Welding Processes
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Principles of gas tungsten arc welding
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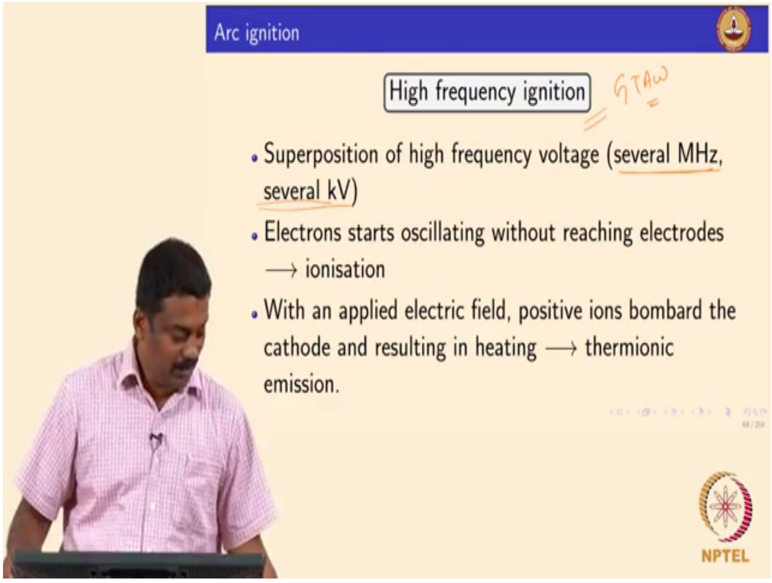

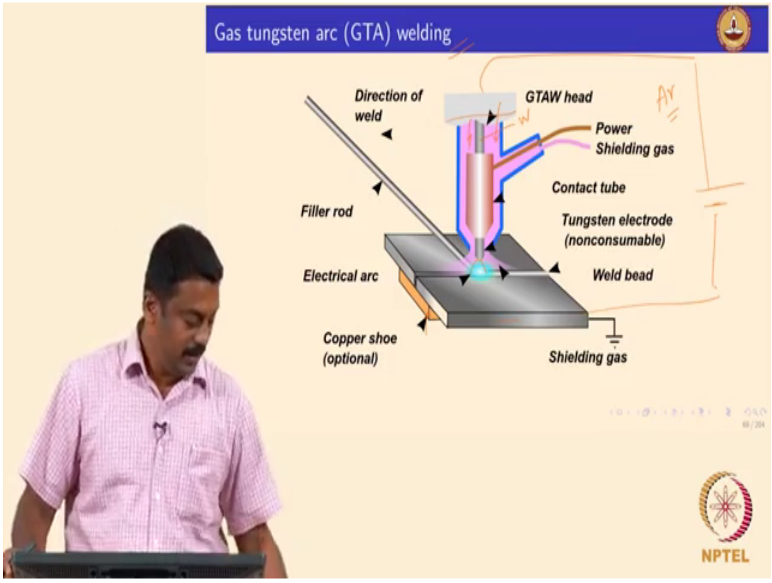

Okay, now will move on to the main process, the gas tungsten arc welding so we look that the physics of arc and we ignited the arc, now we can weld right, so if you look at the gas tungsten arc welding, it is one of the simplest processes, so all we are to do is we need to ignite the arc and then we can weld, so will have in the setups, so this is the base material okay, so sometimes we also use an copper backing plate, backing plate to conduct the heat effectively and you have tip, ceramic tip and this is your tungsten electrode and then you pass a shielding gas and shielding gas goes in the air and then this is a tip of electrode and it form and arc right.

The most of the cases that shielding gas is argon in gas tungsten arc welding okay, sometimes we use organ, helium mixtures okay and this is a contact to you which actually shield, where the main the electrode and then assemblies are molten and then these are connected to a power source okay it is clear.

So it is very simple I just brought this the contact tip set up, so basically this is tungsten electrode, the red colour here means a lot okay, so this is painted with the red is not it, so rad means disoriented, it contains 2% thorium oxide, so we use lot of colour scales, can be green or it can be red and we cannot write its 2% oriented yes right, so we generally we identify the composition of the electrode by the colour code, so if it is red in the top is 2% thorium oxide containing tungsten okay.

So will look at when you are looking at it, so we just have the setup something like this, so we have a this is the contact tube and you have the another one, so these were the argon goes in and then comes out inside over here and then we insert it, the tungsten electrode comes out okay, so this is fixed to another assembly on the top that is it.

So now we need to pass a current between the electrode and the base material and you send a shielding gas, you strike an arc simple is not it, yes in gas tungsten arc welding, again either process characteristics that are all determined by the shielding gas and the current and the voltage is not it, so we looked at the heat generation itself is governed by the electric field E is not it and then shielding gas we determines the number of electrons and ions percent, so that is what we looked at the electric conductivity of arc is not it that the two important fact as that we can influence is number done of electrons and ions that is determined by temperature and the shielding gas right, temperature we cannot control but we can control the shielding gas carefully.

So that NI and NE can be changed right and then E the electric field itself that you apply, so by changing this two we can also change the heat generation in the arc right is clear good.

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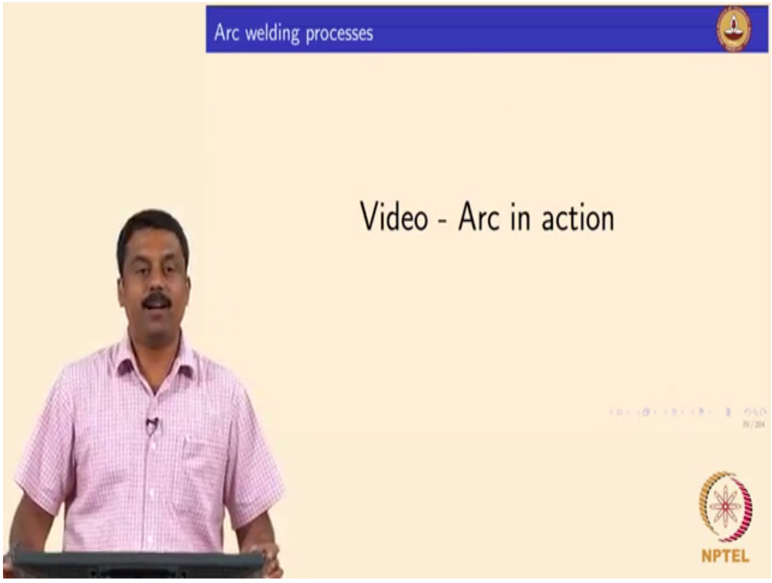

So we look at the video in arc yes, so this is our tip of tungsten electrode what is showed you and we have arc here and it is molten because of the heat generator yes clear, so know what is the polarity of this tip, come on guys, quiz question, so this would be, come on what should reach tungsten electrode, electrons, ions so then it must be negative, so it is straight polarity reversed polarity, if electrode is negative there it current EN thus the straight polarity is not it, so if you make the electron reach the tungsten cathode then you have problem is not it good.

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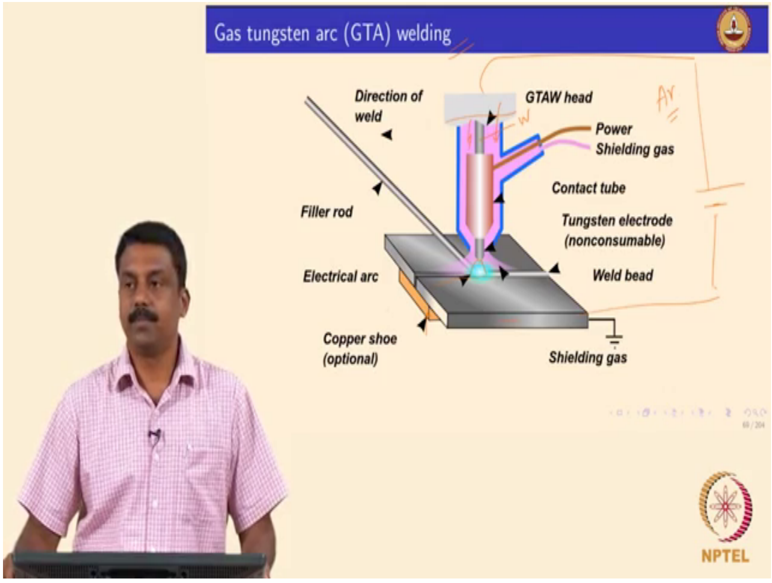

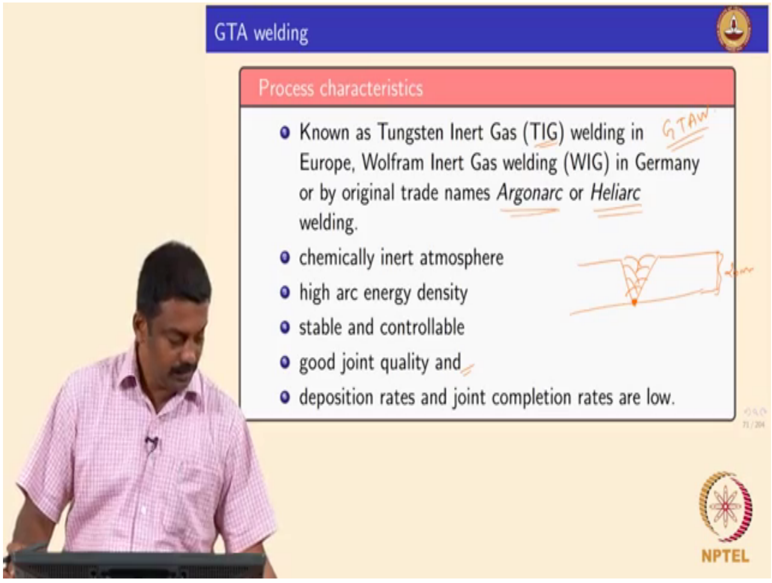

So what are the characteristics again, so one of the oldest processes gas tungsten arc welding, so the name they gave is Argonarc okay, the argonarc welding process okay and then the process they were patented in the name of argonarc or heliarc in in its original trade names and subsequently once a patent got expired then everyone started using it okay, so it is also known as TIG, the TIG is colloquial name okay.

So the scientific name generally we use GTAW, that TIG is a colloquial name like tungsten or gas welding, it is commonly used in Europe, the GTAW is a scientific name okay, so generally we do it in a using in a inert gas, so most of the cases by argon, sometimes with organ, helium mixture okay and it has extremely high energy density because we use organ and helium okay both have significantly high NS and potential okay.

So the energy density, the arc energy will be much higher than using it with the direct emic gases and the process is extremely controllable because you do not really change the arc characteristics by melting fillers right in this case the arc is very stable okay, so once you have arc, make the arc very stable your giant equality will be very good because you are not going to change the envelope, dark envelope characteristics right.

So unfortunately the pass rates are not high compared to GMAW or other processes because you know at most likely adding fillip is not it the GTAW commonly used for and autogenous welds because you just melted interface and deposit right and you can also add filler like I showed you in previous slides and this fillers are added to the arc to melt the filler and then subsequently the filler, the molten filler can feel the weld cavity, the double okay.

So because of that you know the productivity is very low but for the high precision are joints we always use GTAW and if there is no other choice okay and most of the multi-pass welds, so if you are doing a welding in a multi-pass for example thick section welds set on (())() (7:46) he need a 6 process to fill this cavity, all these the root pass, root means the first root pass is always done with GTAW, you may use GMAW or SMAW in subsequently, the root pass is always carried out using GTAW because of the process control we can achieve okay.

Because when you doing root pass that is the first joint you are going to make and you have to measure that the root pass is made correctly otherwise you will allow this is with distortion for example in proper filling of root cavity then that may influence the subsequent process but you cannot use for example it will thick sections and multi-pass GTAW because its waste of time because in order to do very slowly and you will have to fill the material and if you want to add filler with GTAW you have to fillers should reach your weld cavities as well.

So you do root pass with GTAW so once root pass is done properly then subsequently you can deposit remaining process either with GMAW or MMAW, with this the common practice generally we do it okay it is good.

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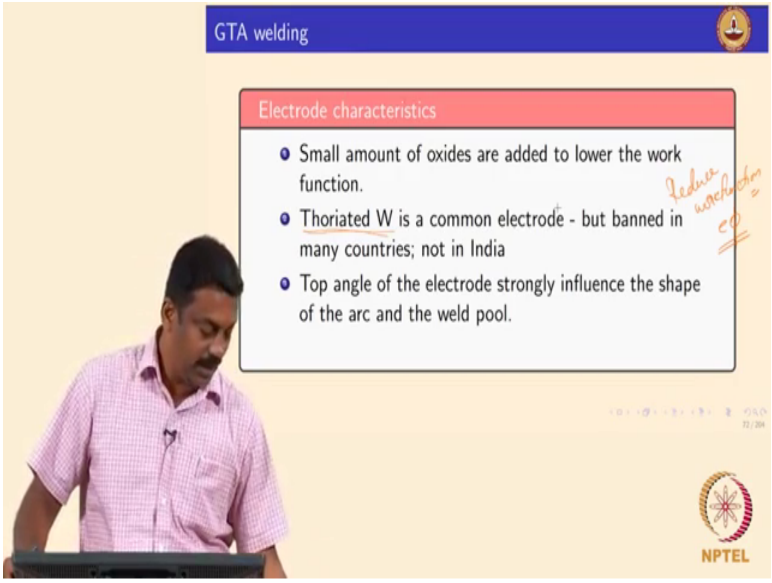

So I told you the electrode is not pure metal, you always had some oxides, why do we add oxides? To reduce what function is not it, that is what function yes, so that is the minimum energy required to knock an electron from in orbit all of metal okay, that is what function is not it, if I, so oxides they have very low function compared to the re-metals, so if you dope the tungsten electrode with a oxides, so oxides are there in surface for example an oxide can release the electrons that is why is low-temperature and once electrons release obviously they had bombard the metals surface and subsequently the trigger thermionic emission okay.

So most commonly use electrode is Thoriated tungsten and its ban in most of the countries because it is radiative and this you cannot buy in Europe but you can buy in India so this is 2% thoriated, thorium oxide containing electrode and unfortunately this gives the best arc okay, so the thoriated electrode because of the work function is solo and it emits electrons sustain manner for and in with and very low electric field.

So unfortunately now we cannot buy this very easily because of the thorium oxide we dope it, thorium oxide itself is very difficult to get, so these are expensive now but we also use other oxides.

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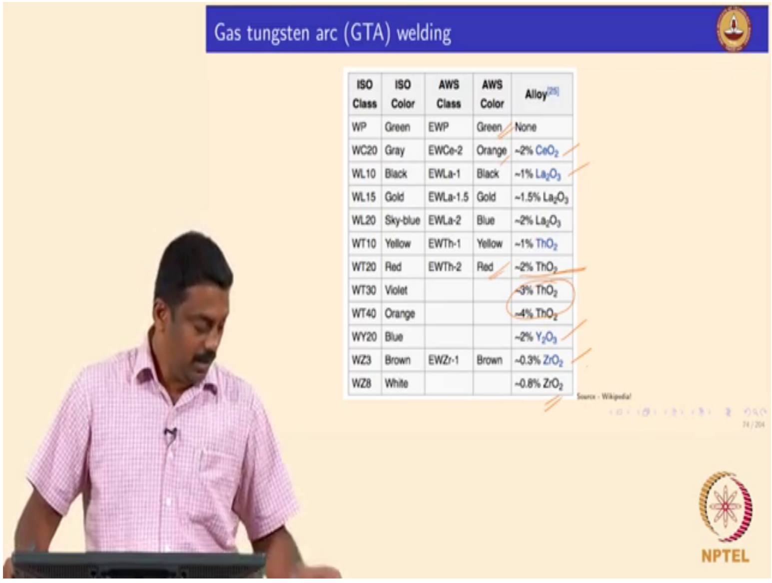

For example Cerium oxide and Lanthanum oxide and Yttrium oxide and Zirconium oxide okay, so one I have here is this guy red label its 2% thorium oxide and training electrode, so in most of the cases by looking at the colour label at the top we can identify the composition of the electrode okay, so we are doing welding specially under material welding for example you are replacing electrode and he will not be have time to read then most of the welders you know, they have all not highly skilled, highly educated but they are very highly skilled.

So in most of the cases we are trying them by this colour codes and standards okay, so for example you may say the green electrode gets pure tungsten okay, so if it is orange label its ciliated, cerium oxide containing electrode are black, gold blue, yellow, the one I have is red, so which is containing 2% thorium oxide electrode and these are very difficult to get okay, so this guys and then blue, brown and then white for zirconium oxide yes, it is clear.

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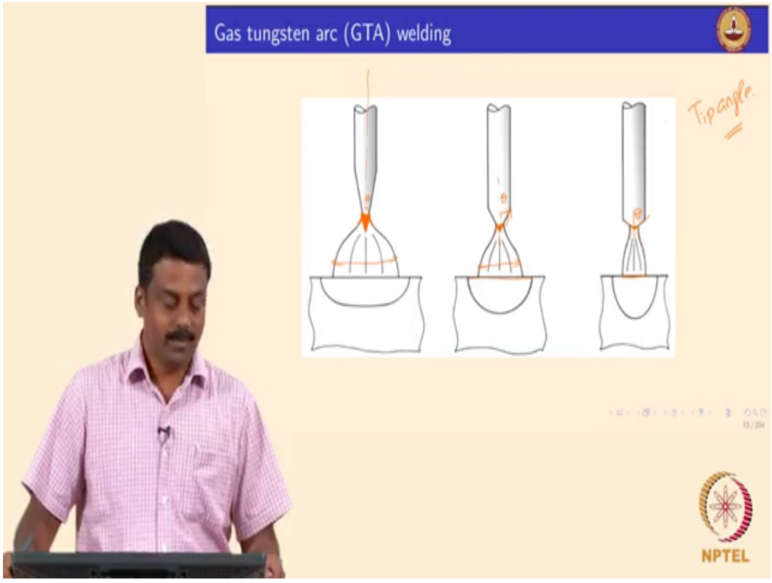

The other important characteristic of electrode is electrode tipangle, it is very very important okay, in most of the industrial production conditions and this is very significant because you may start with emissioning the electrode in the morning they were stiffed rods, so when you keep mould welding it without change emissioning the tip again, you would significantly the bid geometry okay.

So I just put three cases here and if you change the electrode tipangle you also change the size shape of an arc okay, say for example here, so suppose this is your central axis of the electrode and this is the angle theta, if the angle is minimal you have a very sharp tip is not it, so what happens here if you have very sharp tip the area on which you emits electrons are also very high because.

So this entire area can be heated up to beyond its thermionic emission temperature is not it and then what happens the electrons will imitate too much deeper or much larger in area in this case that means that the arc can be ignited some at deeper in the electrode, whereas in this case if this is you are the angle, if the theta is higher than in this case the area in which you trigger thermionic emission will not be as deep as in this case is not it.

So in that case you are arc envelop diameter decreases as compared to this, so you will be converging the arc, to try the converge the arc over smaller cross-section area compared to hear okay, so if you start welding it up after sometime because of the heating the electrode tip would start blunt, would start blunting alright then what happens over time if you are doing after 4 or 5 times or 6 times welding it end ups seeing the penetration increases whereas the weld with decreases right because you will start changing the arc characteristics and why that happens? Because of thermionic emission, you trigger in much more deeper, in this case than in this case and if you have an much even flatter or higher angle then your arc cross-section decreases significantly.

So you will end up penetrating much higher because heat is consulated over very narrow region, you are not changing any para meters, you keep the same electric field, same voltage, same gas, you would end up seeing the change in the weld geometry and this is the classic example, it happens in the production environment, so you start with nicely ground electrode you weld it after unknowingly you change the polarity in such a way that you will end up melting the tip or changing the electrode tipangle and you do it after 10 welds, you did not notice that that electrode tip is changed, you keep on doing it and then coming and showing me the result.

Sir I found an different weld with geometry comparing in the morning and in the afternoon obviously it will change because if you do not look at the electrode tipangle then you will also change the arc envelop characteristics and leading to changing in the brief geometry that happens because again that which point you start igniting the arc, from which point thermionic emission happens okay.

So because in this case is most likely so you will end up heating the electrode area much more deeper where as in here you will be heating only up to this for example and here even less, that is where you trigger emission from where the arc is ignited yes, it is clear, it is good.