Theory of Production Processes

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Lecture – 47
Principles of Gas Shield arc Welding Processes

Welcome to the lecture on Principle of Gas Shield Arc Welding Processes. So, in the last lecture we discussed about the principle of arc welding processes where the shielding is done by coating on the electrode.

Now, the thing is that as we discussed that when we do the shielding based on coating on the electrodes in that case there are certain you know chances that the weld may be contaminated the challenge which is there with the shielding in that fashion is that you have the chances of because every time you are going for the next pass the flux which is reacting with impurities and forming the slag. Now, that is at the top surface of the bead now, if that is to be removed every time. So, that is one of the requirement every time.

Now, if you are not able to remove it if you do the further welding in that case there is chance that it may be trapped. So, there may be flux entrapment that may lead to the poor mechanical properties of the weld bead or the joint which you have been prepared that may be affected the quality of joint may be affected.

So, in that case it is better to basically you this is the requirement that you will have to protect the weld pool. Now, the weld pool has to be protected one is by having that flux another is that why not to use the gaseous gas so that it can create one inert atmosphere around the welding pool. Now, what happens that in the case of even shielded metal arc welding there are many kind of you know happenings like weld spatter is there. So, that is likely to affect the surface finish or so.

Now, that is minimized many way when we talked about the submerged arc welding or so, but then that is also minimized in these cases the thing is that in this case the gases are used which are likely to protect that weld pool. So, that is why this was seen initially the gases which were used where now, or even now, the gases which are used mostly are helium and argon.

So, helium and argon gases normally this is they are nonreactive. So, they are basically passed at the point of the welding or in the weld metal zone or so. So, that basically covers that area. So, that there is no atmospheric contamination and the welding process goes on.

So, if you talk about the this type of process now, normally another thing which is important for this I mean betterment of the process is that many a times as we discussed that when we talk about the shielded metal arc welding in that case you have an electrode an electrode is coating with coated with the flux material and then that flux gets flux along with the metal which is there in the code that gets melted and somehow toward the end you will have a smaller length of the electrode left or because it is connected with the holder so, when their smaller length is left you have to throw it.

So, the electrode basically is working in a two way it has two purposes one is that it is a creating the arc and another thing is that it is you also working as the filler material. So, basically it was assumed that why not the electrode should be only used for creating the arc. So, you must have the electrodes which can produce only the arc and then you may have a filler rod.

Now, the thing is that since that electrode we will only be used for creating arc. So, that should be a material which must have good thermionic properties and then, but you will have to supply some gases or you will have to provide one atmosphere you know a blanket of gases which can protect this weld pool from the atmospheric gases oxygen or nitrogen or so. So, in that case these tungsten electrodes were thought to be the better material.

So, tungsten electrodes are used and in that case when we use the tungsten electrodes then it is known as gas tungsten arc welding. So, the tungsten is used for creating the arc then you are using one gas which is normally a inactive gas and inert gas so, that is helium or argon is used. Helium is lighter as you know that it is it has in lesser weight then the argon and then you will have the further. So, that tungsten will be.

So, you will have to tungsten electrodes these electrodes will be connected to both the terminals like one is to cathode and one is to anode. So, this way you will have the generation of arc and then you will have or you have single transition electrode we can

be used for creating the arc and then you are you know you are basically generating the arc and then you will have a filler material which is in the form of a bare wire.

So, this wire will be at the arc near the arc it will be melted and then the gases which are coming they are protecting it from the further contamination of the weld pool. So, when this tungsten and fluids are used for that in that case we call it as the gas tungsten arc welding. Then another variety of that is that we use the gases, but then you we also use the electrodes which are consumable. So, in that case you will have the metal inert gas. So, that is used when that is known as MIG. So, the in this case basically we are replacing this tungsten electrode.

With the metal electrode itself because that is getting consumed, but then if the principle is that you we you are using you are using the shielding gas. So, that way that protects that weld pool from any type of contamination. Now, in this case we are not using the granular flux or coated electrodes. So, we have already discussed that when we use the fluxes in that case you will have to have a lot of precautions you need to have the proper flow of the granular flux in the case of submerged arc welding or you need to have proper coating on the electrode.

Now, in that coating you will have to be very cautious you have to see that the coating is appropriate of appropriate thickness or inappropriate condition should not be kept in a wet atmosphere so that it pickup picks up the moisture. So, that when you use it for welding then that may lead to another kind of gaseous defects because it will have moisture into it. Similarly you will have when you have the use of fluxes then there is a there are chances of flux entrapment because of faulty welding procedures.

So, you know that way you need to have a. So, these are the advantages of using these shielding gases. Now, one of the advantage that is further is a mentioned is the less possibility cleaning. So, every time you are using the fluxes you need to have the cleaning of the top surfaces. So, that is basically you know one way you are avoiding that further advantage of these type of processes are that that they can be used for the similar metals many a times for hard facing as well as surfacing in these cases. So, you have the production of arc and that way you have an inert atmosphere in that you can go for the welding of even the similar metals or we can have the surfacing you know properties improvement or so.

Now, again since here you have the bare electrode which is pointed one which is focused at the joint. So, you have wide variety of joints design possible because when we talk about the either the fluxed you know granular flux use or the coated electrodes then that flexibility and that degree of flexibility is not there in those cases. So, that is why we try to see that you have wide variety of joint designs which are possible.

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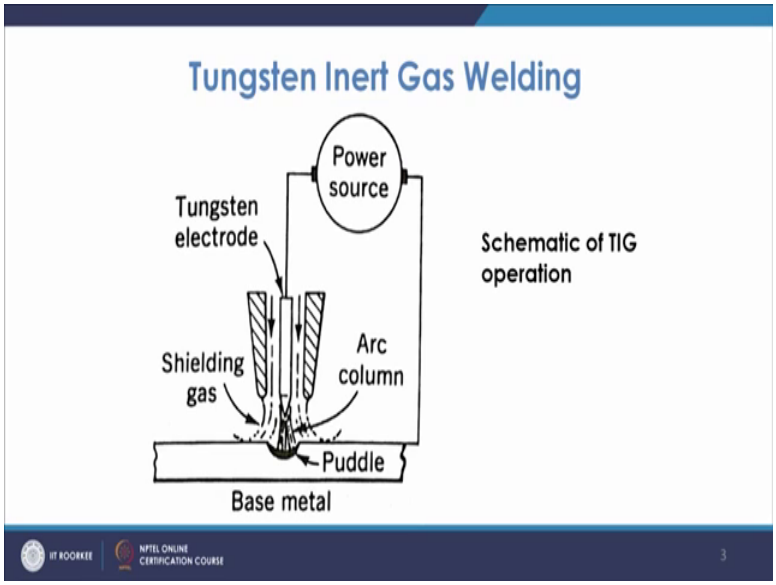

Now, coming to the variety of the gas arc welding process the most popular of these processes the tungsten inert gas welding it is also known as TIG process. So, either we call it as GTAW gas tungsten arc welding or tungsten inert gas welding process. Now, what we see is that in this schematic of this process you have the tungsten electrode which is used to only create the arc. So, the tungsten electrode we can use the DC or AC power supply.

Now, that depending upon again once we use the DC power supply system and depending upon the polarity we can see that where the more amount of heat will be generated. So, just like we talk about the DC straight polarity then more amount of heat will be generated at the workpiece and if we talk about reverse polarity then more amount of heat will be generated in the electrode and also we use in the case of this the AC also and in case of AC as we see that the cycle is changing it is direction say at one point of time you have the zero current. So, that basically at that time physically the arc is extinguishes.

So, basically what we do is there are certain modifications in the case of tungsten inert gas welding we can use the dc cycle of you know for this ac current and also further modification is that you can increase the length of the cycle. So, in the case of straight polarity you can have extended length and in the case of reverse polarity you can have shortened length of time so that in the case of straight polarity you have more heat generated at the work piece and in the case of reverse polarity lesser heat will be concentrated at or generated at the electrode. So, this way you can control that welding process.

Now, coming to this as we see here that in this case you have the flow of the shielding gas from here; so you have the that nozzle or torch so, the torch from both the sides of this electrode you will have the flow of the argon gas or helium gas which is there and if this is working to basically protect this weld pool from any further exposure to atmosphere which ultimately can bringing the gases absorption like oxygen or nitrogen which will be you know creating undesirable phases.

So, this way this tig operation is carried out. So, as we discussed you will have you will have again the chances of you know DCRP or DCSP or you have a AC high frequency. Now, it has another advantage cleansing is there in the case of if you look at the DCRP.

Now, in that case of DCRP what will happen; that the electron will be leaving from the base metal in the case of DCRP as we know that the base metal or metal or the plate or workpiece it is connected to the cathode and the electrode will be the positive one. So, electron will basically be flowing from this base metal to the workpiece.

Now, the electrons which are leaving the base material. So, you know they are I mean that way you know some of the oxides which are protecting the surface of the material. So, they are leaving that especially in the case of aluminium as we know that aluminium has a protective layer of aluminium oxide. So, that way some part is leaving.

Now, in that case the cleansing of this oxide film that will be resulting from the bombardment of the surface you know because as we know that the positive ions will move from the anode to cathode. So, they will be muddying and from this side they are going towards the cathode.

So, basically there is a cleansing of the oxide film and this is a typical you know process which occurs in the case of things which is basically beneficial in the case of. So, that is a special for the aluminium. So, basically for aluminium this TIG is the most suitable one of the most suitable welding process. Now, we will talk about other characteristics of the TIG welding process.

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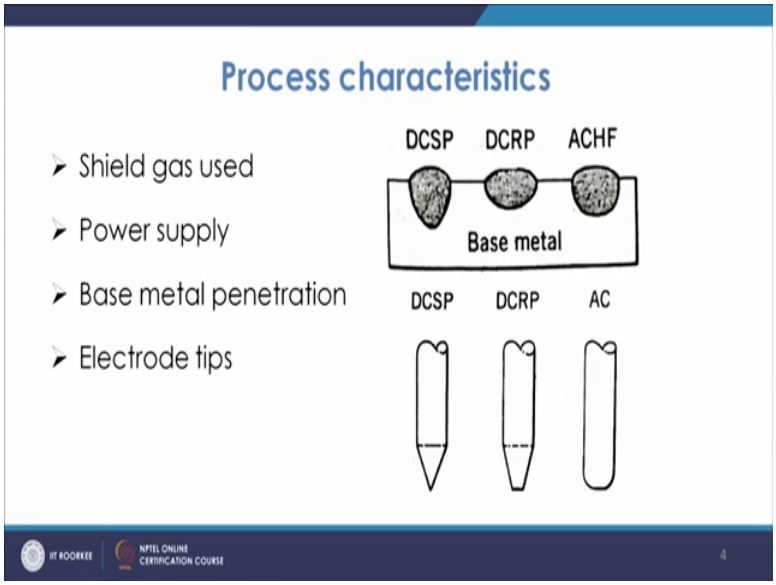

So, as we know that when we talk about the process characteristics the shielding gas used as we know that there are basically two types of shielding gases used helium and the carbon dioxide gas this argon gas and in the power supply and also because the carbon dioxide is also off let has been used in many applications because carbon dioxide is quite cheaper as compared to helium or argon.

Power supply as we discussed that the power supply will be either AC or DCSP or DCRP then you have base metal penetration as we discussed that if you talk about the base metal penetration if you see that penetration will be more in case of DC straight polarity because in the case of DC straight polarity the work will be generating the more heat will be generated at the workpiece and less heat will be generated at the electrode. So, we will have larger penetration possible.

Similarly, in the case of reverse polarity you have lesser penetration and then ac high frequency you have in between the DCSP and DCRP. So, this way you will have the control of the penetration possible by using that.

Then electrode trips a tips if you look at you see that in the case of DCSP and the electrode tip is the pointed one and in the case of DCRP as you see that there is a conical one and blunt at the top and the AC you will have the rounded type of you know appearance at the tip of the electrode.

Now, based on that you will have the different mechanism of the metal transfer you know in the case of this TIG welding. So, you may have droplet type of transfer or you may have a different way. So, that way you use these different electrode tips in the case of TIG welding.

Now, if there are otherwise many aspects of this TIG welding which needs to be studied and especially about the TIG welding setup or the designs which are normally accepted in the case of TIG joint designs in particular and then you have the design of the nozzle how the shielding gas is going to come through that all these aspects need to be studied normally in the case of TIG welding process.

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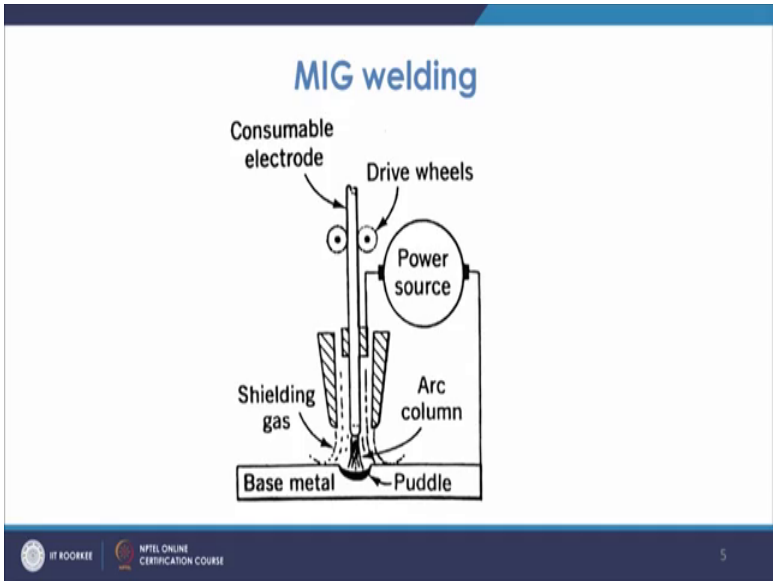

Now, next of the process is the MIG welding that is metal inert gas welding. Now, here in this case as we discussed that in the case of tungsten inert gas welding you have the filler metal which is supplied in this case we use the electrode which is self consumable and we use basically the bare electrode in that case.

So, you do not have the extra filler material, so that is basically you know seen that it is not used so, you will have the electrode which is consumed and you consumed continuously and also you have the supply of the shielding gas which is there for on these two sides and the arc column is maintained.

So, since you have the metal metallic electrode which is consumed. So, this process is known as metallic inert gas welding the principle of you know creation of arc is the same you can have the power source and depending upon that you will have different type of power source can be used AC, DC or AC or DC and the shielding gas most commonly which is used is the either helium or argon.

Now, the thing is that as we discussed that we have basically two types of inert gases helium and argon. Now, helium as we know that helium is coming in the top portion of the periodic table in the inert gases column. So, helium is basically less dense than argon. So, you know in that case more cubic feet per hour is required for the helium as compared to argon.

Now, what happens that in the case of argon you have you can use the clear voltages than with the helium because it has a lower electrical you know resistance. So, that is why these two gases have different you know properties. So, in that case it is normally suitable for welding of thinner materials otherwise these two you know inert gases are normally used.

Helium can also be used at much higher voltages. So, normally it is used in the case of consumable electrode gas welding processes and that is why in automatic MIG welding type most commonly the helium gas is used also as we discussed that more cubic feet per inch cubic feet of the gases based on that also you can have different you know characteristics of the gases which are to be used.

So, this is the aspect either I mean different aspect which are to be taken into consideration it is lightness or how much voltage is to be applied based on that you can use appropriately these two gases the.

Another type of the process which uses these gases which are basically based on this gas shielded arc welding process is the atomic hydrogen welding.

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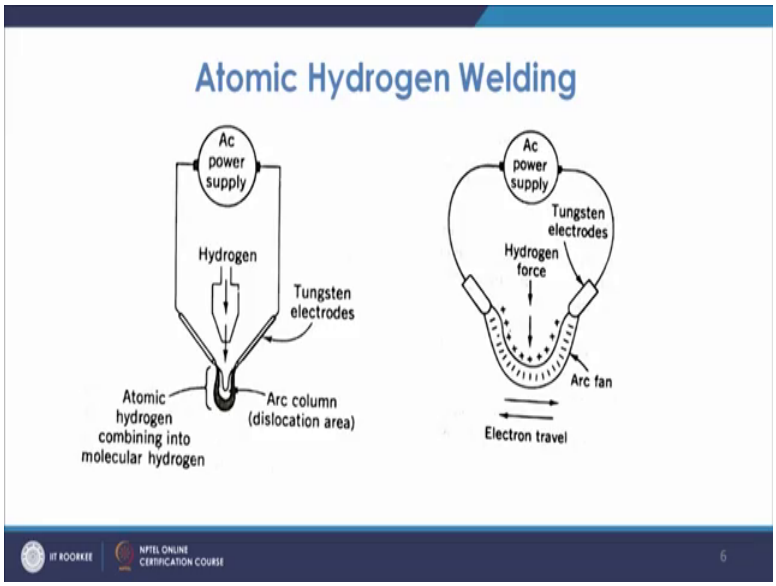

Now, in the case of atomic hydrogen welding what happens that here you have the mechanism in different way. Now, in this case what happens that the electrode will be same way produced between the two tungsten electrodes, but then the hydrogen gas is passed in between them? Now, what happens that the hydrogen molecule which passes as it comes in contact with this arc which is at higher temperature now that basically disassociates so, that breaks that hydrogen molecule into hydrogen atoms.

Now, this basically the once these hydrogen atoms are you know broken from the hydrogen molecule then again they have the tendency to reunite together because they cannot remain in isolation. So, basically they are coming to further fuse or coming further to you know re-associate and in that a large amount of heat is generated and this heat is basically used for the welding application in the case of atomic hydrogen welding.

So, as you see that as you seen from this figure that this arc fan is created as this hydrogen is forced from this side and as this arc is created this arc is they are created between the two tungsten electrodes and as soon as the hydrogen comes because of this that this arc fan is created.

Now, the shape of this arc fan can be controlled by many methods and one is that you can have the offset of the these two electrodes or you can have the control of the welding parameters based on that basically this arc fan shape they can be you know controlled in the case of atomic hydrogen welding. So, by changing the distance between the

electrodes or by offsetting the electrodes or by changing the current basically you can have this fan in different shapes one is the different types of shapes are like you have the silent arc fan.

So, you will have the two electrodes coming and then the arc creating that is known as the silent arc fan then similarly you have the when the arc will create like the small one this one. So, that will be like a standard type of manual arc fan and similarly you will have also the automatic arc fan which will be projecting little bit downwards. So, that is known as automatic arc fan.

So, basically depending upon the different way these electrodes are used you will have different type of arc fan which can be you know achieved which can be made and do the welding process. So, what we see that in this cases of these gas tungsten or MIG welding you will have the process variation like you will may have the use of different shielding gases you will have the use of different power supplies and then this way this is one of the most versatile type of process if you talked about even the shielding gas used.

So, as we are discussing that in the case of use of the shielding gas now, normally because the larger cubic feet per hour is required for you know in the case of helium. So, being the lighter one. So, you know in the case of helium greater weld speeds are basically possible. So, this way your there are more you know larger will speed is possible because it is being lighter more cubic feet per hour is possible. So, that way you may have the larger welding speed it is possible.

Basically, it is when we use the helium as the inert gas and if you use the argon as the inert gas so, basically with helium you can have 35 to 40 percent faster rate of you know welding can be done when we use for this helium as the inert gas. Now, we also do many a times mix these gases to one to other so that you can have the different combinations of because one of the gases are at different costs.

So, that way you can you know mix them and then you can go for optimizing the cost of these gaseous shielding I mean for shielding purposes these inert gases. Now, as we discussed in the past that even carbon dioxide is one of the very favourite shielding gas which is used for welding basically the ferrous metals because of it is quite large inexpensiveness. So, it is quite cheaper as compared to the other two gasses basically it is a as cheap as one tenth as compared to either helium or the argon.

So, that is why many a times we use the carbon dioxide as the shielding gas which is there also you know we have to see that when you are doing with a carbon dioxide then the welding has to be free from the moisture otherwise that we lead to the porosity in the weld. So, this is to be you know seen that that precaution has to be taken when we use to use the carbon dioxide as the shielding material also the if you talk about the carbon dioxide you have it has the greater electrical resistance.

So, because of that the current set current setting has to be more in those cases so that is one of the factor which is to be kept in mind that because of the larger electrical resistance your current setting has to be kept at higher level maybe 20 to 30 percent of higher which we use as compared to in that in the case of helium or argon. So, that is another factor which is to be taken into account when we use this you know carbon dioxide as the shielding gas.

So, this way other inert gases which are used for the shielding are also like nitrogen oxygen or hydrogen. So, basically nitrogen will be you know many a times we use this nitrogen for mixing or the carrier gas with a very small amount of nitrogen used. So, that is normally used as the mixing or the carrier gases very small percentage of the nitrogen and similarly oxygen also is used to very small percentage of maybe 10 percent or so otherwise that may lead into the porosity in the weld and many a times you have the mixture of carbon dioxide and oxygen and argon normally which are used for the welding of mild steel or so.

So, nitrogen content you know that is also to be you know controlled similarly you will have the argon and mixture of helium or so. So, that way you will have the combination of these you know inert gases which do the shielding of the weld pool. So, basically all these are the different operating variables which are to be controlled and depending upon the criticalness of criticality of the component or type of material which is to be welded we use the different operating processes operating variables or so.

This is about the gas based arc welding processes where is the shielding is done with the; so, gas shielded arc welding processes we will talk about the different other welding processes and its principles in the next lecture.

Thank you very much.