Theory of Production Processes

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Lecture - 37
Drawing of rods, Tubes and Wires

Welcome to the lecture on Drawing of Rods, Tubes and Wires. So, in the last lectures we discussed about the forming operations in that we discussed about operations like forming, I mean forging, rolling, extrusion all that we are discussed and most of them were normally done at a temperature more than the recrystallization temperature. So, mostly you have hot forming operations mostly it is done in the case of rolling or you know forging or so, even the cold forming techniques are also applied. And we discussed that you have a specific you know applications or specific cases when you have to increase the strength or the finish then you go for the cold forming otherwise you have discussed about the hot forming.

Now, we will discuss about the production of rods, tubes and wires which are basically another operation of forming. In that you have this talk and then what you do is you have the dye and there is a tensile force applied from the other end opposite end of the dye and then because of that on the dye itself you have the state of a stress which is achieved that we have compressive stress also. So, under the action of that and under the action of this pulling from the opposite side of the dye the material is basically plastically deformed and you get basically the wires or rods or tubes. So, basically the purpose is that you are decreasing the thickness increasing the length.

So, as per the definition drawing operations they involve basically pulling the metal through a dye using tensile force from exit side of the dye.

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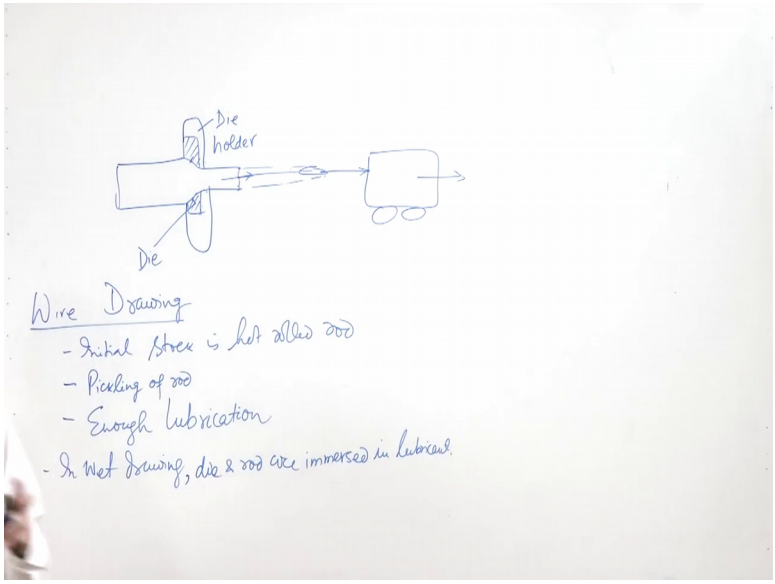

So, you have a dye and then this dye, you have a dye here and then this will be the one and then it has to pass through the dye. So, here you have the dye. So, this is the dye and then what you do is. So, you apply the force here, you are pulling that and here basically the instead of you know compressive force is applied on this body and then this material basically is pulled from this dye cavity. So, basically a stalk of larger cross section is converted into rods of smaller cross section. So, when it is solid cross section then it is known as rod. And if the diameter is very small normally we will define that how you can discriminate a rod from a wire.

So, that basically is based upon the diameter of that end product. So, if it is less than 5 mm then you can say that this as your wire and if it is more than that we call it as a rod, so that is that. And then further if you are making the hollow product. So, that is known as you know tube. So, in that basically there are many ways and you can use a mandrel or even without mandrel you can use the plug. So, there are many methods by which you can make these hollow you know products from this and that is known as tube making. So, this is how this drawing operation is carried out.

Now, plastic flow is because of the compression force that arise from the reaction of metal, the reaction which the metal provides. So, it will be reaction it will be providing. So, this because this compression force and because of that there will be plastic flow and

then you have you are pulling this from this side. So, this way the plastic flow will be occurring this is dye and this is the stock.

So, usually this bar drawing or wire drawing or tube drawing, they are normally carried out at room temperature and basically because there is a large amount of deformation is involved. So, what happens because the deformation is involved you have a lot of energy going into it. So, what happens that there will be temperature rise of the stock I mean after. So, what of the product if you see, if you go that for deformation and since then the last amount of deformation is involved there will be rise in the temperature. So, that also you will see that basically there is a large amount of rise of the temperature and there is certainly some cooling in between when they pass through the dye there may be some inter pass when they pass through that there may be some temperature drop that dye may take some of the temperature, but mostly the temperature of the rod or wire or the tube because of the large amount of deformation which is involved it becomes larger.

Now, if you look at the drawing you know operation normally a draw bench is used for the drawing operation. So, draw bench is the one because as we discussed that you have this dye and this way you have this talk and then you are pulling this. So, from in this side you have a jaw will be there and then this jaw will be pulling it. So, you have a drive. So, this way it will be pulling it. So, this is how the drawing operation is carried out. Now, these draw benches are used when they need not be quiet. So, basically when we go for the wires or so, you can you coil it. So, whether we require to quiet it or not when we do not require to coil it, which cannot be quiet then you use that draw benches and on the draw benches.

So, what we is there that first of all when you have to insert this portion into it. So, initially you are making the end of the rod before inserting in between the dye you are making it pointed with the help of a scissor. So, once you make it pointed then you insert through it and then you hold it from here. So, you have a gripper or a jaw and then with this you can further you can pull it. So, this way the pulling action takes place and that basically is done using the chain drive or the hydraulic mechanism you have.

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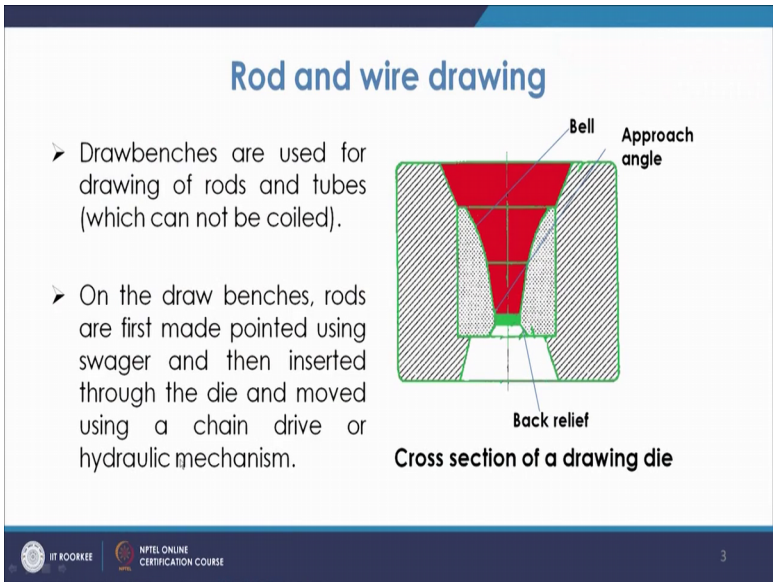

So, using that chain drive or hydraulic mechanism you can do this pulling operation. So, you have basically there is dye and then you will have the dye holder. So, basically normally this dye is host in some you know case. So, that is becoming, this is your dye and this is becoming the dye holder. So, that is how you have the dye holder and then with the jaw you grip this whole rod and then you further you know pull it. So, that is how you try to do these drawing operations.

Now, if you look at the drawing dye, if you look at the typical geometry of a drawing dye you look at this geometry. Now, here what you see is you have this is the bell shaped. So, basically the intrence of the dye that is made bell shaped so that the wire which is entering into the dye that will draw the lubricant the thing is that when you are taking that you know stock in between the dye and trying to pull it. So, at that point of time it must have you know a smooth entry into it. So, you usually apply the lubricant at the surface. So, that is why what you do is this type of shape is basically given. So, they basically try to take the lubricant which is there they will go with it and then that will facilitate its movement inside this part and it will go further down and then at the end they will be coming out.

Now, the thing is that when it is given. So, that is why you are basically giving this a bell shape. Now, the approach this is the approach angle portion. So, basically it is the section of the dye where the actual reduction in diameter takes place. So, that is the approach

angle portion. So, here basically once it reaches then the actual you know reduction of the dye that is reaction of the stock that is taking place. Now, this portion is basically the bearing this green portion this is known as the bearing, and they do not cause basically the reduction, but basically they are causing the friction on the wire. So, that happens in the bearing reason. Further if you look at the other zones you have this further you see the diverging zone and this zone is known as the back relief you know portion. Now, that basically is allowing the metal to expand slightly. So, once the metal goes into that cavity. Now, after this if you look at this position you see that this is basically a little bit diverging. So, that is basically allowing to it to expand slightly and when that why we living the dye.

So, many a times you have the chance to get stuck or you may have the interference. So, basically it will be minimizing the possibility of abrasion which may take place if the drawing process is stopped. So, in that case since you have an area which is larger than this area. So, that way this diverging area or the back relief portion that actually helps or maybe in many cases that dye may be out of alignment. So, in those cases also it helps that it will not create you know any problem in those cases you have that much of relief given on both these sides. So, that way this back relief portion that is helpful.

Now, the dye is normally. So, as you see this is the dye and then you have the dye holder on the side and the dye is normally made of you know the cemented carbide. So, that is normally the material of the dye. So, you have this, this is the carbide nib basically. So, that is your cemented carbide nib of the dye and then this is the casing. So, this portion is the casing that is normally made of steel and this is the portion which is made of cemented carbide where actually, which actually basically gives that assistance to any kind of deformation and where the material is plastically inside which it is plastically deformed. So, that is how this is the cross section of the drawing dye which is what you see in such cases. Now, as we discussed that when we talk about the rod drawing or wire drawing. So, the difference between rod and wire is that you know when the diameter is less than 5 mm in that case you tell them as the wire.

So, that is basically done on the you know multiple dye machine this, the drawing of the such wires they are done on that multiple drawing machine. So, you have one set up where at successive you know stages the drawing option is carried out and every time the reduction of the diameter will be taking place and so, ultimately your wire of requisite

diameter is basically found. So, while drawing when we talk about, it is basically for that the stock material is the hot rod product. So, you have a hot rod, rod which is basically drawn for the wire. So, what you do? When you go for the wire drawing, your stock is initial stock is hot rolled rod normally that is the you know stock that is the basically the one which is used for making the wires. Now, first of all for making wires it is required that the surface must be very much clean. So, before going or before pressing it or before positioning it inside the dye you ensure that it is this surface is completely clean. So, what you do is you clean the surface and for that you do the pickling you know operation.

So, for that you by pickling you remove any kind of dirt or any kind of scale. So, that way pickling is important. So, pickling of rod is done to remove any kind of scale or dirt so that when it goes inside, it does not create an impression on the final product or it does not interfere with this operation of drawing. Now, further when you start the drawing operation one thing is important that there has to be enough lubrication there has to be enough lubrication for the process of drawing to work smooth. So, for that basically the surface coating is applied and normally copper or tin coating is applied which works as the lubricant in the case of you know normally this wire drawing of bristles. So, and that works as a lubricant, also you also use certain conversion coatings and like sulphides or sulphates or auxilates applied on the rod, so they are used as conversion coatings. So, they are used in conjunction with the lubricant, like soap in the drawing operation.

Now, there is another kind of drawing. So, that is dry drawing where you use this dry kind of lubricant and then or dry coating is there and then that works as lubricant, but many a times we also use we also adopt the width drawing operation. Now, in the case of width drawing what happens, the whole unit is basically merged in a lubricant medium. So, the dye and the rod basically are they are completely merged in the oil so that works as lubricant. So, in wet drawing, you have dye and rod are merged in oil in lubricant.

So, basically that is all since it is in a width medium we call it as the width type of forming or width drawing methods. So, that is known as width drawing. Now, many a times you need to when you go for wire drawing or so, you need to you cannot do a large reduction in one go. So, as we know that in one go you have the limitation of going up to how much degree of you know reduction you can achieve. So, for that what you do is you do the reduction in successive stages. So, you go for the successive stages of

drawing and you have multiple draw machines are there with one dye and one draw at every stage. So, that basically from one place it will go and then another, it this will go from there it will enter into another dye and dye and you know dye set up and then it from there it will move to the next one.

So, every time it moves goes into first dye it will come with certain reduction then it will from there it will move to second you know dye machine they are from it will result with certain reduction. So, this way if you have multiple draw machines multiple dyes are there. So, after that, after a few passes or after many stages the degree of reduction up to larger extent can be achieved, so that is how the practice is followed whenever we talk about the drawing operations with large reduction especially for wires.

Now, what happens that every time you go since the reduction of diameter is there every time. So, what happens that the peripheral speeds are increasing, for the for avoiding any slippage between the block and the wire the peripheral speed has to increase and that is basically you know managed with the help of motor mechanism many a times. So, now, let us see the why drawing. So, as we discussed that the wire drawing is starting with the coil of hot rolled road rod then surface coats are used with drawing dye rods are immerse in the you know while as lubricant and then heat generation basically is a challenge and that basically has to be seen that how it happens and some part of the heat is removed by during the inter pass (Refer Time: 22:01), but mostly that temperature becomes quite high. So, you will have to see that the temperature must not reach too high value in the case of the wire drawing typically.

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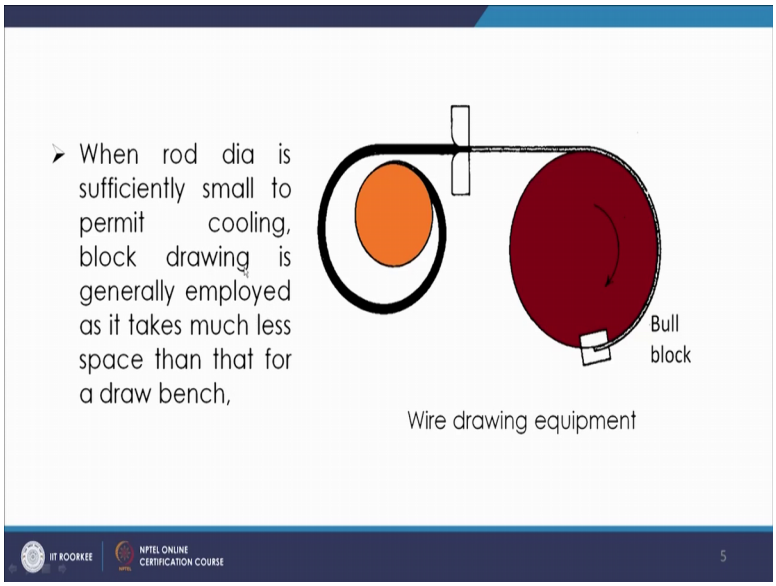

Now, if you look at the operation of wire drawing what you see is you have this block drawing is normally employed when your rod diameter is sufficiently small to permit cooling. So, the way it takes less space and as you see you have this as the stock. So, this is rod which is basically converted in to wires. So, you have this is a stable block and then you this is the, and dye and once it passes from here and then this is basically getting wrapped at this point. So, that is how the wire drawing process is carried out.

Now, coming to the different materials which are basically drawn, if you look at the non ferrous and low carbon steel wires they are produced in a number of tempers ranging from dead soft to full heart. So, basically when we talk about these making the wires of the non ferrous and low carbon steels. So, as you come across you will come across the wires in designated as different tempers. So, basically depending upon the requirement, depending upon that the treatment is given what kind of rod you want you want soft or you want hard. So, that way you are basically going to make the wires and that basically depends upon what type of metal you are drawing or converting to wires and also what is the amount of reduction involved. So, that only will produce you the degree of hardness like if you give the large reduction in the end then you will have basically the very hard variety of wires obtained. And if you are giving very small and then also you are increasing the temperature to a larger extent a little bit higher, then in that case when you do the inter pass (Refer Time: 24:34) or so, in that case you will have the softer variety of the rod.

So, depending upon that you will have these designations you want the soft variety or you want the hard variety it all depends how you are giving the treatment or the reduction treatment towards the final you know stages. So, that is how it goes. Now, in the case of, so what you see is intermediate annealing operation may be required depending upon metal end reduction involves that is what we discussed that when depending upon the type of material and also the degree of reduction involved you may give the intermediate annealing operation and that way further reductions are carried out. What we see is that it has been seen that has been typical type of heat treatment process that is you are pretending heat treatment is given in the case of drawing of steel wires. So, in that you have the controlled you know rate of cooling. So, that way that that is known as patenting heat treatment. So, that is for the steel wires. And in that basically what we do is you are basically going at a temperature and then at the higher from the higher temperature you are coming to, to a bath which is maintained at 315 degree C. So, finally, basically the purpose is to yield the fine per lighting structure.

So, that is how you are going towards that zone from where you are going into that (Refer Time: 26:21) zone and then further you are holding it at a temperature that is at the 315 degree C. So, that way you are having the fine pearlite type of structures. So, this way you can maintain you can see that how by changing the cooling rate you can have certainly that is metallurgical principle that by changing the cooling rate you can control the, you know type of grain structure fine pearlite to coarse pearlite or so, depending upon the cooling rate conditions.

Coming to the tube drawing operation, as we discussed that in tube drawing basically you have the hollow portions in inside and basically in that what happens that you either can use the mandrel or plug or you cannot use. So, they are basically hollow cylinders or tubes which are often cold finished by drawing to obtain closer dimensional tolerances, better surface finish and increased mechanical properties. So, in this case when you do not use anything then we call it as thinking. So, this way if you make you do not use anything. So, in that case the tube which you make that is known as tube thinking then if you are using the, you can basically use the one mechanism where you can have such kind of and this is basically fixed from here.

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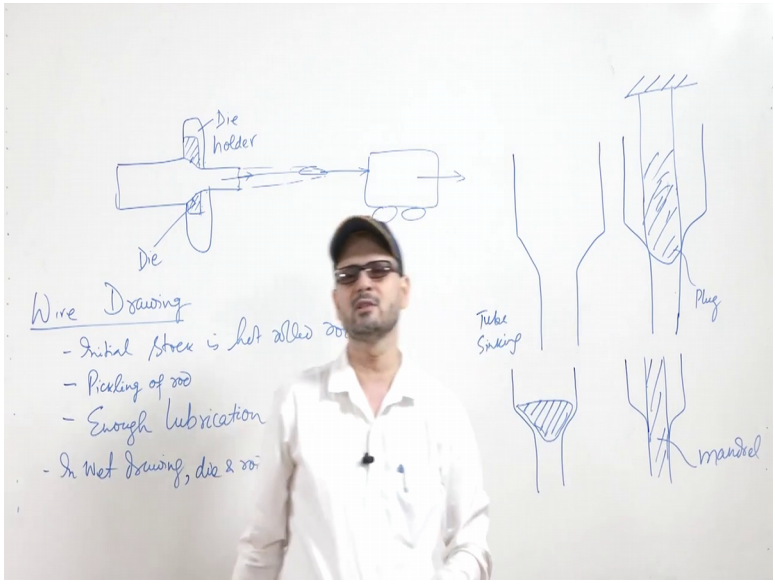

So, this is basically known as. So, here that is basically known as fixed plug. So, this is using the fixed kind of plug. Now, you can have also some mechanism of making these wires where you have a floating type of plugs. So, you have such kind of, you will have. So, this is also a plug using this plug also you can have such type of hollow tubes can be drawn. Here also you can use the hollow tube drawn this is known as this is here whatever you make this is known as tube sinking, and this is basically tube making with the use of plug which is the plug which is fixed one here the this plug is not fixed, but it is floating or else we also use mandrels also to make these you know tubes. So, in that mandrel you have the hole is a one man mandrel is there. So, this use of mandrel is also advocated for making the tubes. So, you have different methods of making these tubes for such cases.

Now, in the case of the tubes what happens that you know in the case of two sinking as you do not use any method to control its you know thickness, here you have these you know places from here you have the constraint from the sides from the inside and so, now so that is why in the case of two sinking certainly the dimensional accuracy will be lesser as compared to other methods. But then in the case of this, this is the floating plug you have the protein plug where the plug is floating and this way the wires are drawn. So, you can go through the different you know methods of having these tube making and certainly when you have such you know different mechanisms you have, different ways in which these processes are carried out, different way the friction forces are acting or

different way they will be producing the finishes on the casting and also the productivity of the process. So, we will discuss about the analysis of these rod drawing process in our next lecture.

Thank you very much.