Plastic Waste Management
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Lecture – 01
Plastics - What is Plastic

So good afternoon, this is the first module week 1 and the lecture 1. So, this is in this particular lecture, we will start talking about what is Plastic. As again thank you for taking this course and as you know the good name of the course is Plastic Waste Management. So, before we start getting into plastic waste though it is very essential to know what is plastic actually, what's actually make off, is it a organic chemical inorganic chemical, where how it comes into existence little bit history behind plastic, how we started using them and then we start we will also in this particular week, we will also start looking at what is it is usage, how much it is being used both from a global contest as well as in the Indian contest.

So, this is first lecture let us focus on what is plastic. So, we will try to look at what is all this about.

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So, this is what will talk about plastic what it is and then to in the week towards later modules in the week, we will talk about types of plastic uses and globally statistics types, we will talk about a little bit in this particular lecture as well.

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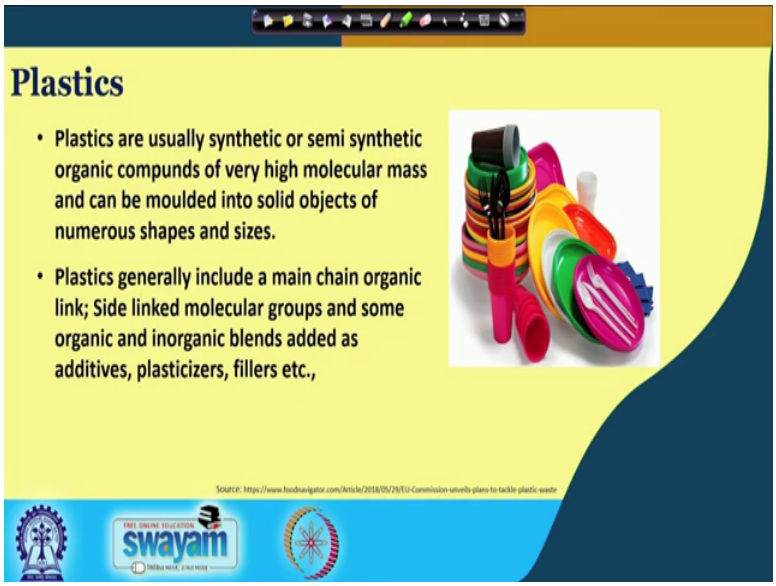

So, what is plastic that is the most important when you say plastic waste management. So, we are talking about a waste, which is essentially means plastic or the major form of that major component in that particular waste is plastic. So, because when you hear plastic waste, it is not always 100 percent plastic many times, it would be 100 percent, but sometimes you will have plastic which is mixed with some other a waste stream as well.

So, plastics is essentially is a synthetic material, its you as you know it is an organic compound as you may probably know it is organic compound a very high molecular mass and the reason why it is so, much used is it is so easy to make different products out of plastic, as you can see in this particular picture, this is just talks about is showing you the picture of a cutlery set and in this cutlery set you can have plates, you can have a spoons, you can have fork, you can have a cups, glasses, trays, different types of glass, thick plastic, thin plastic. So, this is just in a cutlery set you can see so much of variety in terms of the strength and at the at the same time so much variety, you can bring in terms of color and texture and so there are a lot of things that you can make out of plastic that is the reason why it is very popular and we will talk about how things are made as well.

So, as I said it is a synthetic or semi synthetic organic compounds, very high molecular mass and it can be molded into solid objects of numerous shapes and sizes which you see pretty much everyday from the morning you get up, you hold the toothbrush in your

hand, which is a plastic you take to your toothpaste from a tube, which is again a plastic, but it is a different types of plastic as compared to the toothbrush and then you might be using certain plastic cap sorry, plastic tap when you are trying to take the water out from those plastic tap and it may be just you using in your sink that is again a plastic, the plumbing which is going down.

So, just think about I am just talking about just the daily morning routine of us taking our brush and that itself, we are using different types of plastic different shapes of plastic from a toothbrush to the plastic in a plastic tube for our toothpaste then you may have a plastic cap tap which is sorry not cap with a tap for the water faucet and then if you just look below your sink you will have some like a caps, which will with some pipes different type of like a plumbing and then it most of the plumbing these days and most of the buildings are of different types of plastics as well.

So, that is why you see a variety of plastics coming up and it is, but I essentially all those things that you see is a organic compound, it is main chain of that is an organic compound, which will have lot of molecular groups, which you may get mostly predominantly organic, but there will be certain blending of inorganic compounds as well. So, you will have some inorganic compounds which is added and those are added to make a give more strength to it to make it more plasticized like it give it a more workable. So, you can mold it in a different shapes and different sizes and can give us a color you can use as a filler and we look into each one of those in terms of how they are used.

So, as it is a the reason why plastic is so popular is it is so handy so that is the reason why you see the different types of plastics coming up different types of products coming up. Every time even nowadays, there you will have even from many years now you can buy. The other day, I was looking at some of those flower pots, which is essentially it is a plastic, but from a distance if you look at it almost looks like a northern pot because, they give those textures those nice patterns, but when you look at closer when you feel it is actually essentially a plastic like a pot, which you can use for flowers and other things.

So, like and now it is for a maybe last 10 years or so we are also getting into bio plastic that is why if you look at these 2 the bullets, it says predominantly organic mostly organic because, organic means I am talking about non biodegradable organic and there

are some biodegradable plastics, which is also coming up, which we will talk about later in this particular course, when we got into alternative materials and all that. So, this is essentially this is just to give you a brief idea about what is what is the source of all these plastics it is essentially organic.

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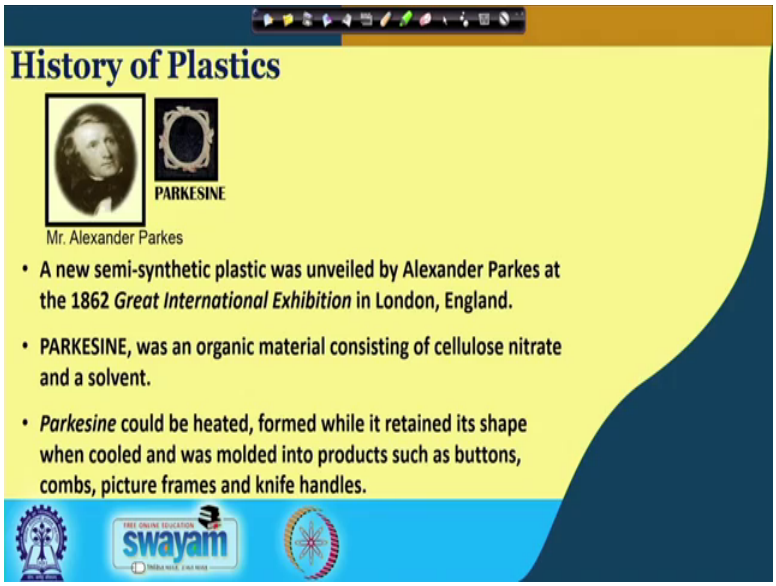

Now, if you look at the history and as I mentioned in many of my courses in the class or online wherever I am trying to delivering a course for any course it is always a good idea to look at a bit of history behind it. So, why what is the history how it came into existent and

Similarly, plastic like since we are talking about plastic waste essentially, we are looking at plastic which has been discarded. So, plastic which was made and then it got discarded. So, it is always today, if you there is a kind of I would say gradually, we also a getting a negative a stigma being attached to the plastic, but plastic is so, convenient and it has helped us in numerous ways to make variety of products. So, that is why the person who invented plastic needs lot of credit for doing that, but at the same time, we could not manage the plastic waste properly that is the reason why we are getting too much of fuse and cries and plastic bands and global initiative on plastics happening right now. In fact, national geographic which you probably watch on TV national geographic channel, they are trying to do to some work in India on plastic waste and I am part of that particular

team, which we will try to do some work and as we make some progress, there I will keep you updated as part of this particular course.

So, in terms of history, it was the first kind of you can say the first compound which was similar to a plastic was done in 1862 in London England and it was a semi synthetic plastic it was done by Alexander Parkes and 9 1862 international exhibition in London. So, that they call he call it Parkesine, which was an organic material essentially cellulose nitrate and a solvent that is what he used.

And the why are the people are excited about that particular compound because, it could be heated it could be formed, while it retained it shape. So, you can form it into different type of like a shapes and when cooled it was molded product you can make buttons, combs, picture frames, knife handles. So, people fall this material can be used in variety of ways. So, that was the first time 1862. So, you think about that today, we are in 2018; so, 32 118. So, almost 100 and how much you like 38 sorry 38 and then 118. So, we are looking at 156 years ago that is when this particular compound first came into what's reported to be in like public domain, where people started thinking about oh you can make a car, we can make a particular material like that.

So, that was long ago 160 some years ago.

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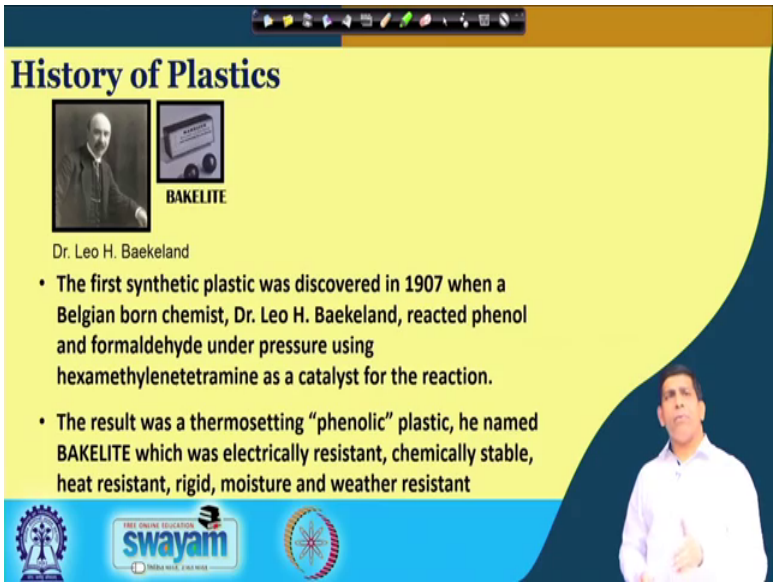

And now, but the recent form of plastic is what we know is mostly synthetic plastic the what you saw earlier just before here is as you can see it is a cellulose nitrate. The cellulose nitrate is essentially mostly you can say nice and natural material, you can call that as well, but synthetic material which we use mostly in our traditional plastic, today was discovered in 1907. So, that was one 1862 so, the 1862, so, another 38 plus 7. So, 45 years later.

And the reason why this material came into being because, people saw the benefit of having a that kind of material, which can be used in a variety of way as you can see the plastic being used today. So, synthetic plastic doctor Baeckeland he in he was a Belgian like a Belgian born chemist sorry he took phenol and formaldehyde, which you have taken some chemistry shown you know what they are if not just Google it, you will find phenol group and the formaldehyde their basic organic chemistry stuff that we have we all have learned in the schools. So, he took those to compounds and put it under pressure using hexa methyl tetra amine. So, hexamethylene tetramine. So, as a catalyst and if you I am pretty sure you know what a catalysis, catalysis is something which helps in enhancing the reaction

So, he uses a catalyst for the reaction under pressure and the result was a thermostatic phenolic plastic and he named it back to Bakelite and which was electrically resistance chemically stable heat resistance or rigid moisture and weather resistance and if you think about these are the properties, which most of the plastic we use today also have depending on what type because, we use it the reason why again reason we use lots of different types of plastics and the reason why we use all those different types of plastics is because, they are useful they are useful for the purpose for which it is designed, whether it is a plumber pipe, whether it is an electrical conduits, whether it is electrical wires, which is a plastic liner on a plastic tubing kind of a small plastic covering on, whether it is an aluminum wire or a copper wire. So, that is those are those helps.

And that is the reason why it is used. So, he made a thermosetting phenolic plastic first and today we do not make it exactly the way he does he did, but we that was kind of the first principle and from there as you will see in next as you make progress today that you will there are different types of different ways, we make those plastics.

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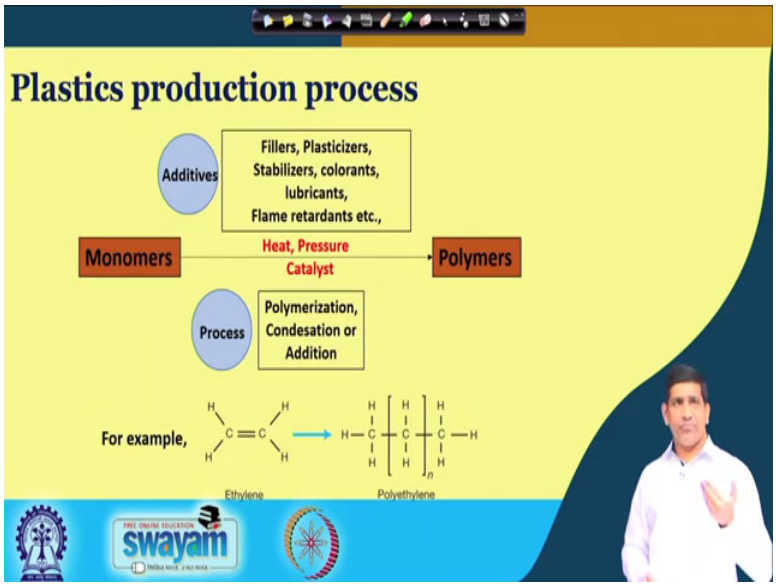

So, in general and again this is a general process and you may have very specific process from different plants, but this is which will which will have a modification of this particular process that you see over there, but it is the in general this is what the process is followed and this is what we are looking at in terms of plastic. So here, what we do we have a monomer as you can see at the bottom we have a like a ethylene is used which is ethylene under heat pressure and catalyst we make it a polyethylene. So, we have a ethylene which is CH 2 CH 2 and then we make a polymer out of that.

So, as this sketch is trying to tell you have your monomers, which is put under heat pressure and catalyst and convert it to a polymer and that polymer is used as a plastic material, but that is not only things that is happening there, you have certain additives as you will as you can see in that rectangle on the top the what are the additives? We could have some fillers and we will talk about each one of them in next fuse, next few slides you will have fillers, you have plasticizers, you have a stabilizers, you have colorants, you have lubricants, you have flame retardants. So, those things are added not all of them are added, but few of them will be added as needed for that particular type of plastic as you will see in the examples.

And then that is the additive that is added, but what is the process? Process as I said earlier it is essentially you are converting a monomer to a polymer and that polymer is you can that is that since, you are converting monomer to polymer the process is called

polymerization and you can do some condensation or you can use do some other addition of like a like different types of compounds in there as well to give it a blended plastics and those things do does happen.

So, which if you look at your remote that plastic is actually not a traditional those number 1 2 3 4 7 that you see, but they are they are there it is not a PTSD PE or at LDPE it is actually not all of them, but depends it is it is a mixture of different types of plastics together. So, that is why it is a we add when we make things from a different plastic compounds.

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So, that is essentially the plastic process and so now, look at each one of those that we talked about in terms of additives catalysts are used, why it is used? These compounds are added to accelerate the hardening of resins because we want to make it harder. So, it will get the strength faster they are used for quick and complete polymerization. So, it helps in completion of polymerization there are for example, you can have Ziegler Natta catalyst is used in the synthesis of many alkaline chain polymers. So, that is what you use for that. So, that is for catalyst to make the reaction go faster that is essentially, what the catalysts do.

Then fillers are essentially inert material, but why do we use them? Because it makes this and our plastic gives a strength to it gives, hardness to it and some other properties can be enhanced as well. So, and it is used as a fibrous laminated or power fillers. So, you

put it in there and usually what we use for filler includes calcium carbonate, talc, silica, clay, calcium sulfate, some calcium sulfate fibers mica glass beads are also used alumina trihydrate is used. So, again depends on what kind of things you are looking for you can have different types of fillers are added

But the reason why fillers are added is because, to impart is strength hardness and other properties. If you are wondering that why I am going into these details and in terms of because, you have taken a plastic waste management course, you are not taken a plastic course, but we are talking about plastic waste management. So, we have to really understand plastic first reason that we do not have we are not going into is a chemical engineering, we will not go into detail of each one of those terms, but at least you should be aware of what are the different materials because, when you are looking at plastic waste, plastic waste will also have traces of calcium carbonate, we will have traces of silica, we will have clay, we will have calcium sulfate, may have glass beads, because these all are used in them.

So, they are there they are there in the plastic. So, when you think about a treatment system for plastic you need to think about that it is not only that organic polymer, which is there, there are a lot of things which goes into making of plastic products and we have to deal with those things as well as part of our plastic treatment system.

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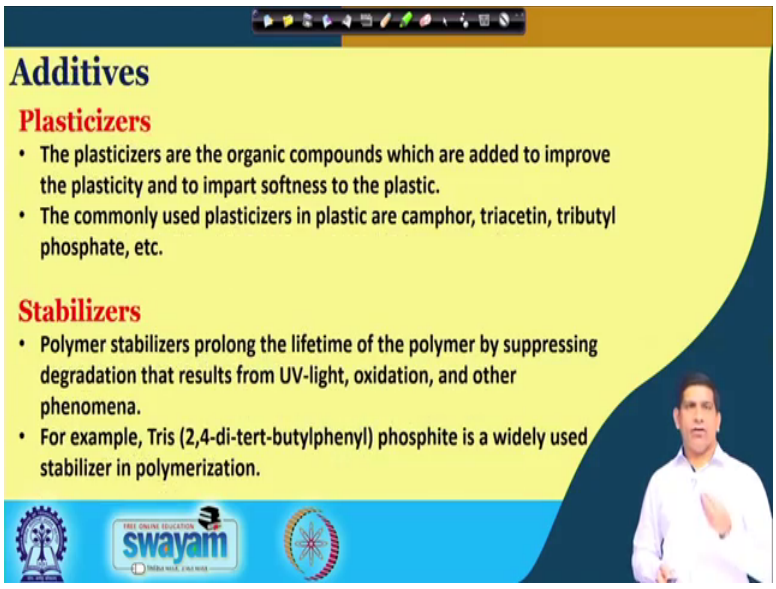

Then plasticizer as the name suggests a plasticizer will do what? It will make things more plus gives more plasticity. So, that plasticity what plasticity and we will impart softness to the plastic. So, what why we need that? Because to have different shapes to make plastic in a different shapes, whether in a like a roll or a thin sheets or you have to make you have to mold it into different kind of complicated shapes and if it is a plasticity is more you can do that. If it is not plastic, if it is not like if it is not the plasticity is less the property plasticity as the property of that particular material is less you may not be able to do that.

So, there are lots of plasticizers which are used commonly used are camphor, triacetin, tributyl, phosphate and those kind of stuff then you have a stabilizer a stabilizer basically, it acts as a stability because it since, the plastics will be exposed to certain things, it will be exposed to light, it will be exposed to oxygen, it will be exposed to different environmental conditions.

And the reason people want people buy plastic stuff especially, because they are stable say, if you have a plastic chair at home it is not that during just one winter and if you have a AC on and then it becomes too hot then again you have AC on and you have too hot it should not crumble it, should not just crumble and start falling apart. So, it has to take different temperature, it can take different sunlight, it does this color. Say, if you have if you watched plastic chairs for example, used especially used in functions or by caterers or decorators and those kind of people if it is used in sun quite a bit, it does get discolored and that is because of the impact of the light impact of a like a oxygen on the weathering or weathering conditions we call in general.

So, a stabilizers, this is the polymer stabilizers they help in prolonging the life of the polymer. So, if you do not have these stabilizers, you will get the wear and tear happening much quickly and if that happens the product will not be stable, if the product is not as stable it will not sell. So, the whole plastic economy we will not really work very well as it works because, people buy plastic stuff because, it has certain durability.

So, similarly here you have the polymer stabilizers helps to do that. So, if you look at some examples there are 2,4 di like a butyl phenyl phosphite is what is used as a stabilizer in polymerization again do not worry about all these big names it is I am not going to ask you these names in your exam, which you will take and further just talking

about the exam as you know this is a NPTEL course like other NPTEL courses you may have taken in the past or if you have this is your first course that you are taking each NPTEL course we have an exam at the end of the course, which you should take in my view, if you are taking this course.

And to get credit for that course if there is an assignment part, if you are not aware of all this go to our website on NPTEL the course website the details are there the because, the assessment is done as a combination of both quizzes as well as exam and the quizzes every week, there will be a quiz and there will be an exam at the end. So, which will be at a designated center very similar to the GATE exam actually where that is how it is conducted as well.

So, if you are not a familiar with that most of you will be because, you may have taken other NPTEL course just in case if you are not go to the website, all the details are there in case you have a any question related to the course or otherwise as well put it on the discussion forum and our team of we have a team, which you are helping run this course. So, they some of some of us will respond back to you depending on what kind of questions you have. So, you will get the answer. So, do not worry about that.

So, and usually you will get the answers within 24 hours that is the goal we have. So coming back to the course, so, it is a stabilizer. So, stabilizer is used to basically give a longer life time. So, things can be stay for a longer period of time.

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Then we have colorants color as you can see there are it is essentially dyes and pigments and why we need those dyes and pigments because, that is why you see those beautiful colors, different plates, different spoons, different colored utensils, different colors of toothbrushes as well and. So, you have variety of colors in plastic products and those that is comes because, we use colorants as the name suggest colorants to help in color. So, they act as filler they impart desired color to the plastic. So, addition of dyes and pigments they helps in 2 ways, they act as a filler as well as the impact desired color the commonly used pigments are zinc oxide, barytes and etcetera.

So, those are used in terms of in color then you have lubricants now why you will need lubricants as well you might be thinking that plastic is already plastics like plastic means what if you from the soil mechanics we used to. So, call plastics plasticity index so that means, it is a that is it is easily can be molded and all that.

So, lubricants helps in terms when we apply to the surface of the mold because, when you are producing plastic products, we do not want the plastic to stick to the surface of the mold in which we are producing say, if you are making a glass or we are making a tube plastic pipe. So, when it will be in a mold as you have done if you those of you who are have done some sort of workshop practice as part of your engineering, if you are an engineering student or if you are even in a diploma holder, you may have done some sort of workshop practice, where we usually use variety of mold to make either even in your school, you may have done clay modeling where you have made like a candles and other things in there as well.

So, we use mold and the lubricants are applied to the surface of the mold. So, the articles of plastic do not stick to the mold. So, it lubricants on the surface of molds allows easy removal of the plastic from the mold as well and the common lubricants that we use as graphite, paraffin, wax etcetera. So, those are the use a stuff in there.

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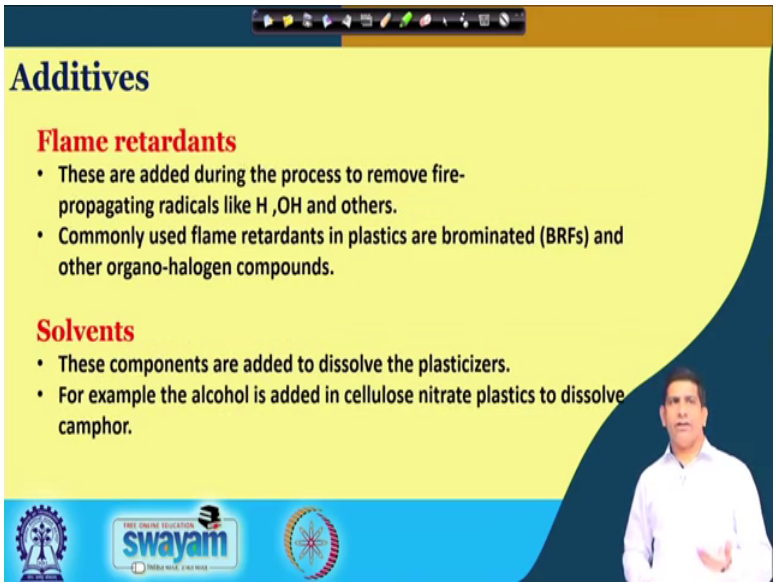

Then this is very interesting flame retardants which is another additive is used. Now flame retardants, if you have followed the environmental news or environmental articles or looking at the risk environmental risk from flame retardants environmental and human health risk almost a decade ago this was a hot topic like we have pfoa and pfas right now. So, like a flame retardants was very was a hot topic, I would say in around 2004 2005 lot of research was going on in terms of the flame retardants, what are the different types of flame retardants? Mostly they are brominated flame retardants, you see lot of bromine containing compound it is a organo, halogen compound. So, they are brominated flame retardants and they have certain adverse environmental impact.

So, these flame retardants they are added during the process, why it is added? To remove the file propagating radicals. So, you do not want fire to happen say think just a simple example, even if you just your laptop or your you these days in your computer use lot of plastic. So, think about your laptop you way as if you if you have one if you have been closer to a computer desktop, you see that they get heated up after a certain point of working certain time of working, it gets heated up and it which gets heated up you do not want that heat to get into some sort of sort like a fire and then destroy your laptop. So, sometimes if the heat is pretty. So, it gets really pretty hot especially, if your fan has some problem as well.

So, in that scenarios this brominated flame retardants what does that mean flame retardant. So, it will not let flame to propagate. So, it will not like fire. So, it basically acts as a fire resistance or fire protection, you can probably in a layman term you can even say that. So, these are. So, remove the fire propagating radicals commonly used or brominated flame retardants BFRs and other organic halogen compound.

Then we have solvents these compounds are this components are added to dissolve the plasticizers, we are use it as a solvent it will help in in getting things into solution for example, alcohol is added into cellulose nitrate plastic to dissolve in camphor. So, those. So, those things are used as well.

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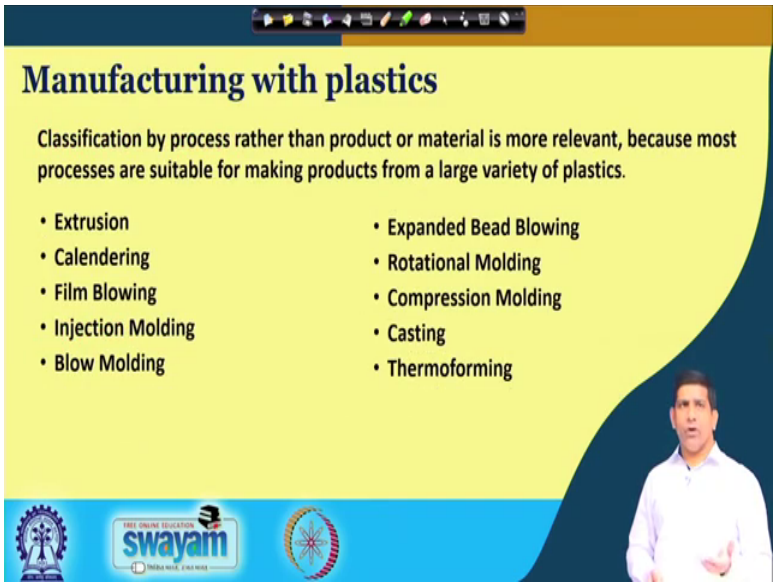

Now, there are different types of manufacturing is done with plastic. So, we will just talk about it little bit in this particular module and then we will continue this discussion in the next module. So, in terms of manufacturing with plastics so far what you saw is what is plastic what are the different like, what is the it is essentially an organic compound and which is a poly is a polymer. So, you take a monomer, you do certain reaction, you make it a polymer, you add certain additives, you add certain things to add a strength add color and you get variety of different types of plastics made.

So now, we are talking about the raw material plastic. Now, we this next step would be to make product out of that. So, the raw material is good, but at the same time we do not we need to make say PT, HDPE those are just having like a long sheets of pet or a long kind

of PET compound in whatever form it is not going to help, we have to make different products out of that.

So, there are different ways of making those product just we will talk about in a minute and then we will stop and then we will continue in the next video. So, it is we here we have we can do many manufacturing in a variety of way, you can do extrusion, you can do calendaring, film blowing, injection molding, blow molding and bead blowing, rotational molding, compression molding, casting thermo forming and if you look at all these different terminology, they are not new. This is nothing is specific for plastics, same thing you may have seen it for glass, those of you are familiar with the glass industry or for the matter any other industry as well.

So, it all depends it is a similar same process, which have been using in the manufacturing world for quite some time. Once, the plastic came in we had we may have we had to may modify some of this process, but we have been using it we have been using extrusion, calendaring, film blowing and all that for quite some time.

So, that is we will continue this discussion in the next module. So, this is like a first week lecture 1 and we talked about what is plastic, we try to in the goal of this the particular video was to tell that can we introduce you to what is plastic, give you some idea about the background in terms of the history like how this came into existence and what are the different material kind of goes into making these different types of plastics.

So, you as you saw there are plasticizers, there are colorants, there are flame retardants, there are dyes and all those things that goes in there. So, when you look at plastic waste they it plastic is there, which is the monomer the polymer, which was made from a monomer and but at the same time lot of other compounds are also present. So, you should have that in mind when you start looking at solution for plastic waste.

Thank you and see you again.