Welding Processes
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Variations in GTAW Process

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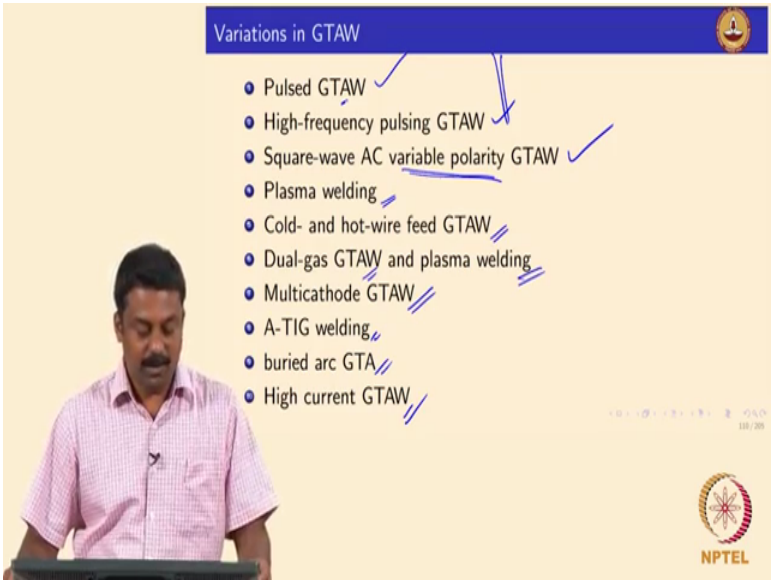

So we will move onto the variations in GTAW because we looked at all the main components I showed you, power source, welding gas, arc, is not it? So these are the three important components in a welding circuit. Now we will see how we can carefully modify these to improve the welding characteristics, to change the microstructure, to increase the productivity, okay. Or you increase, improve the geometry appearance, aesthetics. So by carefully manipulating the physics of arc, the waveforms, and also the power sources, we can improve the process stability under the weld characteristics significantly.

So we will see some variations, some improvements that happened in GTAW in subsequent slides. For example, in using a constant current we can also have pulsed current. It has its own benefit in terms of arc characteristics. We can significantly improve the arc stiffness by using a pulsed DC and we can also increase the frequency of pulsing, high frequency pulsing. And that will also improve the arcs characteristics. Again I already told about the square-wave alternating current because sinusoidal waves they are very energy-inefficient.

Since having sinusoidal current you may also have a square-wave alternating current. And you can also induce variable polarity in DC for some applications. You can use DC current to weld aluminum but because we have a complex pulse sources, we can also choose the polarity in a given cycle so that you get advantage of DC and then you also have advantage of change in polarities. And then subsequently the modification was carried out in the welding setup. For example, the plasma welding, so it is not arc welding, is not it?

So these cases, gas tungsten arc welding, but I already explained not all the arcs are plasmas. There must be critical condition to achieve a plasma state. What is that? Yeah, so you need to have welding neutrality. How do you achieve that?

Student is answering: Increasing electrons.

Increasing electrons. How do you do that? Say everything is fixed. Welding gas is fixed, or source is fixed. The setup is fixed. Can we convert arc into plasma?

Student is answering: Increase pressure.

What pressure?

Student is answering: Gas pressure.

Increase gas pressure, in what way? You mean gas flow rate. Will it change arc into plasma? No. We need one small trick to the arc, then arc becomes plasma. We will see in that in plasma welding case. So then we can also add wires, that is consumable. So you have that arc, then you free the wire, so that you meld the wire and you fill the cavity effectively. So it can be cold-wire, hot-wire and then you may also have a dual gas. So basically you use the two shielding gases to achieve platform. And then you can also, you have plasma, you have a multi-cathode GTAW and an activated TIG using fluxes.

You change the fleet flow behavior to improve the penetration and then you can also have buried arc TIG and then high current gas tungsten arc welding. So we will see the first two in this class and then we wind up quickly, alright? We will see one by one. So all the characteristics and then we move onto the next chapter.

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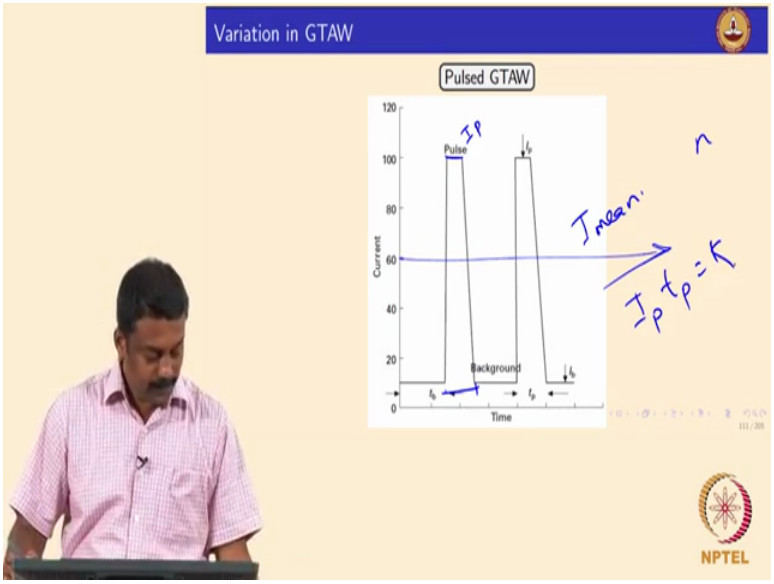

Pulsed GTAW. So why do you need that? What is Pulsed GTAW? So in this case you do not see a constant current. Instead of that you pulse the current as function of time. So it is beneficial instead of having constant current in GTAW, having a pulsed current because it improves the arc stiffness tremendously. Because you also increase by doing pulsing you also constantly change your E. That means that the acceleration, the mean free path of electrons and ions, it also changes. So when you continuously change the input, the I mean, so due to that, the arc stiffness, the arc core temperature also changes significantly.

So you increase the number of electrons which are colliding. And also you increase the number of electrons that are generated because of this collision and due to that the arc characteristic, the arc temperature, arc stiffness, arc core changes to, good, so instead of using a constant current using a pulsed current, so you can change the arc stiffness effectively. So if you calculate the I mean for this waveform, so somewhere for example, 60.

And if you apply a constant current of 60 amperes, the arc stiffness would be much lower than having a pulse. In this pulse case you are going at I p pulse current, much higher than your mean current. So in this case because of the I current obviously you also change locally the ionization in the arc, is not it? The number of n you change at a given time because you have a relationship right. The electron current in the arc, so you change the n as well, because E is changed instantly.

The moment you change, so the n as well as the mean free length L and due to that effectively you are welding at a shorter the pulse time with very high current. So you generate the electrons and you bring it down and you keep a background and then cycle it again. So that means that by in a way you are welding, you are generating the arc effectively with very high current. But you are not maintaining it. If you are maintaining that, then your heat generation also be enormous, huge. So by carefully pulsing from high current to low current background current, you modify the arc characteristics, arc stiffness at the arc envelope significantly.

So this is very beneficial. So if you use 60 amp main current, the direct Trans current and the arc stiffness will be very effective. It will be very good if you use a pulsing current. Okay. And this is possible to generate such a waveform because of the power source what we have by using switching transformers, switching transistors. I am sorry, switching transistors. We can generate such waveforms, is not it? So by rapidly switching arc, right. So we can generate pulsing.

By this process if you calculate the I mean the average, it will be much lower. But the arc characteristics are much improved greatly because of this pulsing. So essentially for a given material, so I p plus+ t p is a constant. And that is characteristic of the material, generally we choose.

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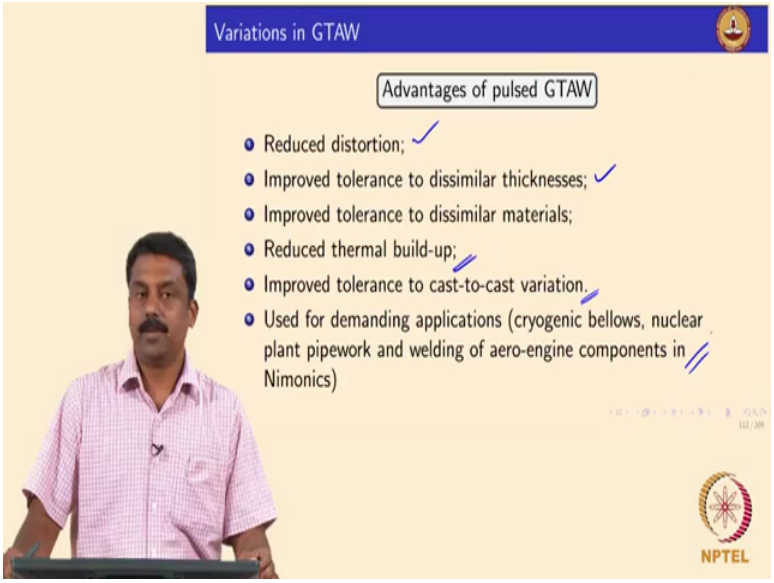

So what are the advantages of the pulsed GTAW? Because of using the pulsed current, so we can reduce distortion and improve tolerance because the arc characteristics, arc stiffness improves

significantly. And you can use that dissimilar thicknesses because of that, and dissimilar materials. And thermal buildup can be reduced because the I mean is lower, is not it? So the heat input can be decreased. And this we will talk about it a little bit later, the cast-to-cast variation.

And that can influence the weld geometry significantly because locally there could be some change in compositions. And those kinds of variations can be overcome by using pulsed GTAW. And generally this kind of waveforms widely used for very demanding applications like cryogenic bellows, nuclear plant pipelines and aero-engine components. Okay. It is good. So we will wind up.