**Plastic Waste Management**
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**Lecture - 02**
**Plastic – Types**

Hello and welcome to the second module of week 1. So, we will continue our discussion which we started in the first module. So, we talked about what is plastic in the first module, today we will try to look at the different Types of Plastics. And, as I like a you will see that we will talk about plastic from it's what types based on the different additives in their different types of usage and all that.

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So, in this in the entire week, we will be looking at what is plastic which we talked about in the first module. Today we will focus on in this particular video, we will focus on types of plastic and probably we will continue that discussion in the next video as well in the next module. And, then the last two module we will focus mostly on the usage and the global statistics like how much plastic is really made in global scale and then also in Indian scale. And why we are discussing all this, with the course is on plastic waste management.

So, the rationale behind having just to look at what is plastic, types of plastics uses and global statistics is to try to get an idea on how much plastic is really out there and

because whatever waste will be produced will essentially we will be produced from these plastics only which we are using in different application.

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So, today's focus is looking at how what are the different plastic like a usage what are the things we do with plastics. So, it is a it is we make plastic and the usage of plastic, we can classify that based on how we are making products. So, you can make products based on all these different bullet points that you see on this particular slide. You can make plastic product using extrusion, calendaring, flame blowing, injection molding, blow molding and we will talk about each one of that in little bit detail in subsequent slides. So, do not get do not do not worry you will you will get the explanation as well.

So, these are the different ways where how we make the plastic products and based on the way the plastic product is made, it can be classified into different types. So, it can be expanded bead, rotational molding, compression molding, casting thermoforming and many of these bullet points that you are seeing on this particular slide is also used for other types of other types of manufacturing of products whether it is from based on a glass based on certain metals. So, it is many things are common, but of course, there are certain things which we will do for plastic which we do not do for other material.

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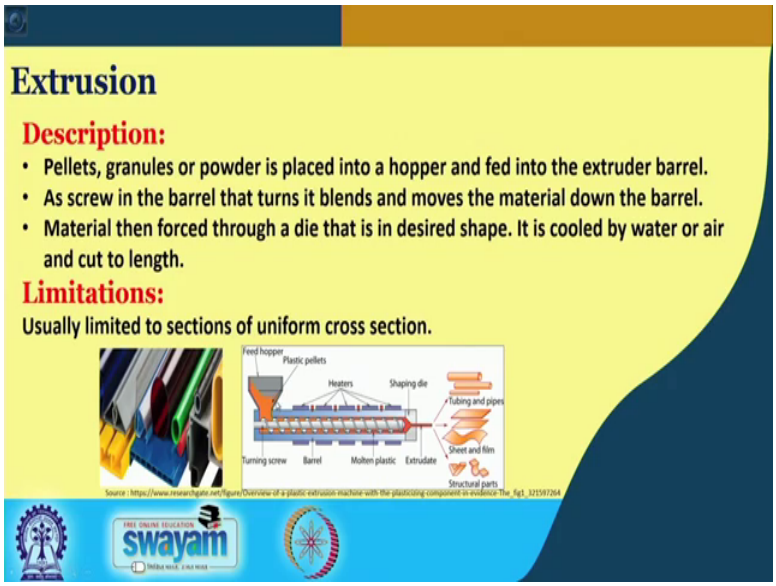


So, in the extrusion how we work with the extrusion it's since you will the if you look at the process behind it. It is you have granules or powders or pallets which is you put it in a hopper as you can see on the sketch, we try to put the material in this hopper over here and then the plastic pallets are form is put it in there and fed into this is this is the extruder barrel. This is a barrel which is an extruder barrel and as the screwed or barrel is turning as it is a turns and blends and moves the material down the barrel. It is when you say a material down, it is not the vertical down here; it is an horizontal down as you can see in this particular sketch.

And then it is a then material then forced through a die where you will there will be a basically a that is put it in the desired shape and it is cooled by water or air and then it is cuts into different length as you can see it can be tubings or pipings or seeds or film. So, this is a basically extrusion extra like you are putting you have a pallets, granules powder. Put it in a hopper a kind of make it semi solid or a liquid kind of form and then you blend it put it put the material down the barrel, put it in a die and put it in desired shape and you cool it down.

So, this is very common very commonly used and it is used for all the glasses and other stuffs; the pipes, the folders as you can see in the picture which on the left side of the slide and then the limitations is usually it is limited to sections of uniform cross sections.

So, you need to have why uniform cross section? Because you already have a desired shape because you cannot have a very variety of shapes coming out from there.

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Other we uses a calendaring. Calendaring is where you can take a plastic dough and there will be two rollers. The rollers will kind of there will be a rolling as you can see on top, there are two rollers which is trying to make this nice plastic sheet which goes through another roller. So, it is like a calendaring it is so, because you as you can see on the pic on the on the photographs its essentially you are you are what you are doing is that you make a dough like a very you make a paste and a thermoplastic mass you formed into a sheet of uniform thickness by pass it through a series of heated or cooled rolls.

And then its what it its used we use it we use this kind of film plastic material either to as a transparency see it is kind of material or you use it for wrapping you put some rapping or lamination. So, you can use these kind of materials are used. So, basically you make you make a sheet material and a covering the you are you can also use it for covering the back of certain plastic. So, those things are also used many times when we try to have a blended paper and plastic it is also used over there.

But there are for every process there are limitations. So, similarly here we have some limitations that very thin films are not possible. So, it has to be certain thickness because what will happen in a very film very thin film it, it will not withstand the strain like a

stress that is goes through this calendaring process and it may tear apart. So, that is why you need to have a certain thickness present.

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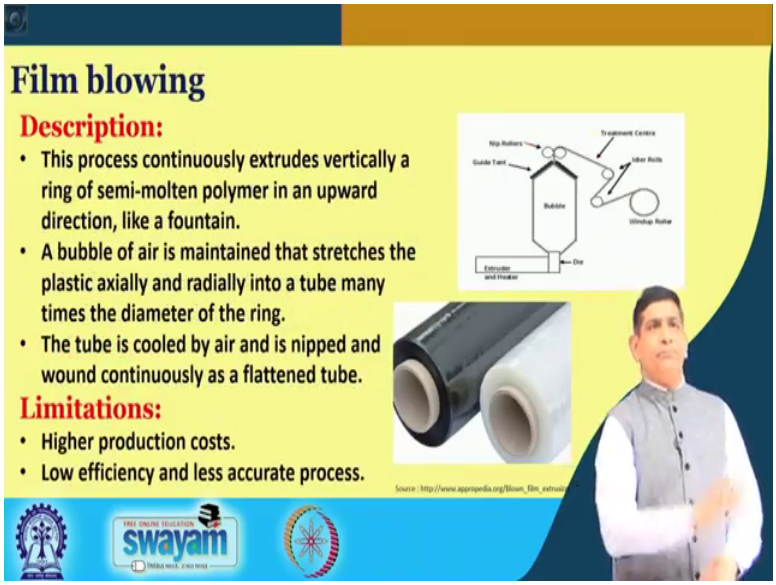


Then film blowing which is again now the another where you can go for like a thinner material it's here you are continuously extruding vertically a semi molten polymer it is like if it is like essentially like a fountain and then you have a bubble layer is maintained. So, you are basically stretching the material and try to makes it in a film I said in particular based on the like a thickness that you require you go for slight modification and the process and then you again since it is a heated up; it has to be cooled.

So, it is the problem with this kind of a stuff is it is a costly because process gets complicated low efficiency, less accurate process. For this particular course you do not have to really get into very nitty gritty detail of how each of one is being manufactured. The reason why we are trying to go over these slides is to give you a some idea that there are a variety of plastics out there. So, when they come to the waste stream, it is also a variety of plastics which was come into the waste stream.

So, when we are try to recycle more and more plastic types getting mixed together it becomes a problem for us in terms of when we try to go for recycling of these plastic um. Mixture of plastic is always you have to as we say in the waste management sector as we say in the municipal solid waste that you have to sort segregate the garbage. Similarly if you have a variety of plastics coming together as a plastic waste, we need to source

segregate the plastic waste types as well. So, that is why it is needed the information is needed to understand what are the different plastic types available in the market which will essentially come in the waste stream.

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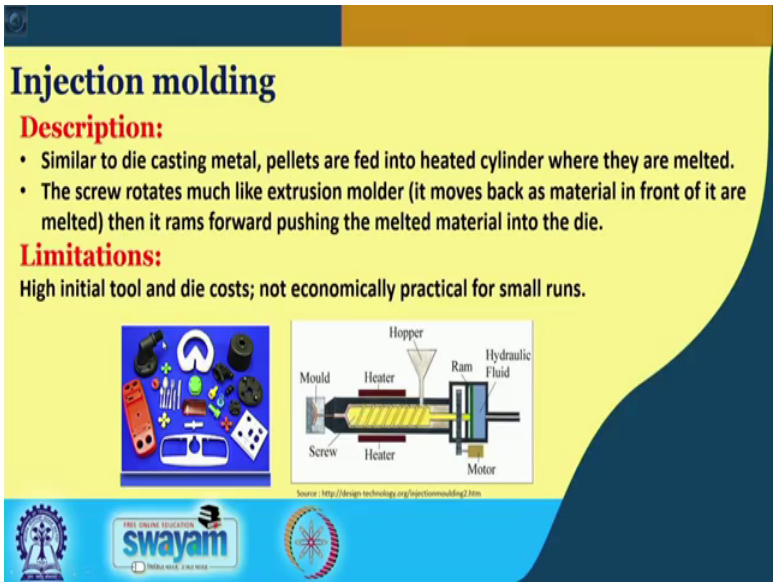


Then other is your injection mold molding which is a very common used for many types of a production process for different shelve. It is a it is similar to die casting metal as you do it for die casting. Again you have lots of shapes as you can see on that blue picture with all the different shapes there it is that is what it is a you have pellets again plastic pallets melted where we are put it in a heated cylinder melted, the screw is rotating here as you can see in this particular pic on this sketch where we have these the which is this is the hopper, this will loaded things in here; you have the mold, this is a heater.

So, things thing things will get loaded up and here hydraulic fluid is putting the pressure, it goes into this particular mold, it passes through this screw, it is while it passes through this. There is a heater on top and bottom which mel sets and then it goes into this mold and makes this like a beautiful shapes that you see over here. So, based on the new type of shapes that you require, you can have those kind of molds present. So, screw will rotate much like extrusion molder it moves back as the material is getting melted, then it ramps forward pushing the material into the die.

So, again what is the limitation for that? High initial tool and die cost not economically practical for a small run. So, you need to do a massive production of this. So, you will

you will set it up for a one particular type of material as you can see on this picture there are different types of different types of products. So, all made from different types of plastics. So, here the thing is that you need to since you will be working with a one particular type of shape at one particular time, you need to produce a huge quantity of that. Otherwise if you have to change the shapes of this mold very frequently, it becomes a more and more costly.

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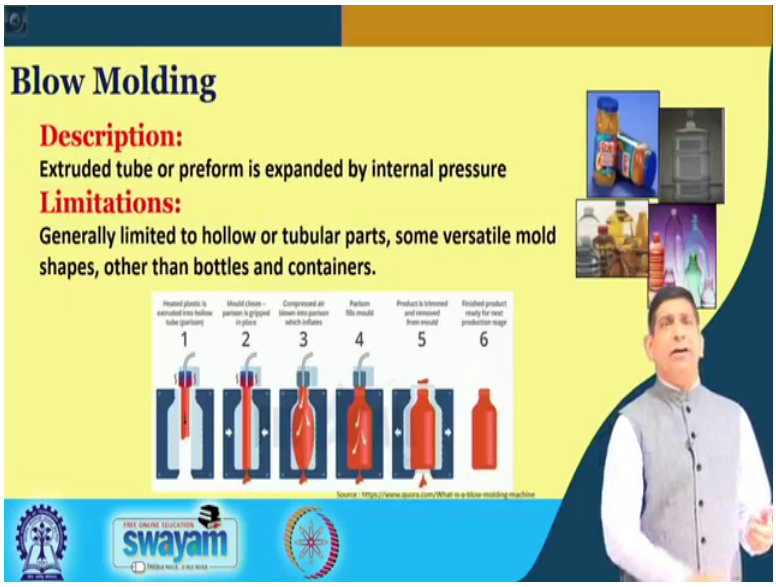


So, that is a kind of thing is required and blow molding very it its used for glass bottles as well where it is you will have a extruded tube or expanded you put some internal pressure and then you blow it is a generally limited to hollow or a tubular parts. You can use it for some other mold shapes as well other than bottles and containers so, most of the bottles here you can. So, see the steps where you will have a first heated plastic is extruded into the hollow tube then in the second step you will have a mold will mold will close and you will have the grip is in place the center position is in place then you blow it by putting some compressed air and which will mold into the inflates.

Then you have the whole thing will fill it as you can see from a number four where things gets all filled up, then you let it cool product is trimmed and then it is cool. Once it is cooled, you cut it off from the top where what this areas that you do not require as well as the bottom you can take them off and then the material is at number 6. It is ready for shipment this is how that plastic bottle is made.

So, again you need to, but again if you sometimes what we do to make the plastic bottle usually, it is just a one particular type. It will be either pet or HDPE most of the times, but our LDPE is as well, but sometimes you may have a blended plastic together and then in that case the recycling of that becomes a little bit more challenging.

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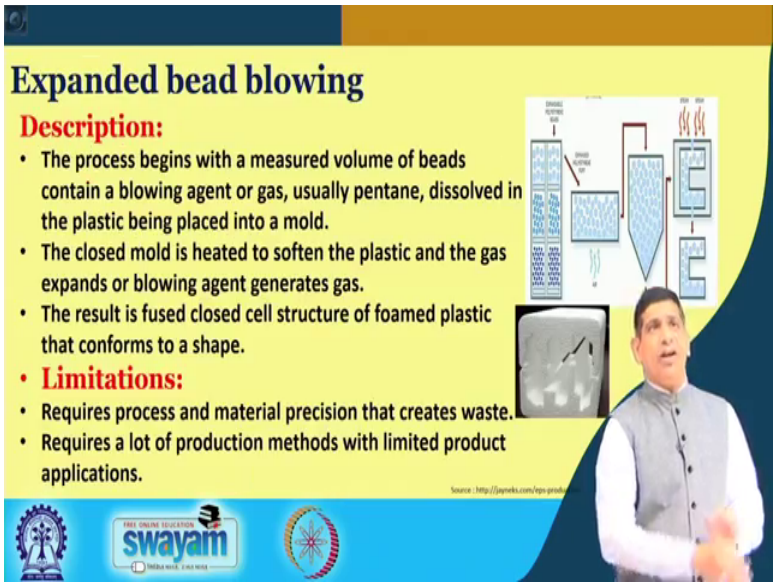


And you can have a expended bead blowing which is another way of you can speak here you take a you take a measured volume of beads, you can have a you can have a blowing agent which is usually a gas usually pentane dissolved in the plastic being placed in the mold. Then the closed mold is heated to which will make the plastics soften.

And the gas will expend and the blowing agent will generate the gas. So, result is fused closed cell structure of foam plastic that confirms to a shape. So, you make so, it is a requires process and material precision and creates some waste as part of the process as well. It requires a lot of production methods with limited product application. So, this type of plastic is used in a very limited application. So, it is a of course, it may become costly as well.

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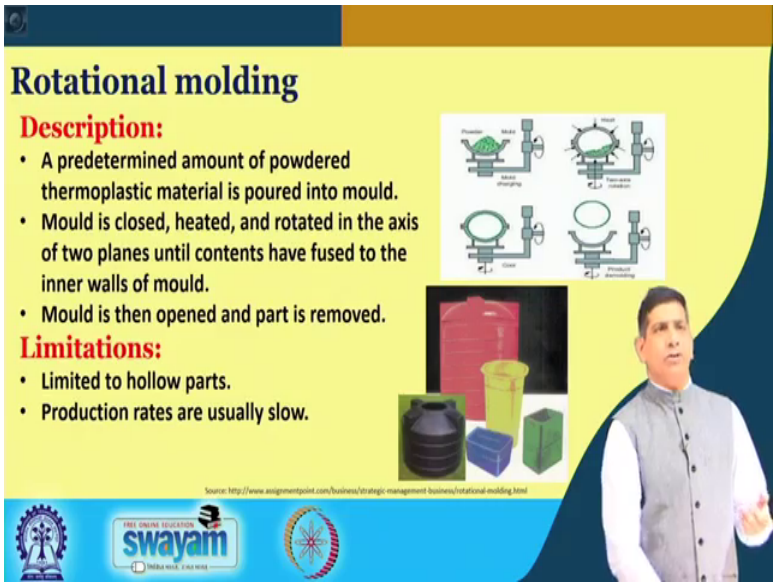


Then you may have a rotational molding where we use for buckets and these trays and the drums those syntax tanks or a big water tank that you see which mostly rotational molding which is used. Here you have a you put a predetermined amount of thermoplastic material, powder thermoplastic material; you pour it into a mold, mold is closed heated and rotated in a axis with two planes and till contents have fused to the inner wall of the mold, then mold is open and the part is removed.

So, it is a usually you it has to be used for a hollow parts. So, you can the ideal for buckets or any container and production rate is usually slow, but here again you need to have of course, a every process has certain you your process efficiency and you have to be careful in terms of have a very nice or say a rotation has to be in such a way. So, that the plastic really gets very nicely on that mold surface; so, that when it cools down you get a drum or which has uniform thickness throughout.

So, those are process stuff which will not go into detail or which will not talk about this is kind of a out of a scope of this course, but this is how those the drums are made. So, you should say it is always as a as I keep on saying in many of my courses that its always better to have some idea about although we are worried about we will be worried about when this particular drum ends up in my waste stream. But, to have a some idea of how this drum was made in the first place is always helps in terms of to see that whether we

can potentially reuse it what could be a reuse applications we can have when this drum comes to the waste.

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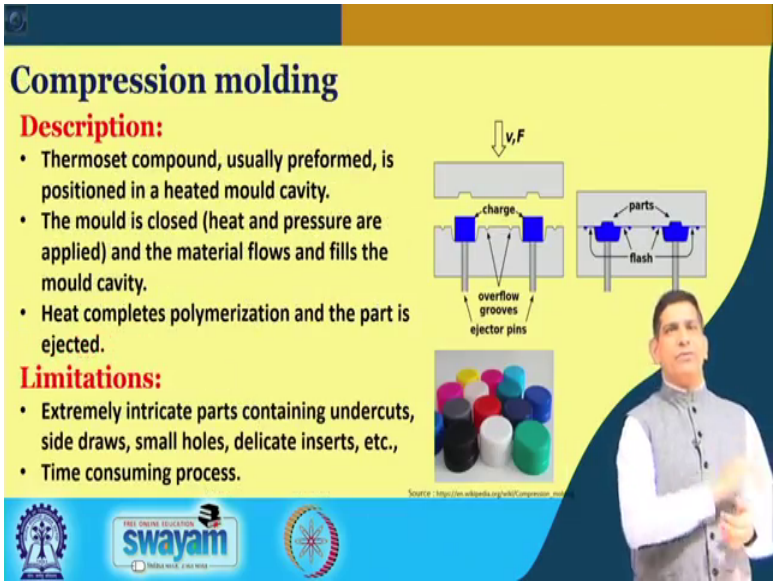


Other is your compression molding where you or the previous one where we are actually blowing things up and trying to get it in the surface of the mold here we are trying to compress. So, here is a thermoset compound usually performed it is you position it in a heated mold cavity you put that in the heated mold cavity the mold is closed and then you put heat and pressure is applied the material will flow and fill the mold cavity. So, it will come to the mold cavity then the heat will completes the polymerization the part is ejected.

So, it is you we use usually use it for intricate parts containing undercuts side draw the small holes delicate inserts etcetera, it's an time consuming process. So, it does take time. So, here we are using compression. So, you basically have thermoset compound which will you use that put it in the heat mold cavity then mold you put heat and pressure. It will go into that particular shape and then you use some heat to complete the polymerization and the part will be ejected out. So, that is a how it is made using the compression molding.

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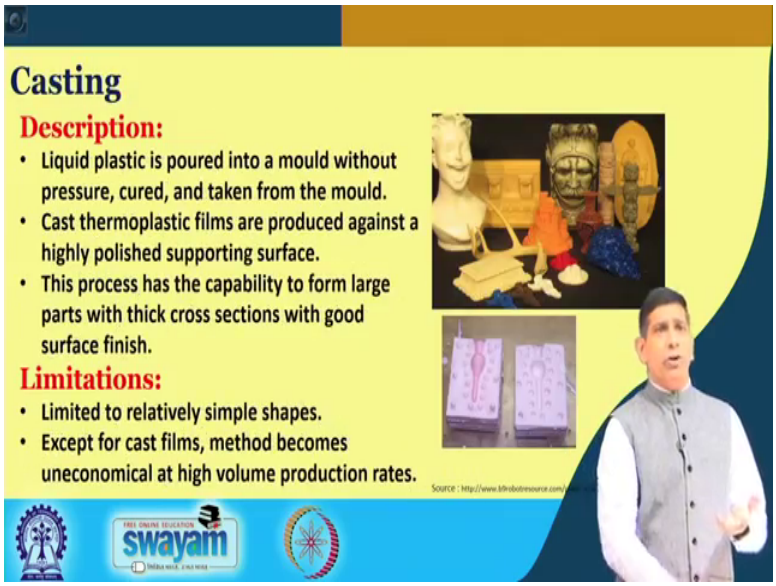


Casting which is again which we kind of use it for a many of our production, we do in terms of it does for plastic even for clay, we do it for a metals casting is very common stuff a very old way of doing things. So, here any casting as we know we have to first make it the liquid. So, in liquid plastic, you will have a liquid plastic which will be poured into the mold and here without pressure cure are taken from the mold.

So, you just put into the mold, then you put a thermo plastic film in terms of the high polished supporting surface. This process has the, you put a large part with thick cross section with good surface finish. So, based on the type of material that you require of course, you have to get the mold made and you put the molten plastic liquid plastic in there. And then you with the plastic as it will cool down it will take the shape of that particular mold. Before you put the plastic we need to put a layer of a material which will keep that plastic not a sticking to the mold surface as we do it for a other applications as well.

So, since the mold is already kind of predefined, we have the shapes of the material of that particular mold is already predefined. It is it has a certain limitation in terms of you will can make it for a certain types of simple shapes we can accept forecast films method becomes un economical at a high volume production rates. So, we have to it is for certain material it works fine, but for in general it is a high volume production rate is required. Otherwise it become uneconomical so, we need to produce a large amount of that.

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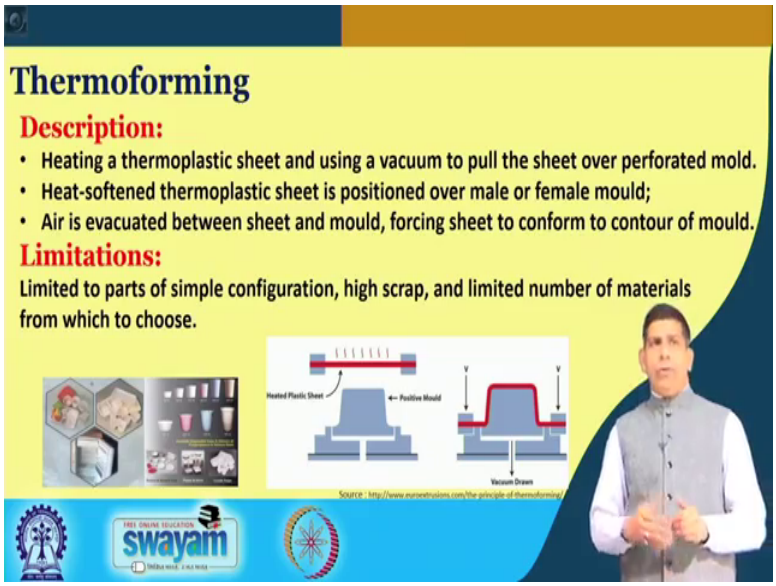


Thermo forming where other method of using it; you use a heater thermoplastic sheet, use a vacuum to pull the sheet over perforated mold heats softened thermoplastics sheet is positioned over male and female mold air is evacuated and then forcing sheet to form a contour of the mold. So, here you can limit it to part for simple configuration, you can if there is a high scar its sorry high scrap more waste limited amount of materials from which to choose.

So, you can, but you can make lot of different types of material as you can see like a tray and different parts for refrigerators different types of containers and so, bowels and like a the like a or say cups and other stuffs those are made using these kind of techniques. So, again there are different ways of doing making different types of products.

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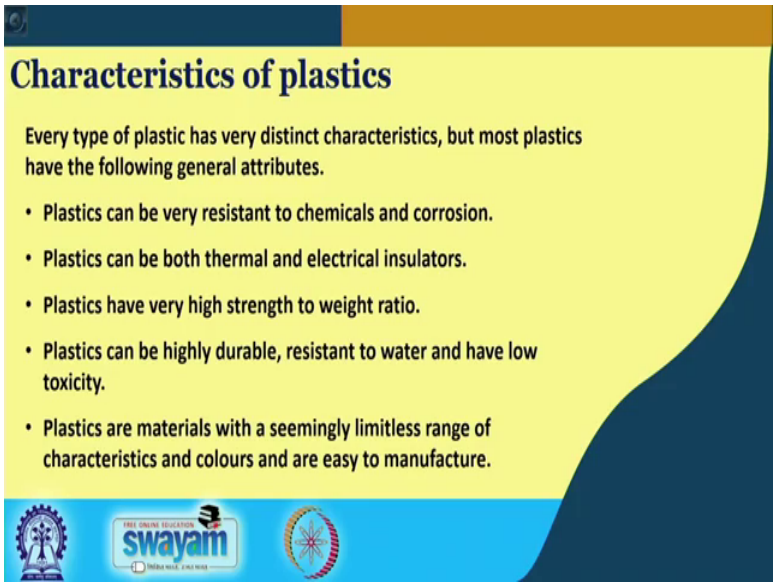


So, based on all these different things that you saw to make we use and if you keep an eye on all the material that you use from morning to evening from when you get up in the morning and the time you get to the bed in the evening. And in fact, maybe several parts of the bed itself is plastic nowadays. So, we use variety of plastic material and they are made in a variety of way. And so, the examples that was shown to you in the slides in this particular module so far was just trying to have an illustration of what are the different types in which a plastic is made and the it is not a there are there could be other ways of making manufacturing plastic products as well. These are the I would say most common most prevalently found methods of a making plastic.

And as you saw it's not many of those method is not only unique to plastic, we use it for other stuff too. So, and then these the different types of products is made using these different methods. So now, we will try to look into some into the characteristics of plastics. So, when we say plastic different application since say for example, if you want to have a very heavy duty tray where you will be carrying a lot of soil and other stuff. So, you really strong toward a strong material as opposed to having a outside just if you want to use it something for single use, small container or you want to make a film plastic kind of material or single use like plates.

So, as you can see there are lots of plates nowadays which is very thin plastic. So, which is essentially single use or maybe used for a couple of times and then it not used

anymore. So, what I am trying to say is based on different types of application, different types of plastic is used and sometimes the manufacturing methods will also be different. So, let us look at some of the characteristics of plastic and then to see that how the product relates with a different plastic characteristics.

So, each type of plastic has very distinct characteristic, but most of the let us look at some of the general attributes like general properties it is why plastic is so popular for the first place like. So, this will kind of try to explain that plastic can be very resistance to chemicals and corrosion. So, as opposed to some other material but so, be it see over say 30 years ago. We were we had very less amount of plastic or you can predominantly save essentially no plastic in our day to day usage around 30 of maybe 35, 40 years ago. Gradually we start today we cannot even think of our day without using plastic.

So, it is why it has become so popular. The reason for that it is resistance to chemicals resistance to corrosion. It can be both thermal as well as electrical insulators. So, it is a thermal insulator, what do you mean by thermal insulator? Means it does not let us temper a heat to pass very quickly and same thing with electrical insulators it its does not let the electricity to pass it through a many times that is why you see the we have a copper wires or the aluminum wires they have a wrap of those plastic material.

So, different multicolor some blue some green, black different colors are used for and that acts as a insulator. So, plastic is used as an insulator material for electrical I have a very high strength to weight ratio. So, one of the thing is for many of the or many of the application, if we have a high strength, but very low weight that that becomes very handy. So, that is a positive point in plastic. It is a very high strength material as compared to the way. It is highly durable does not get bad with water and have low toxicity as well unless the problem that we get in plastic is when it is mismanaged when we are not managing the plastic properly when things are getting into oceans and the rivers and other stuff just last week like I had it you I was working with some people from national geographic and we will I will keep you updated as we move in different weeks; if we have some more update on that.

So, then there are lot of focus around the globe right now is how much plastic is getting into water because that is because when plastic gets into water and eventually to see to the ocean it and the ocean currents and weather all the flows that are happening there it

gets it is starts getting into a small small pieces. And those pieces when its especially if it is a white kind of in color very bright color white which signs on the light and then the birds things that it is a food, it is a small small kind of fish or even the bigger fishes eat those plastics thinking that it is a small fish and that becomes a problem the plastics starts getting into the food chain. And we get worried about plastic showing up in our fish body and we do not want we do not want to consume plastic when we when we are enjoying the fish.

So, it is resistant. It does in good thing about plastic; it is a resistance to water as compared to if you look at the other material that is replaced mostly paper based material and it has a low toxicity unless it is starts getting into all those kind of a oceans and other stuff where it becomes a problem. Even then it is not a it's essentially a mismanagement problem rather than a plastic toxicity problem plastics are material with a limited limitless range of applications, you can make different colors. You can use it for variety of purposes as you can see from when we look you start looking at these material that we use for from as I said from the toothpaste toothpaste and toothbrush all the way to your evening stuff like whether you are even sometimes when you have take the medicine. It will be in a plastic container.

So, those so it is a variety of application and the reason for that is it its a its a limitless range of characteristics. It can it can fit in at many places in our daily requirement of stuff and it you can make it variety of colors and it is easy to make. So, that is with all that its becomes easier in terms of character that is why it becomes a very very popular to use the plastic are there.

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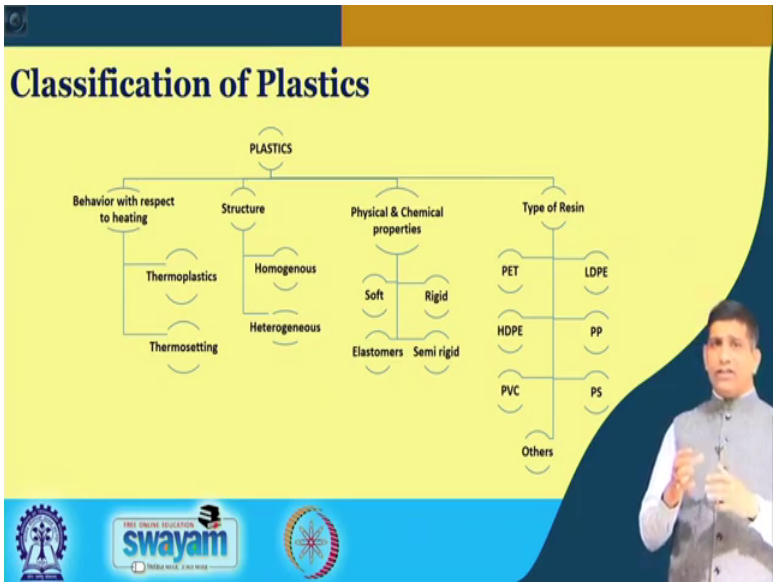


So, if you look at the plastic like in a kind of what we have talked so far in this particular module; if you would try to summarize and take the discussion in a different level. So, plastics it is a there are there are two major tripe you can say, if you look at respect to heating a one is thermoplastic, one is thermosetting plastic. So, we use this term earlier as well in the slide thermoplastic and thermosetting plastic. Then if you think about from a structural it is a either homogeneous or heterogeneous structure and we will talk about some of these in little bit detail, but not too much detail just then we have a physical and chemical properties is that it is soft or rigid or semi rigid or a elasto a elastomers which is like it is a has some elasticity in that and also depends on type of resin. When I say type of resin whether it is a pet HDPE, PVC; LDPE, PP and PS.

So, P what is PET? It is a polyethylene which we are talking about that PET is the mostly the bottles that water bottles that you use whether it is a bit slurry, Echo, Fina and Kinley or whichever brand you buy most of the time it is a PET. Then HDPE is those containers where you have the tighted detergent containers, Saffola containers and those kind of material. Those are your HDPE even the plastic bottles or bacillary bottles or Eco Fina bottle the cap. Cap is HDPE the ring below the cap which is actually connected together before you unscrew unsealed it which is a seal and then while you where you are trying to drink, it you unseal it becomes it is your HDPE material as well. LDPE we made some of those some of the some of the containers we make using LDTE polypropylene is used polystyrene is used PVC is mostly for pipes.

So, these are so these are the typical these are the most common ones and then we use some of the blended plastic together as well especially in electronics and other applications. So, this in this particular module what we were trying to look at if we try to summarize we started looking at what are the different what are the different ways in which plastic is made, what are the limitations of each of the method just brief overview of how the method works and what kind of product is made using that particular method. Then we also looked at some of the characteristics of plastic why plastic is so popular and what are the different properties of plastic which makes it popular, then also looking at the classification in terms of broad classification of a plastic based on its heating, based on the structure, based on physical chemical properties and based on the type of resin used.

So, in terms of the type of resin and we also put numbers like a 1 2 3 4 5 6 7 and 1 means it is a easy to recycle and as we increase the number, it becomes difficult and difficult to recycle based on the available technology today. So, when whenever you look at any plastic product, look at whether it has a recycling number and if it is a recycling number; that means, based on how close it is to number 1, it kind of gives you an idea of how easy it is to recycle. So, every resin has a number PET is 1, HDPE is 2 and thence likewise we have other numbers in there.

So, with that let us close this particular module and then we will continue our discussion in the next module. One thing I would like to again emphasize that we do have a discussion board going on. So, if you have a any question you have a any queries please post it on the discussion board and that is the mode we will use for communication in this particular class and again you will have your first assignment coming out very soon. So, go over the video if needed again and again and all the best and I will see you again in next module.

Thank you.