Theory of Production Processes

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Lecture - 31
Rolling process: Classification, Hot and cold rolling

Welcome to the lecture on rolling processes. So, we will discuss about classification and hot and cold rolling in this lecture. So rolling is very important process of deformation in the most of the plants, if you talk about the plants there you get the blooms or billets, which are produced in earlier days they were all produced in the rolling mills.

So, basically once you have the ingot as we discussed earlier that in the case of metal working processes, when you find; the ingots have a lot of defects they are possible defects in those cases. So, basically, they need to be eliminated and that is why these metal working processes are important, that these ingots were to be you know converted into the usable products. So, the usable shapes which are further used for making the final product.

So, in the intermediate you have to convert them into blooms, slabs or billets, and then these blooms, slabs or billets are converted into further the sheets or plates or, so this process is done by the use of rolls. So, you have the rolls made of very hard material and the material is basically the ingot or it you know slabs or, so they are basically pushed in between the rolls. So, what happens that from one side the ingot or the slab which goes in between the rolls.

So, for that the thickness of these ingot or the slab is more than the gap between the rolls. So, otherwise they cannot move, but then when there is there is you know rotation given to the roll, and then also there is friction at the surface of the roll and in between the metal which is to move into it, then because of the friction it is going inside that roll.

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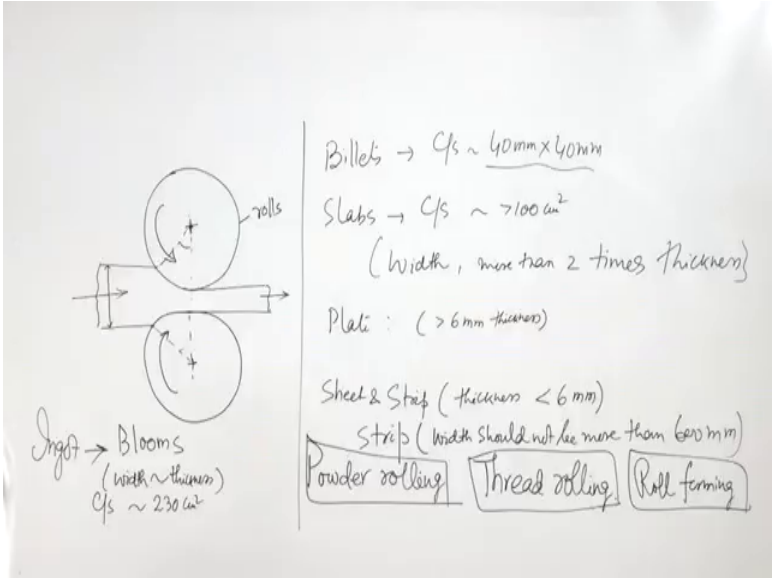

So, the principle is that you have 2 rolls, so there is a roll here and there is another role which is here. So, these rolls are there you know it is not very round. So, try again further to make a better. So, you have this center line so you have again coming as this center line.

So, you will have like this still it is not so good, but still now the thing is that you have a product which has to go from here it is thickness is this one. So, this is the thickness now this can be it is thickness can be reduced and you know once it will go in between the rolls then it will come out of this thickness. So, it moves in this fashion and ultimately this will be of in this fashion it will go.

Now, the thing is that when we use these rolls. So, these are known as rolls and this is the stock. So, this stock can be of anything it may be you know an ingot, it may be a slab or it may be you know billet or blooms or so. So now, that this in got suppose you have got this is put here and depending upon the degree of reduction you will have to maintain the distance between these rolls. So, that also again depends upon the coefficient of friction between the rolls and also the stock material.

So, it will not go otherwise inside it what is done is it will be moved. So, basically this is given if this being the center of the rolls. So, it is given a movement to this roll. So, this will be moved in this direction and this will be moved in the opposite direction. So, because of that once it comes and touches here, because of the frictional forces now it

will try to take this into in between the rolls. So, it will go there and then once it goes into this range then here it gets plastically deformed. So, because of these stresses which are there on this there is compressive stress, which is acting on the surface of this stock and then it moves into this direction.

So, basically this is the this is known as angle of bite, so that you must have taken these courses earlier that these are the rolls this angle which is there, which is formed this is known as angle of bite, then how much can be the degree of reduction basically that also is a factor of what should be the frictional value, so that frictional coefficient friction at this surface. So, this is how rolling takes place. So, process of plastically deforming the material to by passing it in between the rolls is called as rolling that is the definition of rolling.

Now, workpiece is subjected to high compressive stress because there is a squeezing action of these rolls and the part, the stock is basically squeezed in between the rolls and the surface shear stresses are developed here and because of that the material fails. So, this is developed because of the frictional forces which are present in between the surface and so, because of the friction between the surface and surface of the stock and the roll. So, here this friction is generated, so because of that surface here is formed, surface here forces are generated and then that basically shears or plastically deforms the material.

Now, the initial breakdown of ingots to blooms or billets is by hot rolling. So now, again in the case of rolling you have hot rolling as well as cold rolling. So, again it is same as the hot working and cold working temperatures. So, hot working will be for roughing purposes initially for decreasing the dimension from larger to smaller. So, for that these hot working operations are carried out in that you will have different passes will be there.

So, from ingots to blooms or billets is done by hot rolling, so which is further hot roll into plates, rods, bars, pipes. So, you have first conversion from the ingots, because ingot is of larger dimension. So, you will have the ingot converted to blooms or billets and then you have the blades or blooms or slabs they are converted to plates, sheets, rods, bars and pipes.

So, there again the use of hot rolling or you may use also cold rolling, because again it depends upon what kind of property you need cold rolling normally is used for making

strips, sheets and foil. So, cold rolling as we discussed in the past that called forming or cold working normally gives you a better finish. So, whenever the degree of reduction is required you go for hot rolling and when the finish is required finally, you have to go for final finishing in that case you go for the cold rolling. So, in cold rolling again cold rolling cycle will be there. So, that way you will have.

Now, what we have for this you know ingots, then you have the different products which is basically formed by hot rolling of the ingot, initially now from the ingot you get first the blooms. So, in the case of blooms cross-sectional area is greater than 230 centimeter square. So, ingot will be first so you can get blooms. So, in the case of blooms normally you have width will be somewhat nearly to thickness and cross-sectional area will be somewhat around 230 centimeter square.

So, that is bloom 15 by 15 of square or, so that will be known as bloom then you have further you can have the billets from inlet from the ingot you can have blooms you can have the billet us. So, billets normally have the cross section of 40 mm by 40 mm. So, other products which are from the ingots are billet us, so in this case cross section is normally 40 mm by 40 mm. Then apart from that you have the slabs, so slab blooms and billets these are the normal products which you get from the ingots.

So, in the case of slabs the cross section will be normally more than 100 centimeter square. So, you have billets which are very small, then you have slabs, then you have blooms which cross section is even larger for more than 100 centimeter square, and the width will be larger in the case of slab. So, width will be in the case of slabs somewhat more than 2 times thickness. So, if you take about 100. So, it will be something like width will be 40 centimeter and it will be thickness will be 7 centimeters. So, that way you will get close to 100. So, something like 15 and 7 and half something like that 15 and 7 or so.

So, this way these are the 3 products which are basically formed by the hot rolling. Now a days, basically because of the other advancement in casting processes you can get these formation of these slabs and billet us, directly from the continuous casting units by casting itself in the copper mold. So, getting directly, so that basically decreases a lot of these rolling operations or intermediate operations in between. So, that gives you this formation of these slabs, blooms or billet us.

Then the next is from after that these billet us, slabs or blooms, they are the ones from here again further you go and use this billet slabs or blooms, further to make this place sheet, rods, bars or pipes these are used further in the plant.

Now, again you have plated seat are as we know that in this case also thickness becomes quite less. So, we define plate as the one which has more than 6 mm thick. So, you have plate and you have sheet. So, plate is having more than 6 mm thickness and the sheet is having thickness less than 6 mm, but then width also is the one criteria. So, this is plate and then then you have sheet as well as strip. So, plate is plate is the one which has 6 mm thickness and sheet and strip both have the thickness less than 6 mm.

Now, in the case of strip the width should not be more than 600 mm. So, that is what the case of a strip thickness is less than 6 mm and width should not be more than 600 mm. So, this is normally the definition of different kinds of the rod products which we see in the industries.

So, apart from that you have different kinds of rolling. So, by definition rolling means and that process in which we use the rolls to basically deform a particular stock and reduce it is thickness and get the product later on the product will come out of the rolls. The thing is that apart from that this rolling is a use of rolls. So, normally we use these solid products, solid material which is in certain shape and we push them in between the rolls, but we have also some rolling processes like you have powder rolling.

So, in the case of powder rolling what we do is the powder is used basically. So, metal powder will be introduced between the rolls and then you will have a green strip formed. So, that will be further sintered and then that will be further processed and you get the sheet basically. So, you will have the green strip formed once you put the powder and pass in between the rolls. So, and then you have a green strip that will further be treated hot ward or cold ward and annealed, I mean that cycle is followed to get the final product.

Similarly, there is another type of rolling that is thread rolling, so in the thread rolling basically the metal will be passing in between the groups and then in that die itself you have the shape for the thread making. So, once it comes out it will have threads formed on that. So, that is known as thread rolling.

Then you have also roll forming. So, we have thread rolling that is by formula and then after the another variety is the roll forming. So, what we do is that you basically it is a special kind of cold rolling in which the strip will be passed in between the rolls to have some complex shapes.

So, you know here thickness does not appreciably change, but the shape basically you get of different form. So, that is why you have the term known as roll forming. So, thickness is not much of there is change of in the thickness, but then you get the you know you are basically passing it through a series of rolls and you get irregular shaped of channels by the use of this roll forming processes.

Now, we will talk about the roll mills. So, they are also known as a rolling mill. So, this rolling operation is done in the plants in certain shops and these shops are known as rolling mills. So, here you have these rolls then a rolling mill will have the rolls it is wrongly written tools.

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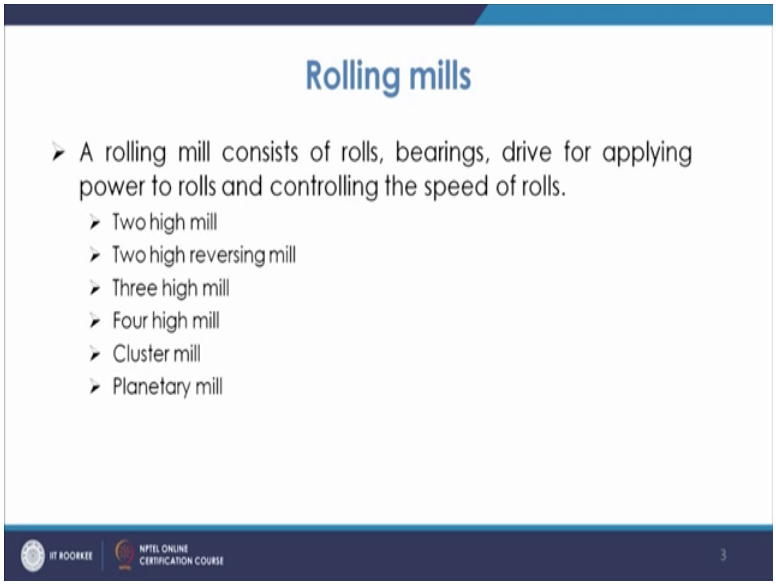

So, it will be rolls and so, you will have rolls then you will have bearings to support that rolls, you will have the drive for applying power to the rolls and controlling the speed of rolls. So, that is how a rolling mill will be defined because basic purpose is to feed the stock or the slab or the ingot. So, for that you must have the rolls at it is own position. So, you will have the bearings to support the rolls then you will have the drive, which should have be applied and we applying the power to the rolls to rotate it. So, the rotate

in opposite directions in between the rolls are moving and also the controlling the speed of the rolls. So, you can control it. So, for that you must have that and then must be housing which should be there. So, this way you will have rolling mills.

Now, rolling mills are of different types like you have simplest is the 2-high mill. So, 2 high mill means you will have 2 rolls. So, there will be 2 rolls of similar diameter and then the metal stock will go from one side and it will pass after getting deformed, and while it comes out in that case it is thickness is now basically equal to the gap between the 2 rolls. So, this is the simplest type of rolling operation. So, that is what we have seen earlier that.

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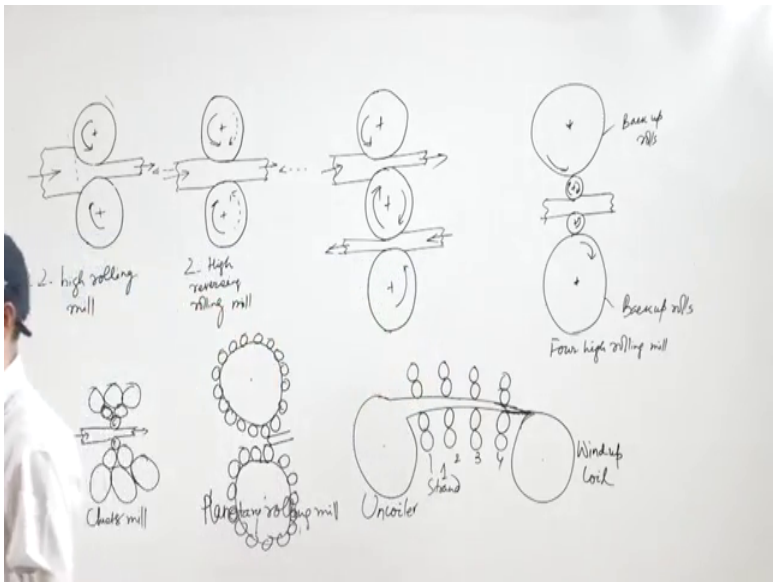

Was a case of 2 high rolling mill you have one roll and then you have another roll? So, it is not very good circle which is drawn. So, you can have one roll, you can have another roll and then the metal will come from here not that way. So, you will have like this. So, this way it comes and then it goes from here. So, basically now this is coming like this and this is going like this is the centre of the rolls, and as we discussed that it has to be rotated like this and this has to be rotated like this. So, this is known as a simple 2 high rolling mill.

Then now you may have the 2-high reversing rolling mill in that basically the work can be passed back and forth through rolls. So, suppose this is the similar roll, but if the object will be further once you have passed it through this and then if you can further

change the direction of the movement of rolls. So, in that case the same thing can further move and there will be reduction in the gap in between the rolls then it is thickness can be further reduced.

So, that is known as too high reversing type of rolling mills. So, in that basically you will have both kind of movement possible. So, you will have once you move like this and then further, so while taking this and you can further move like this. So, for movement in this direction you need to see that the rolls move in this fraction and for moving again in the opposite direction the rolls have to move in this direction. So, this way this is known as 2 high reverse rolling mill.

So, that is the 2-high reversing type of rolling mill, then the another rolling mill is the 3-high rolling mill. Now in the case of 3 high rolling mill you will have 3 rolls. So, in that basically these 2 rolls this top topmost and bottom most rolls are the driven rolls, and this is the roll which basically is driven because of the friction between these rolls. Now if you look at the direction of rotation between these rolls.

So, if suppose this is the roll which has to move in this fashion. So, if it has to move in this fashion then it has to rotate like this. So, that it takes the stock in between the rolls and then it moves here, now after that it is moving in this direction. So now, from here this stock will come in this fashion and then it will come out as this. So, it will be further moving like this and this will be moving like this.

So, in this way if you look at this. So, this will be moving like this and this will be moving like this. So, this will take from this side and it will go like this. So, as you see this is opposite to this and this is opposite to this. So, this or this will have the similar kind of movement. So, this is known as 3 high kind of rolling mills.

Now, you have it is seen that many a times when you use the smaller if you try to rotate the smaller rolls then there is need of small power requirement, so many a times you try to use very small rolls for the deformation, but then they do not they require the support. So, for that there are backup rolls. So, there are one backup roll supporting one of the roll. So, ultimately what is there that you have small rolls for deformation, but then they are basically backed up by the supporting rolls back. So, these are known as backup rolls. So, such kind of roll arrangement are known as basically the 4 high rolling mills. So, this is known as 4 high rolling mill.

Now, in this case suppose this is coming like this. So, it will have the movement in this fashion, and similarly if you have the movement this as this one. So, if it moves in this fashion, so it will move like this. So, similarly this is moving in this direction. So, this is moving in this direction. So, this is moving this direction. So, like that you will have one will be your this will be the working roll, which is doing the these are smaller ones and then you will have the larger rolls for this for giving the rigidity for in the support to this they are known as backup roles.

Then you have sometimes rolls known as cluster type of rolls. So, in the cluster type of rolls again you will have a role which will have the support like there is there are 2 roles which do and it will have the support like in this fashion and then they will have further support in this fashion. So, similarly you will have the rolls initial support like this and then they will have further support like this.

So, these are known as a cluster rolling process. So, this is known as cluster mill, cluster type of arrangement is there. So, again you can have the movement of rolls in that and accordingly the movement of the rolls can be maintained. So, because of this is the primary movement of the rolls. So, this is known as cluster type of movement.

You have also planetary type of rolling mill. So, you will have planetary rolling in that what happens you have the planetary rolls which are there on this attached like that on the whole the periphery you have this way rolls attached, and basically, they are responsible for doing the roll.

So, the job which is there which is coming in contact now this planetary roll is there. So, the job which will come in between it will be deformed. So, again you will have one kind of this. So, you will have rolls attached here. So, you can refer these figures from the standard books. So, you have such kind of arrangement which is there in that case this is known as planetary rolling mill.

You have also formation of continuous strip maybe sometimes, and that is the continuous strip making rolling mills. So, in that what happens if suppose you have a roll, and then you will have the movement, and then what happens now here you will have the support I mean the rolls are there. So, you will have the rolls and then finally, you will have this is for coiling. So, what we see this is a kind of continuous strip making rolls. Now in this what happens you will have these are the strands. So, basically you will have further this

way you will have the rolls these are having different rolls and these are known as a strand.

So, if you look at this is strand 1 2 3 and 4. So, these are the 4 strands, so we call it. So, here what happens you have a uncoiler here this is known as uncoiler. So, basically this releases that coils just like a coil it will release the sheet and then from that it will go successively through these strands, where the rolls are there in between and then ultimately when the thickness will be quite small here, then after that it will come and it will get here wind up, so that is basically known as wind up coil. So, this way the use of these mills are used, I mean for the formation of the rolled products in the rolling industries.

Thank you.