**Welding Engineering**
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**Module - 4**
**Arc Welding Processes**
**Lecture - 6**
**SAW**

So, this the second lecture on the submerged arc welding process. In the first lecture based on the submerged arc welding process, we have talked about the basic principle of the submerged arc welding process, and what is the role of the electrode and the power sources which are used in sub merged arc welding process for developing the sound weld joint. In this presentation on the sub merged arc welding process, we will be taking up first the role of the fluxes which are used in submerged arc welding process, then the various types of the fluxes which are used along with their a positive and the negative points.

Thereafter, we will see the importance of the various process parameters of the submerged arc welding process and their role on the development of the sound weld joint. Thereafter, we will see that advantages and the limitations associated with the submerged arc welding processes and the few important applications of this process. So, here starting with the role of the fluxes, which are used in submerged arc welding processes, we know that like in shielded metal arc welding process role is mainly to protect the weld proof from the atmospheric contamination of the weld pool, so that the deterioration and mechanical properties of the weld joint can be avoided.

Further, in shielded metal arc welding process, the fluxes also help in easy initiation of the arc by providing the low melting point, low ionization potential elements in the fluxes. But here the role of the fluxes is slightly different from what is there in the shielded metal arc welding process.

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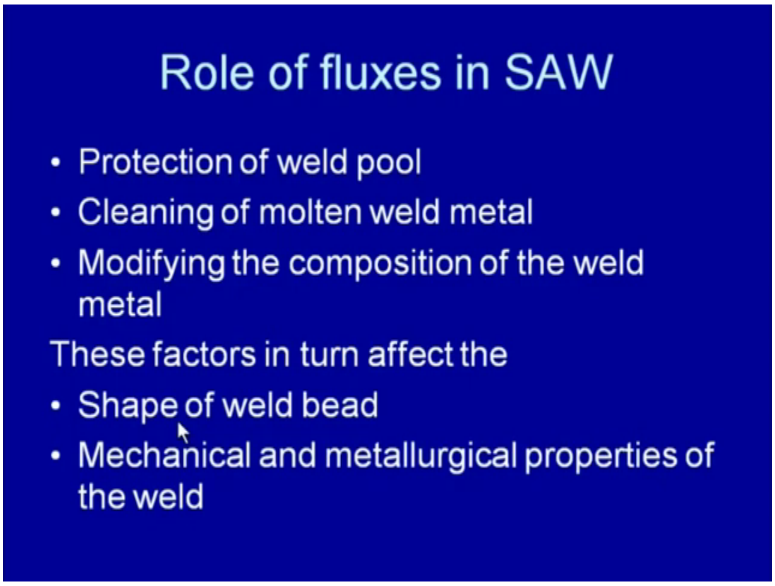


The first one is the protection of the weld pool, the similar to the SMAW welding processes the fluxes in the a submerged arc welding process also play an important role in protecting the weld pool, because the weld pool is covered by the molten flux and the flux particles, and the weld arc is also completely covered by the fluxes. So, when fluxes are used, these help in protecting the weld pool from the atmospheric contamination and any kind of adverse reactions in the weld metal due to the presence of the atmospheric gases in the weld zone.

Further, it helps in cleaning of the weld metal if the impurities are formed in the weld metal and these are removed by formation of the slag due to the reaction between the flux and these impurities. So, thus it helps in removing the impurities in form of slag and cleans the weld metal and further it helps in modifying the composition of the weld metal a. sometimes, it is required to add the certain alloying elements specifically to improve the mechanical properties or to improve the carousel behavior then under those conditions.

These elements are added with the flux and which are then transferred to the weld metal and thus it helps in modifying the composition of the weld metal. So, when these things are achieved these factors in turn help in improving the mechanical properties of the weld metal metallurgical properties of the weld metal at the same time these also help in getting the weld bead in proper shape. So, these are the few the roles which are performed by the fluxes in the submerged arc welding process.

For this purpose a variety of the fluxes are used in the submerged arc welding process like the fused fluxes, agglomerated fluxes, mechanically mixed fluxes and one more type of the flux is there. So, we will be taking up one by one each type of the flux and how it is a made and what are the positive points related with each type of flux and their negative points related with them.

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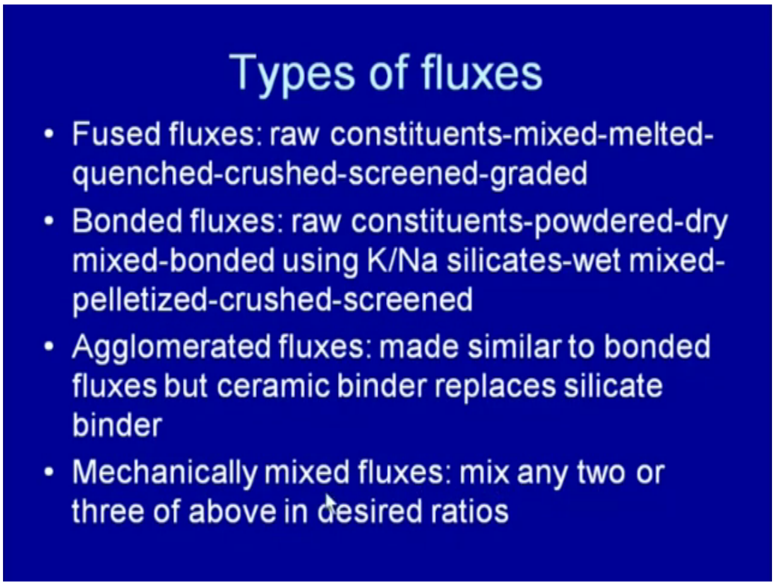


So, the fused type of the fluxes in this these type the fluxes are made by melting the in this whatever constituents are there in the fluxes raw constituents are mixed properly. Thereafter, all these constituents are brought to the molten state and then the molten flux mixture is quenched in the water and this glassy and the quenched a material is crossed. Then it is screened to have the things in the different sizes so grading is done after by screening it for having the flux of the different sizes.

So, here this is one type of flux which is the fused flux in this the raw constituents are mixed. Then melted and thereafter quenching in water these are crushed screened and thereafter graded, so this is one category of the a fused fluxes that is the fused fluxes. The second one it these are the bonded fluxes in these raw constituents are first brought to the powered form brought in powered form thereafter they the dry mixed is obtained all these powdery mixtures are mixed properly in the dry state.

Thereafter, these are bonded using the potassium or the sodium silicates and after wetting these are mixed properly and then pelletized and this platelets are crushed. After crushing these are screened and after screening these are graded in the different sizes to get the fluxes of the different sizes in the different size range. Agglomerated fluxes are made similar to the bonded fluxes just we have described here, but with the difference that in the bonded fluxes we had used the potassium and the sodium silicates for the bonding purpose. While in case of the ceramic while in case of the agglomerated fluxes the ceramic binder is used for the bonding purpose.

Thus, this silicate binder is replaced by the ceramic binder in the agglomerated a fluxes. The mechanically mixed fluxes in this the mixture of the two or more of the above three types of the fluxes is obtained in the desired ratios so that the desired combination of the mechanical properties and the characteristics in the fluxes can be obtained. So, basically in mechanically mixed fluxes mixture is obtained a using the two or three of the above types of the fluxes namely the agglomerated bonded or the fused fluxes in the different ratios.

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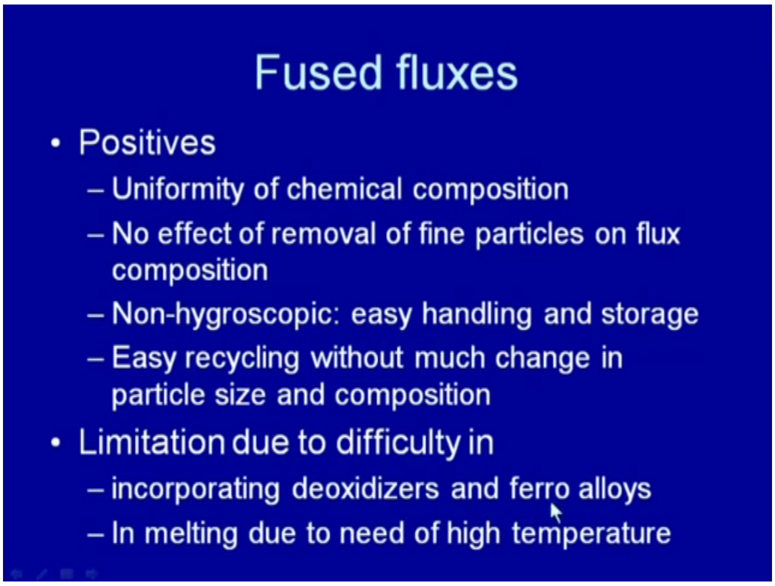


So, that the desired combination of the properties can be obtained in the weld metal the fused fluxes are the one, where we will be taking up the first the positive sides of the fused fluxes. The important thing with the fused fluxes is that the uniformity in the chemical composition of the fused fluxes, so here the uniformity is much better in the fused fluxes than the other types of the fluxes.

Further, if the fine particles in these fluxes are removed there would not be much effect on the composition of the fused fluxes, so there is no major effect on the composition of the fluxes even if the fine particles are removed from the fluxes. Further, which is very important these fluxes are non hygroscopic in nature means they do not observe the moisture easily from the atmosphere. Therefore, these are found to be easy in handling and storage because of their poor sensitivity low sensitivity towards the absorption of the moisture. The next point these are easy to recycle without much change because these do not experience much change in the particle size and the composition during the recycling.

So, once when these are used these can be recycled easily because while in use these do not experience much change in the particle size and composition and that is why the recycling of this fluxes is found to be much easier. Further, but there are certain a limitations associated with the fused fluxes and these are a related with the difficulties in incorporating the oxidizers in these fluxes and some Ferro alloys.

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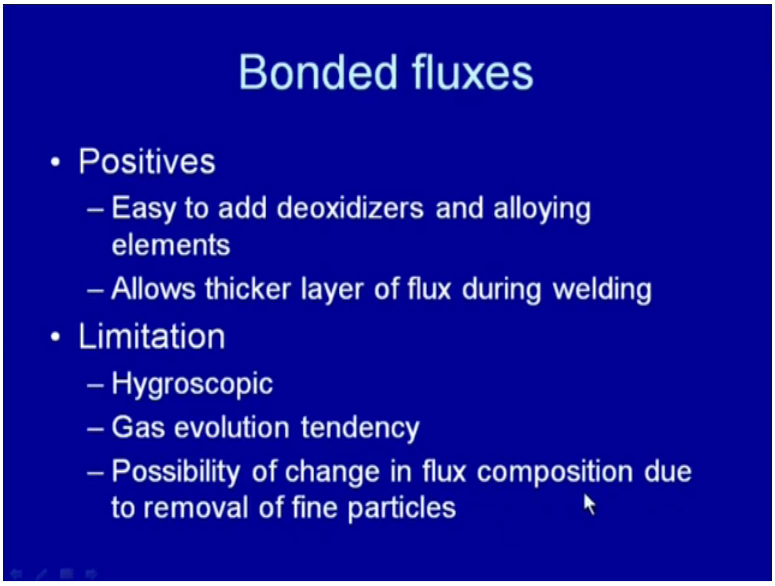


The second is that difficulty in melting of the constituents which are to be used for making these fluxes and this requires very high temperature for to bring them in the molten state. So, high temperature requirement for melting is another difficulty associated with the fused fluxes. The bonded fluxes are another category advantages related with these bonded fluxes are these are easy in these fluxes, it is easy to add the deoxidizers and the alloying elements so that the effective removal of the oxygen from the weld metal can be achieved. And the composition of the weld metal also can be modified further these allow thicker layer of the fluxes during the welding. But they are many limitations associated with these fluxes, these fluxes are the hygroscopic in nature means these easily absorb the moisture from the atmosphere. Therefore, these fluxes require proper baking for removing the moisture otherwise this will lead to the excess concentration of the hydrogen in the weld metal. The induced hydrogen cracking tendency in the hardenable steels and that is why a the baking of these bonded fluxes becomes important.

Further, a presence of the moisture and the other gas and other micro constituents lead to the easy evolution of the gas gases during the welding from these fluxes. The possibility of the change in flux composition due to the removal of the fine particles, so this is the problem where there will be possibility of the change in flux composition. If the fine particles are removed from the fluxes during the storage or during the handling, so this can lead to the change in composition of the fluxes this is another limitation related with the bonded fluxes.

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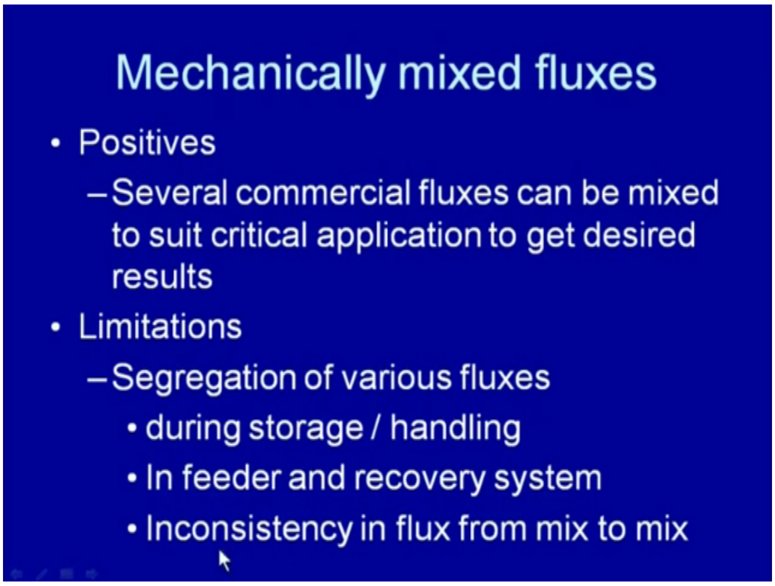

The mechanically mixed fluxes as I said these are made by a obtaining the mix of the fused fluxes, agglomerated fluxes or the bonded fluxes. But the advantage is that the several commercially available different types of the fluxes can be mixed together to suit the applications to get the desired results in the weld metal. So, as to achieve the desired properties in the weld joint, but the limitation with these fluxes are the fine particles or the various constituents tend to segregate during the storage or handling in the feeder and recovery system.

Therefore, sometimes the inconsistency from the flux to flux inconsistency in flux from mix to mix is obtained. So, the segregation tendency during the storage and handling are also in feeder and recovery system leads to the variation in composition of the fluxes which can lead to the variation in the performance of the weld performance of the fluxes during the welding and even since these are made by mechanical mixing. So, inconsistency can be there from mix to mix in the composition and the performance of these fluxes during the welding. As I said some of these fluxes are a hygroscopic in nature therefore, to avoid the presence of the moisture from the fluxes it is necessary that these are baked properly.

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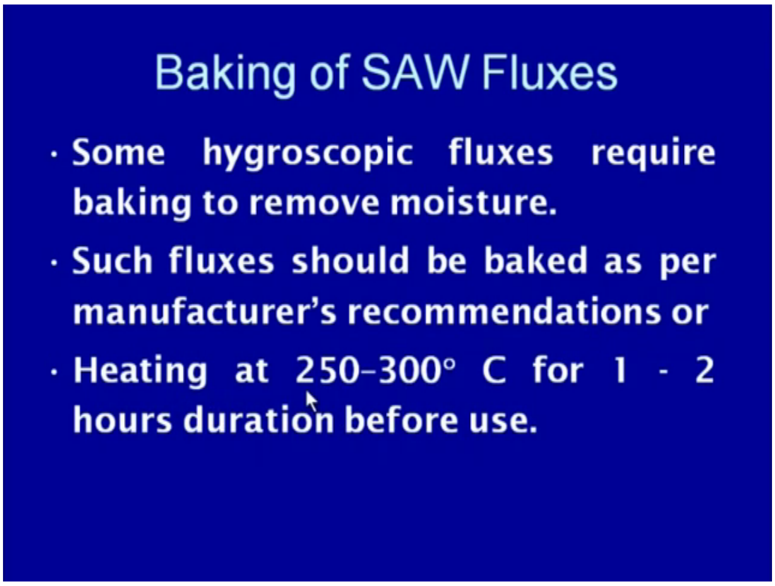


So, depending upon the type of the fluxes and the requirements and manufacturers recommendation the fluxes are baked. And the hygroscopic fluxes are particularly baked for removing the moisture such fluxes should be baked according to the manufacturer's recommendation or in general the heating is done to remove the moisture in the range of 250 to 300 degree centigrade for the duration of one to two hours before used. So that the moisture can be driven off from the fluxes to avoid any presence of the oxygen and the hydrogen in the weld metal. So, that the sound weld joint can be obtained which are free from the oxides and the porosities and can also help in reducing the problems caused by the presence of excessive hydrogen in the weld metal.

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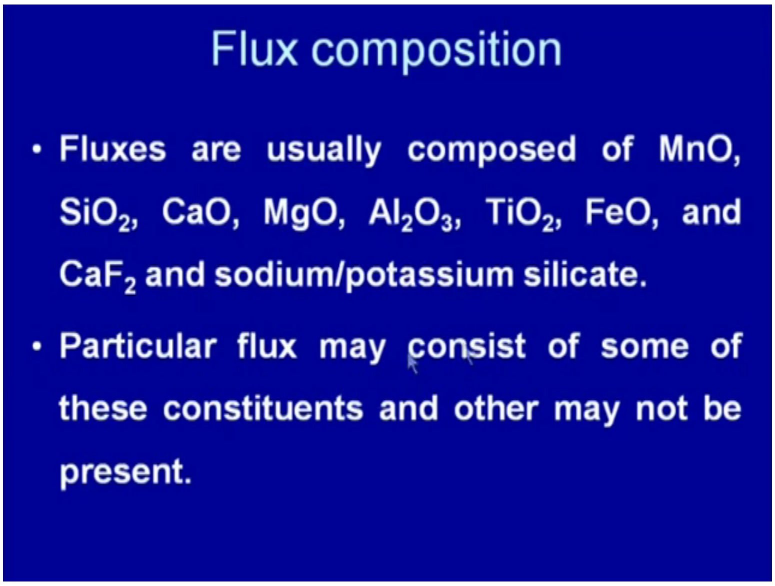


The flux composition fluxes are composed of the variety of constituents and each constituent plays a different role these things we have described earlier. But just for just as a reminder these fluxes are hugely composed of the magnesium oxide, silica, calcium oxide, magnesium oxide, manganese oxide, alumina titanium oxide, ferrous oxide and the calcium fluoride and the silicates of the potassium and the sodium. So, here this the silicates as a binder and some of these oxides act as a donor of the oxygen or receiver of the oxygen. So, the particular flux may consist of the some of these constituents or all these it is unnecessary these other constituents may also be present to impart the desired combination of the properties to the fluxes.

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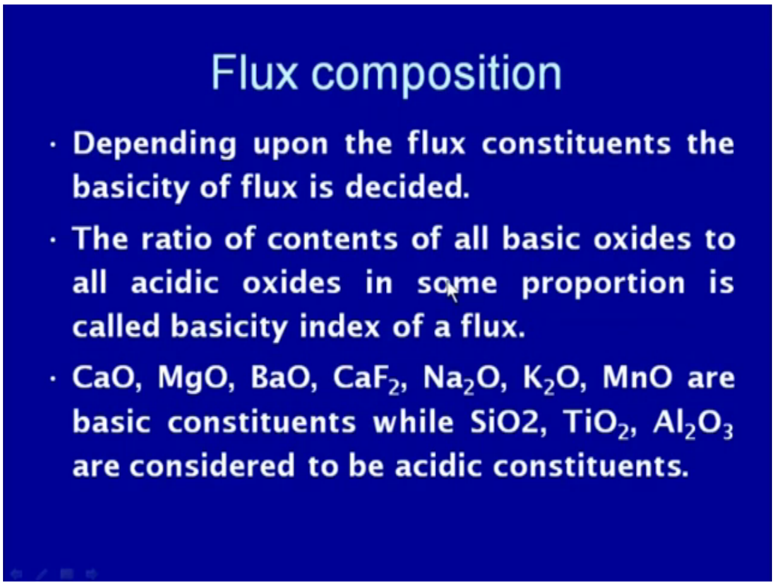


Depending upon the flux constituents present, depending upon the constituents present in the flux basicity of the flux is affected and ratio of the content of the all basic oxides to the all acidic oxides or all non basic oxides in a proportion is called the basicity index. So, basically the ratio of the amount of the all basic oxides to the all non basic oxides present in the fluxes is a defined as the basicity of the fluxes which indicates that how effectively it can remove the impurities from the weld metal.

This concept has been brought in from the steel making weld, this basicity of the fluxes was used to see that how effectively the sulphur can be removed from the steel during it is manufacturing. So, if we see the calcium magnesium oxide, barium oxide, C a F 2, N a 2 O, K 2 O and M n O are the basic constituents while the silicon oxide T i O 2, aluminium are considered to be the acidic constituents. So, depending upon the ratio of the basic and the non basic or the acidic micro constituents present in the flux. We can have the different the basicity is in the fluxes which can range from say point 0.8 to the 2 3 4 etcetera.

So, this basicity is very important because the basicity is in the range of 0.1 0.2 to 1.2 to 1.4, then that helps in getting the cleaner weld while the acidic the basicity of the flux lesser than 1, frequently leads to have the higher content of the oxygen in the weld metal which in turn results in the significant percentage of the oxides in the weld metal. This in turn causes lot of oxide inclusions and deteriorates the mechanical performance or mechanical properties of the weld joint. So, that is why it is important to see that how the basicity of the flux can affect the performance of the weld joint.

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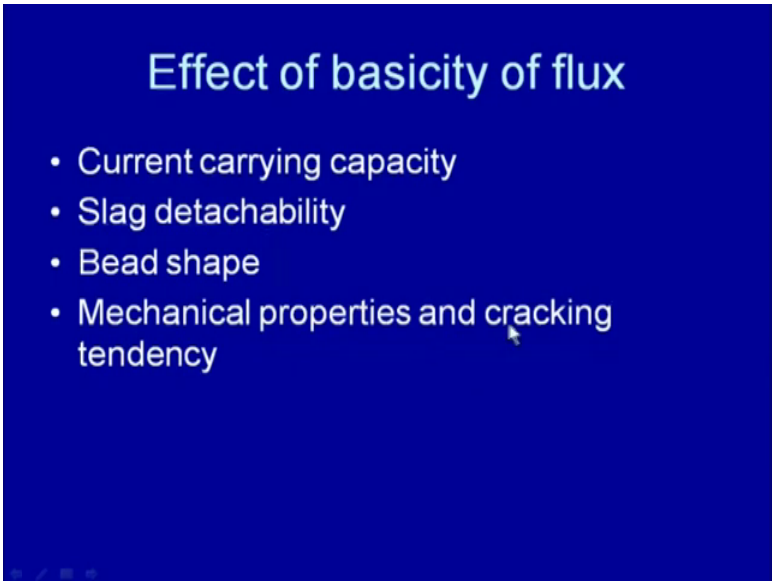


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Basicity of the flux in the submerged arc welding affects the variety of the characteristics which are important in developing the sound weld joint; these are the current carrying capacity, the slag detachability. How easily we can remove from, how easily the slag can be removed from the weld bead the shape of the bead, that is the reinforcement and width of the weld bead and the mechanical properties and the cracking tendency of the a weld joint.

So, out of these if we see the low basicity fluxes helps in the having better current carrying capacity means this can allow the higher flow of the current through the electrode and the welding system can walk with the higher current and the good slag detachability and the bead appearance is also good. So, the low basicity fluxes offers the advantages in respect of the better current carry current carrying capacity means better good slag detachability and the good bead appearance. But the mechanical properties are found to be poor and the poor resistance to the crack development is also noticed. So, means the mechanical properties are poor and the cracking tendency is also more.

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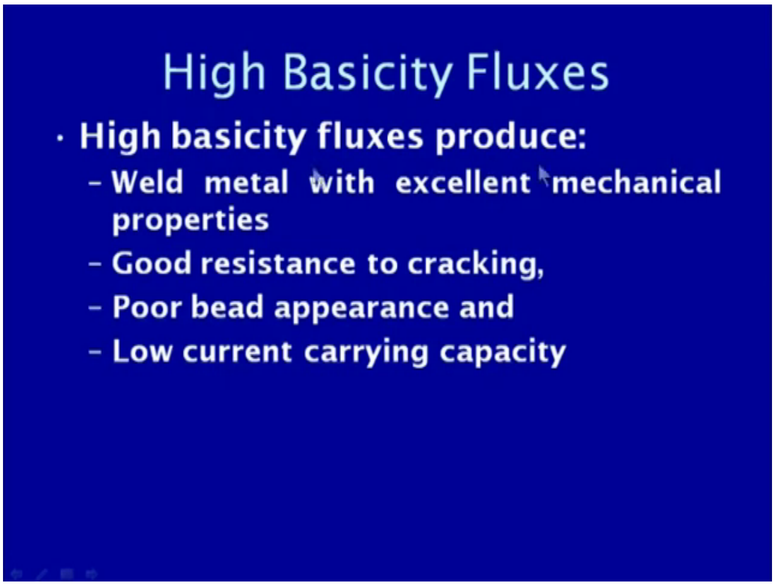


So, when we use on the other hand the high basicity fluxes these fluxes offer the weld metal with very good mechanical properties due to the reduced impurities and oxygen content in the weld metal and cleaner weld metal is produced. This in turn results in the better mechanical properties at the same time good resistance to corrosion cracking is also observed, but the weld bead appearance is poor and the current carrying capacity is also reduced.

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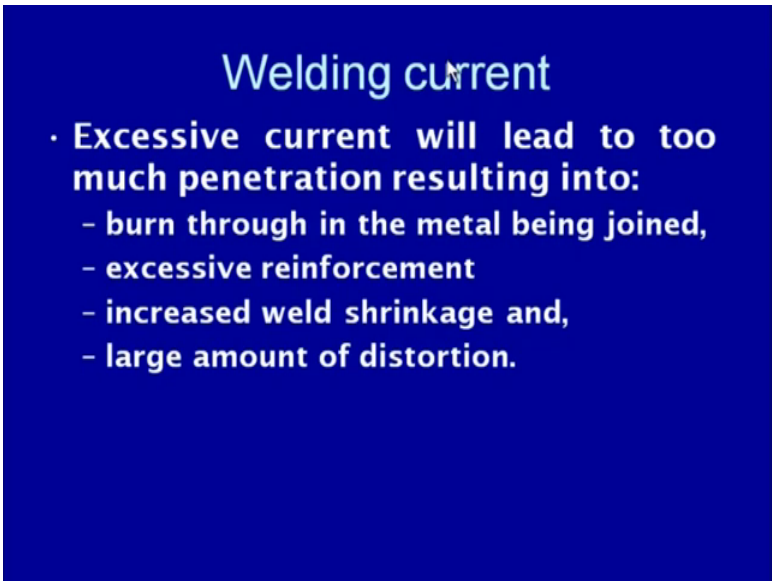


So, we have seen that the fluxes which are used in the submerged arc welding process play an important role in developing the sound weld joint. These significantly affects the weld bead geometry and the way by which weld metal can be made and the cleanliness of the weld metal weld mechanical properties and metallurgical properties of the weld metal. So, it is important to look into the selection of the fluxes properly. So, that the desired weld joint with the good combination of the mechanical and metallurgical properties can be obtained.

Apart from the fluxes, it is also important to see that the parameter which are been used for developing the weld joints are selected properly. So, that the weld metal can be deposited at the desired rate at the same time base metal is penetrated to the desired depth and the good bridging capacity is there if due to the poor fit up. So, the selection of the important parameters like the welding current welding speed welding voltage and the electrode size etcetera done very properly. So, if we see the important welding parameters that affect the process of developing the sound weld joint by the submerged arc welding process includes the electrode wire size that is the diameter of the electrode.

Because here the electrode length is continuous and the electrode is fed continuously during the welding and the welding voltage which is normally in the range of 30 to 35 volts. The current range the welding a submerged arc welding process is known to be high current welding process, which can range from say 200 to 2000 ampere or even on the higher side. The welding speed which is significantly higher in case of the submerged arc welding than the other welding processes. So, the welding speed is also another important parameter because it affects the net heat input under the given set of the welding conditions.

So, out of these parameters if we see the welding current is found to be the most influential a variable affecting the soundness of the weld joint and the deposition rate and the success by which the weld metal can be made. Because it directly affects the melting rate, so higher is the melting rate using the high current helps in a developing the weld a joint at a higher speed and so the productivity increases. On the other hand it also helps affects the depth of penetration in general increase in the current increases the depth of penetration at the same time. How much amount of the a base metal is melted during the welding is also influenced by the welding current being used the selection of the welding current becomes important. Optimum selection leads to developing the sound weld joint with the desired melting rate and desired penetration and the joint with the free from the discontinuities.

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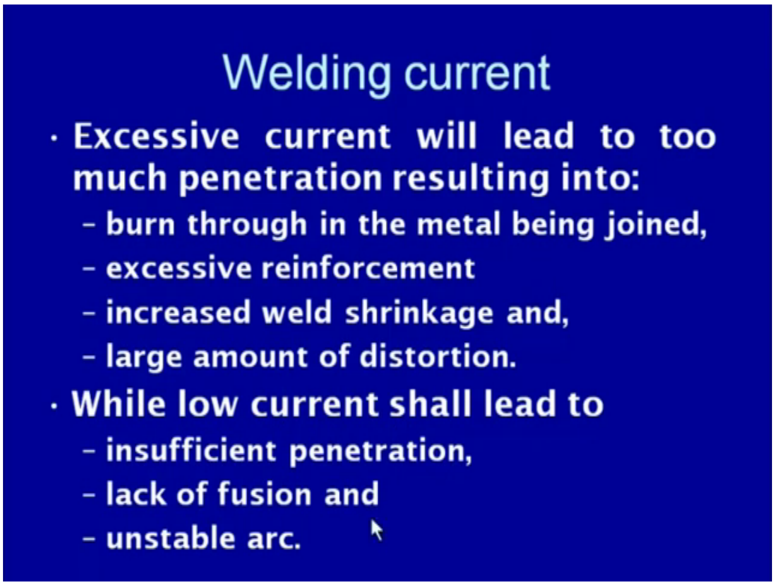


If we select either the excessively high welding current or the low welding current then it can lead to the various unfavorable characteristics in the weld joint. So, excessive current will lead to the too much penetration in the weld joint and which in turn result into the bond through where through thickness melting takes place. And whole is created or the excessive reinforcement is developed due to the excessive melting and deposition of the weld metal or the increased weld shrinkage due to the wide larger size of the weld metal weld pool being formed.

Subsequently, on the shrinkage excessive shrinkage will be leading to the excessive distortion in the weld joint. So, the increased welding current, increased weld shrinkage and the same time the large amount of the distortion because increase in heat input by increasing the welding current will be increasing the area being heated during the welding, so increased. We can say expansion and contraction will be leading to the increased amount of the distortion in the weld joint. While the low current can lead to the insufficient penetration due to the lack of heat desired, for melting the base metal to the desired depth or the lack of fusion.

When, the insufficient melting of the faying surfaces of the base material or even the unstable arc. So, the low current will not be able to generate enough heat, so lack of the a sufficient number of the charged particles due to the poor temperature and heat generation will be leading to the unstable arc. So, arc stability can also be adversely affected with the use of the low current. If we see it is not favorable to go either with the higher current with too high current or too low current and that is why selection of the welding current becomes important.

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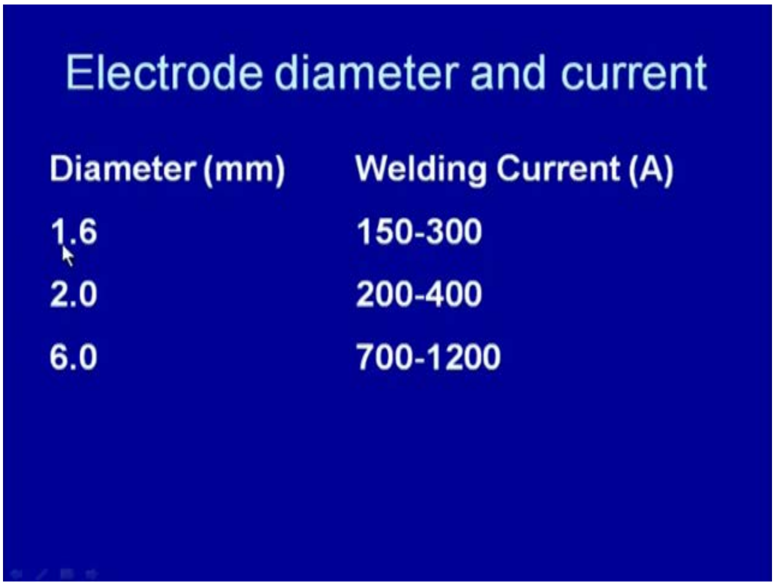

However, they are certain current ranges for the different electrode sizes which are normally preferred. Say for the electrode of 1.6 mm diameter current range can be 150 to 300 ampere for 2 mm diameter electrode the current range can vary from 200 to the 400 ampere and 6 limited diameter electrode current range can vary from 700 to the 1200 ampere.

So, while the use of use of the higher current with the given electrode diameter can reduce can increase the melting rate and can increase the penetration also. But use of the electrode of the larger diameter for the given current value will reduce the penetration depth into the base metal. So, it is important to select the electrode correct welding current for a given diameter or the correct diameter for given welding current.

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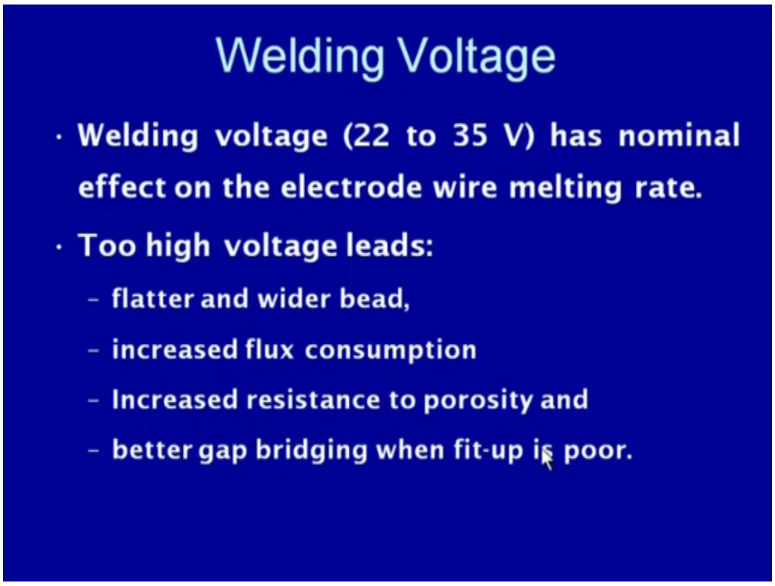


On the other hand welding a voltage normally varies from 22 to 35 volt. Now, if the voltage is varied in this range it has a nominal effect or marginal effect on the melting rate of the electrode. But the too high voltage leads to the flatter and wider bead and increased flux consumption, increased resistance to the porosity and the better gap bridging when fit up is poor. This is because of when the electrode gap is wider means the gap between the electrode tip and the work piece is more. It will be resulting in the higher welding voltage and the arc will also be wider.

So, if there is a any possibility of having poor fit up that will be taken care of by melting the wider zone of the base metal, thus will be decreasing the problems associated with the poor fit up and leading to the better gap bridging capability. Well, the higher arc voltage or the welding voltage will be occurring under the conditions of the greater arc length. So, this a the flux will be covering to the larger zone of the arc and thus the melting of the flux will be occurring at a higher rate which in turn will be increasing the consumption of the flux and the wider and the flatter bead is obtained when the too high voltage is used.

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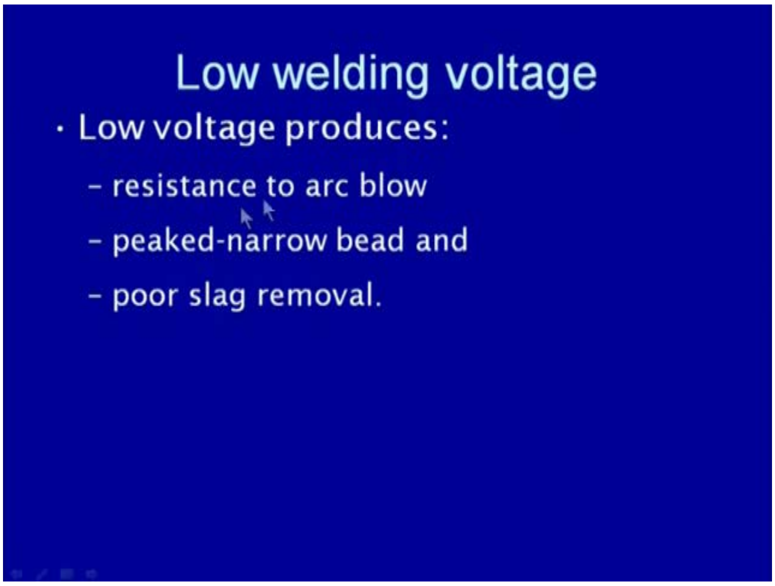


On the other hand, the use of the low voltage a produces the resistance to the arc blow because this will be happening when the arc voltage is low means the gap between the electrode tip and the work piece is narrow, the tendency for the deflection of the arc blow from it is intended path will be minimum. The next is the peaked narrow bead is obtained when the welding voltage is low and the poor slag removal is also experienced when the welding voltage is low the welding speed directly affects the heat input being given to the per unit length of the weld.

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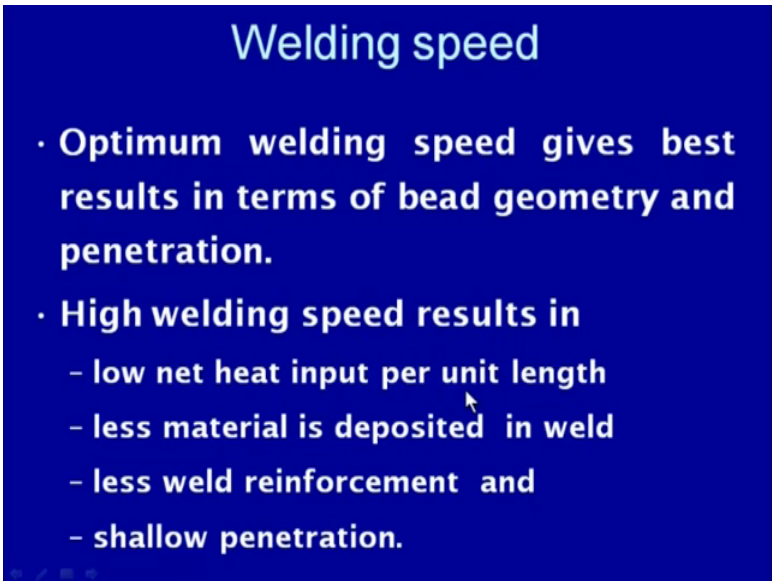


During the welding it is not good to have either too high or too low welding speed and optimum speed gives the best results in terms of the bead geometry and the penetration for developing the weld joint. While the too high welding speed results in the low net heat input per unit length the less material is deposited in the weld bead and the less weld reinforcement and shallow penetration. So, because when too high welding speed is used the arc will be moving very fast and for the given value of the arc voltage and the arc current. If we divide this by the welding speed then the net heat input in terms of the kilo Joule per mm will be reduced being apply which is being applied during the welding.

So, net heat input is basically reduced and because of this the fewer material is brought to the molten state from the electrode is applied molten material coming from the electrode is applied on to the base metal. That is why the less material is deposited into the weld and a due to the higher move a speed of the movement of the electrode along the welding direction the weld reinforcement is also reduced. The reduced heat input causes the decrease in the penetration and therefore, shallow penetration is observed when the too high welding speed is used.

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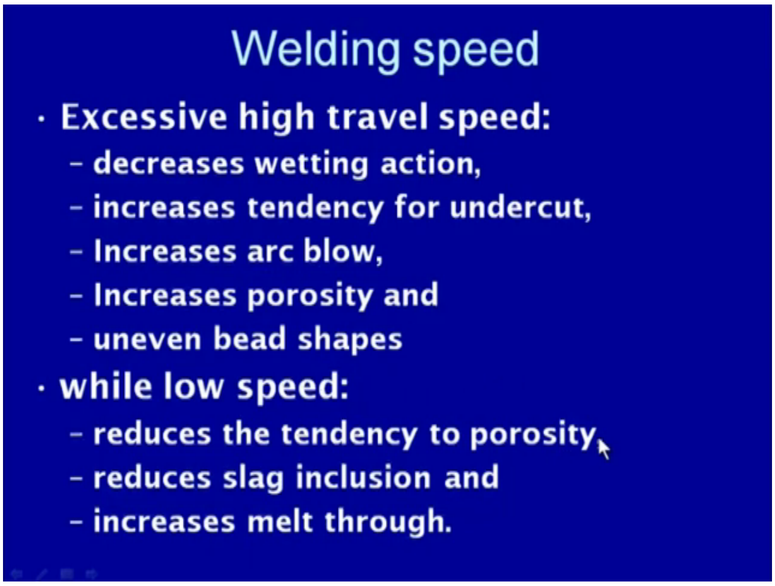


So, now we will see some other effects of the using a unfavorable welding speed like the use of the excessive high travel speed can lead to the decrease in the wetting action. So, we know that the wetting action depends upon the fluidity of the molten weld metal and which in turn is governed by the viscosity and surface tension, so if we provide less heat to the weld metal with the increase in the welding speed. Then it will be offering the higher surface tension less viscosity which in turn will be decreasing the flow ability of the weld metal and thus decreasing the wetting action of the weld metal and increase the tendency of the undercut and further a, because arc is moving at very high speed. So, it will have tendency to deflect from it is intended path.

Therefore, increase in welding speed increases the arc blow further a increase in welding speed also increases the porosity tendency because increased welding speed decreases the net heat input which in turn increases the cooling rate of the weld metal. And thus decrease in the solidification time and decrease in solidification time decreases the time required for escaping of the gases from the molten weld pool.

Therefore, reduced time available for escaping of the gases from the weld pool leads to the development of the porosity due to the gas interruptment and this also can lead to the uneven bead shapes. While the use of the too high too low welding speed reduces the tendency of the porosity because of the higher heat input and reduced solidification rate increase the solidification time. So, the increase possibility of the gases to come out of the weld pool and so the reduced the porosity tendency reduce the slag inclusion.

Because the lot of time is available for the inclusions being formed in the weld metal to come up to the surface of the molten weld pool, thus the content can get reduced. But at the same time it increases the melt through possibility, because of the increased heat input at low speed increases the melt through tendency due to the excessive heat input at one place, directly increased heat input per unit length of the weld.

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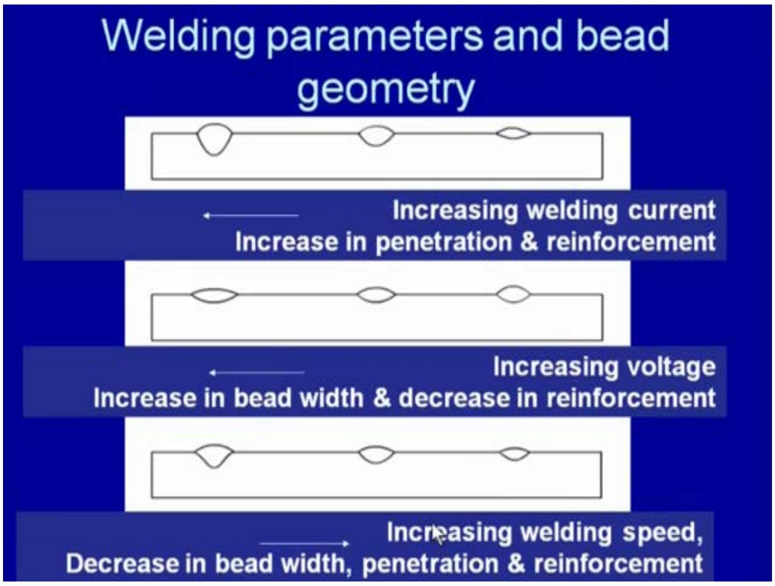


So, if we compare the relative effect of this three important variables on the weld bead geometry then we can see that increasing the welding current will be increasing the welding current will be increasing the penetration and the reinforcement that is what we can see. If we see this is the low current weld somewhat higher current and the highest current weld being made so increasing the welding current in this direction, how the change in the penetration is taking place very shallow penetration higher penetration and the maximum penetration and it is also increasing the reinforcement of the weld.

So, increase in welding current increasing the deposition rate melting rate of the electrode and the capability to penetrate the base metal in turn will be leading to the higher penetration and the increased reinforcement. If we see the increase in the voltage increasing the voltage from this weld to this side so the low weld lower arc voltage causes the narrower weld a bead and the reinforcement is high, but if we use the higher arc voltage then the weld bead width increases but, the reinforcement decreases.

So, if we see here the weld beads being made using the increasing the voltage in this direction from this to this that is shown by this arrow. So, it increasing voltage increases causes increase in the bead width and decreases the penetration. So, the low voltage causes the higher penetration, but the narrow bead on the other hand higher voltage causes the wider bead and shallow penetration.

Similarly, the increase in the welding speed, the increasing welding speed low welding speed higher and the highest welding speed that is in this direction reverse of the above two. So, increase in welding speed decreases the weld bead width here it is maximum then weld bead width is decreasing and decreasing the penetration, penetration is maximum with the lower speed and then it is decreasing and reinforcement, reinforcement is also decreasing. So, increasing welding speed decreasing the weld bead width and penetration and the reinforcement, this is what we can see geometrically the effect of the various welding parameters welding current welding voltage and the welding speed.

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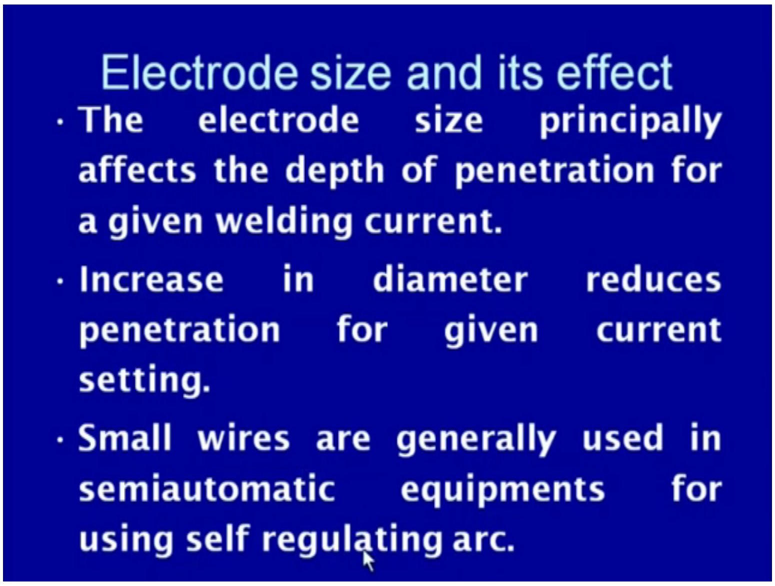


The electrode size is another important parameter that affects the weld bead geometry and it is penetration the electrode size principally affects the depth of penetration for the given welding current. So, if the electrode size is changed for a given welding current then the penetration depth is affected, the larger electrode size for a given welding current decreases the depth of penetration that is what has been mentioned here. Increase in diameter reduces the penetration for a given current setting the small wires are generally used in the semi automatic equipments for using this self regulating arc, so that the constant arc length can be maintained during the welding.

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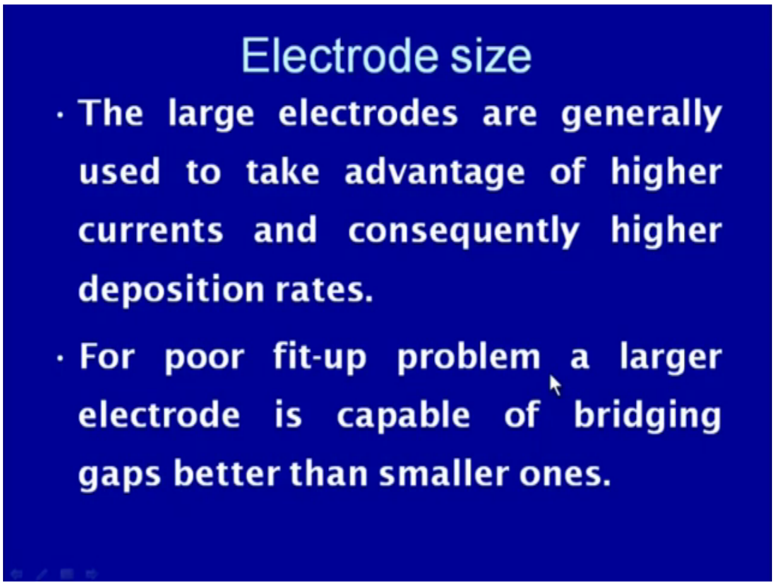


Large dielectrodes are generally used to take the advantage of the high current and so the higher deposition rate, if it is required to weld the thicker seeds very heavy sections then to make sure that the faying surfaces are brought to the molten state up to the desired depth. It is necessary that the heat is supplied in large quantity and to supply the heat in large quantity, yes it is necessary that high welding current is used and for using high welding current. It is mandatory to go with the large diameter electrodes. That is why large dielectrodes are generally used to take the advantage of the high currents.

So, that higher deposition rate can be obtained and the desired penetration also can be obtained for poor fit up conditions large diameter electrodes also help in improving the bridge gap bridge bridging the gap in better way than the small electrodes. So, the larger the diameter electrode larger wider will be the size of the arc and the electrode will be able to melt means arc will be able to melt the faying surfaces to the greater depth from the edge and thus will be helping in the better bridging the gaps between the plates being welded.

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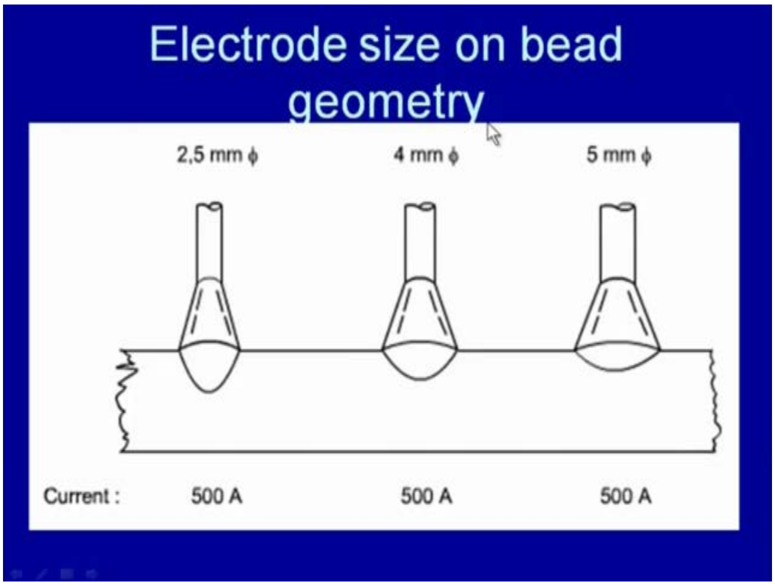


So, the poor fit up problem is a somewhat reduced by using the large diameter electrodes. Further, the electrode size effects the geometry of the weld bead as we can see the use of the small diameter electrode results in the narrower bead, bead is of smaller width, but the penetration is deep. So, deeper penetration and narrow bead is obtained with the small diameter electrode for a given current, but if we go with the larger diameter electrode penetration is somewhat reduced and width is increased. If we go further with the larger diameter electrode, then the width is further increased and penetration is reduced under the identical current conditions.

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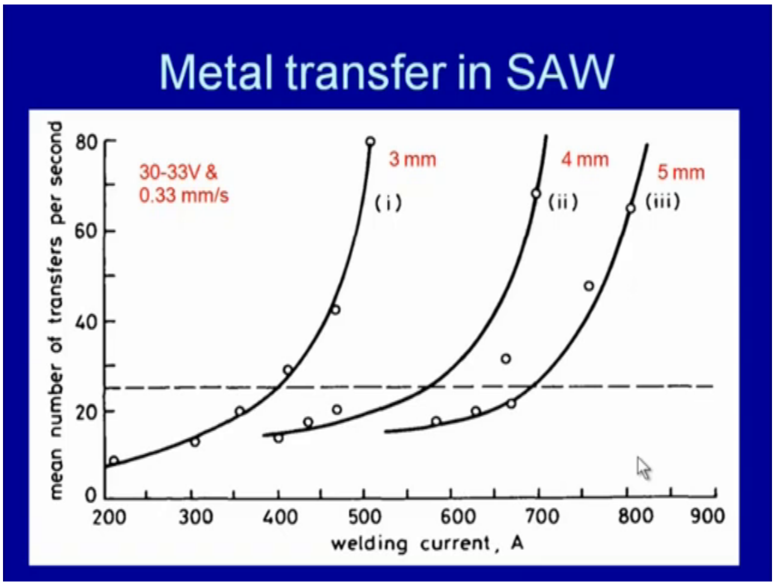

Now, we will see that the transfer of the molten metal from the electrode tip to the weld pool in the submerged arc welding. We know that a the metal transfer is a very is an important phenomena in the consumable arc welding process where electrode tip melts and the molten metal is transferred to the weld pool during the welding. It can happen in number of ways like short circuiting transfer, globular transfer, spray transfer, rotational transfer and explosion etcetera.

So, in a case of the submerged arc welding processes normally discrete kind of the transfer is observed where drop by drop molten metal transfer occurs sometimes the molten metal a from the electrode tip is transferred along the wall of the molten flux also. So, if we see that for a given conditions in general increase in the welding current decreases the size of the size of the drop being transferred. So, the small diameter current for the low current large diameter drops are transferred at the same time the number of drops being transferred per unit time also significantly affected by the welding current.

If we see here for the current setting for the welding using the 30 to 33 volt and the welding speed of the 0.33 mm per second when we use the 3 mm electrode 3 mm diameter electrode then an increase in the welding current increases the number of the drop being transferred per unit time increased from somewhere tend to the 80. This is how we can see there is exponential increase in the number of drops being transferred during the welding per unit time.

So, if we go with the larger diameter electrode then this happens only at the higher range of the current say around 18 to 20, number of drops at around 400 ampere to the 80 number of drops around say 700 ampere current. So, larger is the current, larger is the diameter, higher will be the current required for the for the transfer of the drops as the higher rate while at the low level of the current say the transfer is a transfer of the drops occur at occurs at a very low rate. If we see this a horizontal line, so for the 3 m for 3mm diameter current.

This at about 24 number of drops being transferred at around 400 ampere while it occurs for 4 mm diameter, it occurs around 550 or so in case of 5 mm diameter, electrode a it occurs around 700 ampere current. So, the diameter of the current and a diameter of the electrode and the welding current significantly affect the rate at which the drops are transferred during the submerged arc welding. But most of the time these are transferred in form of the discrete droplets discrete droplets being formed at the tip of the electrode.

The basic concept of the detachment of these droplets from the electrode tip is the surface tension and the pinch force being developed at the tip of the electrode. This is the one of the typical form of the transfer which is observed in the submerged arc welding. Sometimes that the molten metal dropping formed at the tip of the electrode are transferred through the wall of the molten flux to the weld pool. Sometimes these drops are formed and then transferred along the excess of the electrode and this can happen at the much faster rate.

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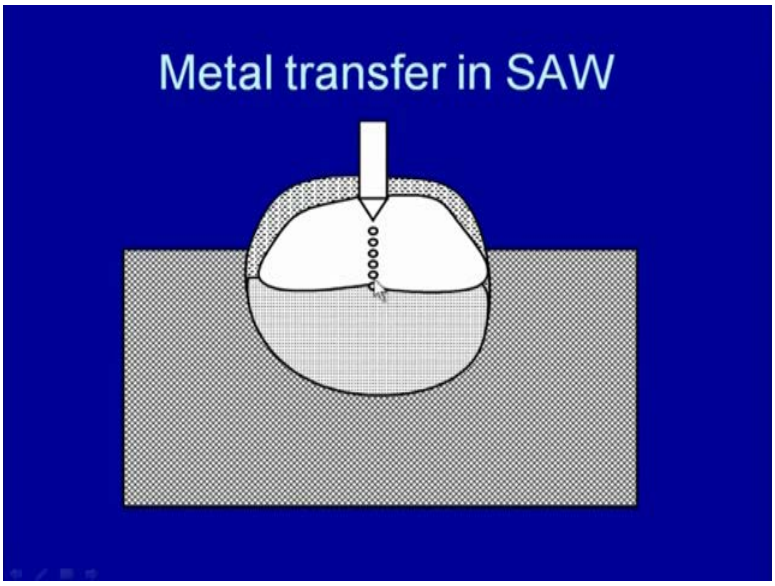


When the droplets are of the very small size, very frequent formation and the detachment can occur during the welding. So, transfer of the molten metal from the electrode tip to the weld pool can occur in the different ways in the submerged arc welding.

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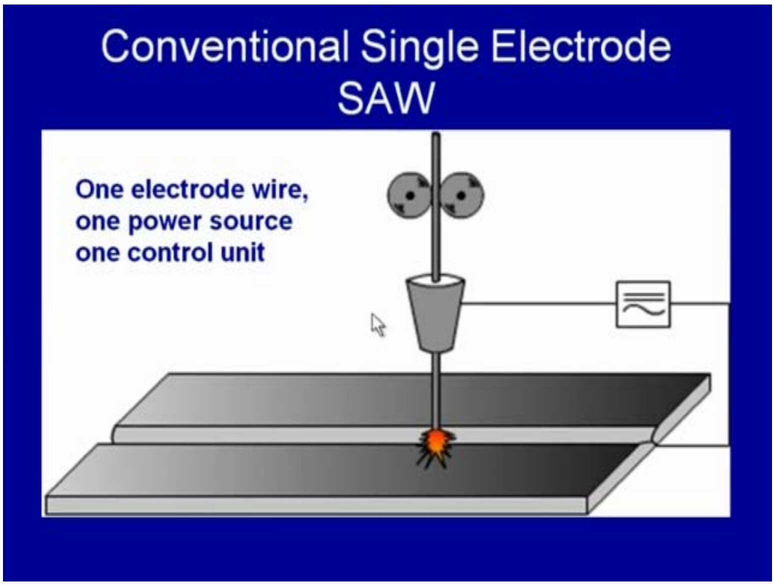


Depending upon the welding current being used or the settings being used during the welding or the diameter of the electrode being used and the characteristics. Now, we will see some of the variants of submerged arc welding process where depending upon the number of electrodes being used the number of power sources are there and how the things are being controlled using the controlled unit. This is the conventional single electrode submerged arc welding process where one electrode is fed continuously through the contact tube.

The arc is established between the electrode and the base material power is delivered by one source and the entire the welding system. The movement of the welding head is controlled through the controlled unit, so there is one electrode, one power source and the one controlled unit in the conventional single submerged arc welding process. If we see the twin arc submerged arc welding process, it uses the two electrode wires like this.

These are being fed through the contact tubes and the arc is established between these two electrodes. The base metals in both the cases, it uses one power source and the one controlled unit. So, this typical set up where twin arc submerged arc welding process with the twin electrodes are used it offers the high deposition rate good bridge ability for the gaps and the high welding speeds are obtained.

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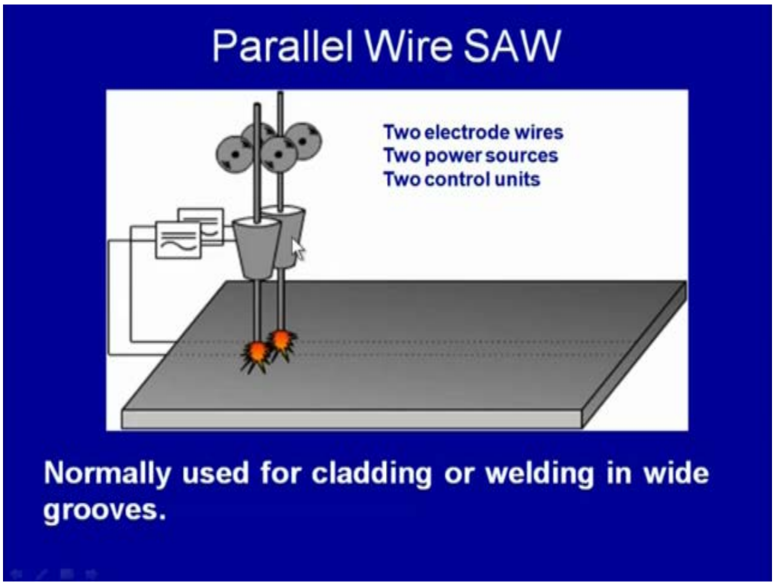


In case of the tandem submerged arc welding process, the two electrode wires are used the two power sources are there two controlled units are used and the set up. We can see the two welding heads are working separately in case of the parallel wire submerged arc welding process, the two electrodes walk in parallel. This kind of set up uses two power sources and two controlled units and this type of set up is normally used for cladding purpose for depositing for modifying these surfacing or developing the weld bead over the surface of the plate or it is also used for developing the weld in case of the wider groups.

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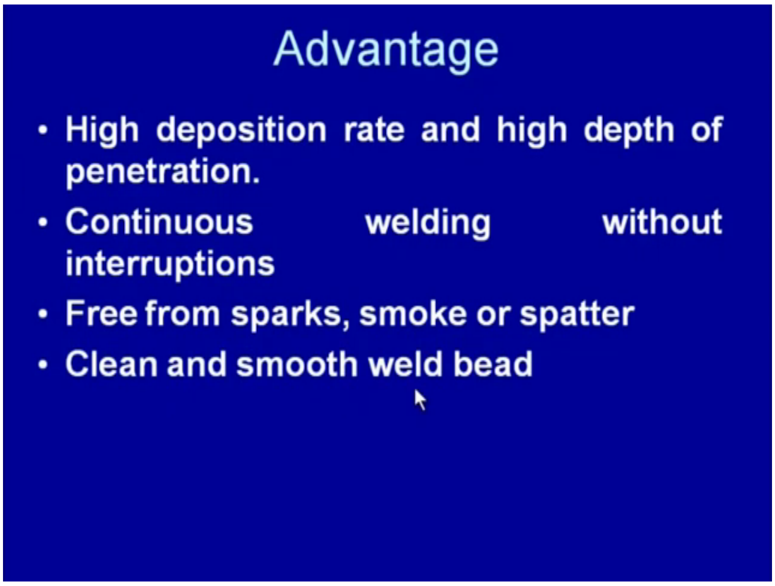

Now, we will see the certain advantages of the submerged arc welding process because of the inherent nature of the submerged arc welding process. It walks with the higher welding current which in turn offers the higher deposition rate and this in turn allows the higher penetration rate and higher penetration rate permits the use of this process for the welding the thick sections. The process is continuous, so without interruption it can walk continuously for welding over meters. Also, the weld is a free from the spark and smoke and spatter and the cleaner weld and the smoother weld bead is generated and the good mechanical properties and metallurgical properties are obtained by the submerged arc welding.

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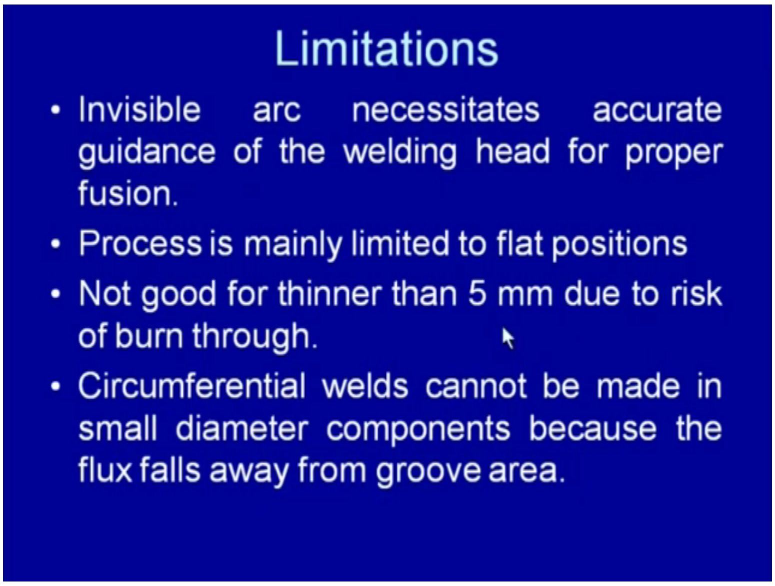


This process also suffers with the certain negative points like arc is invisible say it necessitates the accurate guidance of the welding head for proper fusion of the base metal along the weld line. This process mainly limited to the flat positions because it is required to form a pool of the flux around the arc and other than flat positions like in vertical horizontal and overhead it becomes difficult to have this kind of pool around the arc.

That is why normally limited to the flat positions it is not good for thinner for plates for welding the plates of thickness lesser than 5 mm due to the risk of the burn through because this process is of the high heat input. So, it has the tendency to cause the melt through kind of situation and the circumferential weld cannot be made by this process especially in case of small diameter components because flux falls away from the groove area.

This process finds very extensive applications in the industry for welding the different grades of the steels in different sectors like ship building offshore structural and pressure vessel industries fabrication of pipes and pen stocks L P G cylinders and bridge griders. It is also used for surfacing for the reclamation of the worn out parts or for deposition of the corrosion resistant layers or hard surfacing layers for employing the submerged arc welding process.

So, this is how we conclude this presentation. Now, in this presentation mainly we have talked about the important role the fluxes and various fluxes which are used over, the important parameters of the welding submerged arc welding process. How do they affect the performance of the weld and the characteristics of the weld joint and the two three variants of the submerged arc welding process? Also, we have seen and we have observed that the certain advantages and limitations with the submerged arc welding process apart from the application.

Thank you for your attention.