Theory of Production Processes

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Lecture - 33
Introduction to forging process: Classification and equipments

Welcome to the lecture on introduction to forging process. So, in this lecture, we are going to discuss about the classification of forging processes and also the equipments which are normally used in the forging process.

So, as we know that forging is one of the important foreign process where you have the equipment like hammers or chisels which are the basically equipment used and they are used to shape the components, again, here also you apply the compressive forces on the material and the material is basically compressed between 2 dies. So, as we have seen in the case of rolling, we have the roll. So, rolls rotate and the workpiece is fed in to in between the rolls. So, rolls are moving and workpiece is fed in between the rolls.

Now, in this case, what we do is you have 2 dies and the 2 dies are basically brought near to each other. So, one is fixed in at the bottom or it may also be moving and from the top the another die will be going down and it will be pressing. So, this way the forging work is carried out, it has many advantages we know that all these forming operations are done within a specific aim at first to reduce the dimension of the product in certain direction and then to improve the mechanical properties. So, that we have already discussed the advantages of these processes.

Now, in the case of forging, as we see that metal will be converted to useful shape by hammering or pressing; so, it means you have basically 2 types of equipments one is hammer and another is press. So, as the name indicates hammer means you have the hammering action and press is basically you have basically slow steady pressure is applied in that case so that we will see later on that how the press is defined.

Now, the thing is that you have basically open die forging as well as the close die forging. So, open die forging means the; so, ultimately the purpose of understanding the forging is that you have basically a die.

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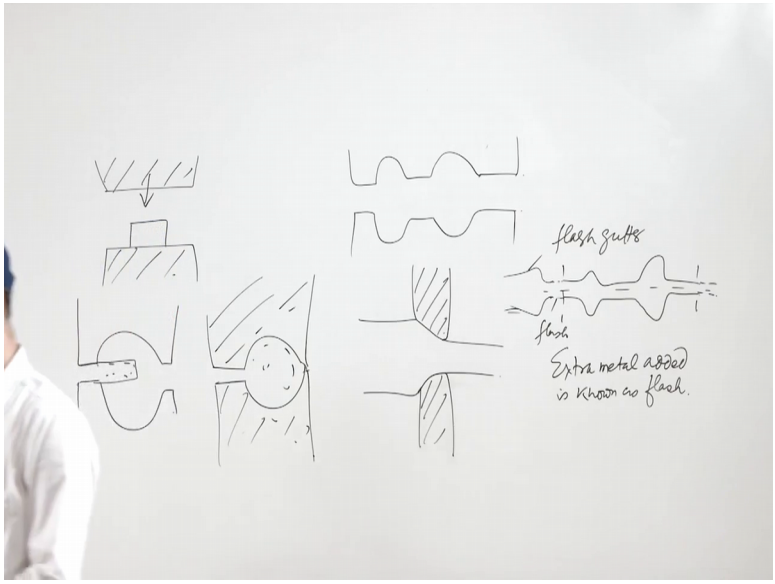

And then you have a material and then another die will be here and so, this basically these are the 2 dies and then it will be moving like this and then it will be compressing it. So, this is the bottom die this is the top die and the 2 dies basically when they meet. Now the thing is that when they are flat and that is able to move in this direction there is no constraint on this side.

So, in that case it is known as the open die forging. So, in that case your dies are flat. So, basically normally for initial breakdown or for initially the changing the dimension of the product you go for open die forging in that case you have the larger stock. So, reducing its thickness these are the you know initially you go using the open die forging.

When we talk about the close die forging now in the case of close die forging the dies get closed. So, you when the die comes when it starts touching and then there is gap, but slowly when the 2 dies basically meet in that case, they are closed from the both the ends and in between in the die you have impressions made.

So, that is also known as impression-die forging because there is impressive made in the die itself and under the application of compressive load when the metal plastically deforms then the metal goes into those recesses or those impressions and you get the final shape of the product.

So, basically that is known as close die forging or impression-die forging. You have; there is a operation known as upsetting. So, upsetting is also a type of you know open die forging where you basically do the upsetting operation you are basically decreasing the height of the specimen that way. So, that is upsetting operation.

Now, what we see is that in the case of forging you have many kind of operations going on and these operations are like edging. So, what we do is in that case of edging, you are shaping the ends of the bars and to gather the metal. So, what we do is when you put the material inside the cavity and then in that case in the edging, you are basically collecting the liqusite amount of material at one places.

So, what happens suppose you have the die like this and you have basically put the material into this like. So, if suppose this is the stalk and when you are pressing them then the material will come and this whole will be; so, this way your material will be saved and your die will be going like this. So, this is your die and this way. So, this is known as edging. So, basically you are basically gathering the metal at its location. So, that way this edging is defined.

You have a term known as fullering. So, fullering means to reduce the cross-section of the portion of the stalk. So, what happens when we try to do the forging in at many places you need to reduce the cross section? So, you are basically taking that. So, you have the fullering tool that we also used you must have seen in the smithy shops or. So, so using that basically what we do is wherever required you can decrease the cross-section. So, suppose you have this kind of.

So, here at this places suppose; so, if you look at this at these places you know the cross section will be reduced and cross section at other places will be more. So, this way you can go for the fullering operations like. So, you have the fullering die and they will take the material away from that it centers. So, fullering tool wherever it will be used they will take the material away and they will basically reduce the cross section of the specimen. So, that will be case of fullering.

Then the next operation will be drawing out. So, in the drawing out basically what we do is in the case of drawing out you reduce the cross section of the work with increasing the length. So, what you do is you apply the tool the die and then. So, suppose you have such as. So, you are you can decrease the cross section and. So, you have a die like this. So,

you have this die and using this die basically you can reduce the you know cross section and increase in the length. So, that basically is known as the drawing out or drawing down operation that is drawing out you know the bending operation where you have the tool is there. So, that will be coming and they will be doing that. So, you have a die of that shape and that will be used to bend the specimen similarly you have twisting soft twisting punching and sharing punching is also there in that case you can do the punching piercing also can be done. So, these are the normal operations which are involved in case of you know forging.

Now, coming to the close die forging if you look at in the case of close die forging basically forging work is never completed in one step you have to go step by step you cannot assume that once you have gone for forging in one step itself you are going to get the final shape in case of open die forging as we have discussed once you do the forging the metal will flatten over the surface seen over the which is kept at the bottom die and when you apply the force then the metal will spread over it.

Now, in the case of closed die forging what happens that you have successive operations to be carried out for finding the final shape? Now what we do is initially you have the operations like fullering edging bending blocking and then you have the finishing. So, this is how in the case of you know close die forging the first operation is fullering. So, they will be increasing the length reducing the cross section at those places. So, that we one will be fullering is there, then you have edging then you have basically bending and blocking.

So, you you have certain stages like blocking. So, blocking means it is a semi finishing operation. So, basically what happens in this case first of all stage by stage the material will go into different dies and slowly the shape of the product will be coming closer to the final shape. So, when the material comes out of the finishing die then the material is ready before that it has to come to the blocking die though blocking die is basically the semi finishing die and then before that you have all the operations required where the material is to be you know going to different pockets somewhere you require the larger you know material or the thickness is more and somewhere it is less. So, this way you have different operations in the case of this close die forging. So, also known as impression-die forging.

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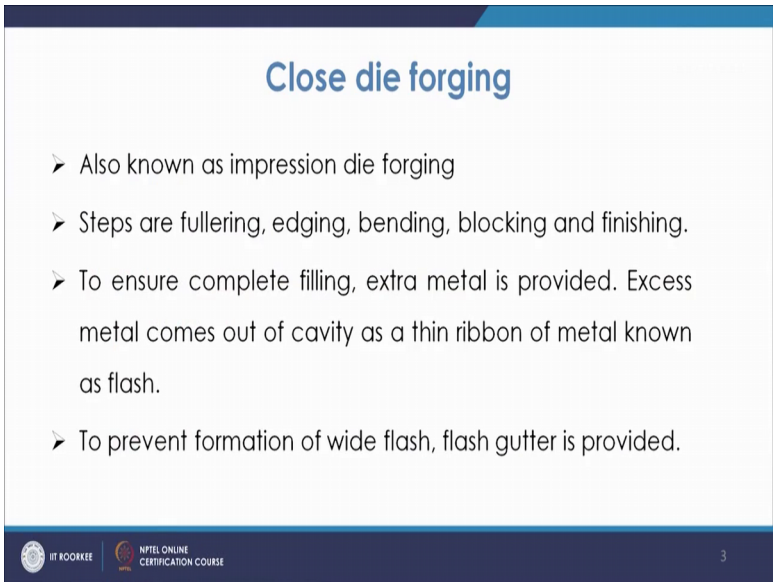

So, what we see is in the case of this you have the steps are first is fullering, then you have edging then bending blocking and then finishing. So, this way you go to towards the final product.

So, what happens initial the purpose initial purpose is to see that depending upon the cavity and wherever you have the requirement of larger material wherever you have requirement of the lesser material less of thickness is there depending upon that you will have to first arrange the metal or send the metal in such a way that wherever you have large thickness more amount of metal goes and wherever you have less thickness less amount of metal goes then you have to see that you have proper corner and radius corner it is given. So, that there is a proper flow of material into the cavities then what happens that you have you are going to the blocking you know stage in the blocking means you have the semi finished stage.

Now, by that time you must ensure that there is. So, what happens that as you see in this case you require to ensure that whole of the you know cavity is filled. So, unlike wise you see in the case of you know casting that metal goes when you have extra metal that goes. So, once your runner; I am suppose or the riser which is connected with the casting and if the riser comes and gets filled it means you ensure that the casting is completely fill if the riser level is above that of the casting.

Now, the thing is that in this case also you need to ensure that none of the portion is unfilled. So, for that basically you have to provide certain extra material and that extra material in this case it will be coming out of the cavity as a thin riven of metal. So, what happens if you are having a suppose something like this type of material now what happens suppose this is the parting plane in that case now what we see is finally, in this case what you see that you get some extra material also in this case here in this side now this extra thin that extra material comes in the form of thin ribbon type that extra material is known as the flash. So, in this case the extra metal added is known as flash [vocalised-noise].

Now, when we go to the blocking operation before that we must ensure that you have properly given the Filat and corner radii because that ensures the smooth movement of metal past these corners and then metal goes into the recesses which are basically away which are in the intricate positions and then you have the formation of flash towards the end which will ensure that the metal has completely filled its whole cavity.

Now what happens that when this flash comes out when this flash comes out it has it is in the fine in the case of thin ribbon type. So, when it will come out it will have a larger you know it is a thin. So, the heat transfer will be rapid and then you know it will try to spread, but we have to try to you know prevent its spread.

So, for that even it is it is having a structure like this you know this is known as flash guitar. So, this is flash and this is known as flash gutter. So, having larger cross section because if it becomes you know quite wide and in that case the resistance to flow will be quite high. So, it will not be able to further move. So, in that case the roll press it will affect the role pressure or you need require very large pressure lot not pressure forging pressure. So, you require very large pressure. So, that way there may be breakage of the dies even. So, you give them some flash data. So, that it comes here and accumulates in that case.

Now, these flashes they have you know some rolls and they are basically working as the safety valve for this process for assess metaling the close die forging. So, and then it also ensures that because once you have the formation of flash and it comes out since it is wide now what happened will happen it cannot come out. So, easily here; so, the extra pressure will be you know experienced by the metal which is inside the die. So, because

of die that basically the cavity is more likely to get filled. So, this way this presence of flash is very important and that is to be also designed by providing proper you know flash gutter in this region. So, this is about the cases of the close die forging.

If you come to further the other kind of forging processes like you have the forging like upset forging is there you have. So, we will especially mainly we have these 2 types of forging process open die forging and the close die forging.

Now, coming; so, we have other specialized type of forging process that we will see later on before that we will discuss about the forging equipments which are used now we will discuss about the different kind of forging equipments. So, as we discussed that we have one is forging hammers and another is forging presses.

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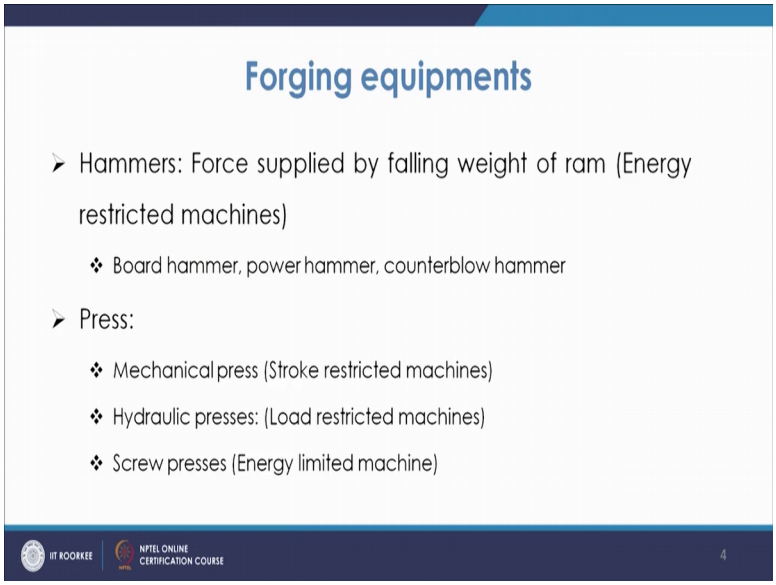

Now in the case of forging hammers as the name looks like, you have a hammering action. So, you have something like a ram which will be acting as a hammer and it will be coming and it will be hitting the job at the die which is kept at the lower die surface. So, this way you have the force supplied by falling weight of the ram.

So, now these hammers; so, it means in this case these hammers are said to be the energy restricted machines. Now if you try to classify the forging equipments you know first of all you can say that it can be classified as either hammers or presses. So, in the hammers, you have the hammering action and you have the impact for use of the impact force

whereas, in the case of the presses, you apply the squeezing action. So, you have slow squeezing action is basically used in the case of these presses.

Now, in the case of hammers what we see is that the ram is falling from certain height and its energy is basically utilized for the deformation. So, since deformation is resulting.

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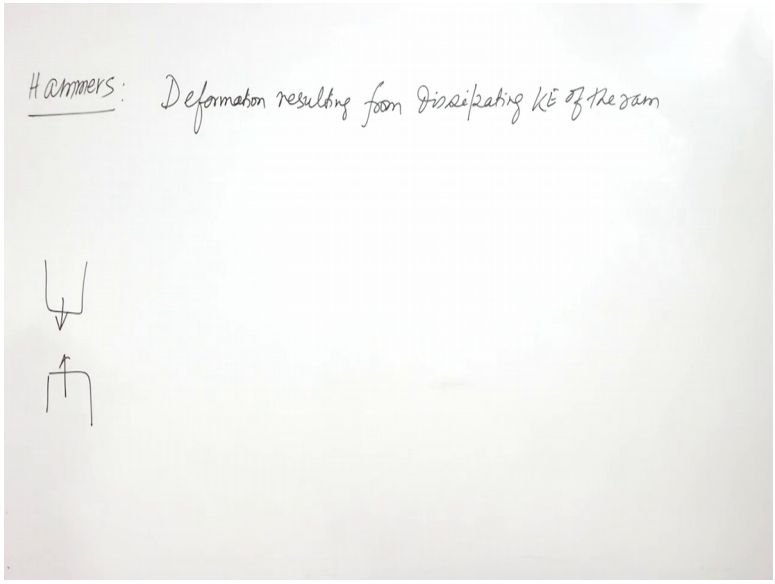

So, in the case of hammer deformation resulting from dissipating KE of the ram; so, since the deformation is the resulting of the resulting result of the KE kinetic energy that is dissipated while it is travelling and then, even then when this is impacting upon the surface that is surface of the job. So, that is why it is known as the energy restricted machines.

Now, if you talk about the different types of these hammers, then in hammer you have the board hammer, power hammer and counterblow hammers. So, normally these are the different types of hammers which are used now in the case of board hammer, you have an upper die and a ram and they are basically raised by the friction rolls gripping the board. So, you have a board. So, that is gripping by that gripping the board, you have the friction draws (Refer Time: 21:59) should be gripping the board and then the board will be released. So, basically the ram will fall. So, you have once you release then the ram will fall under gravity and then it will have it will blow the energy. So, that is how it is known as the board hammer.

So, board will be further you know raised immediately for the another blow. So, this way the blow is you know continuously given and there is a rate upon which by which this blow is basically given and you have the forging hammers which have which gives a repeated blows at the rate of about 60 to 150 about per minute.

So, this way you have these board hammers now in this case of board hammers the energy which is supplied it was basically potential energy due to the weight of the ram and the height of the fall so that way the energy is basically generated and this energy. So, from which height you are basically letting it fall and then also the potential energy of the weight of the ram. So, these 2 things are basically responsible for giving that energy to the workpiece.

Now, coming to the power hammer now in the case of power hammer what happens that in that case basically it falls under gravity. So, it is own weight it will be falling under gravity. Now in that case when it is falling in the case of power hammer you use certain extra; extra source of power air or. So, pneumatic pressure you can apply now in the case of that you can use the steam pressure you can use the air pressure and using that basically when it is the hammer is moving downwards you can give extra velocity extra pressure to generate extra load extra energy. So, that is known as that is the concept of power hammer.

So, also steam or air pressure is used also to uplift the ram after striking it is used to uplift the ram. So, this way since it is giving extra power. So, that is why it is known as power hammer. So, you have basically 2 kinds of energy one is the; you know due to pressure which is applied on the ram because of the air or steam pressure. So, pa into h. So, that basically will be your basically the pressure the energy created because of that pressure and then another is a half a me square.

So, this; what velocity which is falling; so, that energy will be converted to mgh or so; so this way you the concept of power hammers are there in the case of these forging industries you have very high rapid rate of blows in this case and you can apply the load also of larger magnitude in those cases.

Now, another type of hammer is the counterblow hammer. So, in the case of counterblow hammer what happens that you have the rams on both the sides and one is both are moving in normal case of board hammer and power hammer the bottom die is fixed and

this is the ram which is attached and this comes and goes up and down; however, in the case of counterblow hammer both the dies are moving and our job is in between. So, the job the forging press forging work is carried out in between. So, this way that is why it is known as counter blow hammer.

So, in this case this is very much utilized because in the case of board or drop hammer the force is ultimately transmitted. So, your vibration is transmitted to the foundation. So, foundation need to be very strong in this case they are meeting at this point. So, that that foundation need not be so strong in that case because it does not transmit the vibration to the earth or so you need not have that much of problem as regards to this you know vibration is concerned. So, that is counter blow hammer and velocity of ten to thirty meter per second is basically achieved for the ram in these counter blow hammers.

Now, another kind of machines are there that we will discuss like a trf high energy rate forging machines so in that even that higher you know rates the forming or forging takes place.

Now, coming to the presses now the presses basically are one is your you know the mechanical press now in the mechanical place is known said to be the stroke resisted because here in the case of mechanical press your length of the breast stroke and available load at various positions of the stroke represents the capability. So, you have this is this is your mechanical press.

So, in this case basically this is stroke, it depends upon the strokes that is why it is the stroke resistant machine mechanical presses are known as stroke resistance because you have the stroke is depending upon the position. So, you have the stroke is there. So, available length of that pressure stroke is there. So, it will be depending upon the position of this stroke now that basically tells this to be a stroke resisted type of machine.

Similarly, you have hydraulic presses now in this hydraulic presses they are the capability of carrying out the forging operation is limited maximum by a mainly by the maximum load capacity. So, that is why this hydraulic presses here you have the hydraulic medium to apply the load. So, so that is why since the capability is limited chiefly by the maximum load capacity. So, these hydraulic presses are known as the load restricted machines.

There is another variety of press that is screw presses. So, in the screw presses are normally the energy restricted machines because here the energy of the flywheel is concerned now in this case basically the flywheel stores energy and then it releases. So, that is why these screw presses they are known as the energy restricted you know machines.

So, this is about the different kinds of equipments if you talk about the different miscellaneous type of forging operations then we also come across certain forging operations like you have the precision forging or flashless; forging or even near net shape production swim you can design now what we see is just like in the case of casting when your extra metal is like a scrap.

So, similarly in the case of forging as the flash is formed flash is certainly the stage. So, that it needs to be trimmed. So, trimming is another operation which is carried out in the case of impression-die forging when you take the metal out you need to trim the flash which is generated. So, that trimming is another operation.

Now, you have many operations where if you reduce this. So, you get the impression close to the final one and you have flashless forgings or precision forgings because of quite you know low forging loads and low temperatures that if you that is carried out that is precision forging you have the example of isothermal forging also where basically the die and the metal they are kept at similar temperature.

So, in that basically what happens the at higher temperature you require very low value of forging stresses. So, we flow stresses. So, due to that basically you are doing the forging at a very low stress. So, now, normally the die will be made of nickel based alloys and flow within the cavity is quite improved because of certain this kind of forging processes you have also we have.

So, with this what we discussed is that you have different kinds of forging machines you have different kinds like for hammers or presses what is done in forging. So, we will discuss about the forging process analysis also. Similarly depending upon that temperature also you have hot forging or cold forging. So, normally what happens that the hot for this open die forging is the first step and then when you go for the close die forging basically that is the stock from the open die forging? So, that goes for the close die forging before that you have to have the; you know change dimension change to

proper you know size and then you go for the impression-die forging and the metal is put there into in-between otherwise sometimes the pressure requirement will be quite larger or the force load requirement will be quite larger. So, this way we do these forging processes we discussed about the different types of equipments and also the you know types of processes and. So, we will discuss about the analysis in our next class.

Thank you very much.