Processing of Non- Metals

Dr. Inderdeep Singh
Department of Mechanical and Industrial Engineering
Indian Institute of Technology, Roorkee

Module - 4
Plastics: properties and processing
Lecture - 7
Rotational Molding and Blow Molding

Good evening to all of you, I welcome the audience to this discussion of rotation molding and blow molding. As some of you are well aware that we have been discussing the processing techniques for plastics in our last few lectures. Just to revise what we have covered till now, we started our discussion with the differentiation between the thermosets and the thermo plastic in lecture number 1. And then we have discussed one of the important techniques of processing of plastics that is casting.

In subsequent discussions we have discussed the basic principles of some of the processes such as transfer molding, compressor molding, injunction molding, extrusion and today we are going to discuss two important processes that are rotational molding and blow molding. Now, the importance of these two processes lies in the fact that these two processes are used for making hollow plastic parts.

In our last lecture we have discussed the importance of thermo forming in which we have seen that the raw material is in the form of a sheet and this sheet is heated and under heated condition, it gets softened. And this softened sheet is then deformed according to the shape of the mold by the application of pressure, and this pressure can be applied either with vaccum or it can be applied with the help of air pressure or it can be applied with the die-end punch type of mechanical arrangements.

So, different types of raw material that is plastic in this particular case in module number 4. As you know we are discussing processing technique for plastic. So, the raw material in all the cases could be a plastic material, it may vary it may be in the form of powders or pallets as we have seen in the case of injunction molding or it can be in the form of a sheet as in case of thermo forming. So, the type of raw material may vary, but basically it would be a plastic material only and we have to convert this plastic material into the final product.

The products may also vary we have seen for each process. What are the advantages disadvantages and what are the application areas of that particular process? So, if you remember the total conversion stage from the raw plastic into the final product can broadly be categorized into three important stages. This particular point I have emphasized in all the lectures on processing of plastics that three important stages are, stage number one is the heating stage in which the raw plastic is heated and in many case it is melted. The second stage is the forming stage in which the molten plastic or we can say heated plastic as in case of thermo plastic sheet is heated, but it gets melted softened on heating.

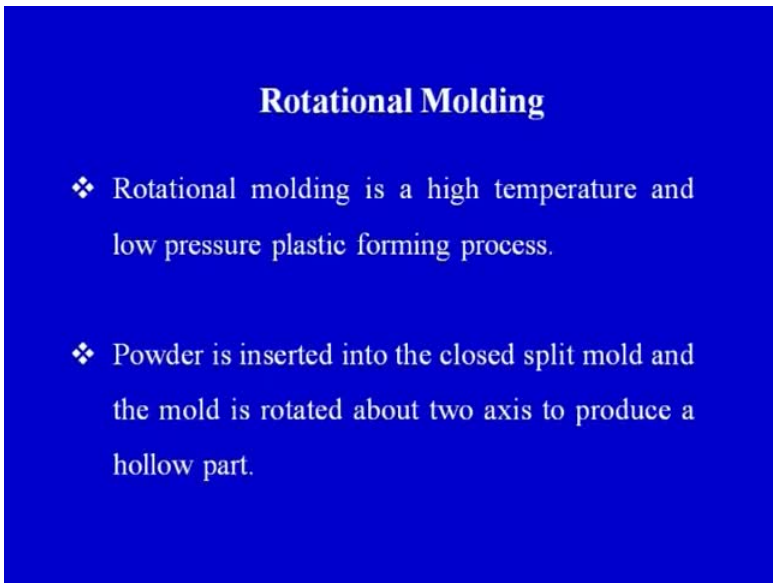
So, the stages may vary that up to what temperature we are heating and what is the effect of that heat on the properties of the raw material? Sometimes it may get melted also and this molten plastic will then be deformed to the stage number one is the application of heat or in single word we can say heating. Stage number two or the second step is the forming. In forming we are changing the shape we are giving the final shape to the product or to the plastic, which we want to convert into the final product and the final stage is the cooling stage in which we allow the final product which has been formed by the first two stages into we can say it is now into usable form when it cools down.

So, that the three stages primarily are heating, the raw plastic forming the raw plastic into the desired shape and then allowing the final shape to cool down inside the mould cavity. The last stage is ejection in which the final product which is cooled down is taken out from the mould. So, basically in all the processes our focus primarily has been in heating the raw material forming the raw material according to the desired shape by the application of pressure or by some other means. Finally, allowing it to cool to take the desired shape and the last part is the ejection of the final formed product out of the equipment.

So, in rotational molding and blow molding also our basic steps or basic mechanism would be same in which we will have our raw material. This raw material would be heated and then it would be deformed, but the deformation may be different. In this particular case the application of pressure may be different or the mechanism of forming may be different. Finally, it would be allowed to cool and the final product after cooling would be taken out from the mould.

So, basically important difference rotational and blow molding with the other processes is that these two processes are used to process hollow plastic parts. So, that is why these two processes have been clubbed together and are a part of today's discussion. So, we will try to understand the basic principle or the basic working of the rotational molding and the blow molding process and we will see diagrammatically that how the processes is actually accomplished?

(Refer Slide Time: 06:25)



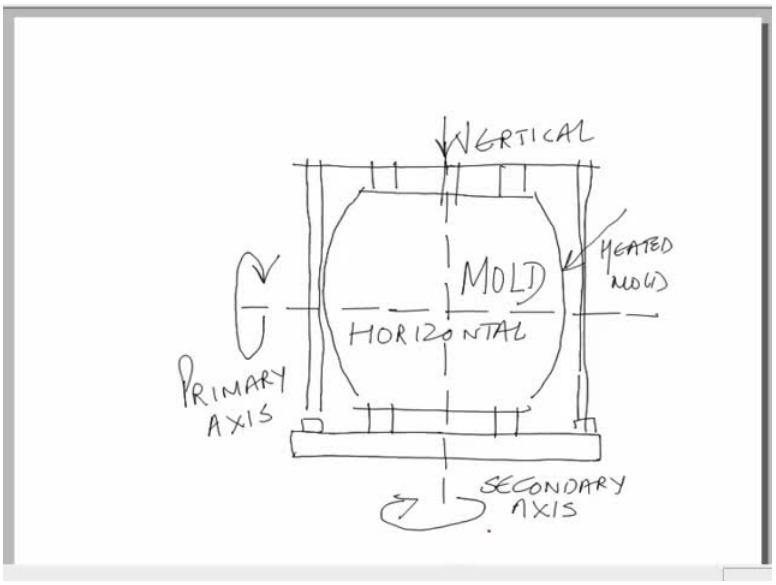
Now, rotational molding process on your screen you can see. The rotational molding is a high temperature and low pressure plastic forming process, which means that we will heat the raw material to a desired temperature, but the application of pressure is not that high. If you remember in our previous discussion, we have discussed the thermo forming process in which the plastic sheet was heated to a particular temperature. Then a pressure was applied to deform the sheet, so that it confirms to the shape of that mould.

So, the pressure was also substantial here lot of pressure will not be applied only the raw material would be heated to a particular temperature. Then under the application of certain type of forces it would be deformed into the desired shape. So, the powder is inserted into the closed split mould now there are two or three important words here closed split and mould. Mould word we have been using a number of time, but closed split means that the mould here is made into two parts or it can be split open into two

part. When these two parts would close together, they will form a closed split mould and the mould is rotated about two axis to produce a hollow part.

I have already emphasized that rotational molding and blow moldings are the two processes which are used for forming of or processing of hollow plastic parts. So, here this particular mould would be rotated about two axis and the two axis we can call as the primary and the secondary axis. So, let us try to understand the rotational molding process with the help of a diagram. So, on your screen I am going to draw a very simple diagram which represents the rotational molding process.

(Refer Slide Time: 08:20)



Now, this is the platform which is supported by the frames. Now, this is we can see platform on which the mould is mounted as we have seen we use a close split mould. Now, this is a mould so we have a mould and then we have two axis. These are the axis that I am drawing on your screen. One is a horizontal axis another one that I am drawing on the screen now is the vertical axis. This is our mould as it is already been mentioned it is a closed split mould that it can be opened into two part to take out the final product and we have the two axis the vertical and the horizontal. This is the horizontal axis, so here vertical axis a horizontal axis and the mould is rotated about these two axis.

Now, this is the rotation about the primary axis this we can call as the primary axis and we can have a rotation about the secondary axis, so this is the secondary axis. So, we have primary axis and the secondary axis and the mould would be rotating about the

primary axis for the given number of rotations and the secondary axis for a definite number of rotations and the raw material is inserted inside the mould. So, we may have an opening at the top for inserting the raw material, so the raw material would be in this case can be a plastic powder or plastic pallets.

So, this mould is also heated, so we may be using a heated mould. So, the mould is heated and when the raw material is put inside the heated mould. It fuse together with the adjacent pallets and finally, under the rotation this particular material which is present inside the closed split mould is thrown out towards the walls of the mould and it sticks to the walls of the mould, although we have a non-stick type of coating, so that the final product that we form do not stick to the walls of the mould.

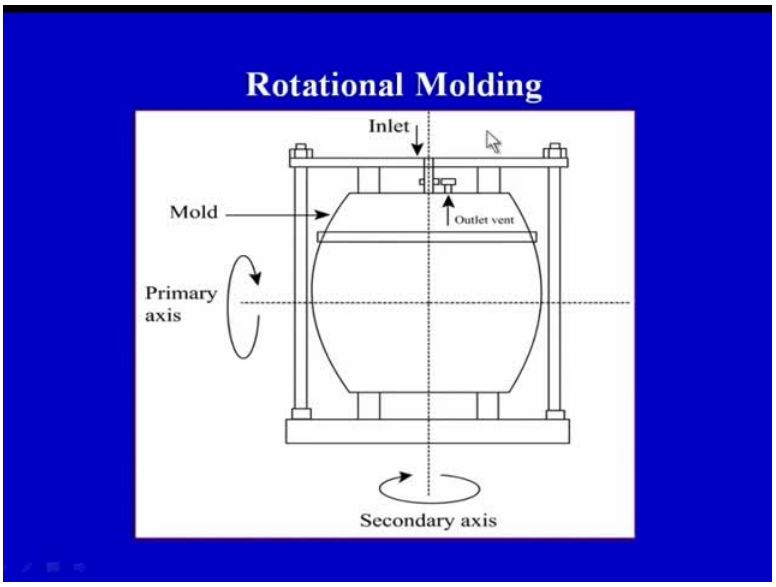
But certainly under the influence of the forces that are generated because of the rotation about the primary and the secondary axis. The material would be thrown out towards the walls of the mould and it would take the shape of the walls of the mould. And finally, after opening the mould the product would be taken out so this is the simple representation of the rotational molding process Once again we can see how the process actually takes place

The raw material is inserted in the form of pallets or powder inside the closed split type of mould. The mould is rotated about the primary and the secondary axis the mould in this case is a heated mould and because of the heat the raw material fuses together with the other other. We can say pallets or the other powdered form raw material and because of the force generated because of the rotation of the mould. The raw material is thrown out towards the wall of the mould and because of the rotation about the two axis the material goes and settles down or confirms to the shape of the mould. Finally, after the material has cooled down the closed split mould is opened and the final product is taken out from the mould.

So, we can make axis symmetry type of component using the rotational molding and as as already been highlighted, that this particular process of rotational molding of plastics is used for making hollow large hollow axis symmetric parts. Now, let us come back to our discussion rotational molding as is clear on the screen is a high temperature, low pressure plastic forming process. We have tried to understand this process with the help of a diagram. Powder is inserted into the close split mould as I have already told the raw

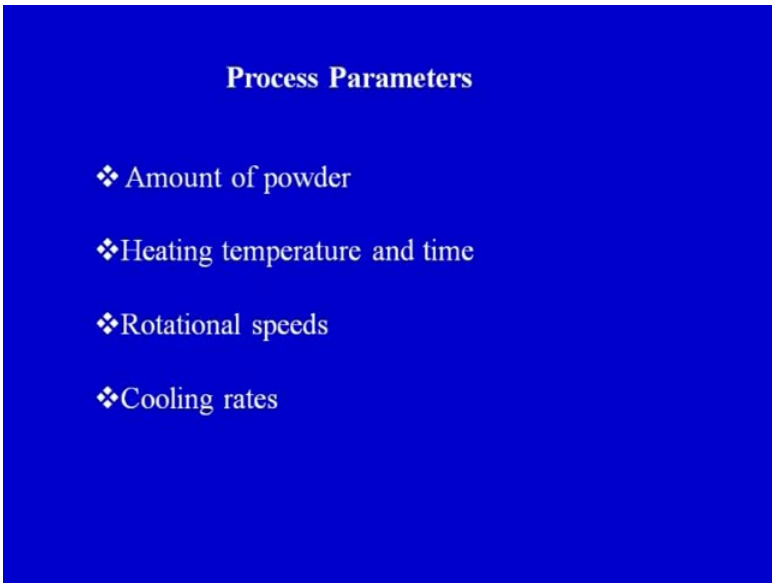
material is in the form of a powder and the mould is rotated about the two axis to produce a hollow part which has already been explained.

(Refer Slide Time: 14:23)



Now, again let us revise this with the help of a complete diagram. The diagram was earlier drawn, this is a heated mould. It can rotate about the secondary axis, it can rotate about the primary axis and this is the inlet for the raw material and on this rotation. This raw material would be thrown out towards the walls of the mould and it would confirm to the shapes of the walls of the mould after the cooling has taken place. The split mould can be opened and the final hollow part can be removed from the mould. Now, the process can be repeated to make similar type of identical products.

(Refer Slide Time: 15:05)



Now, what are the important process parameters as the process does not seems to be very difficult, but there are few important process parameters which have to be controlled. So, that we are able to get a good quality hollow plastic part or a hollow plastic product. What are the important process parameter? Number one is the amount of the powder because a metered amount a measured amount of powder has to be put inside the mould, so that is one important parameter.

Heating temperature and time is also very, very important. We cannot heat too much and if we are not able to provide the optimal heat to the raw material. Then the fusion between the powder may not take place and we may not get a continuous product. So, an optimal amount of heat has to be provided for the metal or the pla sorry, not the metal, but the plastic powder to form a complete product. Do we have to provide a specific temperature or we can say a specific amount of heat has to be generated. So, that the raw material is converted into the final product?

We have also to decide that for how much time this particular heat has to be provided along with the rotation of the mould about the primary and the secondary axis. So, we have to decide on the rotational speeds of the moulds also. Finally, last but not the least we have to see that for how long the mould would be kept closed after the product has been formed inside the mould? So, these are the four important points that have to be

taken into account, if we want to make a good quality hollow plastic part using the rotational molding process.

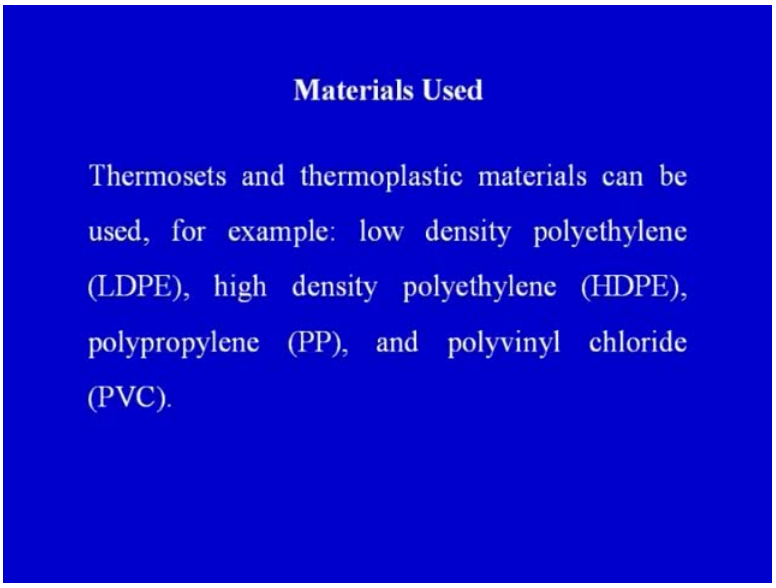
Once again let us revise that what are the important key points that we have to keep in mind when we are going or planning to make a product by rotational molding process. First and foremost we have to decide the amount of plastic powder. which is going as a input into the rotational mould. Second point is the temperature, for how long we have to maintain the temperature or how much heat we have to supply? That is another important point which has to be taken into account and the temperature that we are maintaining or the heat we are inputting will certainly depend upon the type of the plastic material.

That we are planning to form using the rotational molding process, so it will depend upon the type of the plastic and the type of the powder that we are using, so that maintenance of the temperature is equally important. The time duration for which we are going to maintain that temperature is equally important. Finally, at what speed we should rotate the mould about the primary axis as well as about the secondary axis, that is also very, very important. Finally, we should control the time for which the part would be present inside the mould after the after the forming of the part has taken place.

So, cooling rate is also very, very important important point is that how much thickness we want? Now, depending upon the thickness required we have to decide on all these parameters because if we want a thicker wall thickness, we may have to manipulate the parameters accordingly. If we want thin walled sections of the rotational molded product, we have to then manipulate these things accordingly.

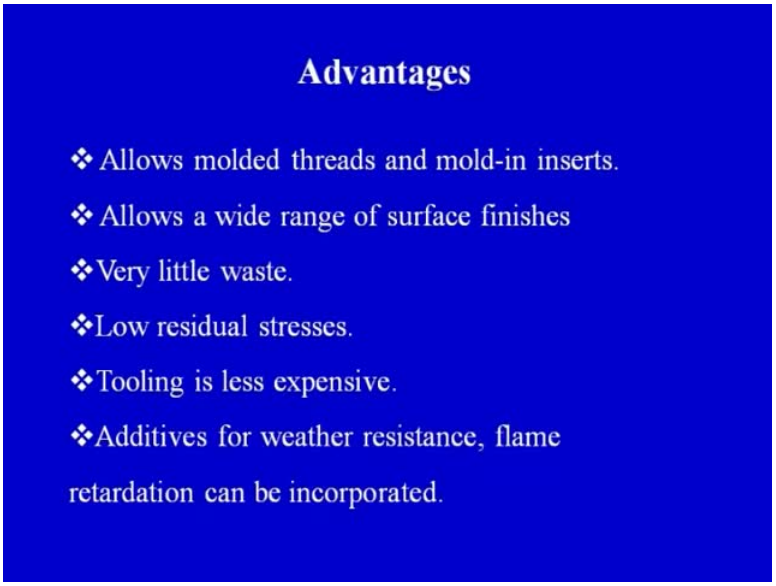
So, these are the four important process parameters, there can be many other process parameter depending upon the shape the type of the final product, that we want to produce. But certainly these four would be common in most of the cases, that how we should control these parameters? So, that we are able to get the product as designed or as desired for a specific applications. So, these are the important points to be taken into account.

(Refer Slide Time: 19:28)



Now, what are the materials that can be used as a raw material? In case of rotational molding thermosets and thermoplastic materials can be used for example, low density polyethylene LDPE, high density polyethylene HDPE. Polypropylene, polyvinyl chloride. So, these are some of the examples of the materials which can be used as the raw material in case of rotational molding process.

(Refer Slide Time: 19:56)



What are the advantages of this process? Allows molded threads and mould-in inserts these, this is one important application of or we can say advantages of rotational

molding, that if we want to have threaded sections in the final product. We can do it using the rotational molding, so we can because this process allows molded threads and mould-in inserts. Second important advantage is a wide range of surface finishes can be got because the outer periphery of the product would be in contact with the mould. So, the inner finish of the mould would be duplicated on the outer surface of the final product that we are getting.

So, if we have a excellent finish on the inner side of the mould that finish would be duplicated on the outside of the final product. So, rotational moulding process allows a wide range of surface finishes and control the surface finish of the final product which has been made by rotational molding process. Also in many of the cases no finishing or no quoting of the product would be required, because the integral surface finish that we get out of the process is sufficient enough for many applications.

So, the waste in this particular case is also minimized why because we are inputting the metered amount of raw material only, so there are chances of less wastage. So, as it has been discussed that the metered amount of the raw material is put as a input into the rotational mould. So, the waste wastage is minimum also you can see on your screen that the residuals chases that are developed are minimum in case of rotational molding. Also once a mould has been made it can be used for making a large number of parts, so the tooling requirements are not that expensive in case of rotational molding.

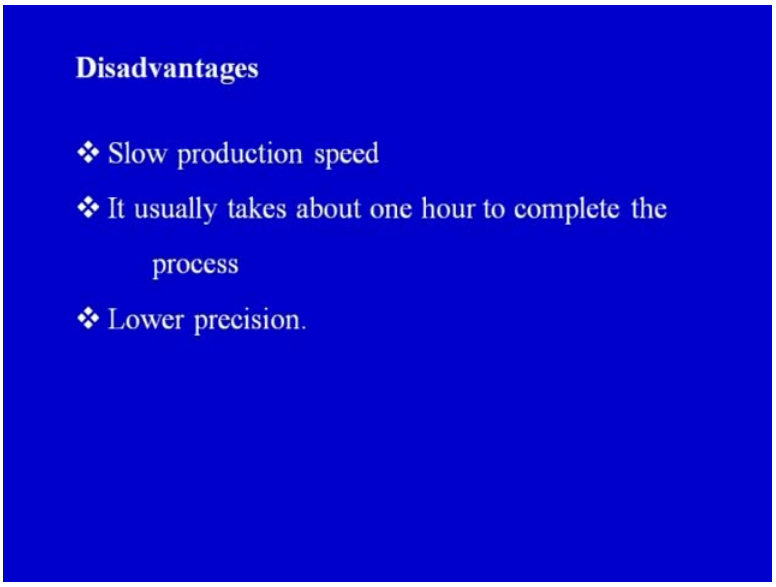
Another advantage of the process is that additives for weather resistant flame retardation can be incorporated. As we are giving the input metered amount of the plastic powder as a input, if we want to make a part which has to have certain specific requirements, like it has to be used for a overhead water tank. Now, overhead water tank we have to produce by a rotational molding process, we feel that it should have weather resistance. It should have flame retardation, so in the input stage only when we are inputting the plastic powder. We can put the flame retardation pigments or the weather resistant pigment into the raw material only.

So, that the final product that we get is having these type of characteristics. So, it is resistant to weather as well as it does not catch fire easily. So, there can be a number of advantages that we can derive out of the rotational molding process. So, we can see once again, let us revise molded threads and mold-in inserts can be easily incorporated in

rotational molded products. Wide range of surface finish can be achieved because it depends upon the finish of the mould surface.

Wastage is minimum, residual stress is also minimum in the rotational molded parts, tooling is not very expensive, also we can incorporate flame retardancy and weather resistance additives in the raw material. So, that the product what we get can be used for these specific requirements, but apart from having all these advantages, there are certain limitations also.

(Refer Slide Time: 23:51)



So, let us see what are the limitations? So, limitations are the slow production speed because we have to rotate the mould about the vertical axis and the horizontal or we can say the primary and the secondary axis. So, the spread of the raw material to the walls of the mould may take some time. So, the process is not very fast as compared to some of the processes, we have seen earlier which are used for processing of plastics. So, one of the limitation is that it is a time taking process.

It usually takes about 1 hour to complete the process. This is in one specific case we cannot generalize, that it would take one hour only depending upon the size. Depending upon the type of plastics, we are processing this particular time may be less also and depending upon the shape complexity. We may require sometimes additional time, so that the powder or the plastic is able to fill each and every corner of the mould cavity.

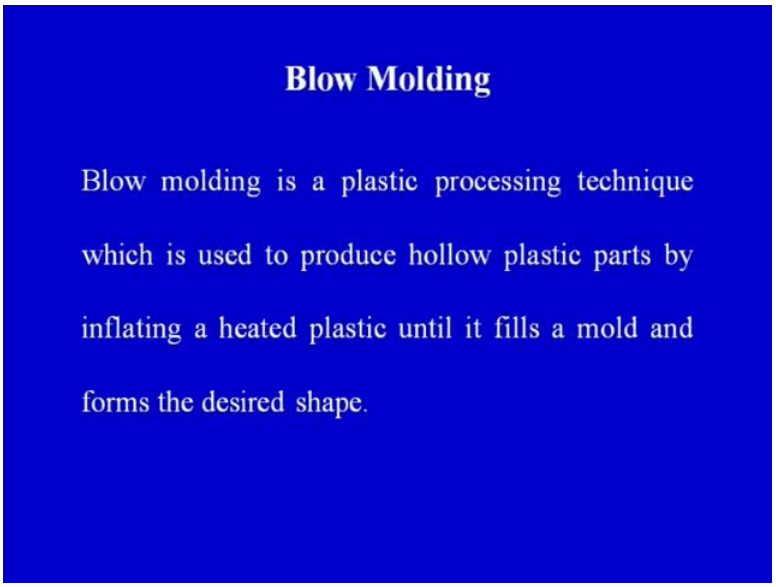
So, this is not this is just a representative time it may vary from lesser amount to a higher amount.

Moreover the precision that we get is not very, very high, so another important point that note in case of rotational molding is that the outer surface finish can be easily controlled by the finish of the mould, but the inner finish of the final product sometimes have to be taken into account. So, that sometimes may require certain additional finishing operations at a later stage. Why because we are inputting the raw material from top and as a heated mould is being used now because of the rotation the raw material would be spreading or would be forced out to the walls of the mould, through the outside surface finish can be good, but the inside finish of the final hollow product sometimes may be an issue. So, that is also can be one of the limitations of the rotational molding process.

(Refer Slide Time: 25:58)

Now, what are the applications of the rotational molding? So, that the products that can be manufactured using rotational molding include storage tanks that I had taken example of a overhead tank, we can say over a building when we use a water storage tank that can be made by the rotational molding process. We can use bins and refuse containers which can be made by rotational molding airplane parts can be made road cones sometimes we see along the road those can be made by rotational molding. Footballs helmets, rowing boats there can be the applications are huge which can be made by the rotational molding process.

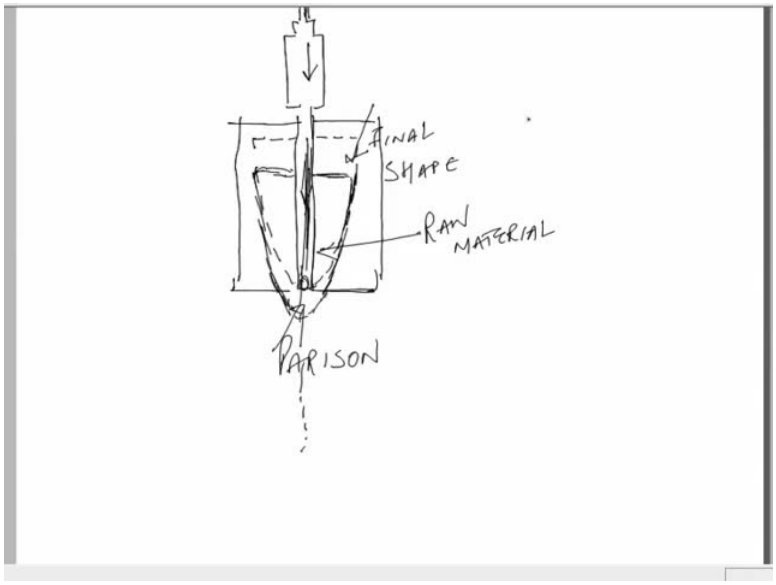
(Refer Slide Time: 26:37)



Now, coming towards the second process that we want to cover today, that is blow molding. So, one of the common feature between rotational molding and blow molding is that both this processes are huge for processing of plastic parts, which are hollow in structure or hollow in nature. So, blow molding is a plastic processing technique which is used to produce hollow plastic parts by inflating a heated plastic, until it fills a mould and forms the desired shape. So, the raw material in this case is is sometimes called a parison and this parison can be made by injuction molding.

So. the raw material or the raw plastic part which is used as a input in the blow molding can be made by injuction molding, which is another process for making plastic parts or the raw material for blow molding can also be processed by extrusion sometimes. So, blow molding is a process in which we will be making hollow plastic parts. The raw material in these cases would be a parison, which would be used as the raw material and in this particular parison we would be injecting or we would be inflating this raw material so that it takes the shape of the mould cavity.

(Refer Slide Time: 28:12)



So, we will try to understand this process with the help of a simple diagram. So, let us see the diagram on your screen you can see. This is we can say a inlet from where the air would be blown then we have to have a mould cavity. Now, this is the raw material, so let me so this is our raw material that we want to form. This is our final shape, this is the final shape that we want to generate. So, when the air would be blown inside this raw material. The raw material is often called a parison. So, we have a raw material and a hot air is blown inside this parison, this is our parison, the point the area that I am highlighting.

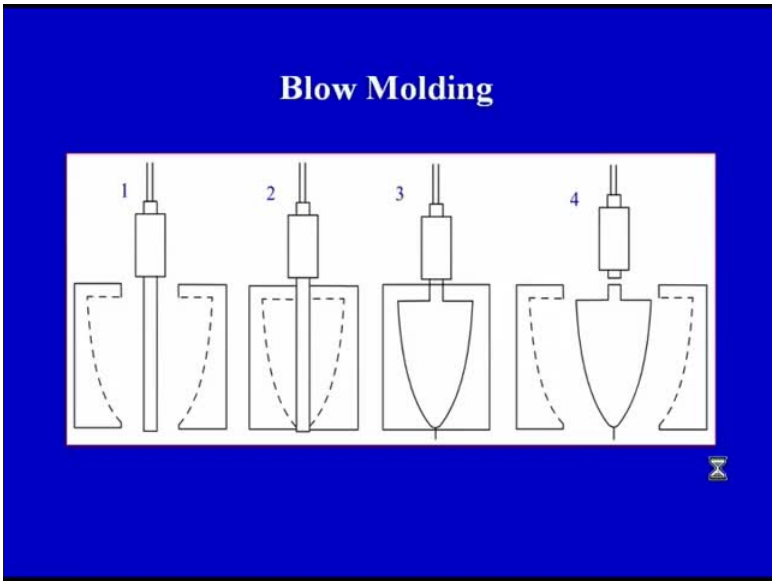
This is our raw material, the hot air would be blown inside this and this would inflate to take this shape. It would inflate under the influence of the hot air, which is blown inside and it would take its particular shape. So, this is the raw material and the name suggests blow molding. So, blow means we are blowing air and molding means that the raw material is taking the shape of the mould. So, the mould is also clearly shown.

It is a two piece mould we can say it can be divide into these two, along this line. So, it is a two piece mould, when it closes down the raw material comes inside. Hot air is blown inside the raw material raw material is called a parison, it is a plastic part and under the influence of the hot air this plastic parts inflates and takes the shape of the mould. Most of the plastic bottles are made by the blow molding process. So, let us now try to see the theory behind the blow molding process.

On your screen you can see that blow molding is a plastic processing technique, which is used to produce hollow plastic parts by inflating a heated plastic. Until it it fills the mould and forms the desired shape. So, in the diagram we have seen that there are two or three important points. First important point is the raw material, the raw material is the heated plastic which is also called a parison. Second important point is how it will get inflated? It will get inflated under the jet of air, which is input or which is we can say coming from the top.

So, we have a air jet, we have a heated plastic and we have a mould so the mould would confirm to the final shape of the product that we want to produce So inside we have the air jet. Air jet would inflate the heated plastic and the heated plastic would inflate. Finally, it would touch the boundary of the mould the inner boundary of the mould as we have seen in the diagram. Once it touches the inner walls of the mould, it would take the shape of the details that are present on the inner walls of the mould. It would be allowed to cool and after the cooling has taken place the mould would open and the final product would be taken out. So, different types of products can be made by the blow molding process.

(Refer Slide Time: 32:50)



So, let us know see and try to understand the four steps involved in the blow molding. As I have already drawn one diagram to explain the basics of blow molding. Let us again see this is the parison or the heated plastic raw material. You can see the arrow is

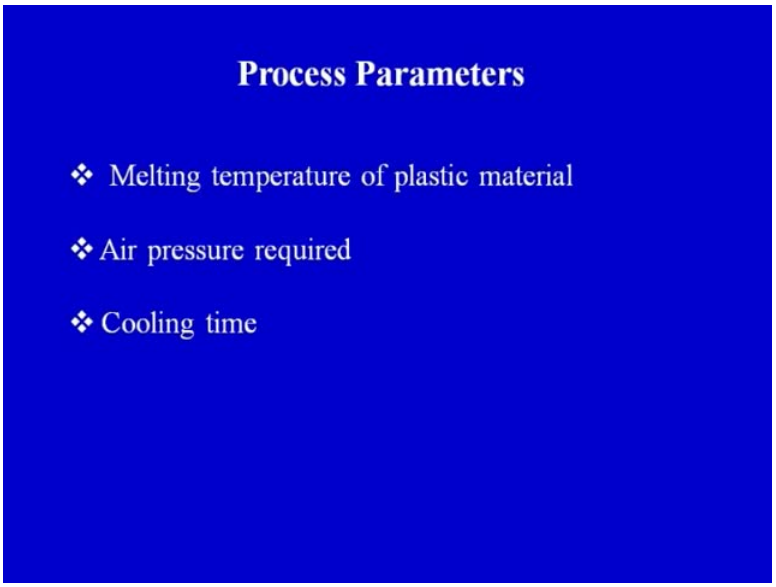
indicating the raw material, it would be available in this particular form can be made by injuction process, which we have already covered. Then this is the two parts of the mould part number one and this is the second part of the mould and this is the inlet for the air from where the air would be coming in and filling this particular molten.

Not molten but this particular raw material or heated plastic material. So, mould is there heated plastic raw material is there and inlet for air is there now in point number two or stage number two, you can see the two halves of the mould have closed down. They have formed a cavity like this this is the final shape that we want to produce. The two halves of the moulds have now clamped together or joined together holding the raw material inside. Air would be injected by here and it would inflate this raw material and it would take the shape of the mould cavity.

It would take the shape of the mould cavity, this is the shape of the mould cavity and once it has cooled the two halves of the mould would open and we will get this final product. So, in stage number four the two halves of the mould have opened up and it has taken final product has been formed. The air supply is there in stage number two and some extent in stage number three and in three to four the cooking is taking place. And in forth, in stage number four there is no supply of air only the mould halves open and the final product is taken out.

So, it is a four stage process stage; one, two, three and four. Stage one raw material is fixed, two halves are open two halves of the mould close down air is injected raw material inflates adheres to the wall of the mould the mould open and the final product is taken out. Now, what are the important process parameters in blow molding process?

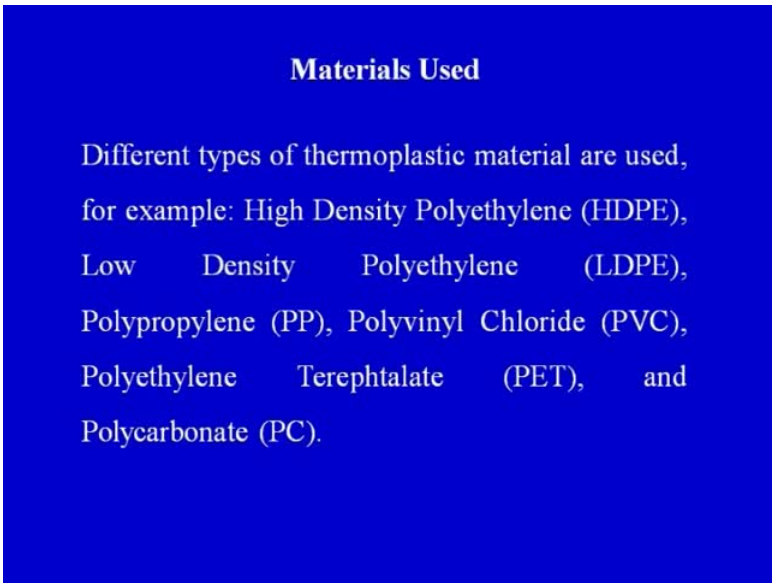
(Refer Slide Time: 35:22)



As you can see melting temperature of the plastic material because although it is not melting, we should not write melting, but the temperature at which it can be deformed. So, the temperature at which the plastic can deform and it can inflate and adhere to the walls of the mould, that is the temperature which is very important. So, that has to be taken into account. Then second is the air pressure required that how much air pressure is required? So, that we can inflate this parison to touch the mould walls and finally, the cooling time the amount of time for which the two mould halves would remain closed for the final product to form. When the two mould halves would open and the final product would be taken out.

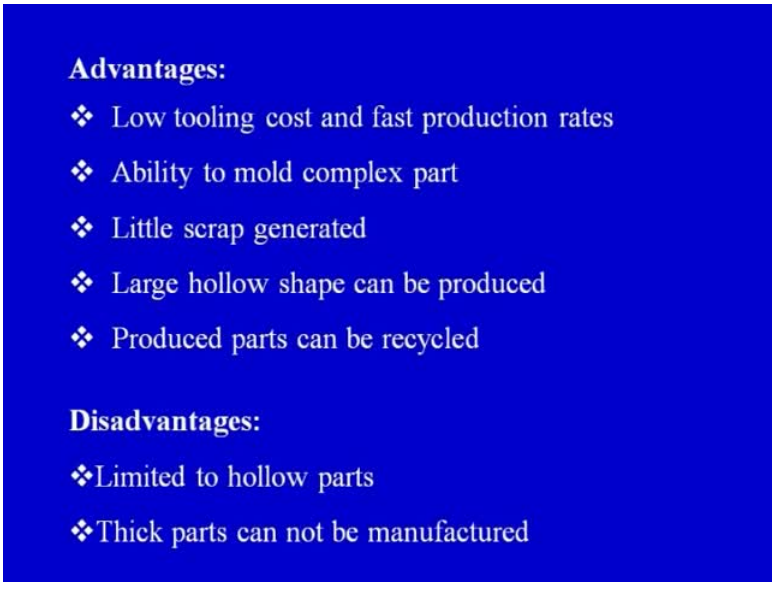
So, this particular time is important, so if it is a fully automatic process and if if all these three parameters are known, the temperature at which the plastic has to be used the pressure at which we have to inflate the raw plastic. Finally, the amount of time which the mould halves would remain closed, then the process can be automated and number of products can be made in a minute. Sometimes in an hour, hundreds of products can also be made. So, this is a fully automatic process, which is blow molding and is used for making hollow plastic parts.

(Refer Slide Time: 36:53)



Now, what are the materials that can be used for blow molding process different types of thermoplastic materials can be used. For example, high density polyethylene HDPE, low density polyethylene LDPE, polypropylene PP, polyvinyl chloride, polyethylene terephtalate as we sometimes use this word quiet often PET bottles. So these PET bottles are made by the blow molding process and sometimes polycarbonate can also be used. Now, what are the advantages of blow molding process?

(Refer Slide Time: 37:22)

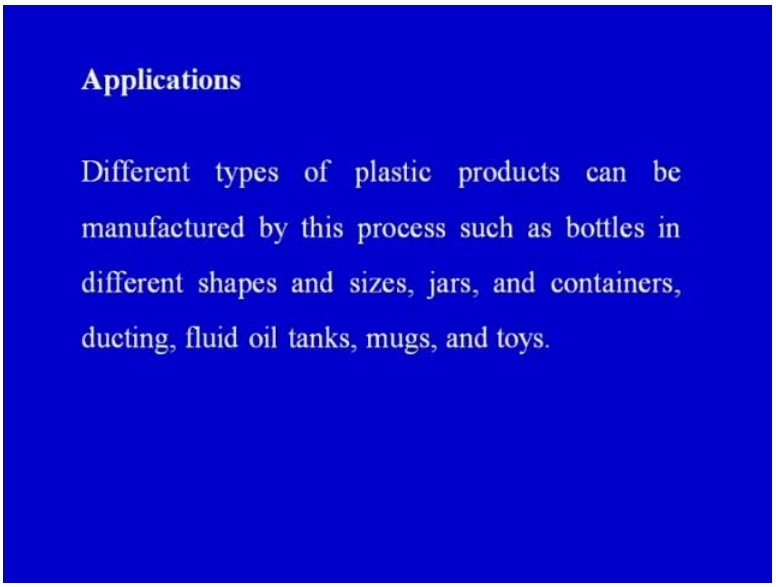


We can see low tooling cost and fast production rates. As I have already emphasized, when we were discussing the basic working of the blow molding process and it is a very fast process and the production rates are extremely high and the tooling cost is also not that much. So, this particular process can be used for mass production as the production rate is very, very high. Ability to mould complex parts if you see many PET bottles or these soft drink bottles. Sometimes mineral water bottles, then mineral water bottles when we see there are fine intricate details on these bottles. So, these particular details can be easily incorporated using blow molding process.

Little scrap generated generated scrap rate is minimum in case of blow molding because the parison, that we are using is blown out and it takes the shape of the final product. So, there is no wastage literally. Large hollow shape can be produced. Produced parts can be recycled even the there is lot of work going on in the recycling of plastics. So, the parts that we are making out of the blow molding process can also be recycled. But there are a few limitations also and what are the limitations?

The limitations are that it is the process is only limited to the hollow parts, that is why because we have a hollow plastic raw material, which we are inflating by the air pressure. So, this particular process is suitable for hollow parts only and cannot be made used for solid parts. Thick parts cannot be manufactured. So, the wall thickness in case of we can say blow molding is limited, we cannot make very thick part products using the blow molding process. Now, let us see what are the application areas of blow molding?

(Refer Slide Time: 39:04)



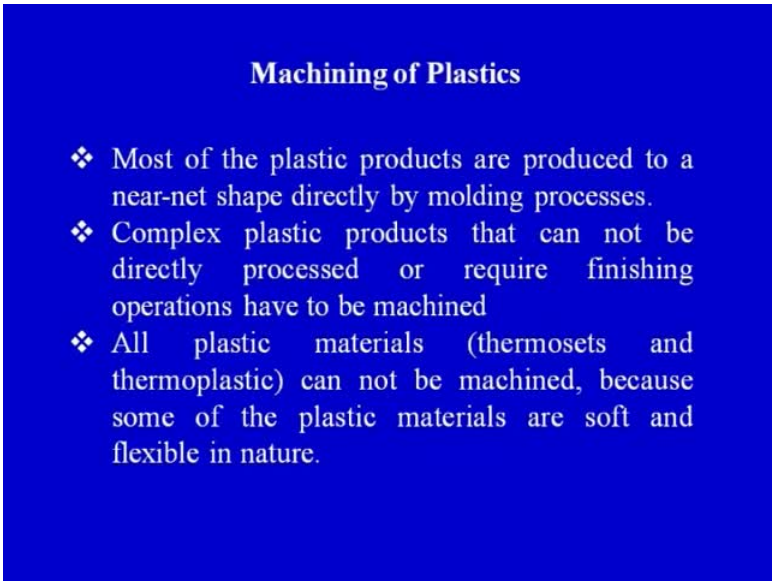
Some of the applications of blow molding are different types of plastic products can be manufacture a process such as; bottles in different shapes and sizes different types of bottles can be made plastic bottles, jars and containers can be made, ducting can be made by the blow molding process, fluid oil tanks mugs and toys can be made by the blow molding process. So, the blow molding process has got lot of applications and it is been used widely for the processing of hollow plastic parts.

So, with this we come to the end of our discussion on the processing of plastics, but one important point, that is left which I have already emphasized in the end of lecture number 6 is the secondary processing of plastics. Although it is not a well developed, we can say science and technology, but in many cases the machining of plastics is also done in order to facilitate the assembly of various plastic products to the other plastic products or to other wooden or metallic products.

So, secondary processing is equally important although most of the plastic parts are made to the near net shaped. So so many proceeses can be used for processing of plastics out of that some of the processes, we have already covered to revise what we have covered in processing of plastics, we have seen the casting process. we have seen transfer molding, we have seen compression molding, we have seen extrusion of plastics, we have seen injuction molding of plastics.

Thermo forming of plastics within thermo forming we have seen different process varying of thermo forming. Today we have seen blow molding rotational molding. So, all these process can be used for processing of plastic parts, but most of the parts that would be produced by these processes would be used readily or the parts that we get are near net parts and as usable parts. No finishing or other secondary operations are required on these parts, but certainly in many cases we may require sometimes secondary processing.

(Refer Slide Time: 41:30)



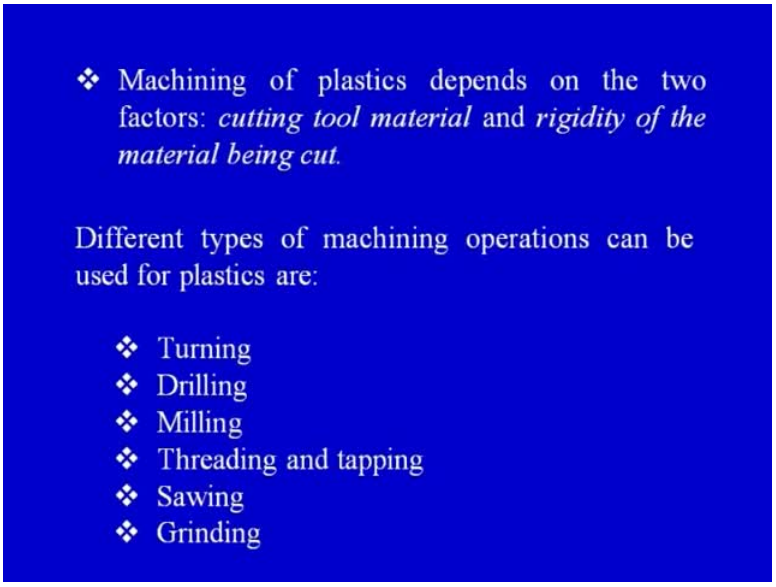
So, let us have a brief discussion on secondary processing that is machining of plastics. So, most of the plastic products are produced to a near-net shaped directly by the molding processes. So, we have seen so many plastics parts manufacturing processes, which are used to make plastic parts to a near-net shape. So, whatever products we see around us in our day to day life most of the parts are processed by the various molding processes and they are used as produced.

No secondary operations are done on most of the plastic parts, but sometimes complex plastic products that cannot be directly processed or require finishing operations have to be machined. Sometimes there is a complex plastic product, which has to be made in three or four simple parts, which can be made by some of the processes, which we have already covered. So, now we have a complex or a intricate plastic part which is made into four different sub parts.

Now, this sub parts have to be assembled together to get the final product and for assembly. Sometimes we may be requiring machining operations. So, machining is a general term we may be requiring a drilling operation where we need to make a hole inside two or three different plastic parts. So, that we are able to assemble them using the mechanical fasteners. So, sometimes the secondary operations in terms of machining also becomes imperative for the plastic parts.

So, all the plastic materials such as thermosets and thermoplastics cannot be machined easily. So, there are issues and damages, which are not similar to the challenges that we see in machining of metals. The, machinability of plastics is entirely different from the machinability of metals. So, in this particular case, so we have to machine a plastic the issues and challenges are entirely different some of the plastic parts are soft in nature or sometimes they are flexible in nature. So, it is difficult to machine them, some of the important points that have to be taken into account.

(Refer Slide Time: 43:45)



While discussing the machining of plastics are the type of the cutting tool material, that should be used for machining of plastics and secondly the rigidity of the material being cut. So, if the material is rigid it sometimes, it is easier to cut, but sometimes when it is very, very flexible it becomes difficult to machine that material. So, machining of plastics is sometimes required and the conditions and requirements for machining of plastics are entirely different from the conditions and requirements that we usually see in

machining of metals. So, different types of machining operations that can be used for plastics are; turning, drilling milling. Sometimes threading and tapping has to be done.

Then sometimes we have to cut the plastic part into different pieces. Finally, grinding. Grinding is most commonly not used in case of plastics because the finish that we get in case of plastic is very, very good and no secondary finishing operations are required, but sometimes some edges may have to be ground. So, that we have to fix the various plastic parts together. So, basically different machining operations can be done on plastics, but there are conditions and requirements, which have to be satisfied when we have to machine a particular plastic material.

The definition of machinability for plastics is different from the definition of machinability for the metals. We will see certain aspects related to the machining of polymer matrix composites in which the matrix would be a polymer material or it would be a plastic material, which would be reinforced with the fibres and what are the issues and challenges that we would be discussing in module number 7 when we will be talking about damage and the condition and requirements, which are specific to the machining of polymer matrix composites or the machining of fibre reinforcement of plastics.

So, with this we come to the end of module number 4 in which we have discussed seven different lectures, and in seven different lectures our focus was primarily to in to study the various processing techniques used for processing of plastics. Just to revise the techniques that we have used for we have we can say discussed in this particular module. We have discussed the casting process in plastics. We have discussed the extrusion of plastics we have discussed transfer molding. We have discussed compression molding, injuction molding, thermo forming, blow molding and rotational molding. So, in our next module our focus would be on a different material processing of different types of materials, which have properties similar to those of non metals.

Thank you. .

.