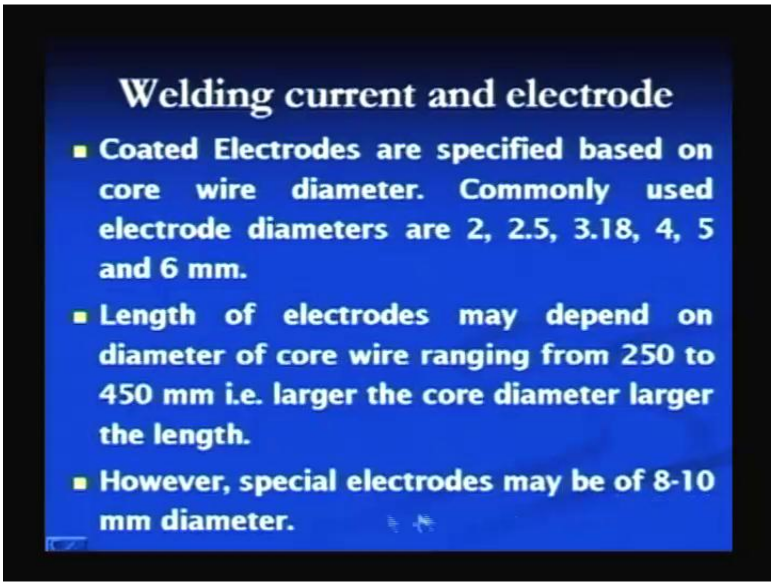

The coated electrodes are specified on the basis of the diameter. As I have said earlier, electrode size is determined from the size of the core wire not from the size of the electrode with the coating. So, the core wire diameter is used to express the electrode, size and the common electrode diameters which are used commercially in shielded metal arc welding process are of 2 mm, 2.5 mm, 3.18 mm, 4 mm, 5 mm and 6 mm; even the larger dia electrodes can be used for the welding of the thicker plates.

So, here the coating in the shielded metal arc welding process plays a significant role, and that is why it is necessary to understand the way by which coatings are characterized or the coating proportions are quantified with the respect to the core wire. And what role is played by these coating materials and what are the different constraints of these coating materials; that is important to understand, and that we will see in the coming slides. The length of the electrode may depend on the diameter of the core wire ranging from 250 to 400 mm length and larger the core diameter, larger the length which can be used.

So, it is common to have the electrodes in the length of 250 to 450; here the length of the electrode is very important, because it plays significant role in electrical resistance heating of the core wire. If the electrode length is more, electrical resistance heating will also be more for a given current setting and that can damage to the electrode coating if the current has been set on the higher side. That is why it is always desirable to set the lower current with the large or longer electrodes to avoid the excessive electrical resistance heating and damage to the coating material.

These electrodes can be in the range of 250 to 400 mm diameter, why? Because if the larger is the diameter of the core wire, greater the length it will allow without electrical resistance heating. Because increase electrical resistance heating due to the increase in length will be balanced by the increase in core diameter; this increase in core diameter will help to reduce the electrical resistances heating effect. And that is why the large core diameter electrodes allow to use the longer length.

However, special electrodes may be of 8 to 10 mm diameter electrodes; that is what I have already said here. And depending upon the needs or depending on the thickness of the plates to be used, the larger diameter electrodes can also be used. Because the larger diameter electrodes will allow to use the higher current setting without getting any adverse effect related to the electrical resistance heating of the core wire and the decomposition of the coating material.

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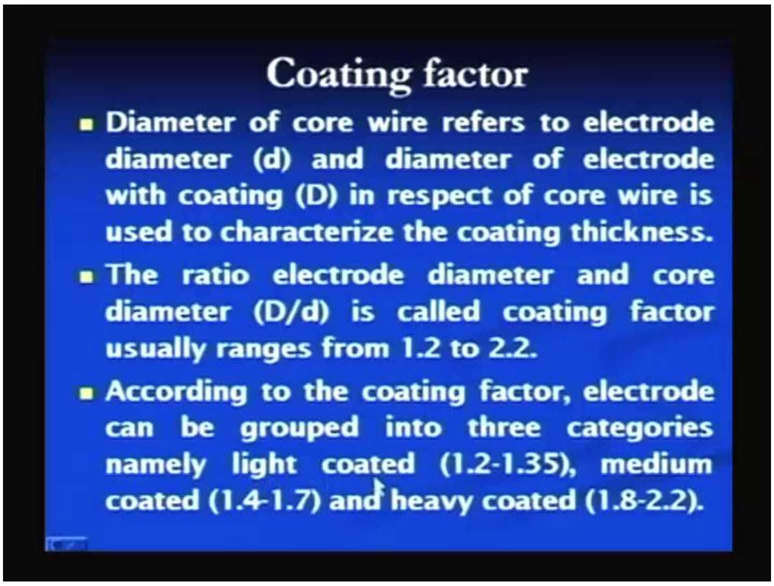

How much coating has been applied on the core wire; that is quantified using the factor known as a coating factor. And the diameter of the core wire refers to the electrode diameter that is D. And the diameter of the electrode with the coating capital D in respect of the core wire is used to characterize the coating thickness. So, that the diameter of the electrode with a coating divide by the diameter of the core wire small d is known as coating factor. Greater the capital D value with the respect to the given small d value, greater will be the coating factor.

So, here the ratio of the electrode diameter and the core diameter; that is capital D divided by small d is called the coating factor. And generally depending upon the thickness of the coating material, its value can range from 1.2 to 2.2, and this is the dimensionless number. So, greater is the thickness of the coating material, greater will be the coating factor value. And according to the coating factor value, the electrodes can be categorized in three broad categories like light coated, medium coated and thick coated.

And the range of coating factor for light coated electrode is from 1.2 to 1.35, for medium coated electrodes it is in range of 1.4 to 1.7, and heavy coated electrodes it is 1.8 to 2.2. Greater the coating factor value, thicker is the coating material applied on the core wire. And accordingly, it will be able to provide the shielding affect to the arc environment, or it will be able to form the slag; less coating material is provided in the light coated electrodes compared to the heavy coated electrodes.

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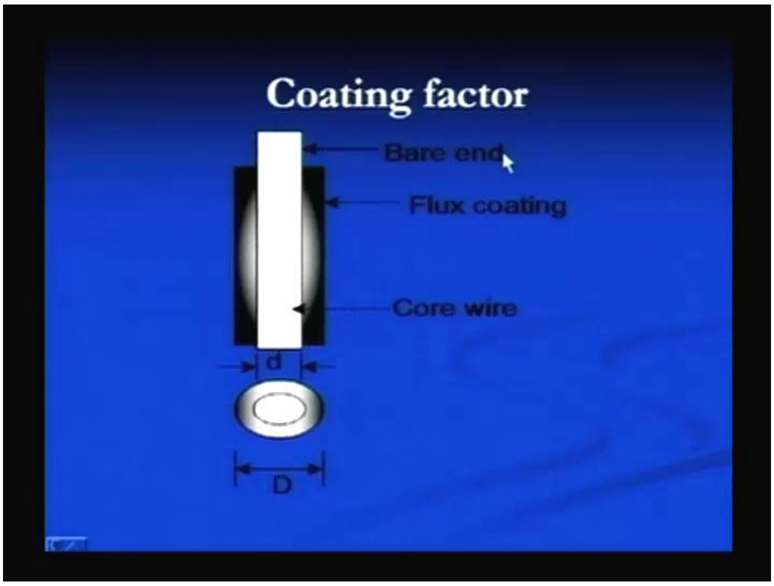

To understand the coating factor in better way, we can see this diagram. Here this white fission indicates the core wire, and its diameter is indicated by this is small d, and this represents outside this core wire here we have flux coating. And the diameter of the electrode with the flux coating can be seen here in this top view, and this outer diameter of the electrode is indicated by the capital D, and the ratio of this capital D and small d is known as the coating factor. And this bare end of the electrode is connected to the electrode holder, and electrode holder is finally connected to the power supply or the power source terminal.

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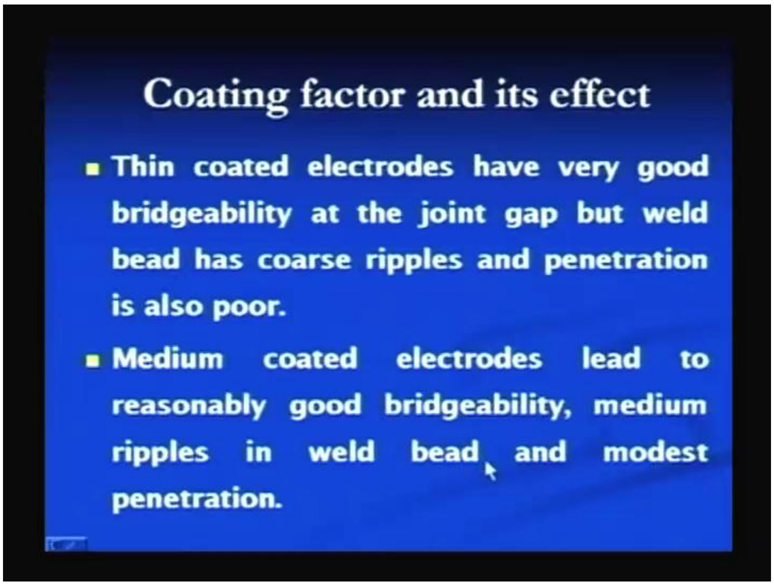

The coating factor effects the weldment or the soundness of the weldment in a number of ways, and one important factor is the bridgeability during the welding. So, thin electrodes have very good bridgeability at the joint gap, but weld bead has coarse ripple and penetration is poor. So, these are the three factors. One is bridgeability, another is the weld bead shape which is in terms of the ripples which are formed and the penetration. So, penetration is poor, ripples are coarse, and the bridgeability is good with the thin coating materials. And with the medium coated electrodes we get the reasonably good bridgeability and a medium ripples in the weld bead and moderate the penetration is obtained.

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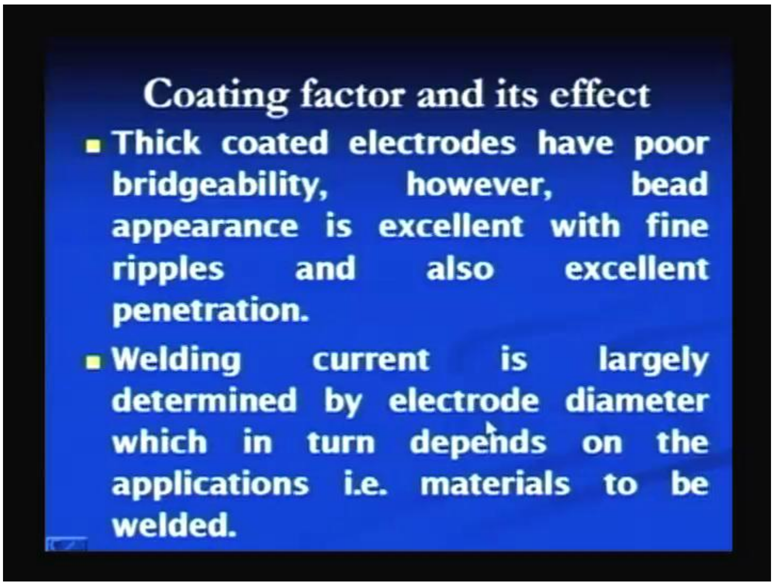

While with a thick coated electrodes offers very poor bridgeability; however, bead appearance is quite good, and the ripples are fine, and the penetration is also good. So, here depending upon the needs for producing the joint, we may select the proper coating factor, because the coating factor affects the bridgeability one and the ripples on the bead which is indicating the bead shape or the appearance of the bead and the penetration. So, penetration increases with the increasing coating factor, bridgeability decreases with the increase in coating factor.

So, that permits the coating factor is to be selected which can satisfy the requirement of the joint which is to be produced. And the welding current is largely determined by the electrode diameter which in turn depends upon the material which is to be welded like thickness of the plates which is to be welded; this is what I have told you earlier.

Now we will summarize this lecture. Here in this lecture, we have seen the schematic of shielded metal arc welding process, the importance of the welding parameters like welding current, welding voltage and the welding speed. And if these process parameters are not selected properly, then what different undesirable effects can be there in the weldments. And in the coming lectures, I shall cover the other aspects related to the shielded metal arc welding process.

Thank you.