Principles of Metal Forming Technology

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Lecture – 35
Introduction to rod and wire drawing

Welcome to the lecture on Introduction to rod and wire drawing. So, in this lecture we are going to discuss further about another process that is drawing operation of rod, wires and tubes. So, drawing operation involves pulling metal through a die using tensile forces from exit side of the die.

So, in that case what we do? We have seen the extrusion process and now this drawing is different here. We are basically pulling the metal. So, you have a die and from one side of the die you will have the stroke coming into and from other side you are going to pull it.

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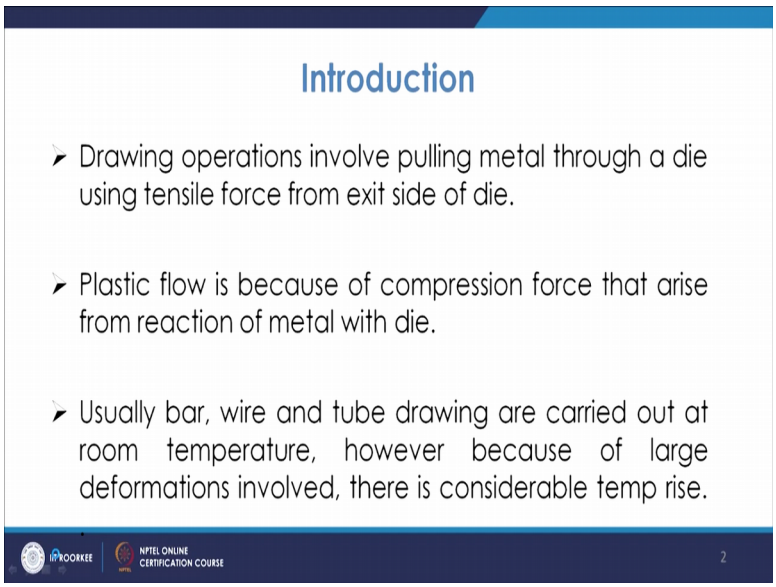

So, using the tensile force you are going to pull and then the material will be pulled and then that will be you know the stored or coiled or so. So, the plastic flow is because of the compression force that arise from reaction of metal with die. So, basically you have as it is shown that you have this.

So, you have a compression force which is arising from reaction of metal with the die. So, you have basically the die through which this coming. So, there will be you know compression force will be there that is developed and that is between the die and the metal and because of that there is plastic flow; that is cost.

Now you have what we do in this case is that we normally reduce the cross section of the you know rod or you know bar or wires; so, slowly as the process carries away. So, our main objective is to reduce that cross section and certainly that will be accompanied by the increase in the length.

Now what happens that normally; what we do is when we do not use any mandrel, then normally that that time when we make the tube that is known as tubes sinking. But otherwise when we use the mandrels, then it is known as the wire drawing. So, that is what so mandrel or plug we used and then this terminology known as the tube drawing or so. The thing is that normally these processes are carried out at not at high temperature; at room temperature or so. But there will be because of the plastic deformation, plastic bulk which is carried out. There will be considerable temperature rise during this processes.

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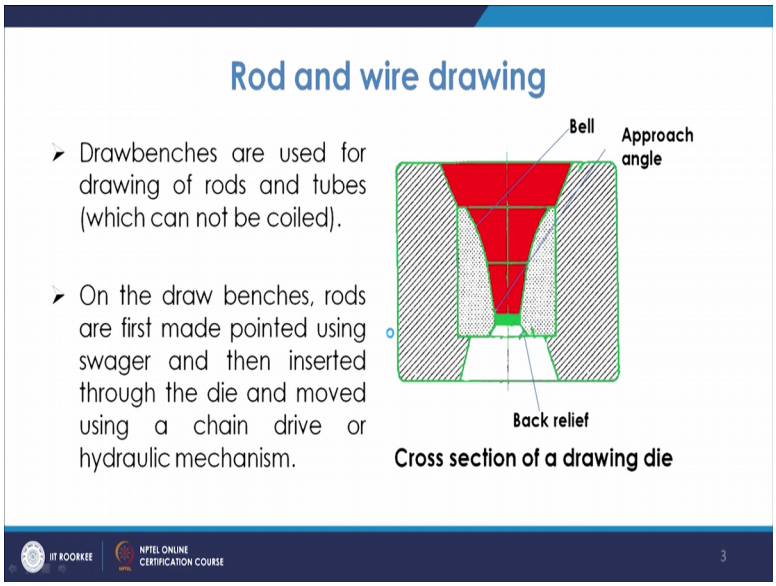

So, we will talk about the principle of the rod and wire drawing. So, what we do is normally such you know drawing dies there. So, this is the cross section of the drawing

die and normally we have draw benches. Draw benches are there to draw these wires or you know rods or so.

So, what is that draw bench? In fact, you have there is a machine. So, from the other side, so you will have the die and through the die basically the stock has to pass and from other side you have basically to pull it. So, pulling it is done through a the drawing head. So, you will have large you know, with large force this draw benches are used and hmm so, these draw benches are like you have normally you have you know a die.

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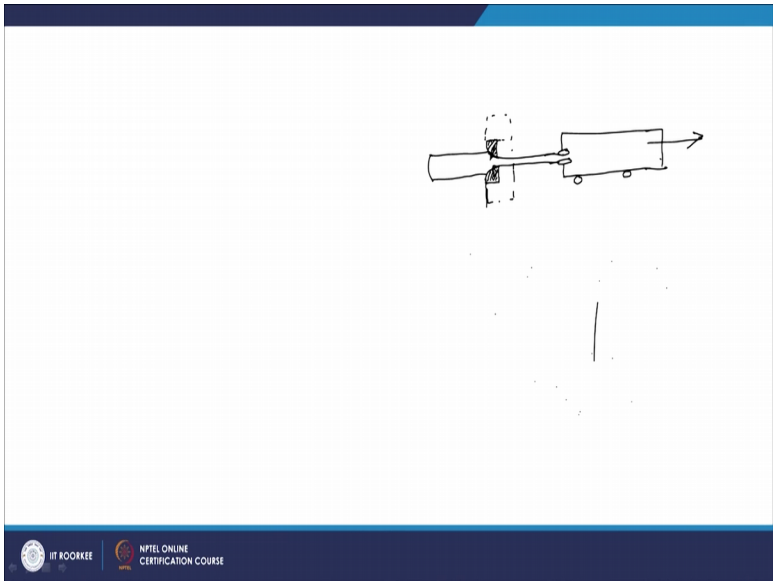

So, normally suppose you have this one. So, this is through it is passing through a die. So, basically you will have a die like this and this will be your die. So, now, what happens that now from here, this is to be pulled into. So, it is to be pulled and at this place you have these you have jaws. From the jaw basically you will have some compressive you know mechanism.

So, you will have certain mechanism by which you can pull it. So, you will have like that. So, from here basically you are pulling it. So, this is you know your die. So, this is your die. Now this die is basically you know this way from here. This die will coming; they have a holder basically. So, this is the holder and from here this will be pulled away and as this is a conical you know you know entries there. So, from the that exists.

So, here we will have the reaction force is which is occurring you know which is applied and because of that this you know deformation takes place and the material is drawn. And then there will be basically you know drawn and then they have to be further coiled or whatever it be.

So, normally what we do is that you have this you know the rod which we are basically putting into it. Normally they are made initially the pointed ones. So, that they can be you know pointed with his stager and then there will be clamped and then further they are basically, you know pulled away using these draw head.

So, normally what we do is that there will be either by the chain mechanism or by the hydraulic mechanism. So, this is we being pulled. Now the thing is that you have normally a for example, typically you have 1 meganewton of pull and 30 meter of run out for that. Draw speed will be normally about 150 to 15000 meter per second that is achievable in the case of drawing.

Now what we are we are talking about this you know drawing die. So, this is the typical example of a drawing die. As we know this is the bell shaped region and you have this is your approach angle here and then further you have this is known as the you know this is the back relief. So, we will discuss about the role of every you know in a portion of this you know drawing die.

So, first of all they are used for drawing of rods and you are making it pointed using swager inside through the die and moved using a train drive, chain drive or hydraulic mechanism. So, what we do? So, normally you have, so as we know that this is the bell portion; now this bell portion basically is for facilitating the entry into this you know die. So, that there will be further reduction in its you know diameter and here also you will have the chances of the lubricant which is basically being carried away. Lubrication is required to reduce the friction. So, what we do is you have at the entrance of the die you have bell shaped.

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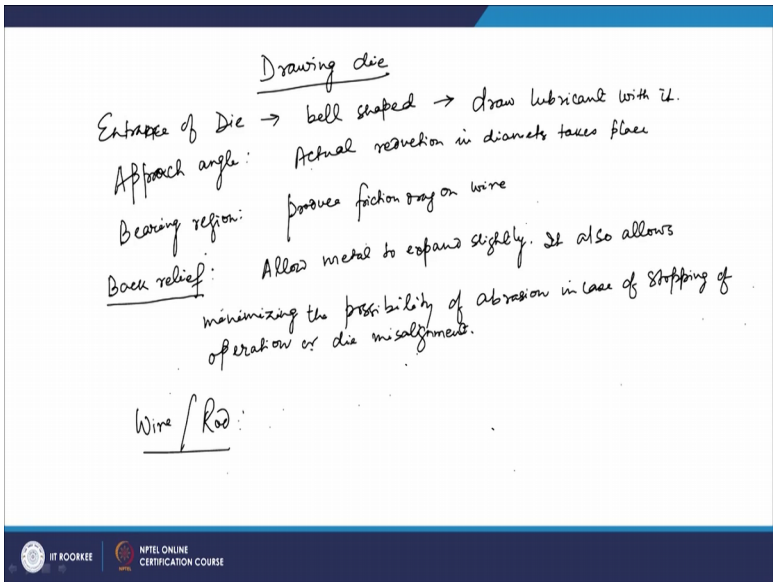

So, for a drawing die, now what we have seen is that you have the bell shape. So, entrance of the die entrance of die is made bell shaped no. So, what happens that this will basically so, draw the lubricant with it. This is what the bell shape is and this will draw the lubricant with it. So, this will draw; so, basically that that will be done by the die. So, die will be drawing the lubricant with it. Also this bell shaped you know bell shape will basically increase the hydrostatic pressure and because of that you know that promotes the also the you know flow of lubricant into the die.

And you have basically there is approach angle. So, that approach angle is there this approach angle is here. So, this is your approach angle as you see. This is the approach angle. Now the function of this approach angle now, this is the approach angle and here basically the actual reduction takes place. So, here actual reduction in diameter takes place. So, corresponding into that you have the half die angle; so you have full angle is the one. So, half die angle will be there that is basically one of the important parameter which is there in the case of drawing.

Then you have the bearing region. So, if you look at the picture further. Now in this basically this is your bearing region. This zone this zone is the bearing region. Now the job of this bearing region; so, this is your, now there basically are not the one where the reduction takes place, but they are basically producing the friction drag on the wire. So,

they basically, so they produce friction drag. So, what they do is they basically at I mean permit the this conical approach of the surface to the refinished portion.

So, they have you have already the one. You have before that you have that approach angle portion where the reduction in diameter has taken place and then they are passing through that bearing region and there basically you will have the ah; there is will be will be no change in the dimension. Basically there will be refinishing that will be taking place in that portion.

Then you have the back relief region this is the back relief region as you see. Here this is the zone which this is the back relief zone. Now in this zone basically what happens that you see that there is increase in the cross section at that point. So, you have come to this region then you have the bearing region, then you have gone to the back relief region.

Now this is the back relief provided. Now this back relief they will be you know they allow the metal through expand slightly. So, they allow metal to expand slightly. So, when the wire is about to leave that time basically since it is being compressed and since it is coming out of the die. So, that time it may expand little bit and so, that allowance is given by providing this back relief. And it will also minimize the abrasion which may take place, if the drawing is stopping or there is any misalignment in the die.

So, you have it also allows minimizing the possibility of abrasion in case of stopping of operation or die misalignment. So, this is the you know that is why you see that this back relief is provided. And normally the die is made of very hard material and they are normally made of the cemented carbide or industrial you know diamond, when we have to produce the fine wire. So, that is the dyer you know made of. And you have also a thick you know casing steel casing is there. So, you see this is your die and then this is your casing which is made of a steel.

So, this casing is normally for its protection of the die and that is normally made of the steel. Now when we talk about the drawing operation, in that case many a times we talk about the wire or the rod. So, we have to know the distinction between the wire and the rod. So, basically wire when we talk the diameter is less than 5 mm and when we talk about the rod, it is normally will be the diameter more than 5 mm. So, that is how this wire and rod is defined.

Now so, it means that you know this wire drawing when we do, basically the that is of a very smaller diameter. So, you have to go for multiple you know times you have to do the reduction because in one go itself you cannot do the whole reduction. So, you have to go for multiple times the reducts. So, so that will be done on multiple die machines; so, that we will look at.

So, when we talk about the you know wire drawing then in that case the process is that. Now the thing is that when we do the starting the wire drawing operation, it usually starts with a coil of hot roll rod which is first cleaned by pickling. So, you have the in hot role rod. From there you make the wires and first of all you do the cleaning of this you know hot roll rod. So, that is done by normally the pickling of pickling process and further you are giving a coating, surface coat on this for the lubrication.

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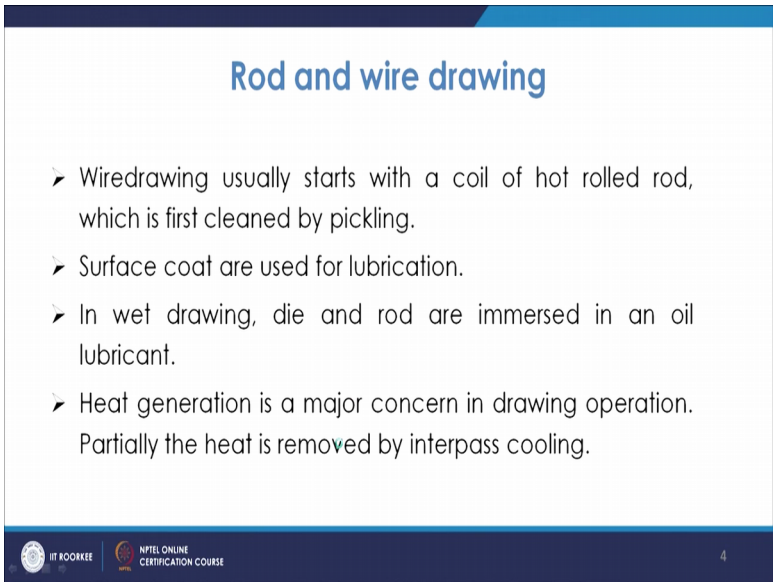

So, the pickling is done basically to ensure that there is no at all any kind of scale or dirt on the surface. So, that when you go into drawing the wires, then in that case that is a non-interfere with the drawing operation or if that is going into it that may result into certain kind of defects.

So, we normally clean it first and then we have to ensure that there is proper you know lubrication that is effective and for that we are doing the surface coatings and also we go for the conversion coatings; so, like sulfates or oxalates. So, which are there which are applied to that rod; that is done I mean in conjunction with the lubricant, you know

normally which is soap which is used in the case of the dry drawing operations. So, with so with soap you have oxalates or sulfates which are used, you know in the drawing operation.

And when we talk about the wet drawing in that case die and the rod are inversed in the oil lubricant. So, in that basically the e p is used as you know additive. So, that is how you normally try to go for these you know applying the lubricant and sharing that there is proper lubricant. So, that your wire drawing operation is going without less of the friction. Now what we do is normally when you have the rod diameter is very very small, in that case what you do is that you know do the block you know drawing. So, block drawing is normally implied.

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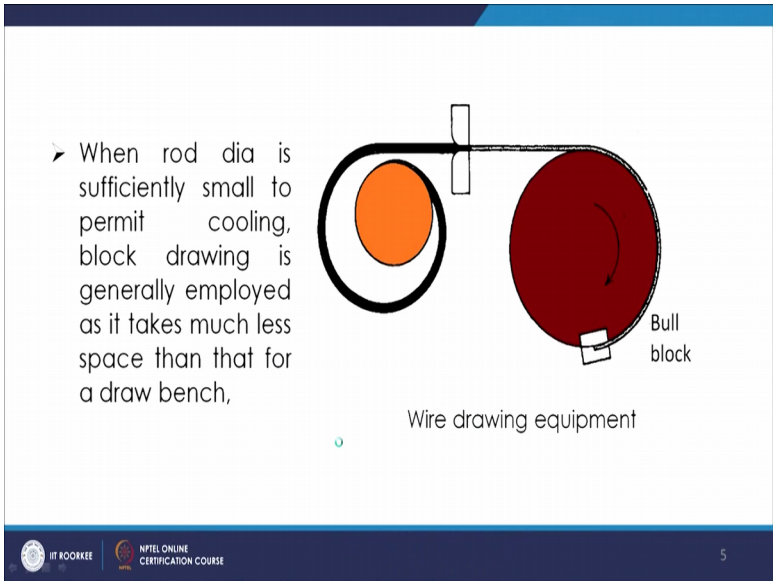

So, when rod diameter is sufficiently small to permit the cooling, in that case you go for the block drawing and it will take much less space than that for a draw bench. So, draw bench in fact, you require larger a space because you have a draw you know head and you have you know the die. So, from there it will go and in the longitudinal direction, it will go on pulling. So, you require a larger a space. But when you have the rod diameter smaller one; typically when the diameter is smaller and it can be coiled. In those cases what you do is you try to draw and further you try to you know coil it.

So, so that basically we will take very very less space in those cases and what you see here is that you have this is the die and this is the wire. So, you know it will also be

coiled and this will be it going through this you know die; as we have seen that from the die it will be entering and then it will be you know given this rotation. So, that it will be pulling from this side. And then once it is coming, then it will be basically you know getting coiled on this block. So, you we use this block drawing for generating very very large length of the you know wires in a very small spaces.

Now this is for that case when you have a, to have a diameter of certain you know you know that if there is a one you know die; so, this your die and you use only one die and you know that at what speed it has to because this is coming at certain speed and depending upon the reduction, you can predict the you know speed at which you have to rotate. So, based on that, you can have the drawing process being carried away in carried out.

Now the thing is that when we have to go for very smaller wire diameter and if that is not possible in one you know restage of reduction, then you go for multiple stage of reduction. So, what we do is you have many you know such dies which are there in between and then, accordingly because every time it will go. So, the speed with which it will be leaving here, that will be used in the next run.

So, at the at the next place when it will be you know further used, at that time basically that will be the input velocity for that stage and then from there further reduction. So, then again velocity will increase; so, like that. So, you may have certain approaches by which you can do it. So, what we do in those cases.

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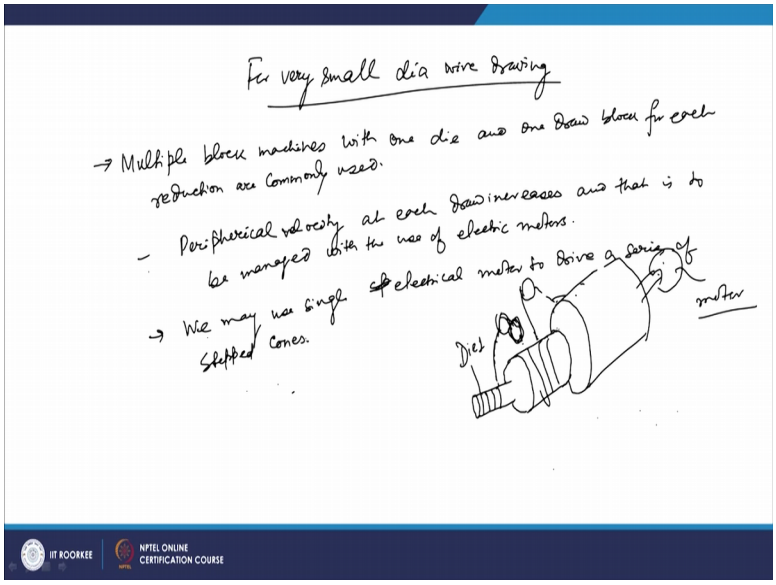

Now so, this is this will come later before that what we do is. So, in the case of these you know when we have to go for very small wire drawing, so you may use multiple you know block machines. So, multiple block machines with one die and one draw block for each reduction are commonly used.

So, this is what the common practice is that you will have as we have seen that in this case you have one die and one block is there. So, in that case what we have is you have every time you have a draw and block. So, that will be taking and then it will go for further next die and then they are so, the way with which it is going away that will be the input velocity for the next die set. So, that way the process will be carried out.

Now what happens that every time your velocity will increase, so peripheral velocity at each draw increases. So, that pheripheral velocity will basically increase at every draw and that is to be managed with the use of electric motors. Now so, for that basically you can have the use of electric motors to do that. There is also another way by which you have the use of the stepped cone multiple pass wire drawing. So, what we do is that what we do is that we use we may use single speed single electrical motor to drive series of stepped cones.

So, basically what happens that you have the stepped cone type of geometry and in that depending upon the diameter; you have you have the different speeds that can be maintained. And accordingly with the help of single motors in this case you may have different motors which will be managing that the speed at different you know values, but

you may have a situation where suppose you have one you know dimension here. So, one stepped cone is here like going out and then from here, you will have further; so you will have this will be going on. So, you will have that stepping then further you have you have further you have you know.

So, this way this is stepping will be going on and you will you know die 1, 2, 3, 4. So, like that it will be you know going on and. So, this will be die one similarly that at attached to you know so, 2 die 2. So, that will be die you know coming up and here so, it will be further. So, that way you will have this will be going further, you will have another die. So, this way die will be you know attached and that will be attached here.

So, this way you will have multiple cone type of arrangement which takes into account. So, you can use you ultimately the purpose is that you have only one motor here. So, you have one motor and that will be doing this purpose. So, that can be used for very small drawing and you can avoid the use of many motors in such cases.

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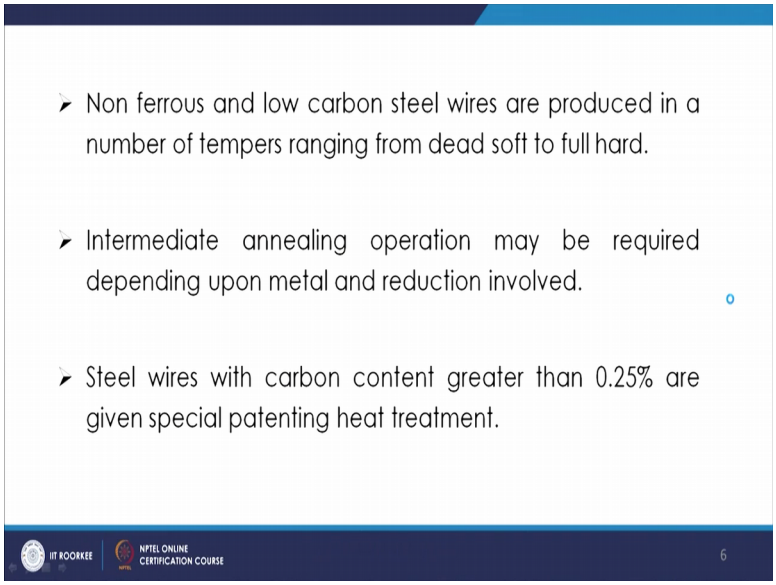

So, non-ferrous and low carbon steel wires are produced in a number of tempers. You know that is ranging from dead soft to full hard. Now the thing is as we know that in the case of wire drawing, since it is a cold working process. So, normally when we are going to reduce the dimension further and further its hardness goes on increasing. So, depending upon how hard you require or whether you require soft wires or you require the hard wires, so based on that you need that treatment of the machine. So, you can have

the soft machine and you can have the fully hard machine. If you have you need the soft you know, if you can have the soft you know wires or hard wires.

Now, soft wires mean that in the intermediate process, you have to anneal. Now, if you anneal; so, annealing is done by heating you know to a temperature to higher temperature. So, you know that annealing process in that we heat the were the critical temperature. So, in that case you are heating and then, further you are doing the you know ah; so once you are heating and doing the cooling at control rate in that case it is an annealing process and it becomes softer.

So, depending upon the you know what kind of temperature is required; whether you require dead soft or you require the full hard. So, that way you can have the different types of you know wires of different you know hardness. There are basically special treatment like patenting treatment also for you know carbon. When if the carbon is percentage is more than 0.25 percent, then you are giving some special you know patenting heat treatment.

Now, in that what you do is you are heating that above the upper critical temperature and cooling you know around 350 degree centigrade. So, that you ensure that there is a fine pearlitic structure and it will be giving you, basically it is done to give you the best combination of strength and ductility. So, for that this you know this patenting treatments are given.

And also there are also certain defects which may come along with this process because of the formation of pipes in the you know, in the stock which is going into it or because of the improper you know drawing operation. There may be several crocking cracking present at the center of the you know wires that is reported; that that may happen in the case of you know this wire drawing treatment.

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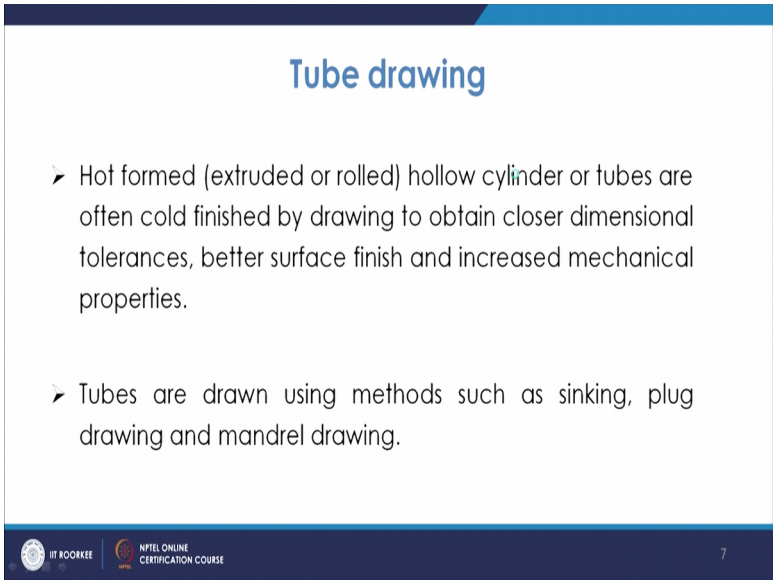

Now, you have the tube drawing also done and tube drawing is hot form that is extruded or rod; that is hallow cylinder or tubes are basically often cold finished by drawing to obtain closer dimensional tolerances, better surface finish and increased mechanical property. So, in this cases what we do is you can have the sinking process where we do not use any kind of mandrel or you can have the plug drawing as well as the mandrel drawing. So, in those cases in one case you do not use you know, any kind of this plug or mandrel.

And another process is that you use the plug that is fixed that may be the plug that is fixed plug or the floating plug. So, that may be used or you can use the mandrel and then that process is carried out this drawing operation. So, you can have this tube getting drawn in a in the case of the hot extrusion or so. So, that is another way to produce that is the way by which so, you may have seen earlier in the extrusion also. And in this case we use this to draw it. So, you have a drawing mechanism by which you can draw this you know tubes also in this process.

Thank you very much.