**Welding Engineering**
**Prof. Dr. D. K. Dwivedi**
**Department of Mechanical and Industrial Engineering**
**Indian Institute of Technology, Roorkee**

**Module - 4**
**Arc Welding Processes**
**Lecture - 4**
**GTAW- II**

So, in the last lecture, we based on the gas tungsten inactive gas welding process, we have seen that how the heat is generated during the welding by this process. What are the different types of the electrodes? What are the various possible gases, which can be used for protecting the weld pool from the atmospheric contamination? We have seen what factors that affect the fluorite required for optimum shielding by the inactive gases or other inactive gases, which can be used for this purpose.

So, in this presentation, we will mainly focus on that if there two passages like argon and helium available for the use to protect the weld pool from the atmospheric contamination. Then, how can we compare and which gas should be selected for this purpose? Apart from this, we will also see that what are the various methods through which arc can be initiated. For the welding purpose, there are three main methods, which are based on the carbon block, use of the pilot arc and high frequency unit. These are the three methods, about which will be talking in detail. Then, there is one variant of the gas tungsten arc welding process, in which the current falls between the low and the high levels.

So, very controlled heat input can be provided to the base metal during the welding. This processes specifically used for the low heat for the applications, where low input is desired. There is another variant of the GTAW process. That is the hot wire GTAW process. In this process basically, filler metal is heated before fed into the arc zone. So, the melting rate can be increased and the heat input the base metal can be reduced for achieving the same welding speeds. This process particularly helps in getting the higher welding speed. So, starting with the factors that affect the fluorite and the relative effectiveness of the shielding gas is like argon and the helium.

If we see that the helium is very light than the air, the carbon and argon; so helium being significantly lighter than the air therefore, it tends to rise immediately in a turbulent manner away from the weld pool as soon as it comes out during the welding. So, the protection by any shielding gas can be provided only if the cover by the shielding gas is formed around the arc and around the weld pool.

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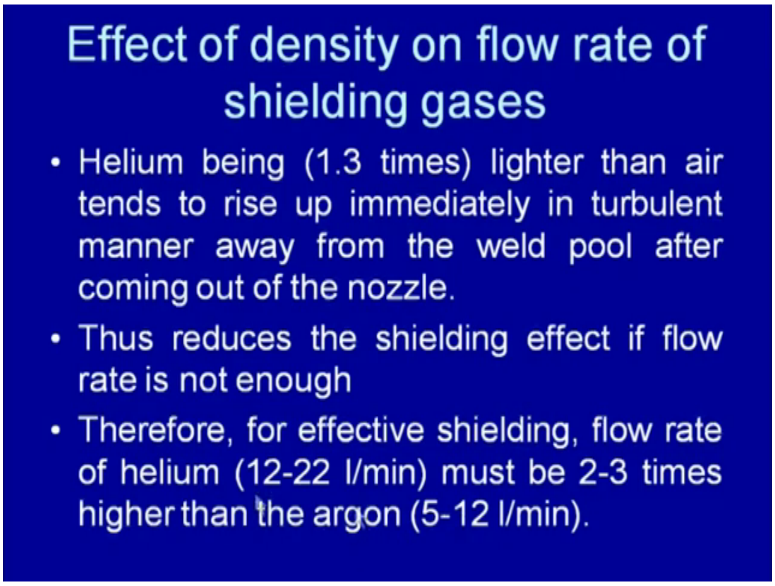


If the gas is tend to come up of the weld pool then, this effectiveness of the shielding is reduced. Therefore, it is necessary that whatever gas is being provided, it should found from blanket around the weld pool and the arc. So, required protection to the weld pool can be provided. But this is helium being lighter than the air. Therefore, it tends to come immediately after coming out from the nozzle. It tends to move up. Therefore, it reduces the effectiveness of the shielding.

Thus, the shielding effect is reduced. If the flow rate is not enough, under such conditions, when the helium is trying to move up as soon as it is coming out of the nozzle then to have the desired shielding effect, it is necessary that the flow rate of the shielding and gas like helium is high enough. Therefore, the effective shielding flow rate of helium must be about two to three times greater than the argon.

Here, argon is heaver, much heavier than the helium. So, when it comes out of the nozzle, it immediately tends to form complete blanket around the weld pool to protect it from the atmosphere contamination. That is why argon requires lower flow rates than the helium. This is the approximately range of the flow rate desired for helium. It is about 10 to 22 liter per minute while that in case of argon it is about 5 to 12 liters per minute. So, the factors that dictate the flow rate to be used for effective shielding purpose these factors are bigger is the size of the pool, large will be the amount of the flow gas that should be allowed to flow from the nozzle.

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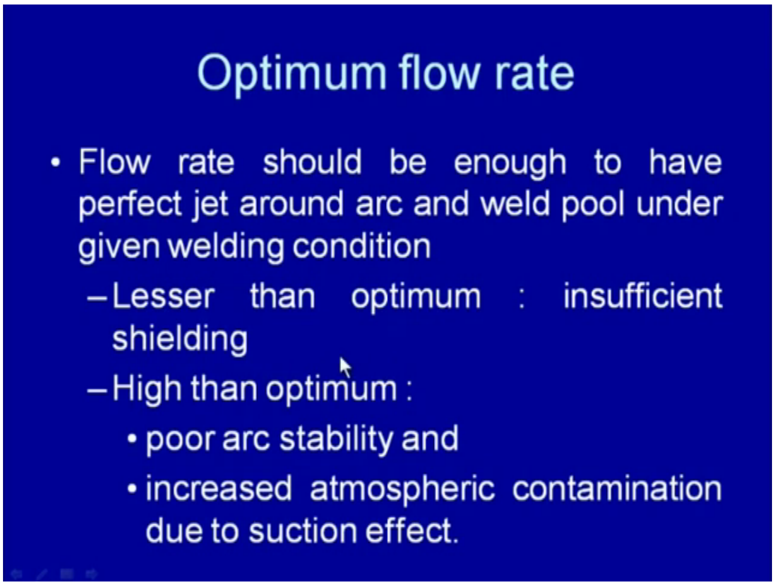


So, it can perfect blanket around the weld pool and the gap between the nozzle and the electrode. If the gap between the electrode and the nozzle is big then, it will require higher flow rate to maintain the perfect formed jet around the arc and around the weld pool. If this gap is small then, the lower flow rate will be required. However, sometimes too, small gap between the electrode and the nozzle lead to the excessive turbulence, which can reduce the production to the weld pool, the distance between the nozzle and the work piece.

Greater is the distance between the nozzle and the work piece, higher will be the flow rate required for getting the desired shielding of the weld pool. So, these are the factors that affect the flow rate desire for optimum shielding of the weld pool. These are the factors apart from type of the shielding gas is being used because in general, we require higher flow rate of the helium gas than the argon. In addition to above factors, ambient air movement around the arc also affects the flow rate desired for effective shielding.

Higher is the flow rate, greater will be the turbulence and the disturbance to the shielding affect being offered by the shielding gas.

Then, higher will be the flow rate required to maintain the proper shielding. So, whenever the ambient movement is more than 8 to 10 kilo meter per hour then, the flow rate, higher flow rate of the shielding gases will be required to maintain the desired shielding affect. So, the flow rate should be high enough to have the perfect jet around the arc and weld pool under the given welding conditions. These welding conditions are like given the electrode and nozzle, the given gas and the distance between the electrode and the work piece and the ambient conditions when where welding is being done.

If the flow rate of the shielding of the gas is less than the optimum then, it will require insufficient cover around the weld pool. This will lead to lot of atmospheric contamination by of the weld pool. So, the weld pool can be significantly reversely affected by the gas present in the atmosphere like oxygen and in nitrogen. If the flow rate of the shielding gas is higher than the optimum, it can lead to the poor arc stability and increased atmospheric contamination due to suction effect to the high flow rate and to low flow rate.

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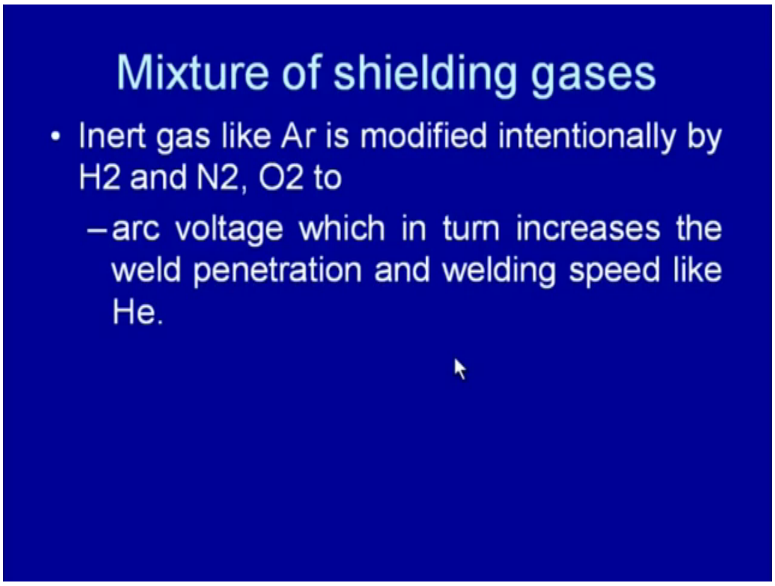


Both are not favorable as per as the effective production of the weld pool is concerned. If we see the helium and the argon, both gases can be effectively used for producing the weld pool from the atmospheric contamination. But sometimes, it is been observed that addition of some gas like hydrogen, nitrogen and oxygen in the argon helps to get the better welding correct characteristics especially, in terms of the higher arc voltage.

That in turn helps to generate more heat and helps to develop higher temperature in the arc. So, in the addition of the gas is hydrogen, nitrogen and oxygen in the argon in a small quantity helps to increase the arc voltage during the welding. It in turn helps to increase the penetration weld penetration and the welding speed.

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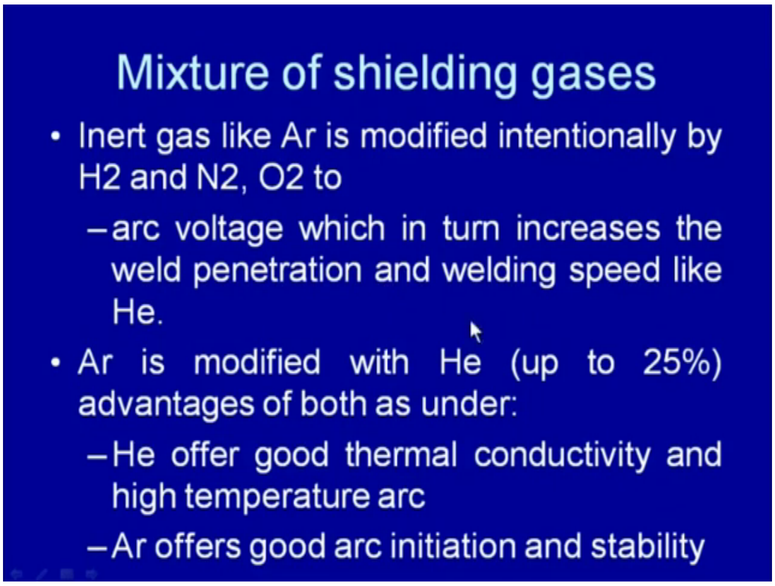


Therefore, helium is sometimes intentionally added with the argon. The argon and the helium mixtures are commonly used to take the advantages offered by both the gases. Individually, helium is good in some of the aspects while argon is good in some other aspects. For example, when a mixture of the helium and argon is used, it offers the advantage of both. These advantages include like helium offer the advantage good thermal conductivity and the high temperature arc.

This happens because of high arc temperature is obtained because of the higher arc voltage which is developed during the welding. The higher thermal conductivity helps to have the higher arc efficiency. So, the advantage of the helium is that whatever heat is generated during the welding in the arc region, which is effectively transferred to the base metal for the fusion purpose. Higher temperature is also generated. So, both these things help in welding and the high thermal conductivity metals and the metals of various sections.

Therefore, helium is preferred for those purposes. So, when helium is added with the argon, it helps to increase its thermal conductivity of the mixture. It also helps in generating the higher temperature in the arc region. When the argon is used means argon also offers the advantage like the better arc initiation and the arc stability. So, when mixture of both helium and the argon is used, that mixture helps to have the positive points related with both the gases like helium and the argon. It is common to have the mixtures of the argon and the helium where helium and where up to 25 percent to take the advantage of helium. This diagram further shows the addition of effect of oxygen addition in the argon.

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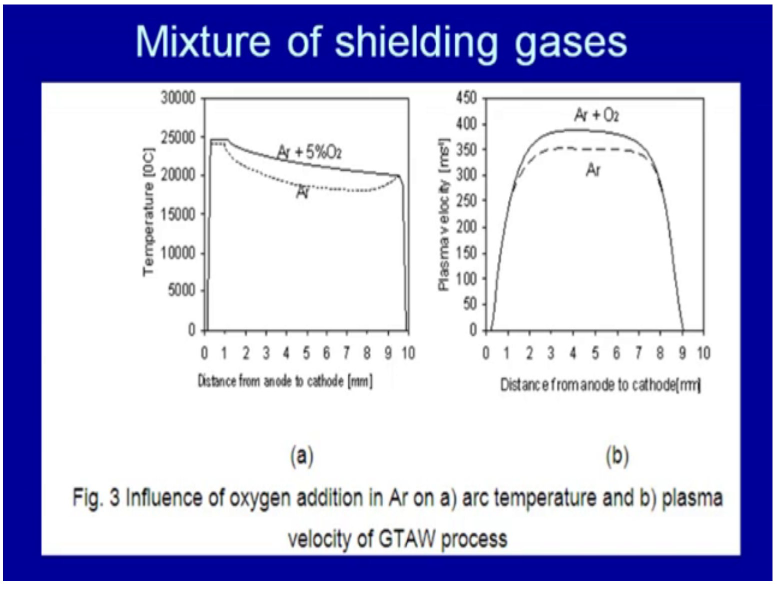


So, when we see here, when the oxygen is added with the argon, we get the higher temperature in the arc zone. Similarly, when oxygen is added, the plasma velocity is found to be higher with the argon oxygen mixture as compared to the pure argon. So, addition of the oxygen in the argon also helps in increasing the temperature and the velocity of the plasma. It helps in increasing the heat being generated, the temperature in the arc zone and these things help in further getting higher speed with the higher penetration during the welding.

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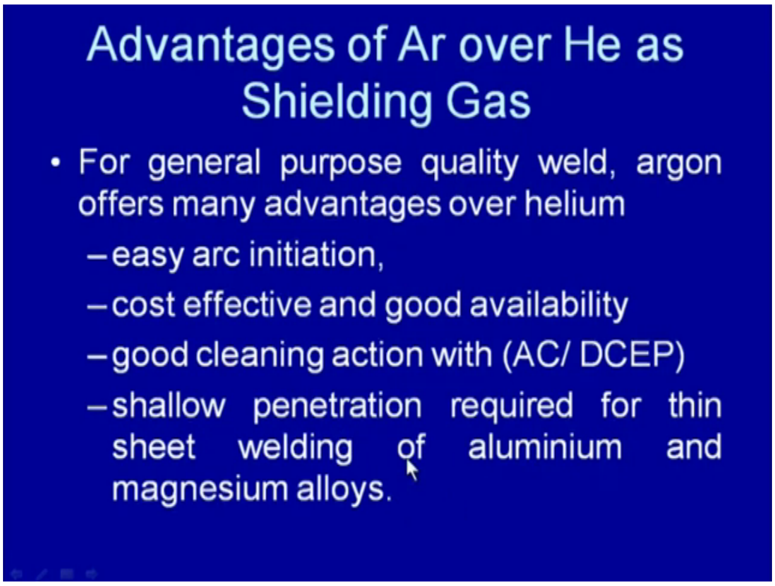


If we compare argon and the helium in this aspect of the various desired properties then, for general purpose weld quality argon is preferred. But, at the same time, it is very cost effective as compared to helium. But, when very high quality welds are required, are to be developed for the critical application then, helium will be used. So, if we compare argon; it offers many advantages over the helium. For example, it offers easy arc initiation. It is cost effective and easily available. Good cleaning action is provided by argon when AC and the DCEP is used especially when we are welding aluminium and the magnesium.

Further, it offers shallow penetration, which is required in case of the thin sheet welding of aluminium and the magnesium because dip of the penetration offered by the helium can lead to the melt alloy kind of situations. So, it is favorable under the conditions, when the shallow penetration is desired for the welding purpose. So, there are many situations where argon offers many advantages over the helium.

Now, we will see that if the tungsten electrode tungsten inert gas welding process is to be used then, we need to strike the arc first. Then, it maintains, will help in generating the heat uniformly and consistently for the melting faying of the base material to develop a weld joint. So, to initiate the arc here with the TIG process, we use different methods.

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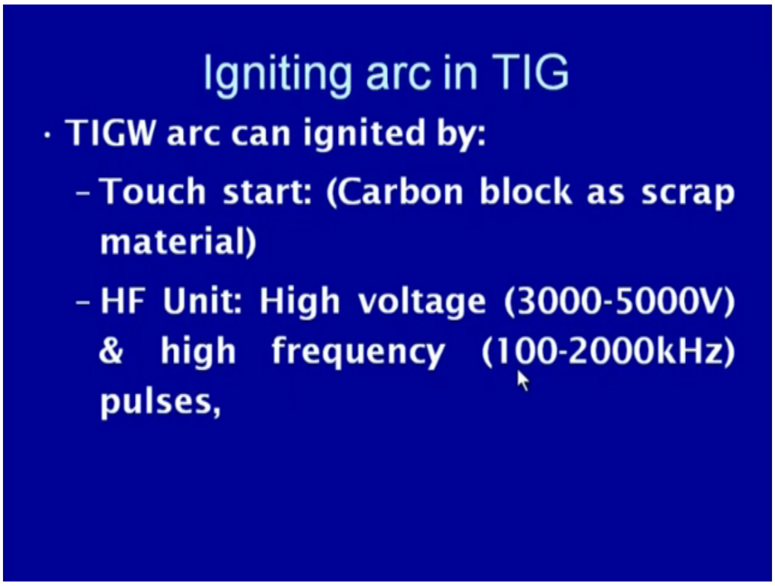


Then, this is the shielded metal arc welding process, which we have discussed in the previous lectures. So, the TIG arc can be ignited by the three methods. One is the touch start, where carbon block is used as scrap material. The second is the high frequency unit, where the pulse of the high voltage of the order of the 3000 to 5000 voltage is supplied at very high frequency.

So, the arc is ignited. The third is low current pilot arc. It is ignited first and thereafter, the normal welding current is supplied. So, these are the three common methods, which are used for initiating the arc in the tungsten inert gas welding process. In the case of the carbon block method first, the electrode is brought in contact of the carbon block. Then, it is drawn apart. Once it is drawn apart, it develops heat and the temperature is increased of the electrode tip. Thereafter, it helps in initiating the arc easily at some other place. So, once the electrode is brought in contact with the carbon block, it is drawn away from the block.

This helps to maintain the arc for a short while so that the heat generated helps to facilitate the electron emission. Once the electrons are emitted, arc can be initiated easily at the spot where it is required, desired. So, this method is not very is not pool proved or we can say suffers from the problem of the carbon pick up and the electrode contamination. When we touch the tungsten electrode to the carbon block to compute the circle and to have the arc for a movement, the heat generated by the arc leads to the little bit melting of the electrode tip.

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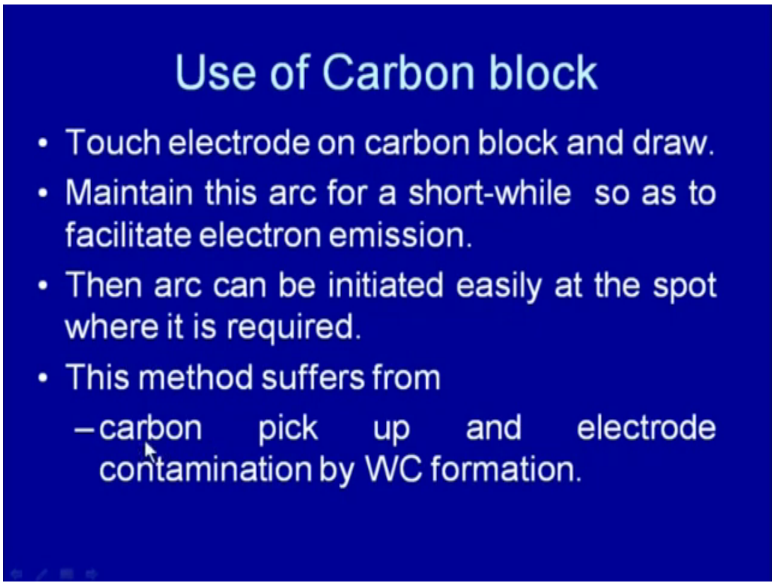


This causes picking up of the carbon from the block to the electrode tip. This picking up of the carbon from the block to the electrode tip leads to the electrode contamination by formation of the tungsten carbide. Once the tungsten carbide is formed at the tip of the electrode then, it leads to have the many undesirable effects.

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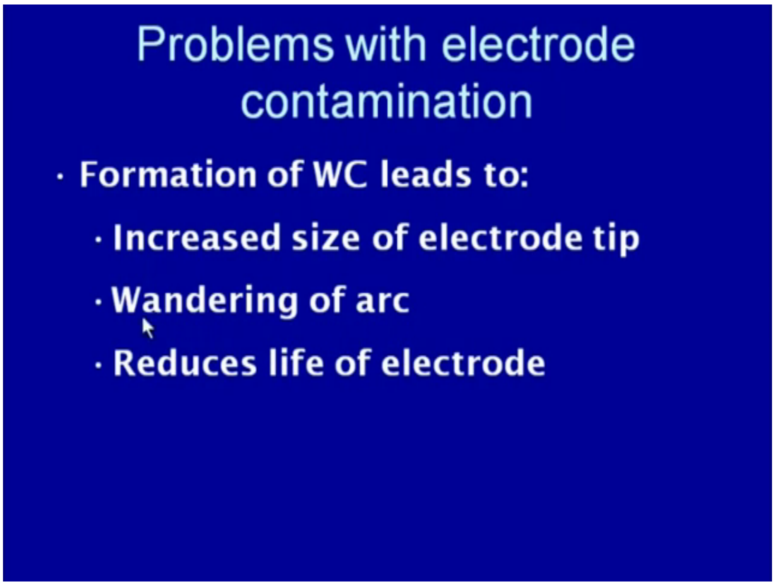

These undesirable effects will be changing the geometry of the electrode tip. The change in geometry of the electrode tip causes many undesirable effects like formation of the tungsten carbide. It leads to have the increased in size of the electrode tip. This in turn causes the wandering of arc because electrode tip is contaminated and electrons are not easily released. So, under these conditions, the electrode arc tends to wandering here and there at the electrode tip.

Further, it reduces the life of the electrode due to the continuous wear and tear of this electrode tip due to the formation of the WC at the high temperature. So, this is not a very favorable method especially, from the electrode life point of view. But, it can be used for the crowd purpose when not very critical applications are to be developed.

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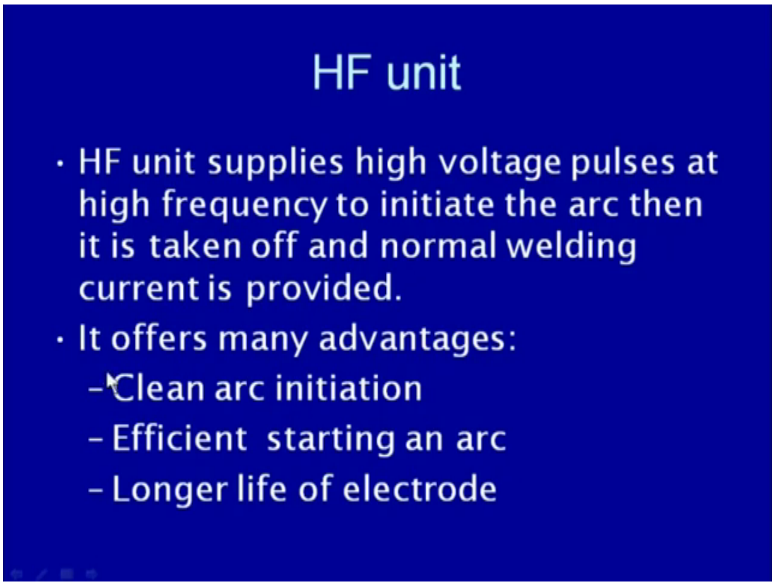


But it offers very low life of electrode. The high frequency unit is another way which is used by the initiating the arc. In this process, a pulse of the high voltage is supplied at high frequency. So, the field emission arc is initiated. Then, it is taken off from the welding circuit and the normal welding current is supplied. So, first a voltage pulse, pulses of the high voltage at very high frequency are provided between the electrode tip and the work piece. So, high potential difference is established between them. By the field emission, electrons are released from the electrode. This leads to have the presence of the charge particle in the arc gap, in the gap between the electrode and work piece.

The presence of the charge particle in the gap leads to have the initiation of the arc. So, once the arc is initiated then, this pulse is of high voltage at high frequency. They are taken from the welding circuit. So, high frequency unit is brought in to use only for initiation of the arc. Once the arc is initiated then, it is taken from the welding circuit. Normal welding supply is provided for establishing the arc, which will generate the heat required for melting the faying surfaces, for developing the weld joint. This method offers many advantages because there is no contact between the electrode and carbon block or the work piece.

So, the arc initiation method is very clean and it is very efficient in starting the arc. In turn, it offers longer life of the electrode. The low current pilot arc is another approach. We have first the low current is supplied while the contact is made by with the base material for initiating arc. Once arc is initiated using the low current, the main power supply is brought into the picture to have required amount of the heat.

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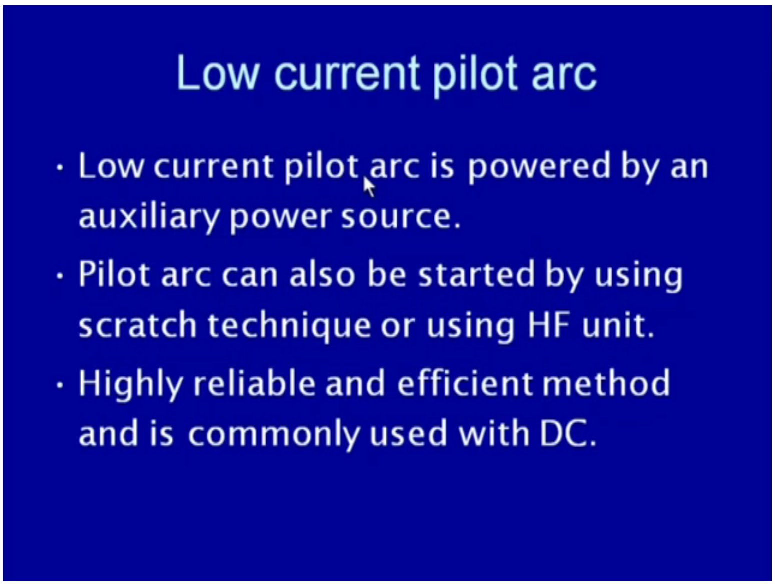


So, the low current pilot arc is powered by an auxiliary power source, which will be delivering a very small current to initiate the arc using the low current. So, the pilot arc can be established using either the scratch technique or the high frequency unit. This method is very reliable and very efficient method. It is commonly used with the direct current. So here, the basic thing is that when we very are using HF unit or the touches, the scratch method very low current is supplied in the beginning. So, whatever arc is generated at the time of contact and during the initiation; that is of very low heat because of the low current. Once the pilot arc is established, the main current supply is brought into the picture.

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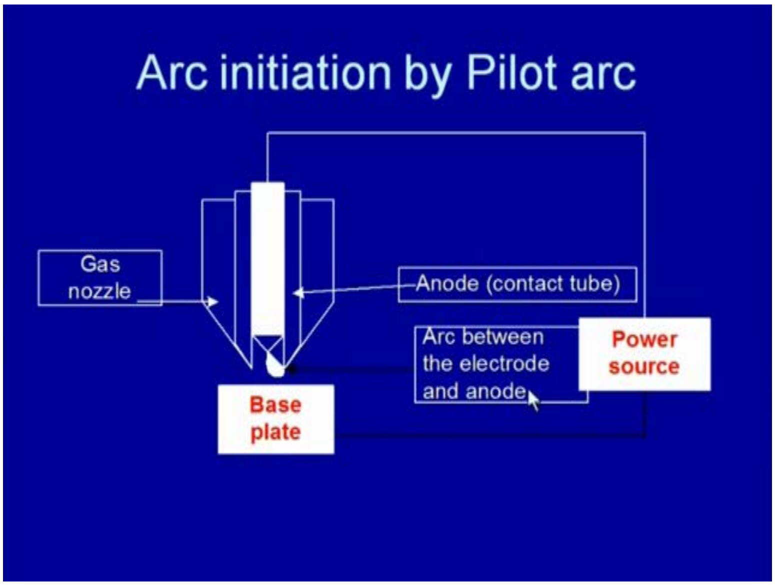


So here, if we see this schematic diagram, in case of the arc initiation by the pilot arc, the high frequency pulses of the high voltage at high frequency and the low current helps to establish the arc between the tungsten electrode and the nozzle. Once this is established, the normal current is supplied to have the welding current between the base material and the electrode. So, the one typical auxiliary service is auxiliary power source is used to supply the low current for having the arc initiation in the beginning. The advantage of this is that the low current arc helps to reduce the damage, thermal damage cause to the tungsten electrode. It in turn helps to increase the life of the electrode.

Then, the another variant of the pulse tungsten inert gas welding process is one where the current is pulsed between current is varied between the low level to the high level. So, this kind of the process where current is varied continuously as a function of the time during the welding is called the pulse welding. The pulse TIG is a variant of tungsten inert gas welding process, in which welding current is varied continuously between a high level and low level.

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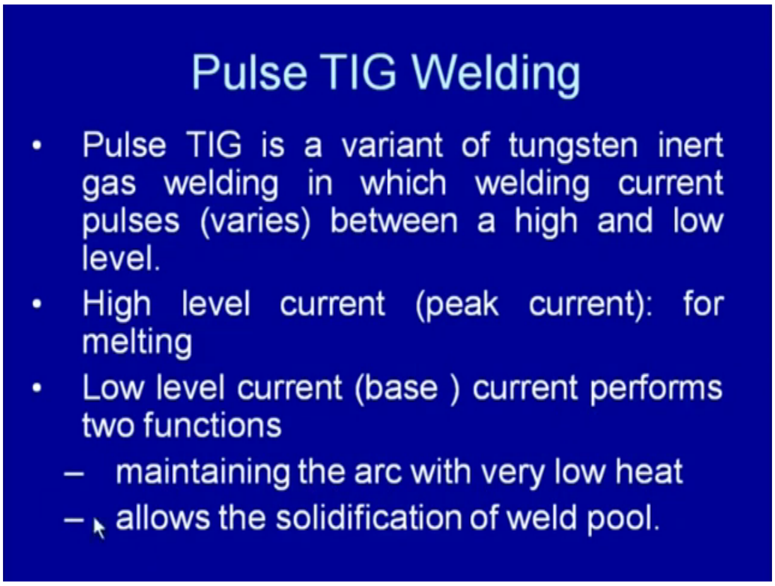


The high level current is termed as the peak current. This current is mainly used for the melting purpose. So, the level of the high current is decided on the bases of the heat that is to be generated for melting the faying surfaces. The low current is called the base current. Its main function is to have just the welding arc with the very low heat so that during the low heat period, the solidification of weld pool can take place. So, basically if we see in this diagram, this welding current is allowed to pulse or very between the high level and the low level.

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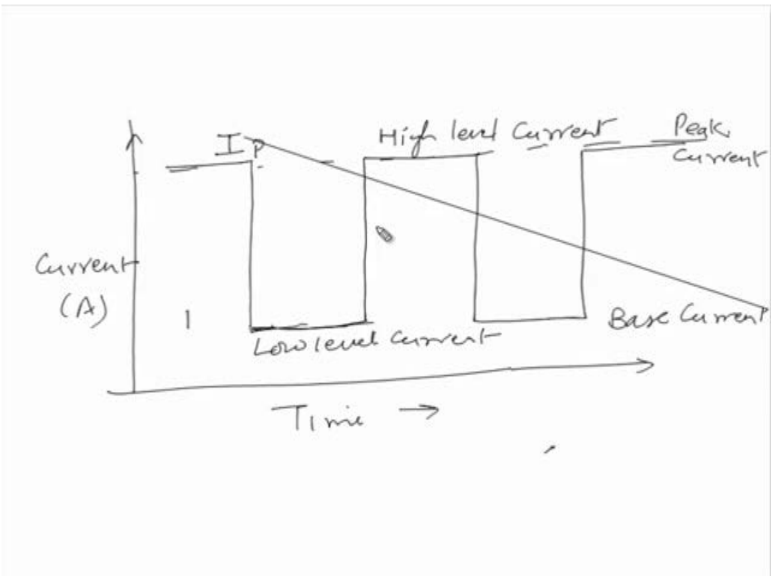

If we see here, we have one time scale. Then, the welding current is allowed to vary between the low level and high level. So, it can vary in this form. There are various wave forms, which exist depending upon the way where as current varies during this process. So this is the time and this indicates the current in ampere. So, the variation between the high level current, this is also called peak current. The low level of current is called base current or background current. So obliviously, the peak current is designated as I p. The base current is designated as I b. Now, we will see how the current varies in the pulse TIG arc welding arc process.

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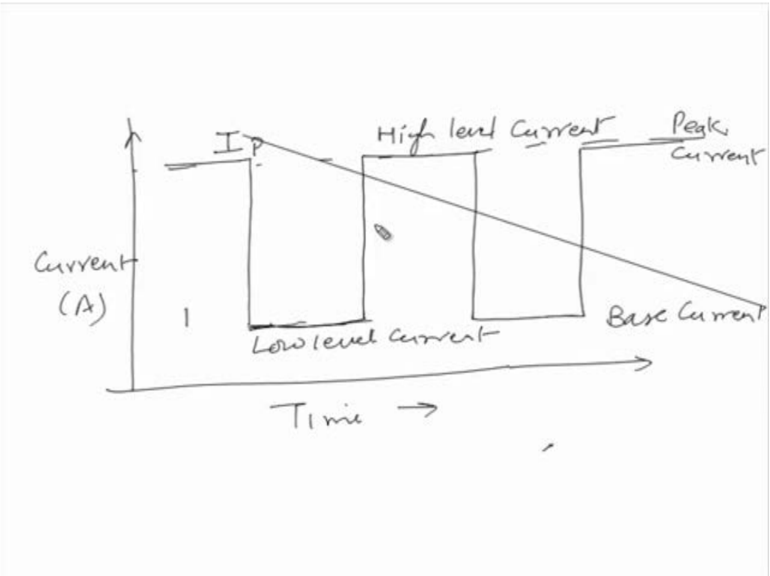


So, for this purpose, if we see that, this y axis shows the variation in current. The x axis shows the time. So, during the welding as the time changes, there will be variation in current. This is welding current variation. If you can see, there can be various waveforms in which current can vary between the low level and high level. This high level current is called peak current. The low level current is called base current or a background current. This is base current or background current. The purpose of the peak current is to make sure that sufficient heat is generated during the welding.

So, peak current develops lot of heat, which is mainly used for melting of faying surfaces. The base current will be developing less heat. During this low temperature, it will be leading to the solidification of the weld metal. How much melting will be taking place and how long solidification will be taking place and the period which the melting will be occurring; that will be governed by the duration of this peak current and duration of the base current. So, the period during which current is high, this is called pulse period. The pulse period will decide how long the heat will be generated for the melting purpose.

That duration of the base current will provide the opportunity for the solidification of the weld metal. So, this is called pulse period during which the high current is generated. It is indicated by I b for base current and I p for peak current. So, if the duration of the pulse period is more, more heat will be generated. On the other hand if the base current is for the larger duration then, the cooling time will be more. Less heat will be generated during the welding. So, this is how the welding current is varied during the pulse welding pulse TIG welding process. However, there can be various tends of various kind of the variation in the current during the welding.

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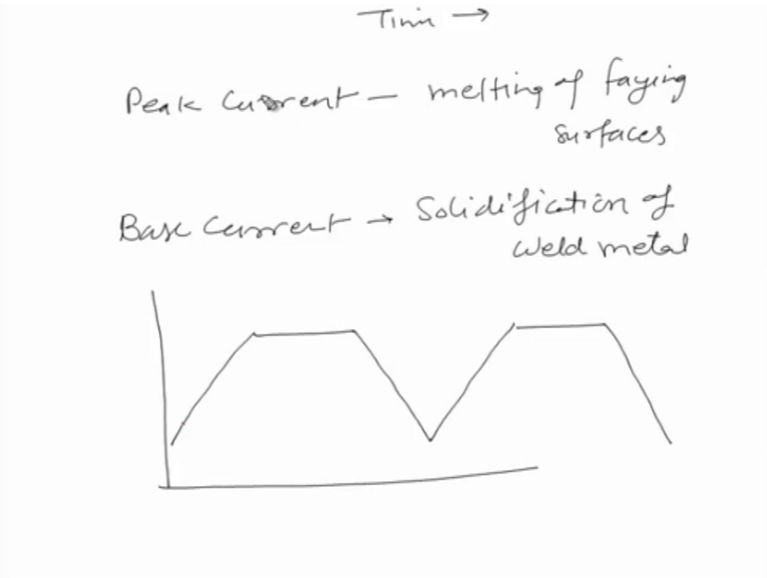


So, depending upon the rate of rise in the current, there can be different slopes. Here, this is square wave form, triangular wave form. Some other wave forms can be there depending on the way by which the current increases from the base current to the peak current level. So, this is what we have seen. High level peak current is mainly used for melting of the faying surfaces.

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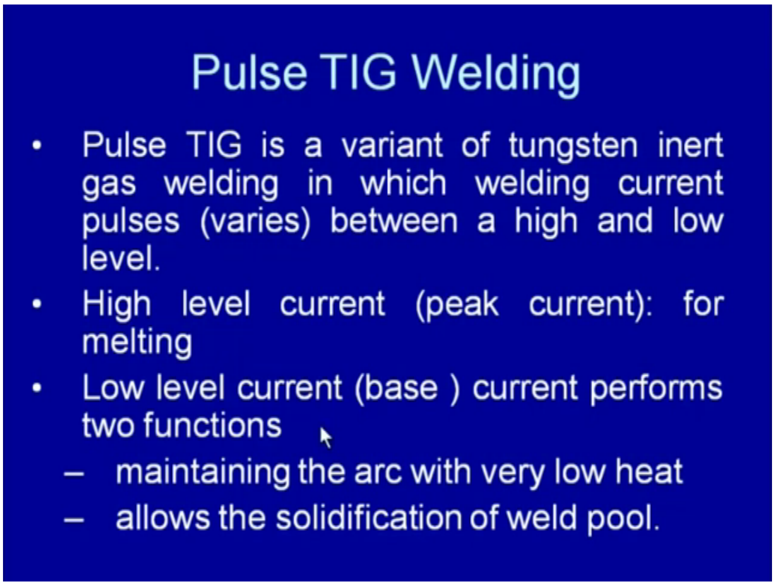


The low level current that is called base current performs the two functions. One, it helps maintain the arc during the welding with the very low heat. During this period, the solidification of the weld metal takes place.

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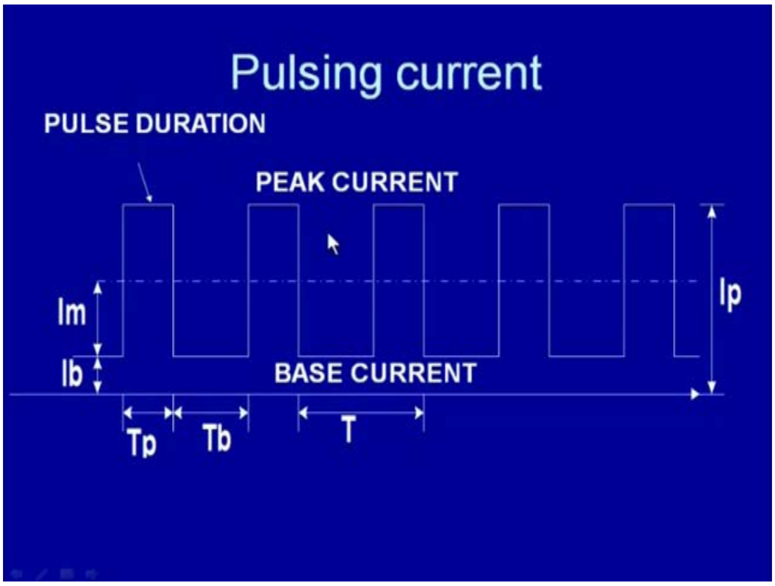


So, these are the schematic diagram showing the way by which pulsing takes place. So, this is square wave form. This shows that I b is the base current. I p is the peak current. It is this depending upon the duration for which the peak current is maintained. It is called its T p. The pulse duration and the duration for which the base current is maintained is called T b. The total cycle of the variation in the base current and the peak current will be the sum of T p plus T b. To sum of this because the current is varying from I p to I b and varies from the different durations, these I p, I b are for the different durations. So, it becomes important to find out the average current corresponding to which heat will be generated.

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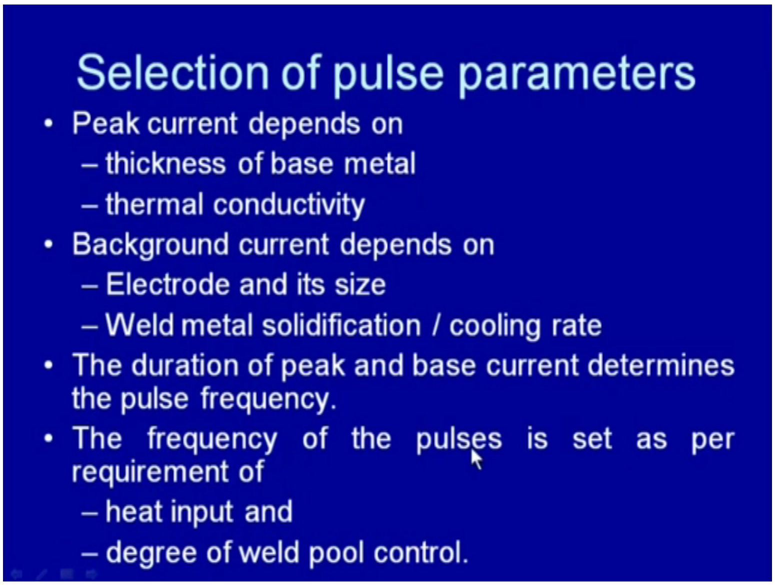


That can be used for the calculation of the heat generation during the pulse TIG welding process. So, what level of the peak current we should select in the main purpose of the peak current is to make sure that sufficient heat is generated? So, melting can take the place. So, if the thickness of base material is high, we will require higher peak current. Similarly, high thermal conductivity materials also will require higher the peak current. So, high enough heat can be generated to ensure that melting of the base material take place.

On the other hand, the lower current or the background current selection depends upon the electrode size, electrode composition and its size. The electrodes like the thorium coated electrode or zirconium coated electrode, they can work even with the low level of current. The pure tungsten electrode will require the higher base current. Similarly, the electrode of the size and the shape of the tip, the electrode of the larger size will require the higher base current. Then, the fine or a small diameter electrode; similarly, the sharp tippet electrodes will require the lower can walk with the lower base current.

Then, the large diameter or the large tippet large sized tippet electrodes; similarly, the weld metal solidification. We want the cooling rate; sometimes too high cooling rate because of the excessive the base current period, the cooling rate becomes high. Because of the high cooling rate the gas in trap take place, which in turn leads to the development of the polar city. So, in which way we want to have the solidification of the weld metal that decides the base current value. However, some ratio between the peak current and the base current is always maintained.

The duration of the peak current and the base current determines the pulse frequency. In general, the peak current duration is greater than the base current. But, some ratio between the peak current and the base current must be maintained. The frequency of the pulse is set as per the requirement of the heat input. If we require more heat then, the high frequency pulse is selected. If we require less heat then, the few pulses of the peak current will be there. That will help in having the lower heat input.

Similarly, the degree of the weld pool control is required. So, if you want to have the better control over the weld pool like in odd position welding, vertical and horizontal welding positions. If we want to have very low input, so that the better control over the weld pool can be obtained, under those conditions of the low frequency, the welding current is used for pulse TIG welding. So, very low frequency, the pulses are used where lower heat input and the better control over the weld pool is required.

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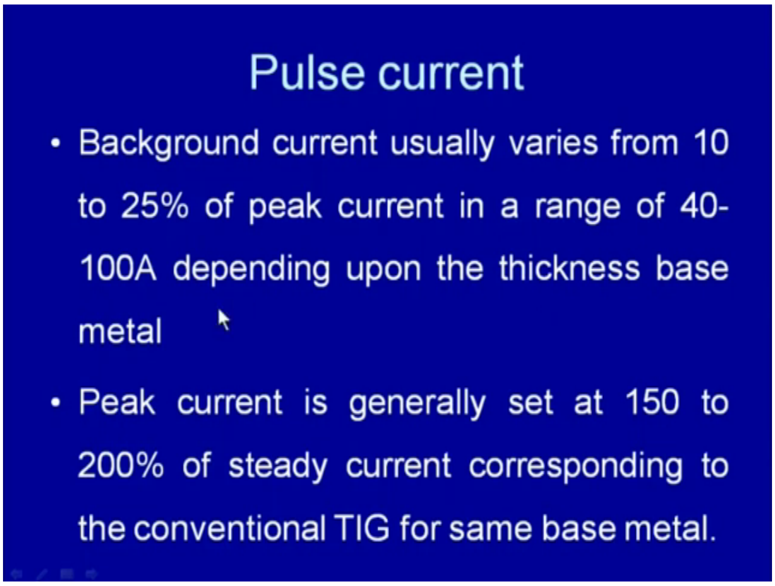

In general, the background current usually varies from 10 to 25 of the peak current in a range of 40 to 100 ampere. Further, it will depend upon the thickness of the base metal to be welded. Some ratio is maintained between the base current and the peak current in such way that the arc is stable enough. Lower heat is also generated so that solidification of the weld metal can take place during this period. Peak current is generally set at 150 ampere 150 to 200; 200 percent of the steady current corresponding to the conventional TIG process for the same base metal.

So, the peak current is normally 1.5 to 2 times of the current. It is normally used by the conventional arc welding process for welding of the same metal. So, the higher pulses of the high current can be provided to make sure that very quick melting takes place with the dipper penetration at the same time followed by the high solidification rate during the base current period. So, this kind of the pulsing helps in re finding the gain in structure and improving the properties of the weld joint.

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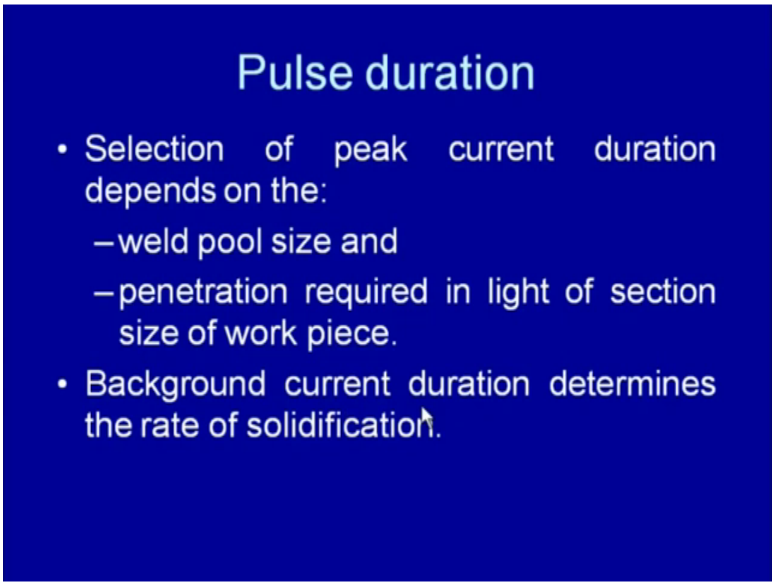


The selection of the peak current duration depends on the size of the pool. We want normally, large size pool is required, and the greater peak current. So, increase in peak current duration in general, increases the weld pool size and the kind of penetration that we want. So, the higher peak current duration, greater will be the penetration. So, the peak weld pool size requirement and the penetration requirement govern the pulse current duration. Further, background current duration determines the rate of solidification background current is very long. Then, the solidification rate will be very high. Under those conditions, there will be possibility to have all the very refined structure. But, the gas in trap and possibilities will also be high. That will in turn lead to the gas defects like the polar cities.

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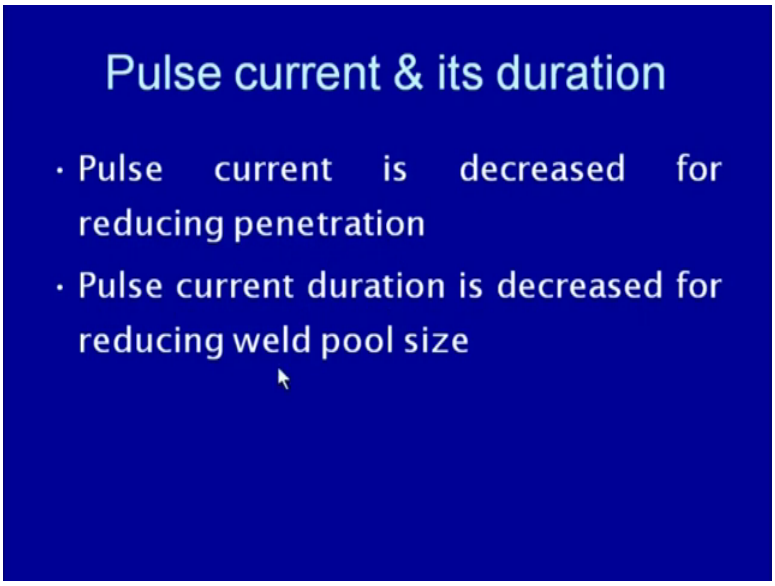


The pulse current is decreased for reducing the penetration. So, if our purpose is to have the lower penetration, mainly lower pulse current. It means the peak current value is decreased. The pulse current duration is decreased for reducing the weld pool size. So, there are two aspects which will affect like the pulse current will be affecting the penetration the weld pool size. So, the value pulse current that is the peak current will be determining the penetration.

Its value is decreased for reducing the penetration. On the other hand, the pulse current duration is decreased for reducing the pool size with the pulse current is for the longer duration. Obviously, it will be generating more heat and in turn, it will increase the weld pool size. Therefore, for reducing the weld pool size, the pulse current duration is decreased.

So, what is the role of the current pulsation? If we try to summarize, the pulsation of the welding current facilitates the welding of the thin sheet by using the very low heat input. We know that high is heat generated only for low duration, very for short duration. The weld pool solidification is facilitated during the base current period. So, if the cycle of the peak current and the base current continues then, using the very less heat input, we can successfully weld the thin sheets without melt through problem. Therefore, the pulses of the weld current facilitate the welding of the thin sheets.

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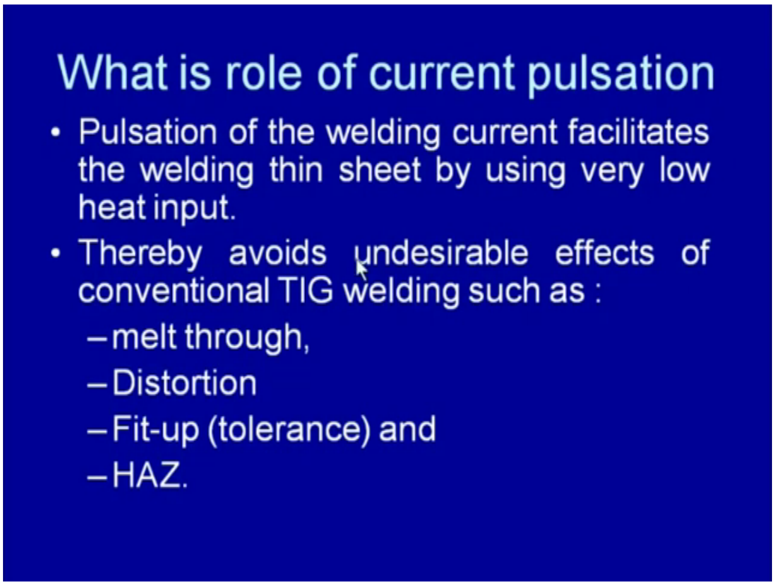


This is because of very low input capabilities. Therefore, it helps in avoiding. This particular feature of ability to provide the low heat input helps in avoiding the undesirable effects related with the high heat input. It is normally associated with the conventional TIG welding in this process. The constant value of the current is continuously supplied. That in turn leads to the high heat input to the base material especially in case of the thin sheets. So, high heat input during the welding of the thin sheets causes the problem of the melt through, distortion, fit up problems and the wider heat affected zone.

We know that if the excessive heat is supplied then, the base thin sheet will be melting immediately. Whatever molten metal generated, that will fall down during the welding. So, that melt will be leading to the defect in the plates being welded. Similarly, high heat generation will be causing the differential expression and contraction and the plates being welded. Due to the poor rigidity and the thickness of the thin plates, they will have tendency to be at trapped and the start in the different ways.

Similarly, there will be problem of the fit up. It will be difficult to control the tolerance. The heat affected zone will also be wider because of the excessive localization of the heat up to the greater distance. In case of the thin sheets, it will be leading to the development of the wider heat affected zone. So, under what conditions the pulsation, we can use? What kind of the spots are there? How is the heat generated in the pulsing is done?

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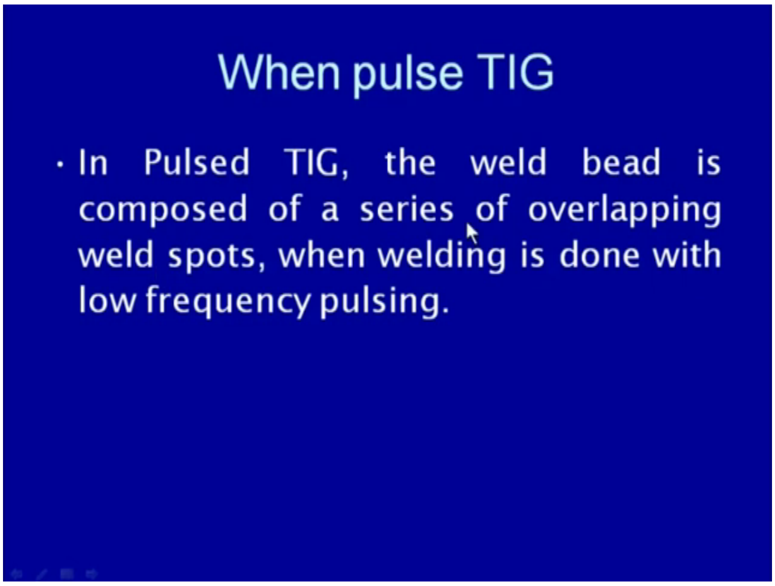


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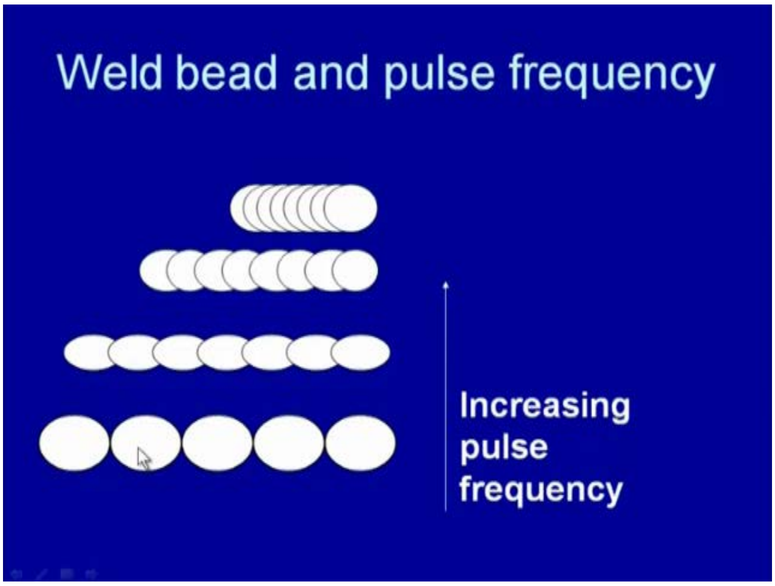


In pulse TIG process, the weld bead is made. We will see that the bead is composed of a series of overlapping weld spots. When welding is done with low frequency, these effects can be very clearly seen in using this diagram. If we see that, the peak current is coming up into the picture.

After certain interval of time especially, when we are working with very low pulse frequency then, the peak current is there at different interval of time. We will be able to see that the heat generated is developing the spots like this is the situation, when very low pulse frequency is used. If we increase the pulse frequency then, the heat generated will be developing the weld pool. These weld pools being made will be overlapping to each other. If we further increase the pulse frequency then, this percentage of the overlap will keep on increasing.

We will be able to see that the continuous weld pool is being found with the some degree of the overlap. So, if the pulse frequency is increased, the peak current will be generated at very short intervals. It will be developing the weld pool and making possible to solidify quickly at very short interval of the times. So, in the increasing in pulse frequency, we can see that the time after which heat is generated; lot of heat is generated and reduced. We will be getting the continuous, almost very fine with the great overlapping of the molten weld areas with each other.

So, increasing the pulse frequency obviously will be increasing the heat input to the base material. But further, overlapping will also be increasing. It has been observed that when we work with the low pulse frequencies, the effect of the and the pulse TIG welding is found more on the structure and on the mechanical properties as compared to the situation, where high pulse frequency is used. When we work with high pulse frequency, in that situation, we will see that the pulsing takes place very frequently for long. We get almost just like the weld being developed using the conventional welding without pulsing.

In conventional welding also, the current is pulsed at the rate of the say 50 hertz or the 60 hertz, where current magnitude value is varying in sinusoidal manner; value passing through the 0 and the maximum values. So, the pulse frequencies up to 10 gives much better results as compared to higher pulse frequency. So, if we want to see, we have seen that in the pulse TIG welding, the current varies between the peak current and the base current and the duration for which the peak current remains is designated as T p.

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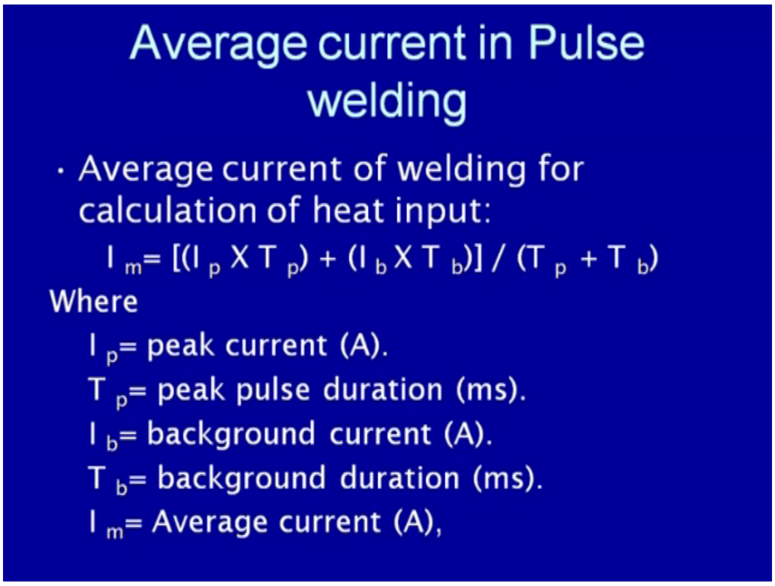


The duration for which base current remains the termed as I b. So, if we want to average out what current actually for the pulse TIG welding works for determining the heat input during the welding, we need to find out the average current value under the pulsing conditions. This is where pulse current is varying between the base current and the peak current for the different durations. So, to find out that, we can use this formula where the I p into the T b plus I b into the T b. So, we can recall it again. I that is the mean current is equal to I p into the T p, that is the peak current into the peak current duration. It is the pulse duration plus I b base current into the base current duration divide by T plus the T b.

This is the total cycle time, which combines the pulse current and the base current duration. So, here we can say that I p is the peak current in amperes. T p is the peak current duration in milliseconds. I b is the background current ampere. T b is the background duration milliseconds. Here mean current that is average current in ampere, this equation can be used for determining the average current so as to calculate the heat being generated during the welding when the current is pulsing between base current and the peak current. So, to see that if we are supplying the heat in interrupted manner especially, when there is pulse current, there is not much heat is generated when the there is a base current

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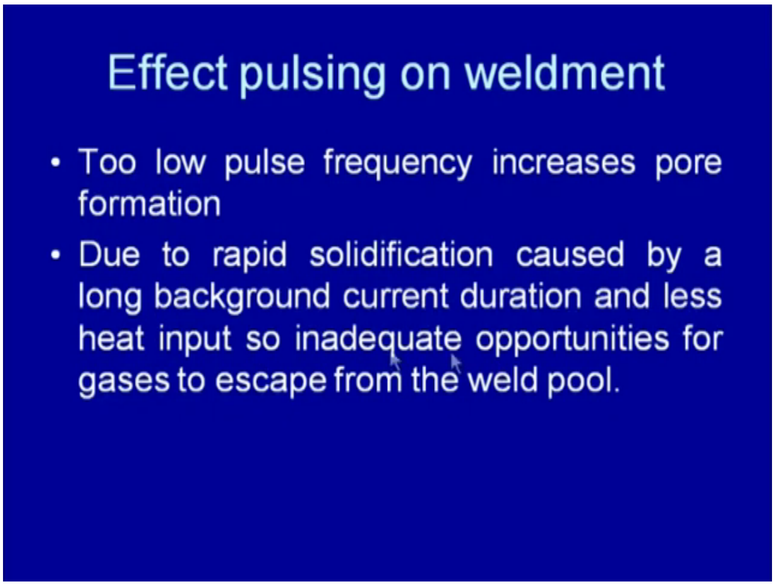


So, the low frequency helps in effecting the desired macro structure. The kind of the soundness of the weld joint, which is formed in so low; as I said low pulse frequency will be developing the heat very less during the welding. This is because of peak current will be there for the shorter duration and the base current will be there for longer duration. So, but the too low falls frequency means very less heat input and very high heat and very high cooling rate will be experienced by the weld metal during the welding.

This in turn will increase the tendency of the polar city formation. Due to the rapid solidification caused by the long background current duration and less heat input under the conditions of very low pulse frequency lead to have the inadequate opportunities for the gases to escape from the weld pool. This in turn leads to the development of the gases defects in weld metal. Further, low pulse frequency also the affects the structure in the mechanical properties of the weld joint like a fine grained structure can be achieved in the both the cases.

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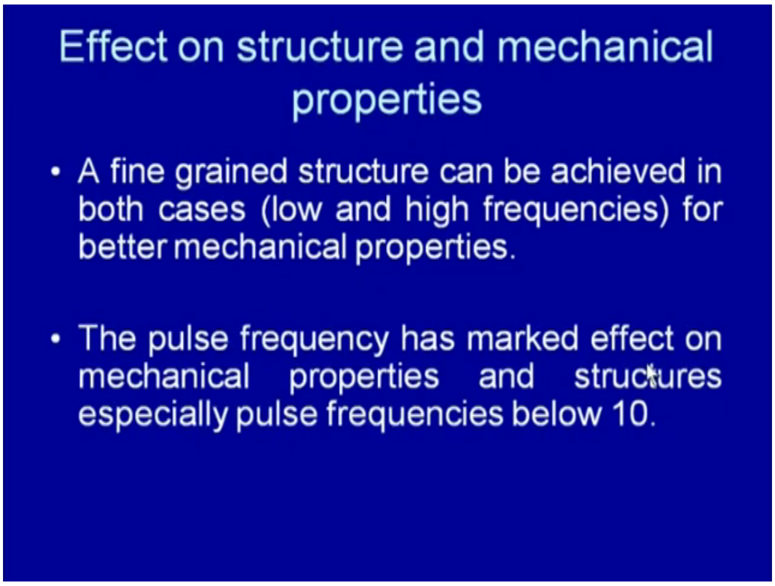


When the low falls frequency or very excessively high frequency is used for the better mechanical properties, the pulse frequency has marked effect on the mechanical properties and the structures especially, when the pulse frequency is below 10. Now, we will see another variant of the tungsten inert gas welding process, where the preheated the filler wire is fed in the arc region. So, the melting can be achieved at higher rate. The weld can be made at the higher speed. For this purpose, one variant of the tungsten inert gas welding process or the GTA process is the hot wire tungsten arc welding process has been developed.

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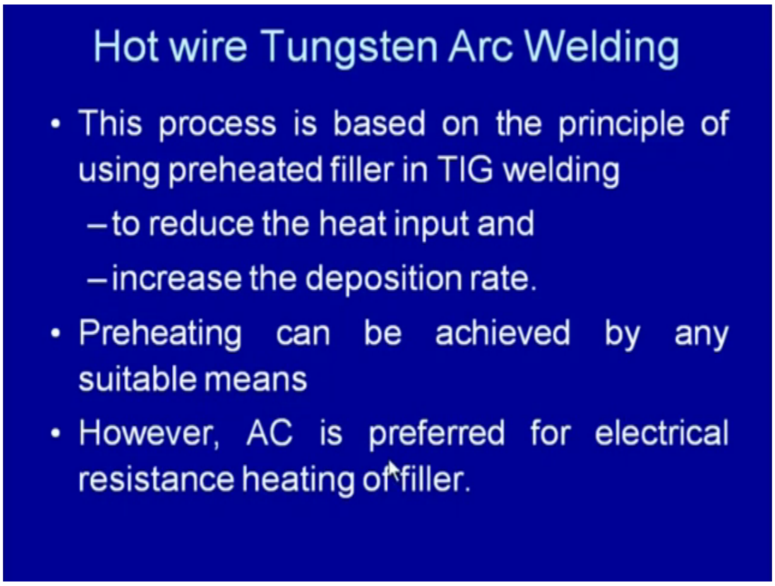

In this process, this process is based on very simple principle, where very preheated filler metal is fed in to the arc zone during the welding. So, this preheated filler metal helps to reduce the heat required for the melting of the filler metal one and another is that it increases the rate of deposition. So, increase in deposition rate helps in increasing the speed of the welding. This preheating of the filler wire can be achieved by any suitable means. This can be the electrical resistance heating. Any external method heating method can be used for this purpose.

However, this preheating of the filler wire electrical resistance heating by supplying the AC is commonly used because when DC is used, sometime it causes the problem of the arc blow. So, if we compare the kind of deposition rate which can be observed by the hot wire GTAW process and the conventional GTAW process.

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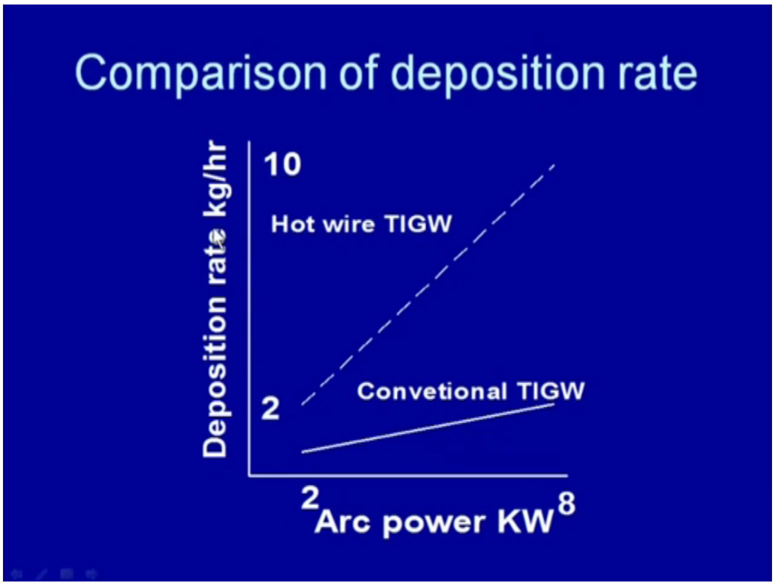


Then under identical the welding arc conditions for the given arc we can achieved the much higher deposition rate by the hot wire GTAW process and this becomes possible because the lot of heat required for melting of the filler material is reduced when the hot wire GTAW process is used. Because preheated wire requires very less amount of the heat from arc which is being generated during the welding and because of this, the melting rate of the filler wire becomes much greater than that of the conventional GTAW process.

The higher melting rate of the filler wire facilitates in having the higher deposition rate by the hot wire GTAW process as compared to the conventional TIG welding process under the identical arc power conditions. In generally, if we can see that with the increase of the arc power helps in increasing the deposition rate, but the increase in arc power causes significant increase in the deposition rate especially when we are using the hot wire GTAW process.

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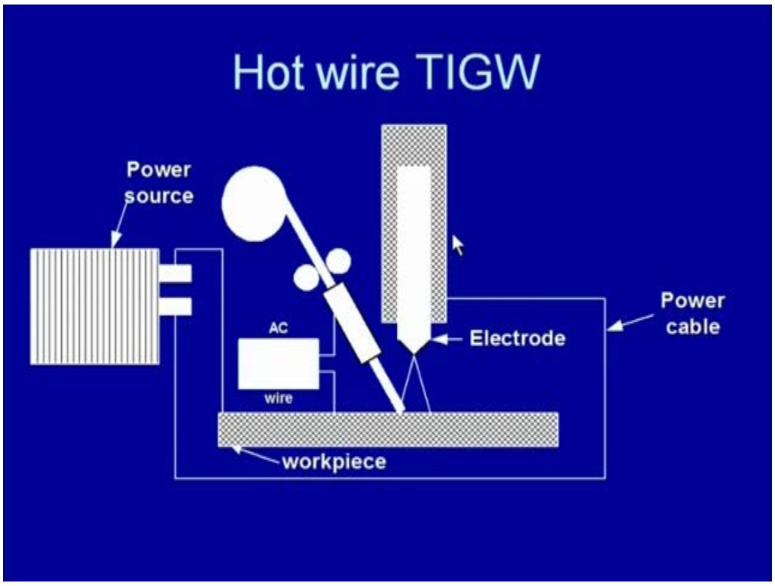


So, this is a schematic diagram showing that here the tungsten electrode and the tungsten electrode is connect to the power supply. There is an arc gap. The hot wire preheated wire is fed into the arc zone for the melting purpose. So, the preheating of the filler wire is done through the electrical resistance heating. For this purpose, AC is normally preferred. So, the current is supplied to the filler wire so that by electrical resistance heating is it is preheated.

Then, it is fed into the arc region so that it can be brought to the molten state. It can be supplied, where it is desired. This is how it helps in having the higher deposition rate during the welding and achieves the higher welding speed. For the preheating purpose, AC is preferred over the DC for the preheating of the filler wire so as to avoid the tendency of arc blow.

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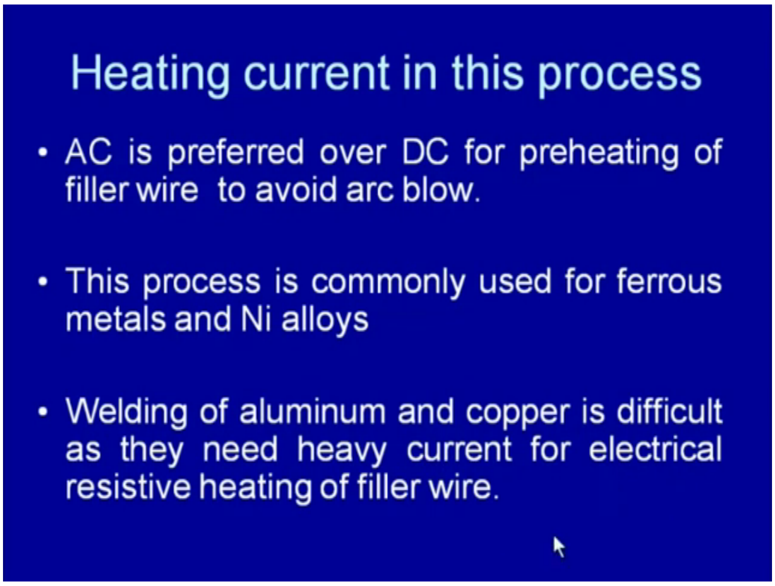


This process is commonly used for the welding of the ferrous metals and the nickel alloys the welding of the aluminum and copper is found to be difficult by the hot wire GTAW process, because it requires lot of current for the heating by the electrical resistance heating principle. So this is the last portion of the GTAW process, where we have seen the two variants of the GTAW process; one was a the pulse GTAW, where current is pulsed between the background current the peck current level, and the second one was the hot wire GTAW process, which is specially used for the high deposition rate purposes.

So, in this presentation we have talked about the factors that governed flow rate required for having the effective shielding using the inert gas. How can we compare the argon and helium in terms there characteristics for the effective shielding purpose? We have also seen that how can we initiate the welding arc in the GTAW process apart from these two variants of GTAW process incoming lecture will be talking about the plasma arc welding process and the submerged arc welding process. So, this is how I conclude this presentation.

Thank you for your attention.