Welding Processes

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Arc welding power sources Part 02

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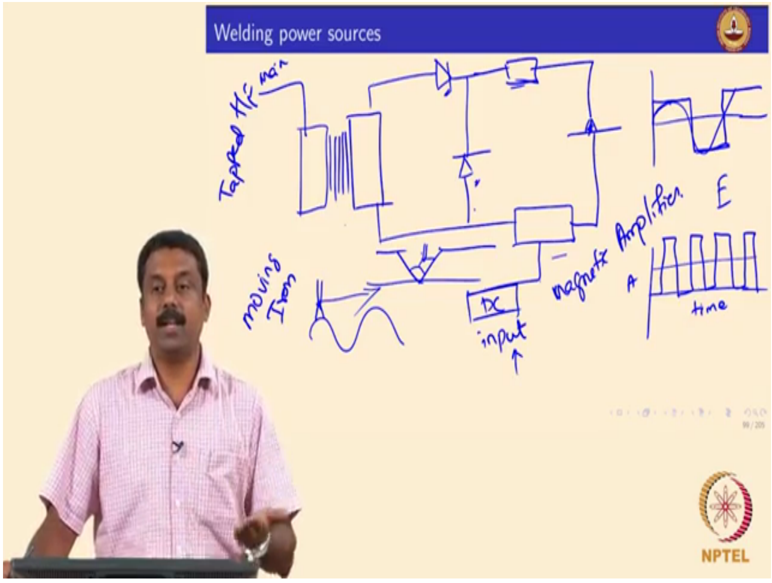

Okay, so we will continue from last class so we looked at the conventional power sources, what are the 4 types we saw? The first one was tapped transformer so in that we used taps, so these taps would regulate the output currents based on the parameter windings we are selecting. So suppose if you have transformer so we will have varying number of taps in its primary windings so based on the switches we can select the number of windings we want to use to control the voltages across the transformers.

So we will have a transformer anyway and this transformer is connected to main and then you will have an output from this transformer is given to subsequent rectifiers to convert the alternating current coming out of the transformer to DC direct current and then you will have inductor to regulate the output to the arc. So with that we can somehow change the high voltage connections coming from the main to a low voltage and high current which is needed for the arc ignition and subsequently for welding.

So the difficulty in this type of conventional transformer is regulation of the output. For example in tapped transformer so we cannot regulate the output gradually so if you select one of the switches obviously each switch would have its own power rating, suppose if it has a power rating of 100 amperes and then 10 volts, next switch will have its own defined power rating so we cannot have values in between. So the gradual changing of the output it is not regulated by this simple tapped transformer systems.

So there is some development happened so by removing the taps that we have by changing that into moving ion, okay. We looked the second power source is moving ion where you will have not taps anymore in the primary winding instead you will have a simple ion rods which can be pushed in between the primary and secondary winding of the transformer by a motor for example we can connect a motor which can go up and down in the transformer so that we can gradually change the output current from the transformer.

But there are lot of issues with this because of the heat loss and then mechanical wear and tear that happens over the time so the moving ion transformer is also not energetically efficient because you also heat up, it needs lot of cooling. So now if you look at the efficiency of these transformers they are not that great because you lose lot of power by converting from one circuit primary circuit, secondary circuit so you lose lot of power.

So people thought about it and then they invented some more modification to the output circuit so we will have a current from the transformer coming out as it is based on the transformer power rating and then we can regulate the outputs in the output circuits. So then the output circuit came with a regulator by keeping a variable inductor, is it? So the output circuit from the transformer so it goes away and instead of that we will have something like this, I will have another variable inductor and you will have arc here.

So this variable inductor so what the function of this is to regulate the output current so we will have the transformer transforming the currents from the mains and subsequently either you can convert the AC alternating current into direct current and then that output current can be regulated by using a variable inductor with the output circuit, it is possible. So that is what we have looked at in the third case in a variable inductor, the inductor is nothing but a choke it actually can regulate the voltage and current coming to the output circuit.

Again there are lot of problem because then this inductor it cannot be operated remotely so someone should be there or you need to do it manually and remote control is not possible if you want to program it for example. So then you will modify the variable inductor into a magnetic amplifier so they replace this simple inductor into magnetic amplifier where you may have an magnetic saturation controlling the output current.

So we have replaced with variable inductor into a magnetic amplifier, where you will have a primary and secondary windings same as in the transformer and you will have a saturation coils saturation magnetic coils which can be the magnetic flux density and max mass magnetization can be regulated based on the DC current because these are electromagnets that current supply we give that DC current we supply to this magnetic amplifier, if it is fully saturated that means it will not conduct current, it is saturated.

So by getting relationship between the currents, field density and the mass magnetization, then we can choose or we can vary the output based on the amount of the mass magnetization the circuit the amplifier undergoes and this case is very easy for us because we can regulate the current by say for example in this case to controlling to DC input, so DC input based on the input the saturation the mass magnetization changes. Suppose if we have magnetic amplifier works in 0 to 10 volts DC volts so 10 volts if you are sending it is fully magnetized, so it eats the saturation magnetization that means that the output stops, okay.

So because it is reached heat saturation magnetization, so recall the curve the stresses curve we thought in last class. So the relationship between magnetic field density, flux density with respect to mass magnetization the moment you approach saturation so then there will not be any output coming from the amplifier to the circuit and you can change the mass magnetization based on the input current what you give from this DC input means I give 10 volts, you give 8 volts then so obviously you will get some output because it is not fully saturated by doing so we can regulate because DC's power supply can be regulated such a way that you give defined volts to saturate the electromagnets inside the magnetic amplifier, so then the regulation is possible.

So these kind of conventional power source if you look at here the control is very difficult the precise control or the waveform what we get it these are all predefined you cannot modify that. For industrial applications so you will be welding day and day out 3 shifts 1.2 mm aluminium in AC alternating current in 80 amperes and 10 volts. So then you can predefine the power source characteristics you make your own power source based on the need with the components what I told, then it will work day and day night no problem because you need one current and one voltage for your application. So you need a constant current welding in a given voltage.

So then this kind of power sources can be tuned for that application and then regular production jobs can go continuously. Suppose if you want to play around the waveform characteristics, so you want to vary the voltage for example during welding you want to do arc length corrections, that means that you need to set the arc length constant irrespective of sample surface. That means instantaneously voltage should be changed because arc length changes that means that voltage also changes but you need to keep the current constant.

So those kind of complex waveforms requirements the conventional power source they lack these features for predefined power rating, power setting these conventional power source are very good. Suppose if you want to modify the waveforms if you want to change the characteristic of current, voltage curves as a function of the welding time, then you cannot use conventional power source.

So thanks to the invention of semiconductors and transistors, rectifiers and diode based rectifiers so lot of development has happened in a welding power source as well to introduce all these semiconductors in the power sources so that this kind of the control feedback can be achieved by introducing semiconductors into the power sources, okay so the modern power sources they moved from the conventional transformer, rectifier, invertor, the inductor based power source into a semiconductor based rectifiers or diode based rectifiers and also the transistor based the waveform regulators.

So the next generation power sources from this conventional power sources they started the power source manufacturers started to use the advancement that are happening in semiconductor industry for their own benefit to make the power sources. So for example in most of the welding cases when you are using an alternating current so it is not addressable to use on a simple sinusoidal wave because this is not really efficient waveform to use it in for welding.

So because when you are using it in such sinusoidal wave the peak current is not reached instantly but whereas peak current actually gradually increases and reaches. So this is very bad for arc characteristics the arc stiffness so (when you are achieving) when you are trying to get peak current you should reach it at instantaneously and then maintain it such on a some value so that you know your arc stabilizers.

So if you have a sinusoidal wave then the arc stability decreases significantly because the E we talked about in the equation it is constantly changing. So the stability of the arc reduces significantly when you use sinusoidal wave. So we will have to have some mechanism to make sinusoidal waves into square waves, in some applications square waves apart from square waves we may also have a pulsing.

For example you may not use a constant current DC, instead of that we may also have the pulsed DC, well lot of benefits in terms of arc stiffness and arc stability we can achieve by using pulsed DC current, we will see in this class how it is advantageous. So if you want to have a pulsing which we know that it can improve the arc stability significantly so these kind of complex waveforms cannot be generate by the conventional power sources because what we have it is all electronic unmechanized system which cannot give you the pulsed current or square wave current or if you want to keep the current constant over time or the voltage constant over time it is very difficult with the conventional waveforms the feedback control is also not possible.

Suppose if you are welding a complex geometry say a wavy surface something like this and you have GTA torch making an arc. Suppose if you are welding if you are trying to move the GTA torch along this direction, then you have a problem with conventional power source. So obviously so this is not a flat surface. So this kind of situation can happen if you are using multi pass welding in GMAW.

So if you have multi pass welds so you will have so one pass and the other pass maybe praising like this and you need to weld it if you want to weld it in a constant arc length so then you will have to have a feedback mechanism where the power source can predict immediately the change in voltage, then it can adapt itself so that you maintain in a constant voltage if you want to know constant voltage current in (GMAW) GTAW.

So this kind of feedback control and adoption is not possible with conventional power sources. Therefore, the advancement that we have had in power sources by using semiconductors and transistors and microprocessors they made our life the welders life very easy because we can improve the arc stability you can take a benefit of these advancements in microprocessor technology, we can also change the metal transfer characteristics and weld pool behaviour therefore, the metallurgical and mechanical properties.