Finite Element Modeling of Welding Processes

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Lecture - 34
FE-based modelling approaches

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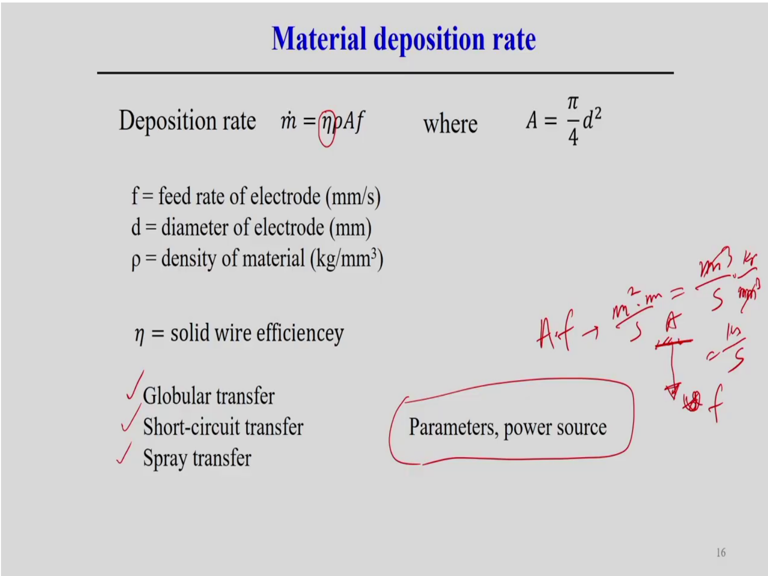

Hello everybody, now last class we are discussing about the different kind of the metal transfer mechanism associated with the gas metal arc welding process. So, objective was to analyze this kind of metal transfer thing is basically for the development of kind of a metallic printer or we can say that kind of additive manufacturing technology. So, some sort of understanding of the different kind of the metal transfer is required.

Now, we try to look into the different aspect say what we can develop the model on metal transfer model the that is actually very much focused to the gas metal arc welding process or maybe we can say that exclusively gas metal arc welding process or the other welding process associated with some kind of the metal transfer.

So, we know this metal transfer mechanism is actually very much complex in nature and the development of all the physical phenomena occurring during this particular process is very difficult to develop one model. Rather we can look into the different aspect physical aspect associated with this during the metal transfer part and then how we can model them looking into the dividing the different zone. And accordingly we can make some kind of the modeling approaches we can follow, that we will try to discuss here.

So, before doing that some overall idea that how this metal transfer is normally happen in gas metal arc welding process. So, it is a simple way we can represent this thing there is a continuous feeding of the wire arc. So, continuous feeding of the wire and there is a generation of the arc and then basically it follows some kind of the feed rate.

So, this feed rate is continuous in that assuming that is the continuously and this particular phenomenon we try to capture to develop in develop the model in terms of the, what are the temperature distribution? What are the flow field associated with the either the metallic component or either in the case of the in the within the arc also.

And even within the field that shielding gas flow rate or flow field is possible to estimate using the modeling approach. So, definitely once we look into this thermal analysis and this material flow these particular cases we have to solve we know that governing equation, particular governing equation along with interface capture or basically interface methodology has to be look into this thing for the development of the model.

Now, material deposition rate simply we can estimate the deposition rate m dot equal to the efficiency term is there you can see this is the efficiency term and the density of the material and the cross sectional area, cross section area means normally you can estimate the what is the deposition at which in terms of the volume flow rate or in terms of the mass flow rate.

Now, when you try to look into this mass flow rate or volume flow rate, in these cases first we try to look into the volume flow rate then the velocities suppose feed velocities particular direction is this one. So, or maybe you can say that f is the feed velocity feed in the particular direction, but normal to that direction what is the cross sectional area that has to be considered here. So, this cross section area assuming the diameter of the wire is d small d. So, cross sectional area equal to pi by 4 d square.

So, then cross A equal to pi by 4 d square. Now, if we assume the feed rate of the electrode is some unit is say millimeter per second and diameter is the length basically in terms of the diameter of the electrode the length unit, that is millimeter in this case and for example, density of the material is this.

Now, we know A into f. So, that indicates basically millimeter square into millimeter per second. So, it is basically millimeter cube per second. So, this is the volume flow rate. So, volume flow rate when you multiply by this density then it becomes mass flow rate. So, density for example, here say kg per millimeter cube. So, it becomes kg per second. So, this is the mass flow rate simple calculation we can do.

But we can use the solid wire efficiency term because in this case there may be some kind of the we can loss we can account here also and that in terms of the efficiency. Now, we have already discussed that this is the globular kind of the metal transfer may happen and short circuit metal transfer may happen, spray transfer happen, but of course, whatever metal transfer mechanism involved we it is always that we try to keep that there is a continuous feeding of the wire.

So, continuous feeding of the wire, but mechanism of the metal transfer can be different it can be globular kind of transfer, it can be short circuit transfer, it can be the spray transfer also or even it can be the pulse rate transfer kind of the metal transfer mechanism may involved.

Now, of course, this metal transfer all actually influenced by the what are the different parameters, we use in this cases and what are the power source characteristic is a continuous or pulse all these cases the metal deposition rate depends on the, even if we try to handle the for example, there is a pulse current supply in case of the gas metal arc welding process.

So, in that cases we everything we can do all this calculation based on the average power. So, if based on the average power we can estimate what is the average power because average power is equivalent even is a pulse condition also, the average power is equivalent to the their continuous mode of wire.

So, therefore, for a pulse current application we can estimate the average current and based on the average current we can estimate all these kind of parameters, all this calculation deposition rate can be done in case of pulse current rate. So, apart from this thing, what can be the modeling approach?

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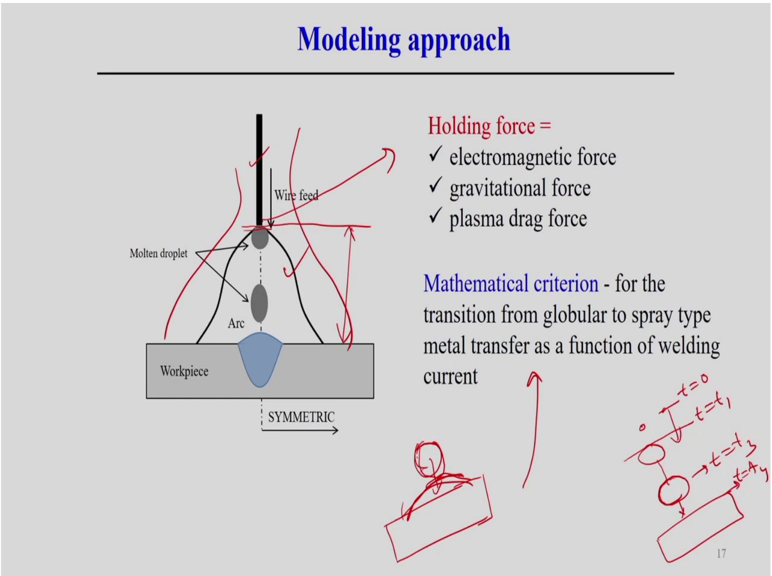

So, already mentioned this thing that transfer mechanism can be different, but this transfer mechanism can normally most of the cases we can estimate we can find some kind of the critical condition. Such that it decides the whether the metal transfer mechanism follow some sort of the globular kind of the transfer or short circuit or in kind of the spray kind of the transfer normally happen.

But that condition has to be developed looking into this thing, but if we assume there is a some kind of in general we talking about even any kind of the metal transfer mechanism in general is a simple you can assume there is a droplet transfer from where and there is a droplet is transferred the creation of the droplet. And then this droplet is transported through the creation of the arc in the field of the arc through the creation of the arc.

And then droplet becomes finally, part of the molten pool. So, it actually makes to the with the molten workpiece in this particular case. Now, point is that if there is a continuous feed rate then we in the modeling approach we assume the continuous feed rate and there is a continuous development of the supply of the droplet.

So, it is like that only we can put the condition that say for a particular situation or for unit time may be particular certain time the phenomena is something like that, there is a this zone is held constant between the electrode and workpiece and there is a continuous supply and there is a continuous melting or creation of the droplet from the electrode tip.

And such that the gap is maintained as a constant assuming this thing and there is a arc is created between the electrode and the workpiece and in between the droplets transported from electrode to the workpiece. And then this can be considered say this phenomenon is happening over a with certain frequency.

So, within certain frequency means then we have to look into the cycle time. So, we look into one cycle time and one cycle time there is a one droplet is transported from electrode to this arc this phenomena, but at the same time maybe before transported from electrode to the workpiece material there may be the possibility of the creation of the another droplet on the electrode.

So, this phenomena we try to make the model. Now, this holding force we know the electromagnetic force, gravitational force, plasma drag force is also there because this plasma this arc is created. So, we can say this actually associated with some kind of the plasma drag force.

Now, since it is a symmetric kind of phenomena if we assume this thing say the basically electrode is normal to the workpiece. So, in that situation we can assume this is the symmetric problem. So, symmetric problem only half of the domain we can consider for the analysis.

Now, this holding force and maybe this there is a one thing is that first is the what we can set some criteria at this point, that what kind of the droplet formation will be there, but this can be considered as independent of the modeling approach means what are the temperature distribution and flow field that is independent of the condition for the metal transfer mechanism associated to this particular process.

So, some sort of mathematical criteria may be needed to set for the transition from the globular to the spray type of the metal transfer and that can be represent as a function of welding current, but this can be set. So, do some kind of the simple analytical calculation we can follow and this condition and can be obtained from this particular analytical solution, so, what kind of the metal transfer there or if there is a transition from the one kind of the metal transfer mechanism to another thing.

Point is that this condition for the different kind of the metal transfer mechanism is we assume the independent of what the modeling approach or may be modeling approach means the, what we are solving the heat transfer and fluid flow phenomena associated with this particular problem.

Now, suppose is this is the actual domain of the analysis. So, now, we have to look, what are the different domains? So, you can see there are the two different kind of the domain one is the metal domain, maybe you can consider the metal domain. That means, from the electrode this we can start from this point. So, there is a starting the formation of the droplet.

Now, droplet is growing over as a function of time. So, droplet is growing over as a function of time. So, once particular size arises and there is a balancing effect of the other driving forces for the detachment of the droplet. And then one particular timing say a droplet can grow from very small to little bit bigger, but this normally happens over a finite time.

Now, then put the put some analytical criteria to detachment of the droplet from the electrode. So, that is also time phenomena now droplet detachment happens one particular time t. So, say for example, t equal to 0 and t equal to t1 with this particular time droplet is detached and say this is the workpiece, now droplet is transported. So, for example, there is a change of the shape this particular position say t equal to t3 in this particular situation.

Now, when it is touch to the workpiece and becomes part of the finally, first it will touch to the workpiece and then molten become becomes part of the workpiece metal. So, then suppose it we count t equal to t4. So, these are the at the different time phenomena we can track how the molten is that if the, this kind of modeling can be done from here to reach the becomes final part of the workpiece.

So, in that cases to do this kind of analysis maybe it is an in the form of a mathematical model development is quite complex then we have to look into. That one approach can be like that maybe we can track what are the droplet creation and the droplet is becomes final part of the workpiece material.

So, this is the one domain metal domain from the electrode tip to the to up to the transport to the workpiece. Now there is another domain also for example, the analysis something like that. So, this is the suppose this is the initial shape of the workpiece, now there is a droplet transported. So, droplet just touch into this workpiece.

Now, that means, this wants touch to the workpiece there is a addition of the mass to the domain only, which we are focusing only on the workpiece. So, then it becomes part of the workpiece and it becomes it mixes, it basically mixes with this thing and droplet becomes spread over the workpiece surface.

So, this how from that up to the from the touching point to the spread over the droplet over to the workpiece, during that time period we can make the model also even one touching through the workpiece. And then we can follow for that when spread over the workpiece and then how the solidification or maybe the cooling phenomena happens associated with this process, this whole phenomena can be captured during this process also.

But in this case definitely there is addition of the mass to the workpiece domain. So, this way one we can track how the droplet transported to the workpiece and the second part of the solution domain only on the focus on the workpiece and then we can analyze the workpiece and the that means, with the if addition of the particular droplet what may be the free profile can be obtained on the workpiece. So, this is the another domain of the analysis.

So, this way we can divide the different domain sub domains and within this different domain sub domain. We can solve the governing equation associated with this thing for example, if it is considering only on the heat transfer part, then we can solve only the heat conduction equation during this particular process maybe at the define geometry or the defined boundary interaction.

Then if there is a need to follow need to look into what are the metal flow field also then we can solve the Navier-Stoke equation of the fluid flow field we can estimate along with the boundary condition. Apart from this thing, if we want to track what are the free surface profile of the droplet as well as the when droplet is transported through workpiece, what are the free surface profile of the workpiece?

To look into this surface profile, then we have to look into some kind of the interface tracking method to understand the how the this thing the shape of the droplet or shape of the workpiece normally happens during this particular process. So, this way we can analyze this thing looking into the different domain or what kind of the governing equation has to be chosen what kind of the boundary condition has to be there that you have to look.

But apart from this thing since this particular domain under there is a flow of the current. So, definitely it is associated with some sort of the magnetic field. So, in this case maybe this whole domain is basically affected by the magnetic field this then we have to consider the magnetic we may be considered the magnetic field. For example, this magnetic field is not affected the only the heat transfer analysis, but magnetic field is it normally affects the fluid flow phenomena.

So, in that case we have we should know the magnetic field can be act as a body force when you try to solve the Navier-Stoke equation to understand the material flow field. In that cases this magnetic field can be act as a body force for the solution of the Navier-Stoke equation in this particular process.

So, in that cases the magnetic field will come into the picture. So, that is another aspect to look into, but that can be incorporated first is the first magnetic field potential equation has to be solved and from there will be able to predict what is the magnetic field in this particular process. And of course, magnetic field is basically driven by the current density distribution also.

So, then once we get the magnetic field and that can be we can consider as input as a body force for the solution of the momentum equation and that will in impact on the flow field in this particular process, so that is also there. So, there is a complex interaction of the different physical phenomena associated with these things, this is one aspect.

Another aspect is the if you see there is a arc. So, arc what are the distribution of the arc, arc is the different medium. So, different medium even we can follow the momentum equation also and we can predict the potential lines of this particular arc. The flow field also can also be possible to solve in this in the to represent the arc, only for the arc.

Now, apart from the arc there must be it is associated with we are not showing here, it is associated with some sort of the shielding gas also. So, shielding gas is also interacting in this thing. So, flow of the shielding gas can also be modeled simply by solving the momentum equation also then we can predict the flow field in case of by using the shielding gas.

Because this arc pressure and this thing and the flow field that by the shielding gas that actually influence the free surface profile on the workpiece surface. So, here this free surface profile when droplet is interacting on the workpiece material also then what way the free surface profile will be generated in this particular interaction. That is influenced by the arc pressure also at the same time the shielding gas pressure also the flow field by the shielding gas. All actually influence the free surface profile on the workpiece.

So, therefore, this analysis the separate analysis of this this distribution of the flow field in case of the arc as well as the shielding gas is also required. Of course, there is interaction of the shielding gas and this arc also, but maybe we can neglect this thing then modeling approach becomes more complicated in this particular situation.

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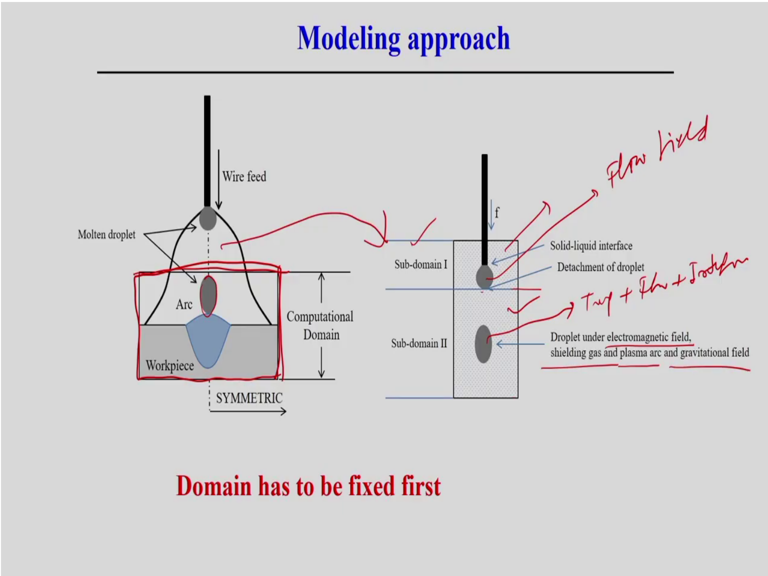

So, let us look into this thing the simplified way what we can do the modeling approach. So, already we have we explained this thing for example, wire feed rate is there, feed rate is there and for example, the one thing is that suppose this is we can consider this as a sub domain. So, sub domain is something that this is the some part of the solid wire is there and then at the tip there is a this formation of the droplet.

And then the between the electrode and the droplet there is a solid liquid interface is there. Now, this we can do a conduction analysis and this in this case in this particular domain and this domain is basically associated with some sort of the different medium and the gas medium is there surrounding this particular part.

So, therefore, up to the detachment of the droplet. So, droplet form and then grow this we can do simply the temperature analysis that temperature analysis means when it is heating the critical temperature. So, say assume the melting temperature then droplet start forming once droplets start forming then once is the liquid state then we can start within the droplet also we can start forming the flow field also.

Apart from this this temperature field we can estimate what is the flow field. Now, this flow field is influenced by the different driving forces for the detachment of the droplet. So, once you estimate the flow field using the different detachment of the droplet then we can find some kind of the condition also, the detachment of the droplet occurs.

So, once detachment of the droplet occurs then we can look into the another sub domain. So, sub domain two we can consider. So, then droplet under the electromagnetic field see droplet become under the electromagnetic field is there, shielding gas also there and plasma arc and the gravitational field all is acting and there may be some other driving forces is acting.

Now, this one detachment of the droplet happens then we can consider the this is separate domain for example, it starts at this point detachment of the droplet happens and this to before touching the workpiece up to that part we can consider the another sub domain too. So, then within the sub domain there may be change of the shape of the droplet, this is under the influence of the several driving forces.

For example, electromagnetic fields even the shielding gas environment even arc pressure also all actually act here even gravitational pressure is also there. So, therefore, what we can do in this cases we can do may be only the thermal analysis that means, temperature, as well as the flow field also we can estimate.

And then apart from this thing we can add the any surface tracking method also, such that we will be able to predict what is the free surface profile for this particular droplet. So, all these things are there. So, it is a temperature plus flow plus interface tracking method.

So, all these three phenomena has to be considered to look into the actual shape the temperature distribution and the flow of the material within this droplet that can be able to predict this thing. So, this is the sub domain two. Now, we can consider this as a this is domain one now this is the one part up to this part this is we can divide the domain one and the sub domain within the domain one that is a sub domain one and sub domain two and this other part is that other computational domain.

So, for example, this is touching to the workpiece and this touching through workpiece and there we can consider only the metallic domain, but this metallic domain is the metal domain such that will be only the purpose of this thing when touch the droplet transfer to the workpiece then what can be the free surface profile and that is more important.

Because you will be able to know what is free predict the free surface profile which may be helpful to gain the information in case of the metal printing technology development.

So, therefore, in this computational domain touching the workpiece, but this everything happens under the influence of this arc may be free surface profile we can consider this as a up to this as computational domain. And then we can predict the free surface profile under the influence of the arc pressure and this thing this electromagnetic field and the arc pressure or may be the flow field of the shielding gas within that this domain is transported to the workpiece.

So, then here we can predict the free surface profile using this particular domain, but of course, here in this particular domain this once is this thing we can look into the heat transfer mainly the heat transfer analysis. And the heat transfer analysis as well as the fluid flow analysis for this domain because this is already molten state. So, fluid flow analysis and plus the interface tracking.

When droplet is basically becomes part of the workpiece. So, all this kind of the analysis is possible this thing, but once you do all this analysis and you will we want to apply some kind of interface tracking method also then it is necessary to fix the domain for example, assuming some size of the droplet. So, droplet of touching these workpiece through workpiece.

So, we can fix this as the computational domain and within this computational domain, we can do the analysis of the temperature distribution as the flow field. But only this computational domain, but flow field and free surface field, but it is associated only with the metallic domain only the metallic component part.

Now, we can exclude here, the what is the effect of the analysis for the gas and the arc also, that part we can exclude, but the shielding gas distribution the their distribution their flow field and even arc pressure basically arc formation their domain of the arc. That can be done separately that is the different domain of the apart from the metallic domain.

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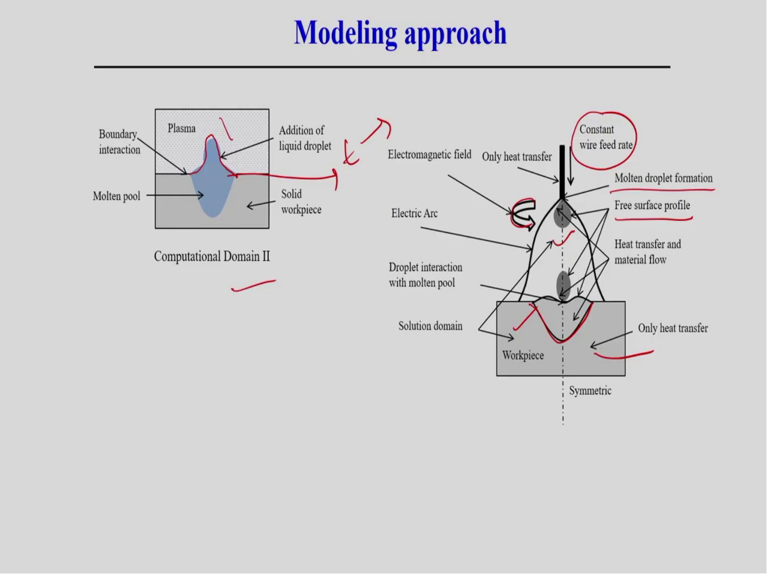

Here droplet addition here also computational domain two I have already explained this thing computational domain, if you see it is under the influence of the plasma may be the under the influence of the plasma on under the arc. Then boundary interaction addition of the liquid droplet to the another molten pool and this is the solid workpiece. So, here start with this thing then gradually over the time how the free surface profile evolves that is the final objective all this particular computational aspect.

Now, if you look into overall this thing see the in gas metal arc welding process and metal transfer part then we see that constant wire feed rate is there always there this is the creation of the arc molten droplet formation then free surface profile of the molten droplet and the molten droplet formation is there at this particular point and only the heat transfer is there.

Then electromagnetic field it is acting the electromagnetic field acting these things then electric arc will be created here and then after that droplet interaction, droplet transported and then interaction with the molten pool happens. And then this is the solution domain means this is also solution domain, this is also solution domain, but we have already explained that we can divide the different domain.

But this is within this we can do the heat transfer and material flow, but this is the solid workpiece. So, only heat transfer equation has to be solved. So, this way if you physically understand what are the different phenomena is happening based on that we can decide, which governing equation has to be solve one particular domain.

So, if you look into overall all these things making in a single make a single domain and analysis all this thing in the different part, it is very really complicated it is very difficult almost impossible. So, rather we can divide in the different domain and then we can look we can do the analysis.

And of course, once we do the different domain and then interaction may be some strategy, how we can interact from thermal model to the fluid flow analysis or how will interact magnetic field to the fluid flow field. So, that has to be incorporated because you have already seen this thing that, when you solving the governing equation as a heat conduction equation there is a heat generation term is there. So, that is internal heat generation term.

So, sometimes the thermal phenomena all this thing can be incorporated through the internal heat generation term if there is a fluid flow phenomena there is a scope to incorporate the body forces. So, maybe other driving forces can be incorporated through the body forces.

Or driving surface tension forces can be incorporated through the surface forces in the governing equation or that can be surface tension force or maybe other surface force acting during this fluid flow model also that can be incorporated through the in the form of a boundary interaction.

So, all this interaction phenomena has to be considered and then you have to choose the basic governing equation to solve then we will be able to solve this kind of the complex problem, but definitely finally, we can say that it is better to solve all this phenomena by dividing the different computational domain and then solve for the different kind of the domain.

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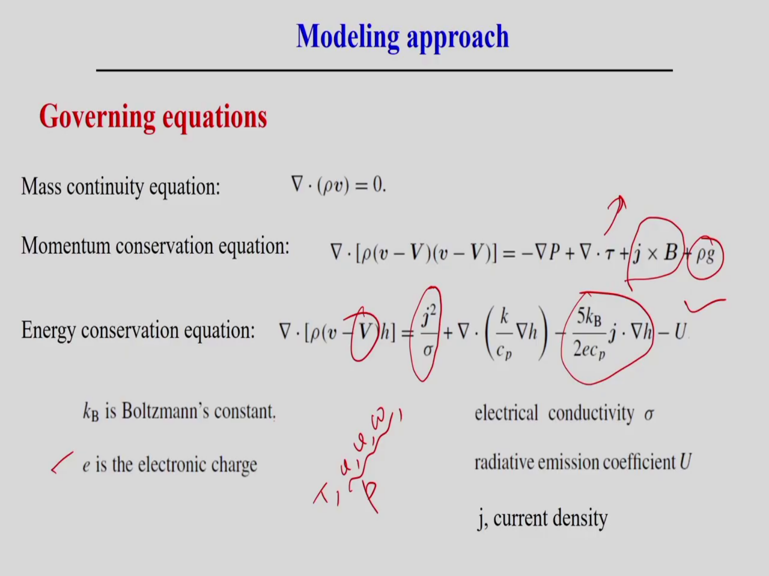

Now, if you look into the in modeling approach what are the different governing equation is normally used in this particular domain that is some idea this thing. First is the government equation uh this complete problem associated with the metal transfer in the gas metal arc welding process is that continuity equation. First need to solve the continuity equation then momentum conservation equation, we have seen already the momentum conservation equation.

And then we can see the moment of conservation equation this the shear stress is there. So, in the shear stress maybe we can look into either surface tension term or the surface tension can be incorporated through the boundary condition. Here the it is associated magnetic field current basically the current density and magnetic field is associated here and this is the other driving forces may be in the fluid flow phenomena the other driving body forces.

That can be incorporated here in the fluid flow phenomenon we have seen the momentum conservation equation. Now, energy conservation equation we can see against the energy conservation equation we can see it is associated with the electrical conductivity and then j is the current density.

So, electrical conductivity and current density is associated that can be the energy conservation equation in terms of the heat generation term and we can see the other term also there, this is also Boltzmann's constant. So, this is a radiative emission though, actually the radiative emission all this thing and that electrical, how the electrical field is interacting also that there is a scope to incorporate all this thing in the energy conservation equation as well.

So, but all this phenomena in these cases it depends on the current density. It simply how what a we can incorporate or interacting this the magnetic field or the current density that particular current density distribution in the governing equation that can be that you can see also that they are having some influence in the energy transport and that is why you can incorporate all these things. So, definitely apart from this thing the this is the welding velocity V is the welding velocity and e is the electronic charges.

So, because of the electric field and the presence this thing there may be some sort of the heat generation and that we can incorporate in the energy conservation equation apart from this radiative heat transfer as well. So, these are the governing equation that, if you solve this governing equation you will be able to know that solving the basically this temperature distribution that velocity field u v w is a three dimension, this is the velocity field.

So, this kind of and apart from this thing we will be able to get the pressure field also. Pressure, because Navier-Stoke we can see the momentum we can see in it is associated with the pressure. So, these are the output from this particular governing equation, but you see whether these are the output from this by solving this governing equation, but how there is interacting of magnetic field also there.

So, that different way we can incorporate the effect of the magnetic field in this particular governing equation that we have shown here also.

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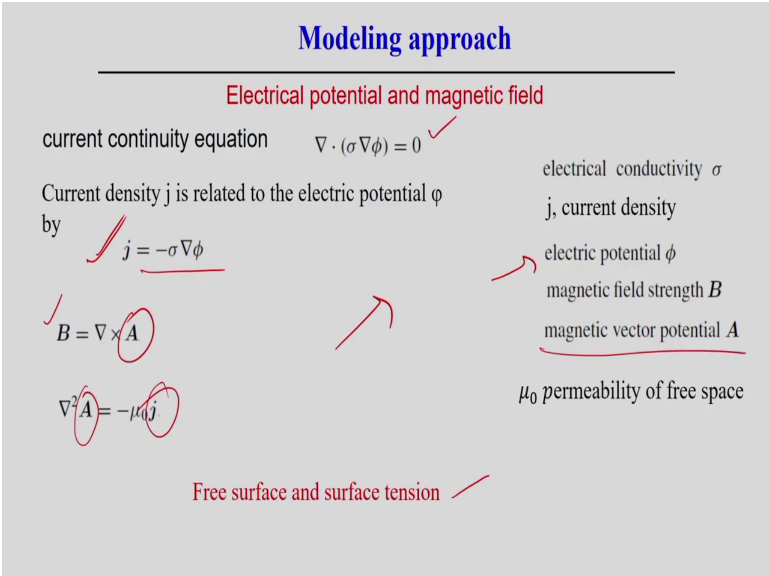

Apart from this thing electrical what we can estimate the magnetic field also. So, electrical potential and magnetic field what we can get this kind of information because in that cases current continuity equation has to be solved. You can see the current continuation equation has to be solved here and where the current density is related to the electric potential is this j current density in terms of the electric potential we can incorporate that there is a relation between these two.

And apart from this thing B is the magnetic field strength and magnetic field strength B is the magnitude field associated with the magnetic potential vector. So, A is the magnetic potential vector and magnetic potential vector is associated with the current density and mu 0 is the basically magnetic permeability of the free space.

So, so it means that electrical potential and the current continuity equation has to be solved here to get the magnetic electrical potential field. So, phi electric potential field we need to get first. So, once we get the electric potential field from there and electric potential field from there, we can estimate what is the current density also we can link between the current density and then current density from the current density we can estimate the magnetic field.

So, basically need to necessarily the electric potential field as well and there from there we can estimate what is the magnetic field existing during this particular process. So, in this cases we need to solve all these kind of the equations and then we have to understand that how one equation is linked from the another equation, if you solve it will be getting all this phenomena.

Now, apart from this thing once say. So, this thing are basically then we can get the magnetic field distribution also, but this magnetic field distribution also this information is also necessary to look to solve the governing equation. For example, conservation of mass movement of energy equation there is a need the input from the magnetic field also. So, that will help in this particular case to get this pressure temperature and this thing the velocity field.

Apart from this thing we need to solve the free surface profile and the surface tension. So, basically we have to understand the how the surface tension force is acting there and then from there we can estimate what they can develop some model for the free surface profile. We have already explained the interface different interface tracking method also, but we have to adopt this interface tracking method and such that we will be able to predict the free surface profile.

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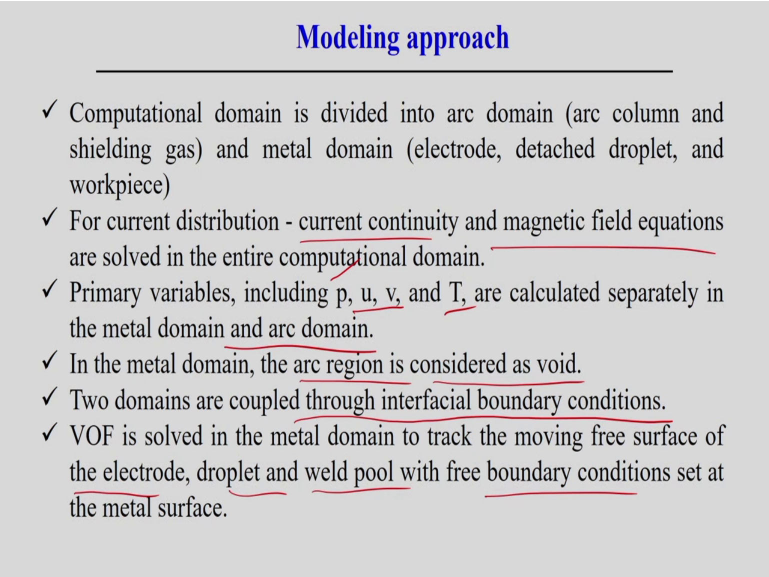

So, therefore, we can look into that there is a complex approach are there to get all this kind of the flow field. Now, if you look into this thing modeling approach of gas material arc in a nutshell like that computational domain is the divided into the different either divided into arc domain arc domain means the arc column and the shielding gas.

So, that we can consider this as arc domain and the metal domain another separate domain that is called electrode detached, the droplet and the workpiece this we can consider as a metal domain, but there is a several sub domain can be created within the metal domain also.

Now, for current distribution we can say the solve the current continuity equation this thing and magnetic field equation are solved in the entire computational domain. So, if you know the current distribution therefore, current continuity equation and magnetic field equation has to be solved for the whole domain and then in this case we have seen the primary variables the u.

So, pressure and the velocity component and temperature are basically that is required to calculate separately in the metal domain only.

In the metal domain and the arc domain because arc domain this pressure distribution velocity field temperature domain also we can estimate because this domain medium is different as compared to the metal domain or metallic material. So, therefore, in metal domain the arc region considered as a void.

Once we look into the metal domain the arc region is considered as a void or in the metal domain we are looking into this thing depending upon this thing. We can estimate what are the flux volumetric flux in the associated with this thing that volumetric flux can be incorporated, in the conservation energy conservation equation or momentum conservation equation.

And there that can be input as in terms of the body force in both the equation and the equation can be solved for the more precisely can be solved for the prediction of the velocity field and the temperature field. Now, two domains are coupled through the interfacial boundary conditions.

So, definitely it is also possible the two domains that means the arc domain and the metal domain can be coupled by interfacial boundary condition interfacial boundary condition because these are the two different medium. We can see this is a kind of a gaseous medium another is the kind of liquid medium or we can say the liquid medium and the gaseous medium.

So, in between there is interface. So, that interface interfacial boundary condition can be imported in this particular solution. Now, VOF means volume of fluid method can be used in the solve on the metal domain basically to track the moving free surface of the electrode, that we can see the moving free surface of the electrode and the moving free surface of the droplet and the weld pool with the free boundary conditions set at the metal surface.

Basically we will be able to predict the weld pool profile also using the volume of fluid method. So, volume of fluid method is simply the one of the interface interfacial interface tracking method, that we can apply to look into the different shape and size of the droplet and as well as the free surface boundary of this particular droplet.

So, these are the in general the overall approach of in case of the metal transfer associated with the gas metal arc welding process. So, analysis of this particular approach or maybe in the modeling approach is basically helpful or applicable when you try to develop some kind of the wire arc based additive manufacturing processes. So, thank you very much for your kind attention.