Principles of Metal Forming Technology
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Lecture – 34
Extrusion of tubes and pipes, extrusion defect

Welcome to the lecture on Extrusion of tubes and pipes and extrusion defect. So, we discussed about the extrusion process and normally what we have so far studied that depending upon the cross section of the you know cross section at the diode late. You can have that cross sectional product and you are basically extruding rod or so ah you no more conveniently.

However, if you have to make the tubes and pipes that can be made by the extrusion process also; in those cases we have to use the mandrel and with the help of that so what is done is that so when you are pushing from one side, in that case the there will be piercing first with the mandrel and that piercing will be going from one side till the die opening. And then, from there if when you are pressing, then the tube type of structure is produced.

So, if you look at some you know this process what we do is suppose you have ablate.

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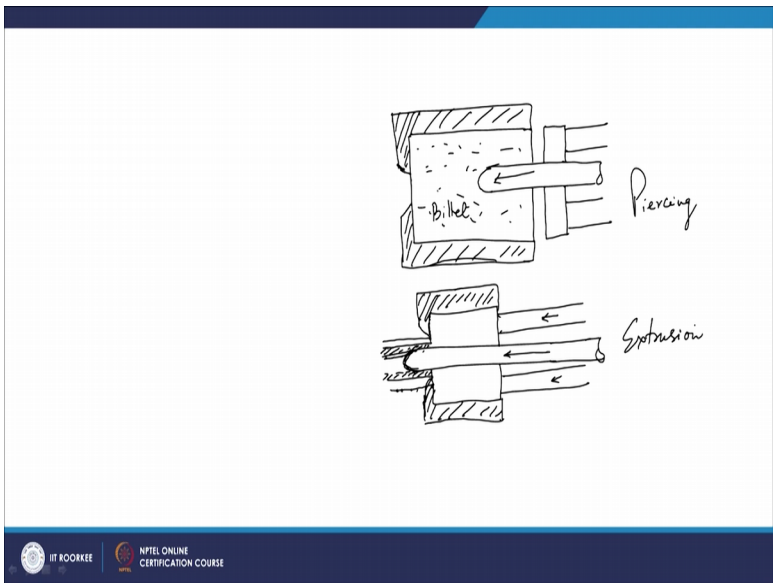

So, this ablate is to be propose extruded and in that case you will have a mandrel here.

So, this mandrel actually this will be given the movement and this mandrel basically will be you know pushed from this side and what will happen that now this is your billet. So, this is your billet.

So, you can write that this is your billet and there will be ah you know piercing mandrel. So, this will be your piercing mandrel and (Refer Time: 02:34) that it will be basically pressurized from that side.

So, you will have here the force which will be working upon them and we see on this way on this side basically you have the die. So, you will have a die opening from here. So, that will be basically the container. So, this container will be there and on both the sides, you will have further on this side you have the container.

So, now, the thing is that this is your mandrel and this will be moving from this side. So, this will be for piercing and this piercing will be going on and also we can have this piercing once it goes. So, when it will be coming at the outlet, it will it will look like you will have the mandrel here coming all together up to the full length and this is your mandrel.

And now, you have this side that the clearance which is there in between that die wall. So, that will be the thickness of this tube which is produced and this way. So, from here you have the.

So, you have billet suppose coming to this part. So, similarly you have a billet on this part also. So, once the mandrel will be here; now once the extrusion process starts. So, what we can see is that you will have the you know die ah.

So, die will be appearing like this and die opening is there and that way you have the, you know again the pressure mechanism from this side. So, again the movement of this, it has to go till the end part. So, so this way you will have this internal diameter is maintained and this part is the solid pipe, the thickness of this pipe.

So, this way you are getting. So, you will be getting this is not there. So, it will be coming like this. So, this way you will have the production of these kind of seamless tubes which is formed in that. So, what we see is that initially you will have to pierce.

So this will be your piercing process and then, from here once it comes then it will be extruding. Now the thing that we also take we also take the hollow you know billet in in those cases so that you can ah pierce it; you can without much need of the piercing you can have, but certainly you will have to have because you have to pierce first of all through the billet.

So, you can have the, you know provision of the hollow kind of billet. So, in that case it will be coming here; but the things that when you have the hollow billets in that case the inside you know surface that may get you know ah oxidized because of the high temperature.

So, in such cases there may be difficult in such cases. This is your piercing and then finally, you get the extrusion of the, these 2 type of structures.

Now, there are also many methods of making the seamless pipe and tubing and what has been done in those cases that there has been used of rollers basically and certainly the use of mandrel is there and in that basically because of the you know movement of the rollers of which is there on the top and bottom and many cases there has been 3 rollers also used.

There is a continuous you know production of the seamless you know pipes and tubes. So, in that what has happened there is one you know setup that is known Mannesmann mill.

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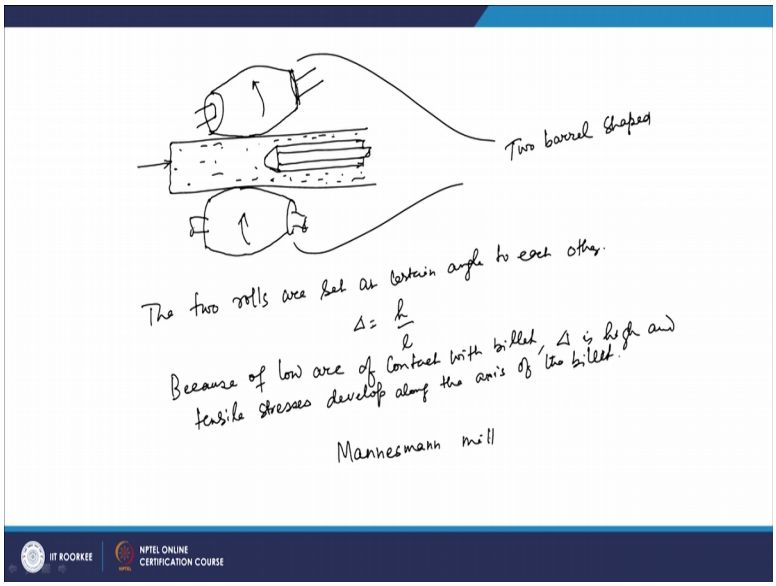

Now, in that case that have been done is suppose you have a billet which is there of suppose this thickness. Now in this case it has to be you know ah that tube to be extruded; now seamless pipe is to be extruded in the that case. Now this is used for normally the lottery piercing of the, you know steel and copper billets.

Now, in this case there is a mandrel here again. Now this mandrel will be having like this and now, in this case ah your mandrel has got the, this is a attached and getting the support from this side.

So, that way you have this mandrel. Now what happens that you have basically on these 2 sides; what happens that you have the use of such kind of roller. So, this roller is used and this will be further having. So, you have such kind of you know.

So, this roller similarly there is another roller which is on this side. So, this roller will be like this and then, it will be going having this shape. So, you will have this way it will be rotating in fact and now what is happening? In this case you have 2 barrel shaped rolls are there.

So, these are the two rolls which are rotating and there are these are the two barrel shape rolls. So, these are two barrel shaped. So, they are the different rolls and they are set at certain angle to each other. So, they are. So, that the two rolls are set at certain angle to each other.

Now, what is happening that the axial thrust will be developed because of their rotation? The axial thrust as well as the rotation is you know because of the rotation of these barrel shaped rolls, the axial thrust is developed on this and as you have the low arc contact with the billet as you see that there is very low arc of contact here on the billet.

So, the delta is basically that is h by l that will be basically very very high and there will be tensile stress developed on these you know along the axis of the billet.

So, what happens that because of that because of this? So, the metal flows at this place and it will be pierce at this point and the metal will be moving. So, so there will be movement of the metals. So, once it is you know flow because of the low you know delta review high value of delta that is h by l.

So, because of. So, one is that. So, as we know that delta is h by l. So, l this is arc contact is very very small. So, because of that there will be you know large amount of tensile stresses which are developed along the axis and this because of this.

So, so, you have because of low arc of contact with billet. So, your delta is high and tensile stress is developed along the axis of the billet. Now because of this what happens that you know the opening at the centre.

So, now, here since there will be a mandrel which is you know there; now because of the flow the metal will flow and the cavity will be generated. So, such kind of you know this is piercing is done at this point and you get seamless kind of you know structure.

So, once you have this metal now that that will be only going into this reason. So, this is basically Mannesmann mill it is known as. So, this is basically Mannesmann Mill.

Now, the limitation with this Mannesmann mill is that it does not provide very large wall reduction. So, there are basically other types of the plug rolling mills and in those you know plug rolling mills what happens that you have the rolls.

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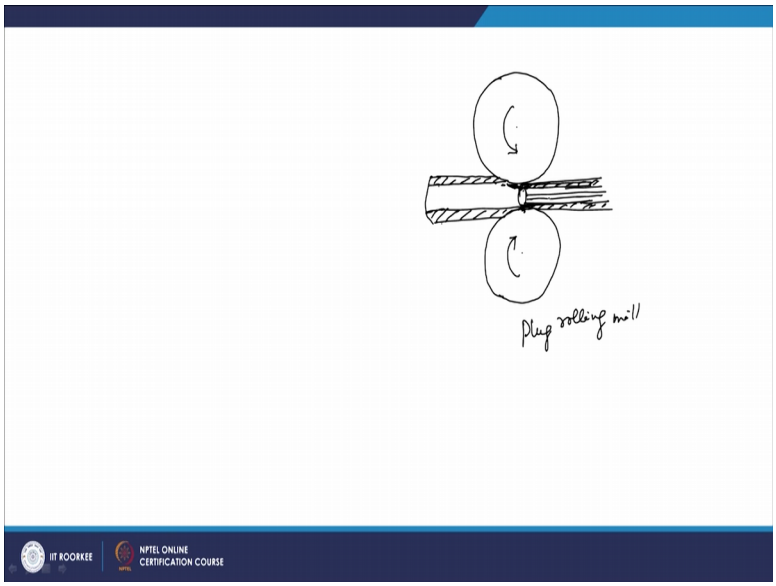

So, you have two rolls. Now in such rolling mill. So, you have basically coming up. So, this way you have the, you know you have the placement of mandrel here at the centre and because of.

So, you certainly there is certain gap between this. So from here basically this tube goes away with certain thickness. Now this is the thickness of the you know the tube which is produced and this is your plug mill. So, this is your mandrel which is there.

Now, here in this case you have a long you know you have tube which is over the long mandrel and you have a plug; this plug this is known as the plug, you have the use of the plug. So, that is why this in this case it is known as the Plug rolling mill. So, you have this is known as Plug rolling mill.

Now in this case this ah this role is rotating in this direction and this is rotating this directions; anyway this is basically bringing this into it and because of the presence of this plug basically now here the metal goods and it is basically ah you know deformed at the at this point. And then because of this clearness between this plug and in between and between these two rolls.

So, this is your gap between the rolls your metal comes. So, since we are using this plug we call it as the plug rolling mill. There is another setup which is using that 3 rolls and that is you know the they are the you know are known as the Three roll piercing.

So, you have the three rolls basically under the, that action further the tubing processes are carried out. One of the other variety is the reeling mill which will be burnishing the outside and inside surfaces.

So, these are the four methods which are used for making this seamless pipes and tubes in the extrusion industries. Now further we will discuss about the different types of, different way, the different way how the defects occur in the case of extrusion.

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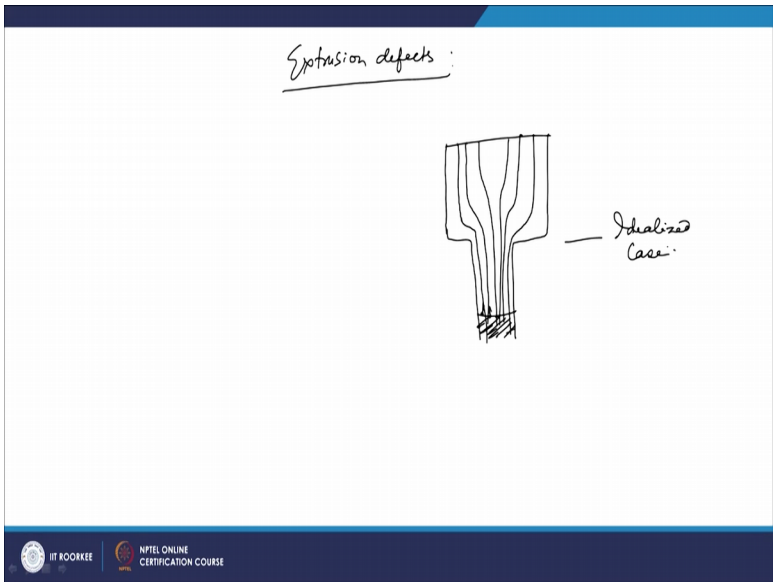

We will talk about extrusion defects. Now when we talk about extrusion as we know that when the metal is you know pressed from one side, the metal has to flow and there will be friction at the container, liner and the billet that interface the new friction and for you know decreasing that friction we apply the lubricants.

But, again that lubricant is how much lubricant is used how is the you know what is the thickness of that lubricant and how the lubricant flow is maintained. So, it may so happened that the lubricant has properly been along on the surface as the extraction process goes on or it is not.

So, depending upon that basically the friction conditions which is there on the surface that will try to alter the you know the flow of the grains which occurs inside the extrusion and that leads to certain kind of defects in the extrusion.

More importantly when you have the flow of the material and if there is no proper lubricant, in those cases and also there are certain cases when suppose you have more chilling at the container; you know container side I mean on the surface of the billet and if the inside is somewhat cooler, then the surface will chill.

And when you are trying to apply the force, when the metal at the you know surface will resist the any kind of flow and there will be flow only from the middle portion.

So, the result becomes that you have may have the formation of dead zones at certain locations because there will be flow from the centre initially that will go through the cavity and then, later on once you are coming towards later part then your only outer periphery part is left and what you see many a times is that that may lead to certain kind of defects known as extrusion defects.

So, we discuss how you know how this flow of this you know flow of metal which takes place inside the extrusion die.

So, how that is affected. So, suppose what we see is normally what we do is we use the lubricants ah in the extrusion process and when we talk about the hydrostatic extrusion in that in that we know that in that case when the brittle material extruded. So, you have physically the presence of fluid from all this side. So, that increases the lubrication and that way you can extrude more effectively.

Now, what we has been there has been some if you know effect to show that how this container wall friction if it is increased how that will be you know visualized how it is it can be seen. So, suppose in normal case, when we talk about the extrusions; suppose you have this way you are doing the extrusion.

Now, our in such cases what happens that typically when you have very low friction you know that there is low fiction, low container friction and you have well lubricated film. In that case if you look at your you know flow lines will be appearing like this.

So, they will be coming and then you have smooth flow. So, this is the indicative of the you know flow lines in such cases. So, like that you will have the you know flow which is occurring you know if you can take this as the end part. So, your the flow lines appeared like this.

In the case of idealized condition, when you do not have you know very very low you know friction and there is well lubrication in such cases.

Now, if there is you know if there is increased container wall friction and. So, this is for idealized case. Now if you have the increase in the you know wall fiction.

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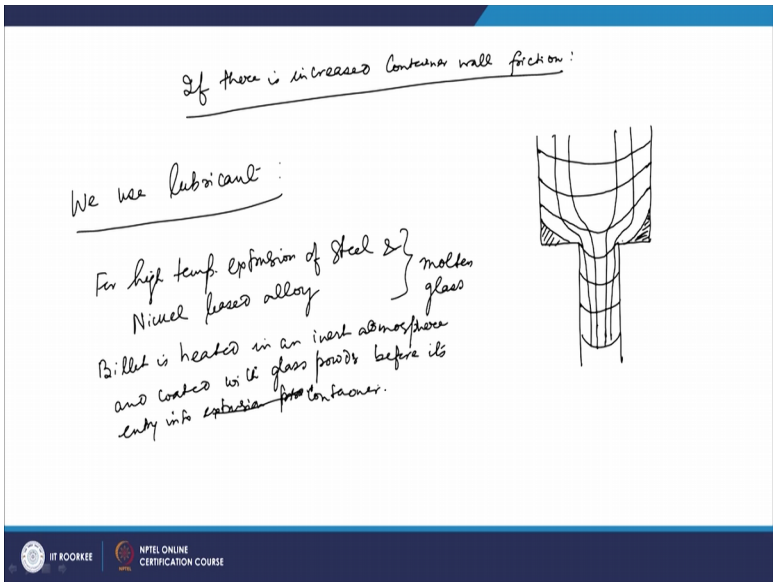

So, if there is increased container wall friction; now, what we see in the in such cases basically your you have distortion of this grid pattern takes place. So, in such cases, now in such cases what happens that when you have increased this friction between the container of wall and the billet.

So, what will is happened the, this there will be at this places you will have certain results which are formed and this results basically become the dead zones. So, and then you will have this flow going like this.

So, which was earlier you know straight. Now, in this case you will have because there is friction. So, you will have now you know more stress requirement at this sides and a metal will more importantly try to follow ah in order to flow from the you know middle sides. So, your flow lines will be going like this, after that it will be usual.

Now, in in such cases what happens that basically basic the basic characteristics is that there will be formation of this dead zones. Now main characteristics is that when you have increased wall friction; now what this zone which you see this becomes dead zone

and dead zone means they are not taking part in the flow during the initial flow of the metal through that die.

And ultimately what happens that when you are towards the end of the process, then the you are trying to you know push it towards that that and they have basically also in between them there might be temperature loss.

So, now the this part which is coming towards the end, there maybe you know extrusion defects and because of very high friction conditions that we led to those cases where you get the ring type of structure, circular ring type of structures if you look in a very transfers direction. Then, you look at the circular ring type of structures in such cases and because of the presence of the dead reason this type of defect known as extrusion defect.

So, also the effect is can be you know interpreted in the sense that you will have the shear zone development because of that and that is not basically productive. So, normally that is you know that you are classified as the redundant work because you are doing the work that is not of use.

So, that is redundant work and even if there is further increase in that you know wall friction on the container, then there will be further stepper zones will be you know formed our planes will be formed on these sides.

So, this kind of defect basically you will have shear zone on formation on the sides and that will be leaving a thin you know skin ultimately in the end which will be left in that. So, normally you must see and it will be very difficult.

So, further you clean that material portion if that zone becomes the share zone is further steeper, then a zone of a certain thickness is basically left over the container part which is to be cleaned every time. So, that is another you know defect which is attached with such you know process.

So, what happens that for avoiding this, we use the lubricants and normally we use we use lubricant. So, what we do in the case of hot extrusion normally where used the lubricant which has very low shear strength and which also should be stable enough to prevent any breakdown at high temperature.

Now, for high temperature you know steel for high temperature is extrusion when we are doing for of steel and nickel based alloy; if you look at these alloys normally we use the lubricant as the molten glass. So, what is happening that you know billet is heated.

So, billet will be heated in an inert atmosphere and coated with glass powder before its entry into extrusion press. So, you know into the container; so, into the container. Now the thing is that once you apply this you know layer of lubricant and then it is placed there.

So, basically it all words first as the lubricant to reduce the friction also once you have applied this. So, that will also serve to reduce any kind of heat transfer is will be taking place from the surface and there has to be a lubricating film which is which has to be maintained and normally that is about 25 micron meter thick.

So, that you know thickness of the lubricant layer is to be maintained and also you have to have ah take into account the viscosity of this lubricant and this coating thickness which will be you know that will be depending upon.

So, that depends upon the rate at which the lubricate will be melting and is able to be melting or to be softening. So, based on that this lubricant and you know that coating thickness will be developed and also what is how your expression speed is there.

So, you may have high extrusion speed or you may have low extrusion speed that also you know decides that what should be the thickness; that also decide that how long this you know lubricant has to be you know.

It may so happened that in the initial part a large you know if the speed is basically ah a large part of the coating has been applied and later on the coating or the lubricant has become less which as increase the you know friction and that may lead to friction and that may lead to further the formation of the defects.

So, basically lubricant viscosity has a strong effect on the you know extrusion pressure in that case because the ones that lubrication is over that will try to increase the pressure on in the in. So, increase the pressure and then formation of this shear zone and that may lead to the extrusion defects. You may have basically the formation of pipes in between.

So, that is because of the inhomogeneous deformation in the case of direct extrusion because of the movement of the you know faster movement of the central portion of the billet as compared to the you alter periphery as it happens whenever you know you have the lower temperature may be on the size as we discussed.

So, in those cases that pipe, pipe may be formed towards the end and that pipe. So, that is why some part of it is basically discarded also. So, there is loss of productivity in those cases. So, these are typically the aspects which are related to the lubrication of this lubrication in extrusion and this is to be you know kept into account while designing this process.

Thank you very much.