Processing of Non-Metal

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

Module - 4
Plastics: Properties and Processing
Lecture - 4
Transfer Molding and Compression Molding

A warm welcome to all of you in this lecture on transfer molding and compression molding. Let us first take a overview of what we have discussed in this particular module, this is module number four which is focusing on processing of plastics and overall our focus is on processing of non metals. So this is module number four in which we are focusing on the processing of plastics. If you remember in the previous three lectures, we have discussed the basic aspects of the plastic material. We have seen what are thermosets, what are the thermoplastics, and what are the basic characteristics and properties of both, what are the specific application area of thermo sets, what are the specific area of thermoplastic. And we have also seen in lecture number two that what are the various mechanical properties of the thermosets and thermoplastic.

We have tried to understand the stress-strain behavior that how a plastic material would fail, how it would take the load will take place finally, the necking will take place, plastic deformation, and finally the failure. So, we have seen how the thermo sets will show the stress-strain behavior and how thermo plastic will show the stress-strain behavior. Then we have seen that how the failure would take place if these polymers are loaded under the fatigue loading. Finally we have seen the creep behavior also that how creep is important specifically in context of the polymeric materials.

In that particular lecture that is lecture number two in module four, we have also focused on the casting process specifically in context of the polymeric composites. We have seen that in processing of plastics there are three important points which always have to be kept in mind, which is the heating of the raw material, the melting of the raw material and finally, the forming of the raw material into the desired shape. So, melting may not be an important step in all the processing of plastics, but certainly the raw material heating of the raw material, the forming of the raw material into the desired shape and finally, the cooling are important steps in any plastic processing process.

So, I have told that we should be keep three alphabets in mind when we are talking about the processing of plastic material. So, the three important alphabets are the h that is heating; f that means forming, and c that means, cooling. So, heating forming and cooling should always be kept in mind.

So, we have already seen in lecture number two that what is the casting process? In casting, we have seen that the molten plastic is poured into the desired mold and the shape of the mold will give us the shape of the final product. So, there are only two important steps involved. First one is the melting of the plastic material and second is the pouring of the plastic material into the desired mold or the designed mold. And the shape of the final product would adhere to or confirm to the shape of the mold which that was the first process that we have covered in processing of plastics.

In our previous lecture, if you remember the lecture number three in module number four, we have focused on the extrusion process. In extrusion, we have seen that in in addition to the melting in the raw pelletes or the raw material in the form of pelletes or plastics pallets in addition to melting we are applying the pressure also. And how the pressure is being applied that we have tried to understand that using a rotating screw, the screw excluder fits the material into the dye and the dye gives the shape to the final product. And we have also seen that what are the important process parameters that have to be taken into account when we are talking about the extrusion process. Also we have seen what are the various process variants in extrusion, although we were not able to cover all the process variant, but still we have seen some of the process variants like the extrusion of a tube of a plastic material, we have seen how a film or a plate of plastic material can be made. We have seen co extrusion and we have seen one or two other processes which are used or which are the process variants of extrusion and are used for making the products out of plastic product. I have forgotten to mention we have also see jacketing that how a jacket of a plastic material is extruded on top of a metallic wire material with the help of the diagram we have tried to understand that jacketing process.

So, there can be large number of processes which can be used for processing of plastics and in today's lecture ours focus primarily is on two important processes which we would try to understand with the help of the diagram also that is the transfer molding process and the compression molding process. So, transfer molding process, we can draw the analogy of the transfer molding process with that of the casting process, in which we

have melted the raw plastic into the molten form and this molten plastic was poured into the mold cavity. So in that case in casting, the cavity or the mold that was shown was an open type of a mold. But here in case of transfer molding, in most of the cases, the mold would be closed between the two mold halves and the plastic would be injected there or would be transferred to that location with the help of pressure.

So, we will try the understand the basic details or the basic working principle of the transfer molding and the compression molding process in today's lecture. Moreover, our focus would be to understand that what are the specific advantages and limitation of these process in comparison to the other processes which are used, and also we will see that what are the specific application areas or what are the products which are produced by the transfer molding and the compression molding process. So, with this particular introduction now we can start our discussion on transfer molding that what is the process, what are the advantages limitations and applications of the transfer molding process.

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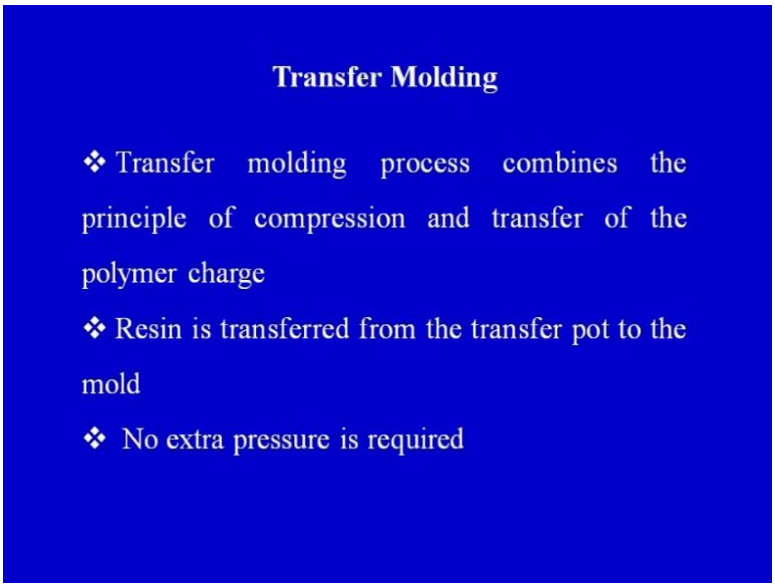

So, transfer molding process combines the principle of compression and transfer of the polymer charge. Now, the polymer charge we can say is the raw material. So, the raw material in all these cases whatever we will be discussing in this particular series of lectures on processing of plastics would always be a plastic material. So, the raw material is a plastic here in this particular case specifically we are calling it as the

polymer charge. So, the transfer molding process combines the principle of compression and transfer of the polymer charge. So, here the compression would also be there that is the compressive load would be there, and the polymer charge would be transferred to the location where the exact product is being formed. So, we will try to understand this with help of the diagram.

And the resin is transferred from the transfer pot to the mold. So, we have mold we have a resin which is in the molten condition, and this resin or the polymer or the plastic in the molten form would be transferred to mold with the help of a mechanical action. And no extra pressure is required; only the pressure required is to transfer this particular polymer charge or the molten charge into the mold cavity.

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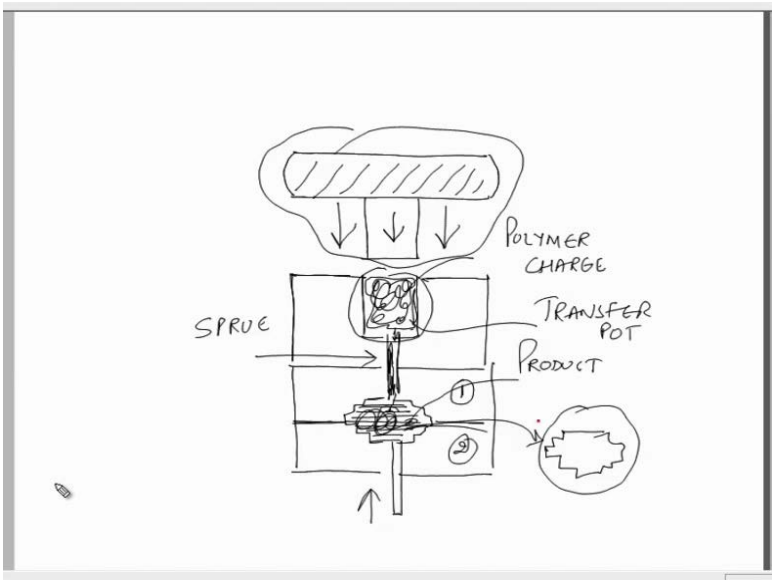

So, you can see, on your screen, we will try to draw a very simple diagram of the process. So, this the way we are going to apply the pressure. Now, this is the place where we have kept our charge. So, our charge is placed here or the polymer charge is placed here and through this polymer charge would travel. So, this is the direction in which the polymer charge would travel when the pressure would be applied and finally, we have a product. Now this is my final product that I want to generate. Now this will not be open, this would be made into dye halves. This is made into die halves; this is the first half and this is the second half. So, this is made into die halves. This is the pressure applying mechanism; this is the polymer charge, and this is the product that we want to generate

and this product would be coming out once the process is completed. So, this is the final product that we will get.

So, the mold is also made into half and in order to facilitate the easy removal of this particular product, we can also have some ejection mechanism. So, this particular ejection mechanism would come into the picture once the product has been made. So, basically this is this can be called as a transfer pot where we have kept our charge. So, from this transfer pot, the charge is in the molten state we are applying the pressure with this mechanism, this is the pressure application mechanism. So, that the pressure is acting on this pot and this can also be covered. So, this can also be covered. So, we have a transfer pot; in this transfer pot, we have the charge and finally, on application of this pressure this charge would travel trough this can be called as sprue. So, this would be travelling through the sprue into the mold cavity, and this is the mold cavity which you are seeing on the screen, and finally, we will get a product which would be taken out like this.

So, this is the simple process and we can draw a simple analogy between the casting process and the transfer molding process. The only difference is that the molten plastic now is been supplied to the mold cavity under the application of some pressure and the pressure acting devices or actuating devices is shown there. So, in the transfer pot we have the molten plastic and we are sending that plastic through the sprue into the mold cavity, and it is the mold cavity where the final product is being formed. So, this is a very very simple representation of the transfer molding process where the molten plastic is been transferred to the mold cavity to get a final product which would be exactly according to the shape of the mold cavity as has been shown on in the diagram.

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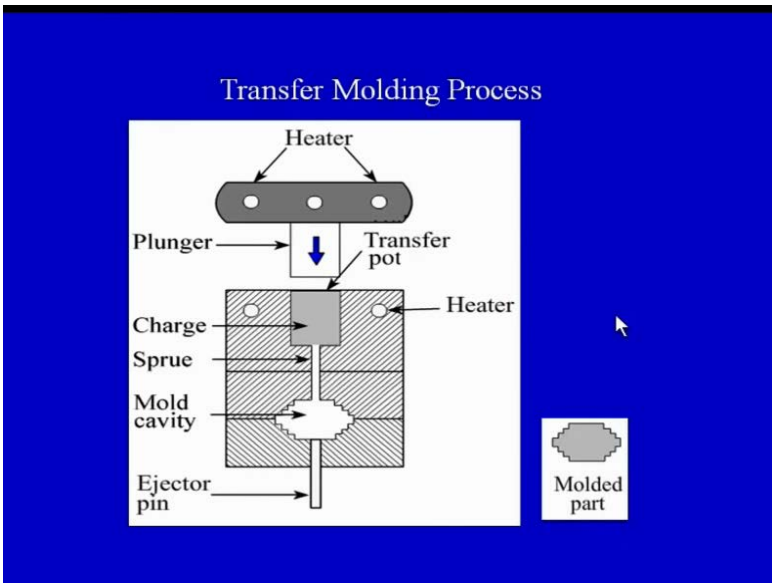

So, the let us now further try to understand the other details of the transfer molding process. So, whatever diagram I have drawn on the screen, we can again look the similar type diagram which is there on the screen. So, we have here additional element that is the heating element. This is the plunger, this is again as I have mentioned in the diagram, this is a transfer pot where we have the charge or the polymer charge this is the molten plastic or the polymer charge. This is called the sprue; this is the sprue then there then again there are heating elements to heat the charge. So, when this is in the molten state, this transfer pot would be subjected to pressure from this mechanism and the charge would travel along the sprue into the final shape or into the final cavity.

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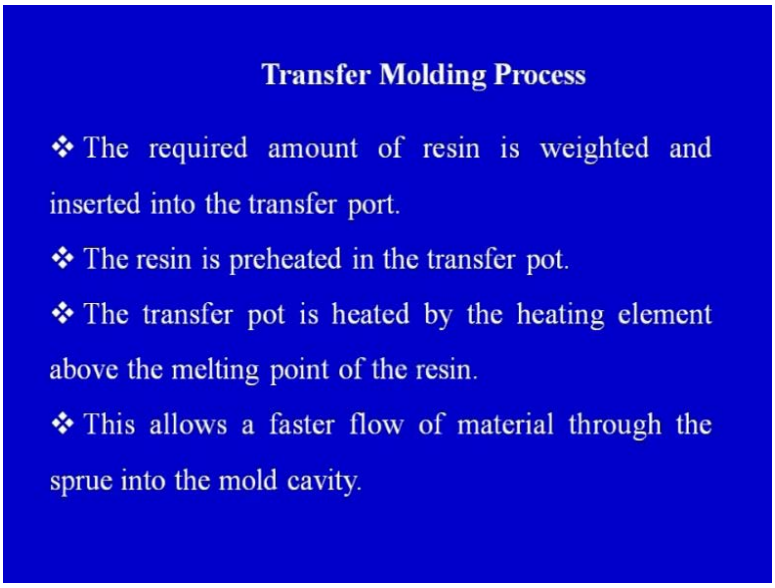

So, the transfer molding process the required amount of resin is weighed and inserted into the transfer pot. So, first important point is that in this particular case, we are going to meter the amount of charge or we are going to measure or ration the amount of charge that we are going to put inside the transfer pot. Why, because we know that what is going to be the volume that of the final product that we are going to produce by the transfer molding process. Now depending upon that volume we will input the charge in a metered way. So, the required amount of resin is weighed and inserted into the transfer pot.

The resin is preheated in the transfer pot they got because it has to be in the molten state then only the pressure would be there and it would be guided through the sprue into the final cavity. And in that cavity, the final product would be formed and that the two halves may open, the ejector pin will push the product which has been formed inside the two mold halves and we would be getting the final product. So, to start with the first step is the required amount resin is weighed and inserted into the transfer pot.

First point it is very clear. The resin is the preheated in the transfer pot if you remember in the diagram we have seen that there are heating arrangements, again we can see there are heating arrangements, this is the heating arrangement and the charge would be heated throughout the process. Then the transfer pot is heated by the heating element above the melting point of the resin that is very very clear. This allow the faster flow of material through the sprue into the mold cavity. Now this particular material or the molten

polymer material has to be transferred to the mold cavity, because the mold cavity is the place where the actual action is taking place that is the actual formation or the actual processing of the product is taking place.

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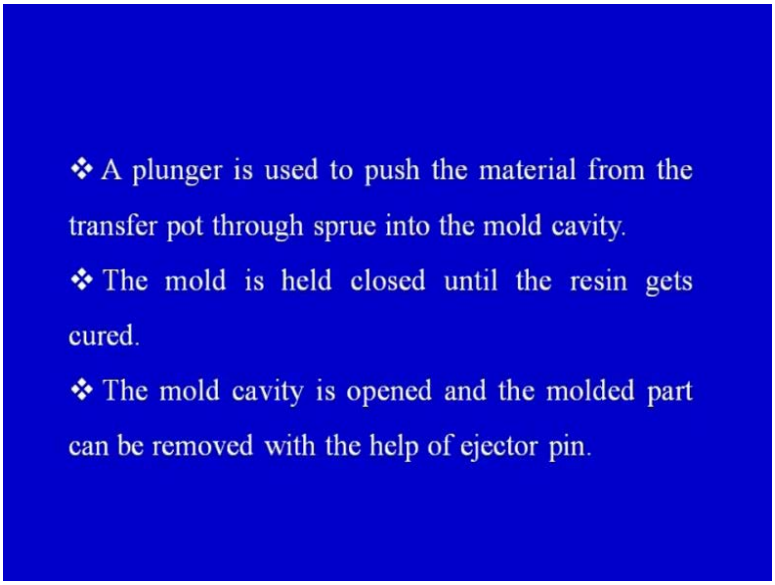

A plunger is used to push the material from the transfer pot through the sprue into the mold cavity that we have seen in the diagram that this there is the pressure mechanism which we may call as a plunger. And this particular plunger is used to transfer the material from the transfer pot through the sprue into the mold cavity. So, the mold is held closed until the resin gets cured. Now this is an important difference between the casting that we have seen in our previous lecture in which we have seen how casting of plastics is done. The mold that was shown there was the open mold which was open to the atmosphere, but here the mold that we have made is a closed mold.

So, here in point number two on your screen, you can see the mold is held closed until the resin gets cured. Now the curing process also we have seen in lecture number one where we have seen the thermosets cure irreversibly and thermoplastics cure reversibly. S that differentiation what is curing process, there I have emphasized that curing can be achieved under heat or it can be achieved by the reaction of a particular polymer with the particular hardener. So, mold would be closed in case of transfer molding, and it would be kept closed till the material which was in the molten stage. In the transfer pot which has been transferred from the transfer pot through the sprue into the mold cavity

solidifies or takes a shape of final product that would be definitely similar to the shape of the mold cavity.

So, the mold is held closed until the resin gets cured. So, the resin in this case is the polymer material which was there in the transfer pot which was melted and transferred with the help of a plunger through the sprue into the mold cavity. So, the mold cavity it is opened and the molded part can be removed with the help of a ejector pin. So, the diagram that I have drawn I have shown a ejector pin which can operate from bottom and if the final product is sticking to or adhering to the bottom part of the mold. This ejector pin will just give a slight tap on the backside of the product, and the product would be pumping or jumping out of the bottom side or the bottom part of the mold. So, the ejector pins can be used to remove the final product, which has cured which has become solid out of the mold cavity. So, the process is not very complicated, but there are few important things or process parameters that have to be kept in mind specifically in case of the transfer molding process.

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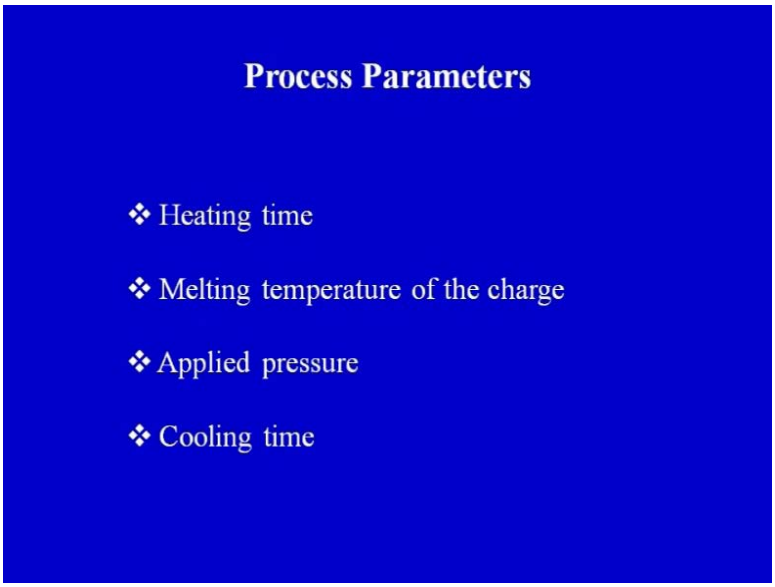

So, on your screen, you can see that what are the important process parameters that are very very relevant in case of the transfer molding process. So, first is the heating time. If you remember around the heating pot there were so many heating element. So, how much heating time should be there and for how long the polymer charge that is there in the transfer pot should be kept under the heated condition that is one process parameter.

Second is the melting temperature of the charge that is one of the important point which always has to be kept in mind that is the properties of the raw material. Now, there may be some raw materials, which may not render themselves suitable to be transfer molded. So, these important points have always to be kept in mind like what is the melting temperature of the polymer that we going to use or that we going to use as a raw material for making a product by the transfer molding process.

So, an important point to note is for how long we should heat the polymer charge. What are the important properties of polymer that we have using for transfer molding, then how much pressure should be applied. And finally, how much time we should give for the two mold halves to be closed that is the cooling time in which the product is getting cooled. So, the product has been formed. The charge was the transfer or the molten plastic was the transferred from the transfer pot with the help of a plunger. It was guided through the sprue into the mold cavity where it started the solidification or where it started to get the shape of the final product. And so, the plastic which was under elevated temperature is now slowly coming down to the room temperature and getting the final shape of the product. So, for how long the two mold halves or the two die halves should remain closed, so that is also very very important that can be called as a cooling time. So, the cooling time is also equally important.

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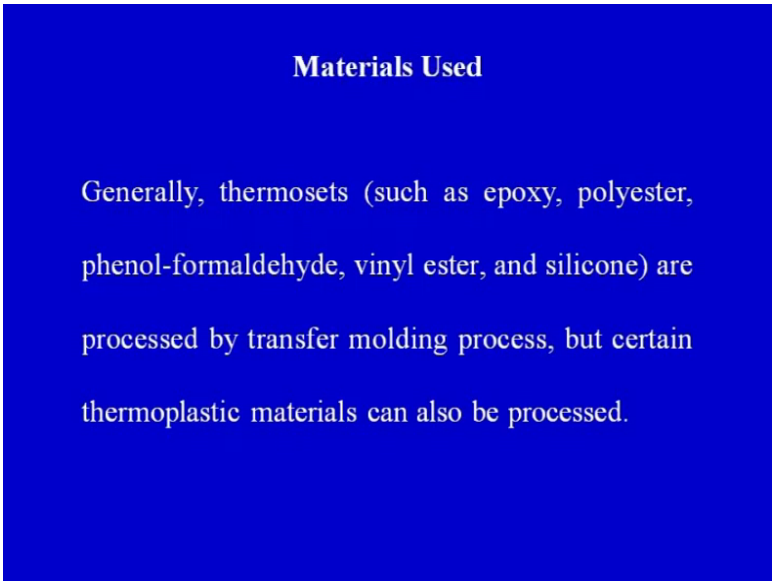

Now, what are the materials that can be used very quickly we will see that the materials that can be used for transfer molding are different types of thermosets such as epoxy, polyester, phenol formaldehyde, vinyl ester and silicones, and these can be processed by the transfer molding process, but certain thermoplastic materials can also be processed. So, basically in transfer molding, we can make thermosets, but we can also use the same process slight modification for the thermoplastic materials also.

So, the import ants point for us to understand is that what is the basic working principle of or what is the basic working mechanism of the transfer molding process that we have tried to understand with the help of a very simple diagram. So, this is the process which has been commercialized and a large number of products can be made by the transfer molding process. We would be seeing that what are the advantages of this process, because we have seen that it is fairly similar to the casting where we have just melted the plastic material and poured that plastic material into the mold and the plastic material took the shape of the mold material or the mold shape. So, basically what can be the differences or what are the advantages of the transfer molding process that we would now be focusing on.

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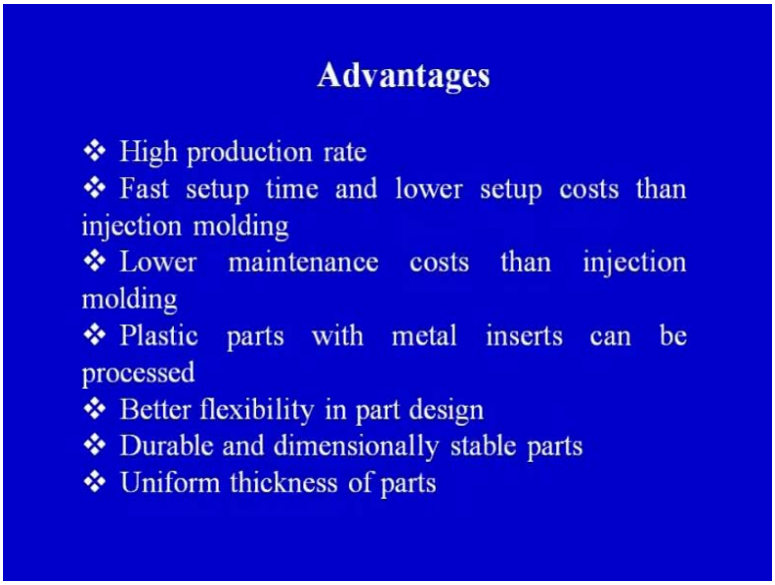

Now, what are the advantages? The advantages are very well mentioned on your screen you can have an idea, first is high production rate. So, the production rate is high in case of transfer molding. It can be atomized also, automated process can further improve the

production rate. Fast setup time and lower setup cost than injection molding. Infrastructural requirements are less as well as the infrastructural setup cost are also less in case of transfer molding process. Another point is lower maintenance costs than injection molding. So, the maintenance costs are also less plastics part with metal inserts can be processed. So, we will be seen in the applications that how a plastics inserts can be sorry metal inserts can be put inside the plastic products. Other important advantages are the better flexibility in part design because it is a closed mold processes the mold cavity is present between the two mold halves. So, fairly complex designs can be made and the material is flowing and in the liquid state and it is going to fill the mold cavity. So, the problems associated can also the less, but the degree of flexibility in part design is also to a particular limit only a very complicated and a very complex product may have its own set of disadvantages when it is to be formed by a transfer molding process. So, a better flexibility on part design is there, but there is a limit to the part complexity

So, those parts that are made by transfer molding process are durable and dimensionally stable. So, the kind of dimensionally stable parts that we desire to make can be made by the transfer molding process. So, uniform thickness of parts can be achieved in case of transfer molding process. So, we can see that there are a large list of advantages which we can see or which we can observe with the transfer molding process or which we can find with the transfer molding process. So, all these advantages although lead to a large number of applications of transfer molding process in processing of plastic parts, but any of the process will not only have the advantages only there would be certain disadvantages also which would be associated with the processing techniques. So, we have seen that in case of transfer molding we have got certain set of advantages.

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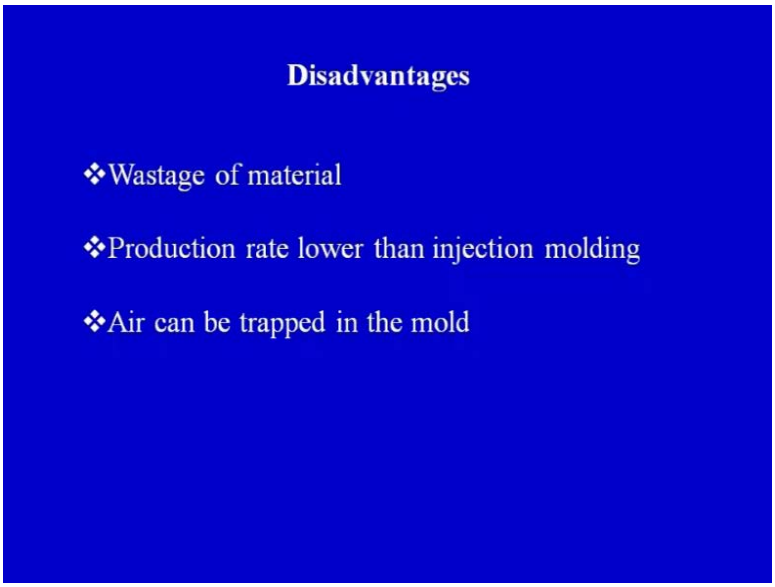

We will also have certain disadvantages is now what are the salient or important disadvantages which are observed or found with the transfer molding process these are the wastage of material. Sometime the material or the metered amount that we have taken may not be transferred fully to the molding cavity. So, leading in the wastage of the material production rate lower than injection molding, yes, because in injection molding we can have a very fast cycle times and a large number of parts is made in a minimum amount of time. But in case of transfer molding the production rates are comparatively lower as compared to the injection molding process as well as the air can be trapped in the mold that is another disadvantage. Although it is a closed mold, but when we are transferring the plastic through the sprue into the mold cavity certain time there may be air aspiration that may take place and may form bubbles inside the final product which can be one of the disadvantages of the transfer molding process.

So, air can be trapped inside the mold that has to be avoided. So, these are certain disadvantages, but if you look at the advantages and the disadvantages list we can see that, yes it has to be certain application where transfer molding can be used. So, our focus now in the subsequent slide would be to highlight that what are the important application areas of the transfer molding process.

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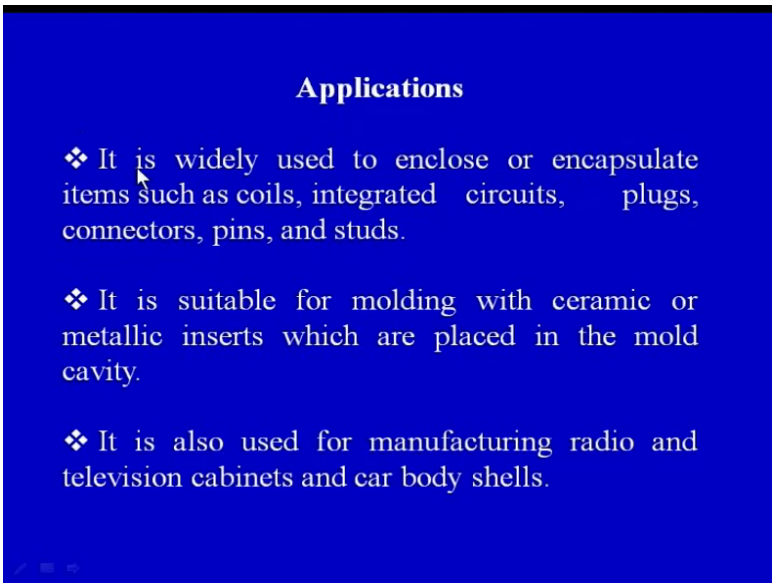

So, on your screen, you can just have an idea point number one, it is widely used to enclose or encapsulate items such as coils, integrated circuits, plugs, connectors pins and studs. So, if you just have idea of the process just go back to the diagram that we have seen in this this particular process, these particular process can be have used to encapsulate, so many different electrical equipment as I mentioned on the screen coils, integrated circuits, plug, connector, pins etcetera. So, how that can be done we have a transfer pot, in which we have the molten pot or we have polymer charge or the plastic charge. Now, this charge is getting heated and the heated charge is transferred through the sprue into the mold cavity.

Now, inside the mold cavity, we can keep all these equipment whatever we want to encapsulate, and when the plastic will flow through the sprue and will fill the mold cavity, already we have whatever has to be encapsulated inside the mold cavity the plastic will come and it will encapsulate the equipment that we want to encapsulate. So, it will come and it will fill the gap or the vacant spaces that are present inside the mold cavity where the integrated circuit or a plug is already kept. So, the plug is already there, the plastic is flowing through the sprue and it is filling the space between the plug and the mold cavity and thereby encapsulating the plug inside a covering of plastic material. So, transfer molding process is widely used to enclose or encapsulate item such as tools, integrated circuits, plugs, connectors, pins and studs. So, that is one important application of the transfer molding process.

It is suitable for molding with ceramic or metallic inserts which are placed in the mold cavity. As I have already mentioned these important inserts can be already placed inside the mold cavity, and the plastic can flow from the transfer pot through the sprue into the mold cavity and fill the space like and vacant there and further encapsulating or we can say enclosing the metallic or the ceramic inserts. Transfer molding process can also be used for manufacturing radio and television cabinets and car body shells. So, there can be other advantages or other applications of transfer molding processes also and to name a few it can be used for making cabinets and car body shells also. So, till now, we have seen one of the important process of processing of plastic that is transfer molding. We have tried to understand this with the help of a simple diagram and we have seen what are the various parts of a transfer molding setup, and we have seen what are the important advantages, limitations and the application areas of the transfer molding process.

Now, we will shift our attention to the second process that we have to cover today that is the compression molding process. In compression molding process, the compression of the charge would be done between the two halves of the mold. So, inside there would be cavity, and we would be compressing the polymer charge inside the two mold halves and the charge would flow and would take the cavity or take the shape of the cavity or take the shape of the cavity generated between the two mold halves. And finally, it would to allowed to cool and solidify and we will get the final product.

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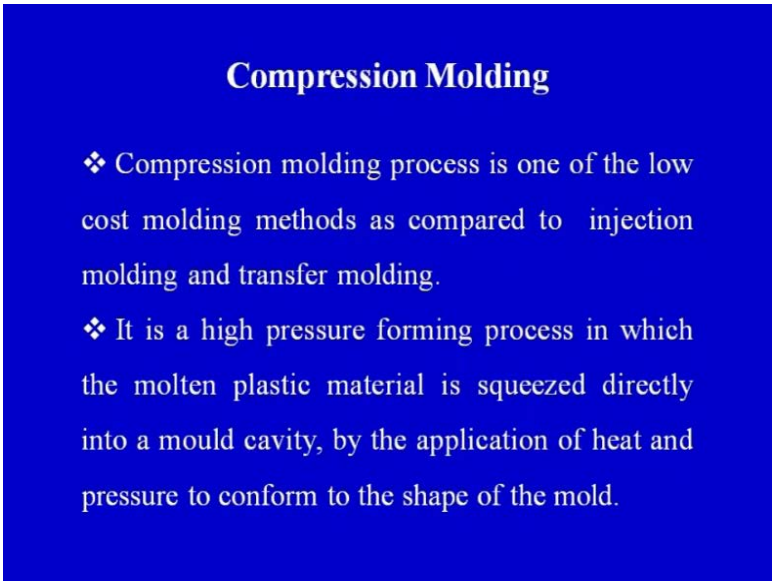

Now, let us try to understand the process of compression molding. In compression molding, you can see the compression molding is one of the low cost molding process or low cost molding method as compared to injection molding and transfer molding. So, injection mode compression molding is far cheaper as compared to injection molding, as well as compression molding is cheaper as and we can say is easy to do as compared to transfer molding, because here we require only two plates and inside we can have a cavity of which we want to generate the final product. So, I am again reading the point number one your screen, you can see the compression molding is one of the low cost molding methods as compared to injection molding and the transfer molding. So, it is a cheap process.

It is a high pressure forming process in which the molten plastic material is squeezed directly into the mould cavity by the application of heat and pressure to conform to the shape of the mold. So, we can have a polymer charge, a plastic charge inside the two plates of the mold and heat and pressure can be applied. So, that the charge takes the shape of the mold cavity which would be generated between the two die halves. Now, let us try to understand this with the help of a very simple diagram. On your screen, you can see that there are two parts of the mold. These two parts of the mold are joined together to make the mold cavity.

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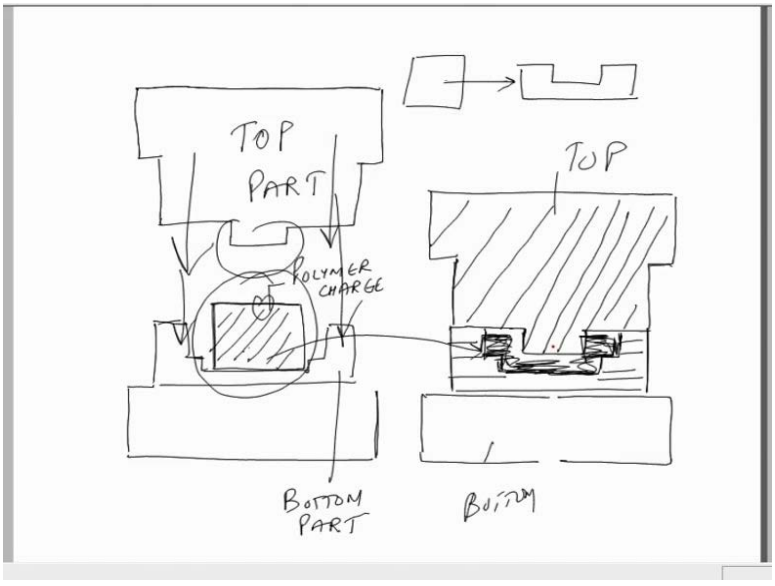

So, let us draw the diagram. So, this is we can say top part and then we can have a polymer charge. So, this is the we can say is the polymer charge. So, we have a top plate or a top part of the mold we have a polymer charge and then we can have a bottom part also. So, we have a bottom part which is placed on the table. So, the top part would move down and we have a bottom part. So, we have a bottom part of the mold we have top part of the mould we have a polymer charge and we can certainly have heating elements which would be used to heat the polymer charge and the pressure would be applied when these two parts would combine together. The top and the bottom part the pressure would be applied on this polymer charge and we will get the final product.

So, we can see when this top part and the bottom part or top half and the bottom half of the mold would combine together, they would apply pressure on the polymer charge, the polymer charge is in the heated condition because of the heating element. And we will get the final product according to the desired dimensions as well as the according to the desired shape. So, let us see now when the two parts will close together how we will get the final product.

On your screen, a matched diagram is shown in which the top and the bottom parts of the mold have combined together. If you remember this was the top part of the mold and this is the bottom part of the mold. So, the top part and the bottom part of the mold have joined together and the charge now has taken the gap or has flown into the gap or has entered into the gap which has been generated between the top and the bottom half of the mold. So, the top and the bottom half of the mold have joined together the charge which was placed here in this particular shape has now taken the shape of the final product. So, we had the charge which was something like this and now it has taken this particular shape.

So, we can see that we have been able to give a shape to the polymer after heating it and after applying a sufficient amount of pressure from this shape we have been able to generate this shape how by the application of pressure and by the application of heat. So, we have a top part of the mould and we have the bottom part of the mould, we place our polymer or the raw material inside the top and the bottom parts of the mould. And then when the two half of the mold would combine together, they will generate a mold cavity and because of the heat the molten material would flow into the cavity generated between the top and the bottom half of the mold. And finally, we would get the desired

product. So, this is a simple process again we will revise this with the help of the diagram on your screen, you can see.

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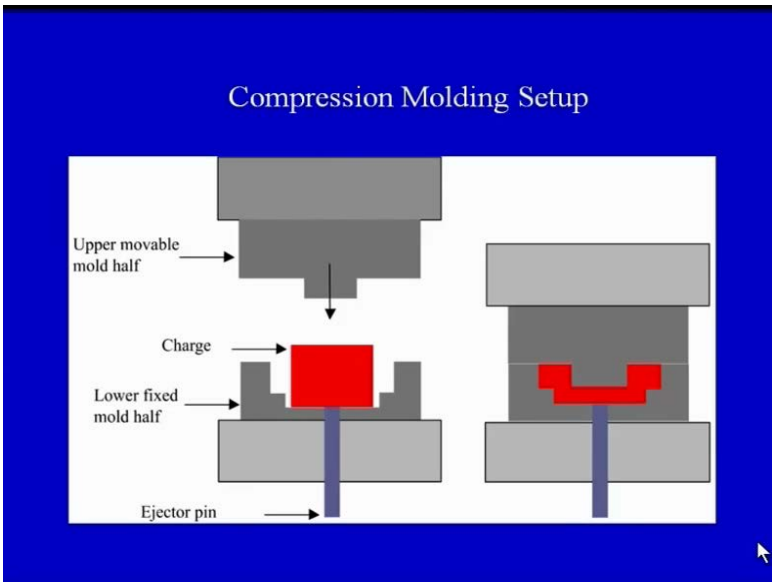

This is a simple diagram which I have drawn this is the compression molding process. So, we have the upper movable mold half this is moveable this is moving in this direction. We have a lower fixed mold half this is the lower fixed mold half this is the charge red color this is the polymer which we want to give the final shape. Now, this what I have not mentioned in the diagram that I have drawn this is the ejector pin, now this particular ejector pin can be used to eject the final product.

Now, the upper movable mold half, now this is the movable mold half which can come down as well as it can go up also. Now once the cycle has been completed, it has applied requisite pressure on this polymer charge, it would retract back after the cooling period. Now for a specific period of time, the upper movable mold half and lower mold or lower fixed mold half would remain closed, and once the curing process or once the the polymerization or once the product is ready the upper movable mold half would go back or it would retract its previous path. And finally, this product can be taken out with the action of this ejector pin which would just give gentle tap on the product and the product would jump out of the lower fixed mold half.

So, this is the simple process of compression molding in which we have a upper movable mold half a lower movable mold half and the polymer charge, and finally, there is a

ejector pin to cause the easy ejection of the final product which has been found by the compression molding process.

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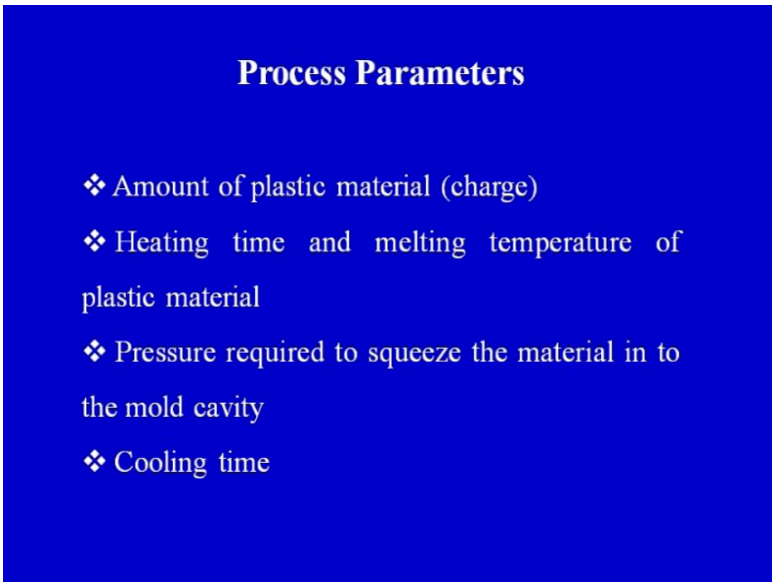

Now, what are the important process parameters in compression molding? Now let us see the amount of plastic material that how much plastic material we should keep in the lower fixed mold half that is important that has to be decided. Second is the heating time and melting temperature of the plastic material for how long we should heat the charge that is placed on the lower fixed mold half, and what is the melting temperature of the raw material that has to be taken into account.

Third - pressure required to squeeze the material mold cavity. Now the mold cavity is being generated between the upper movable mold half and the lower fixed mold half. So, in between, we have a mold cavity now within that mold cavity how much pressure should be required. So, that the molten plastic is able to fill each and every corner of the mold cavity. So, the pressure required to squeeze the material into the mould cavity is equally important.

And finally, once the material has filled each and every corner of the mold cavity, the two mold halves would remain closed until the final product is ready inside the two mold halves. So, the cooling time is also very very important and the time we will allow the two mold halves to remain closed without any heating taking place and the final product is now cooling into the desired shape. So, the amount of that time or the amount for

which the two mold halves would remain closed after the process has been completed is called the cooling time and it has also to be decided properly because if we give too large cooling time our production rate may suffer. So, we have to see that what is the optimal value of the cooling time that we should decide. So, that the production rate is also high and the product that we are getting out of the compression molding process is also of high quality.

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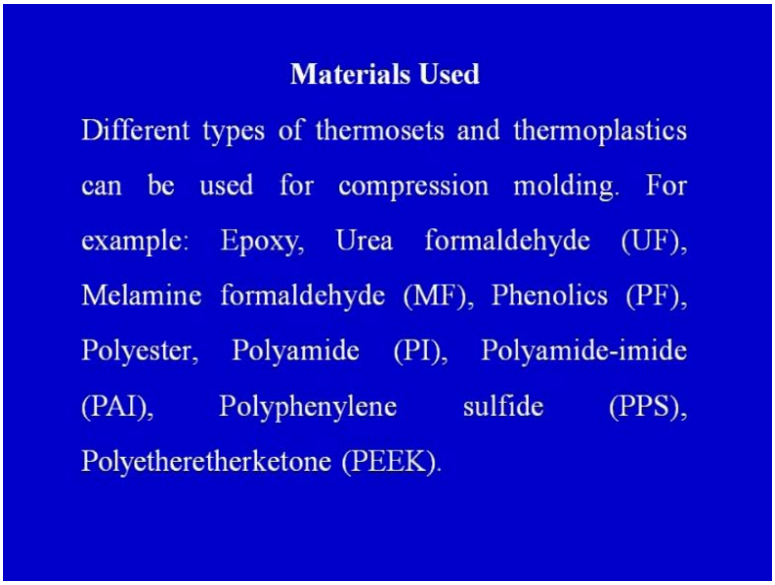

Now, the different materials can be used, different types of thermosets and thermoplastics can be used for compression molding. So, some of the examples are given again and again. We are focusing on some other thermosets and thermoplastics epoxy, urea formaldehyde, melamine formaldehyde, phenolics polyesters, polyamide, polyamide-imide – PAI, polyphenylene sulfide, or polyetheretherketone are some of the plastics which can be processed or some of the polymers which can be processed by the compression molding process.

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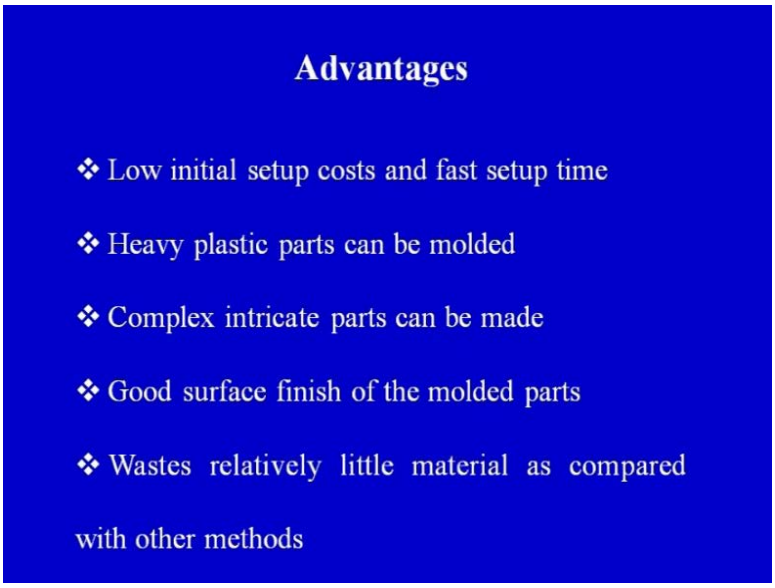

Now, what are the advantages of the compression molding process. Now low initial setup cost and fast setup time, which we have already seen that compression molding is cheaper as compared to transfer molding and the injection molding process. Heavy plastic parts can be molded we can have large mold halves two mold halves and we can give we can get bigger products also heavy plastic parts also. Complex intricate parts can be made, because we are applying pressure also on the plastic in this particular case. So, therefore, we can make complex parts because under pressure the plastic may be able to flow to the each and every corner of the mold cavity. So, complex parts can be made by compression molding.

Good surface finish of the molded parts. Why, because the processing is being done in a closed mold and the mold cavity is finished on both sides, because we have a top mold half and the bottom mold half on both sides we have the mold. So, whatever the product we are getting will have good surface finish on the top side also because of the top mold half and on the bottom side and also because of the bottom fixed mold half. So, the waste availability is little as compared to the other methods. So, the material wastage is also minimum in case of the compression molding process. So, these are some of the advantages which are related to compression molding and if we have some additional attachments to compression molding we can have additional advantages also, but each and every process will have certain limitations also.

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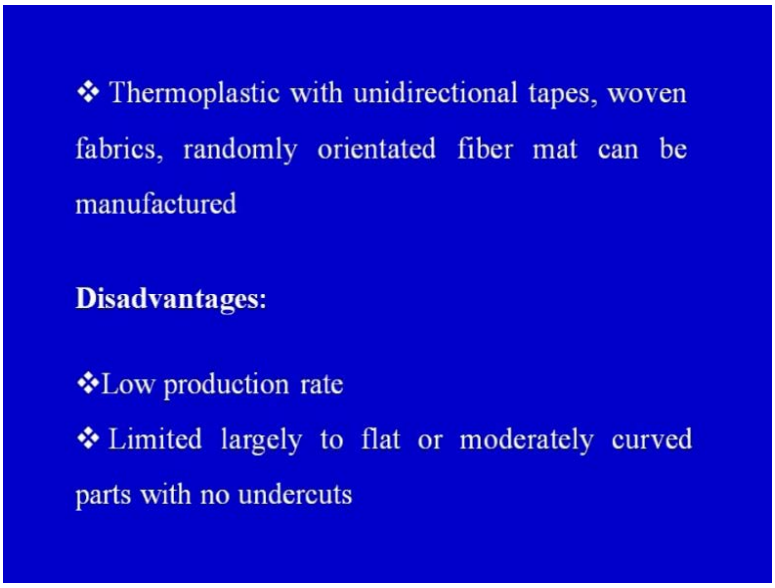

So, let us try to see what are the limitations, now, one of the advantages which is left is thermoplastic with unidirectional tapes or woven fibers randomly oriented fiber mat can also be manufactured. Now, this particular compression molding process in which within the mold we are having the fibrous reinforcement also. We would be covering in another module which would be focused on processing of polymer matrix composites, but certainly reinforced plastics can also be made by the compression molding process.

Now, let us see what are the important disadvantages of the compression molding process. Now disadvantages are the production rates are not very high, because we have to apply we have to supply certain cooling time also, we have to say in other words we have to allow certain cooling time also for the proper formation of the products and discrete products are made one after the other. So, we have to see what is the cycle time for making a single product. So, limited largely to flat or moderately curved parts with no under cuts. So, under parts with under cuts are a limitation in case of compression molding, but certainly this process can be used for making parts which are flat or have fairly curved geometries. So, these are some disadvantages related to compression molding.

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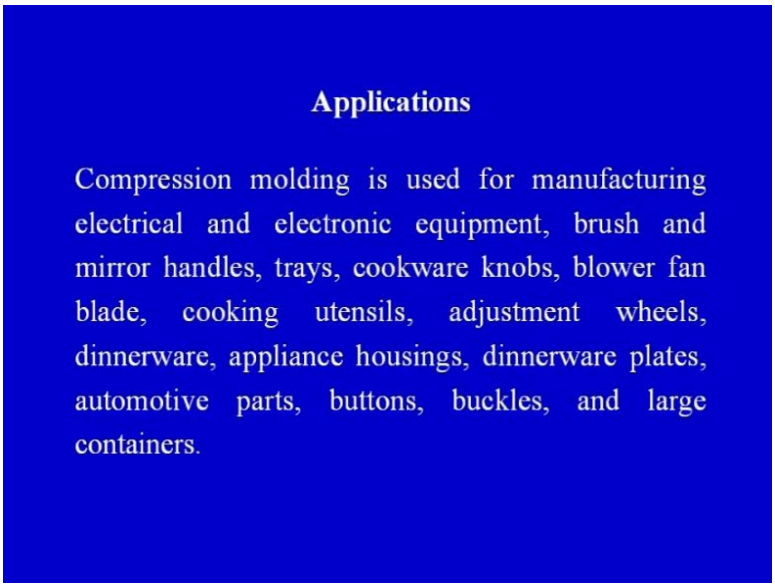

Now, finally, we come to the application areas of the compression molding process. Compression molding is used for manufacturing electrical and electronic equipment. Brush and mirror handles can be made by compression molding, trays, cookware knobs, blowers, blower fan blade, cooking utensils, adjustable wheels, dinnerware application appliance housing dinnerware plates can be made. Automotive parts can be made, buttons buckles and large containers can be made by the compression molding process.

So, our idea primarily is to understand the basic principle or the basic forming technique that is used in compression molding. So, with this we come to the end of this particular lecture on transfer molding and compression molding. Just to revise what we have covered today in this particular lecture our focus primarily was towards the processing techniques that how the process actually takes place and we have seen that how transfer molding takes place with the help of a diagram.

To summarize the polymer charge of plastic is kept inside the transfer pot which is heated and the polymer charge is transferred through the sprue with the help of a plunger or the application is applied by the plunger and the charge is transferred through the sprue into the mold cavity which is in a closed form. So, the mold cavity is closed, the charge reaches to the mold cavity and there it solidifies into the final product. And we have seen what are the important advantages, limitations and applications of the transfer molding process. In case of compression molding, we have tried to understand the basic

working of the compression molding process with the help of a diagram. And in case of compression molding also, we have tried to understand that what are the various advantages, limitations and applications of the compression molding process. In our subsequent lectures, our focus would primarily be on the other processing techniques, which are used for processing of plastics.

Thank you.