Plastic Waste Management
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Lecture - 31
Possible Alternate Materials to Plastics - Greener Alternatives

So welcome back this is now we are in week 7 as if you remember from the course outline in week 7 what we had proposed to be the content of this course is looking at the alternative materials. Last week we were looking at how to manage the plastic waste, now we are moving say if we do not have to use plastic what are the alternatives and what are the newer things which is coming up replacing plastic? Lots of biodegradable plastic and similar material.

So, we will talk about some of those material in the class in this video and then as every week we will have a reading material which will include this set of slides and will also include some PDFs which will be posted which are being posted online as well.

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So, let us get started so for this at week focus is on Alternative Material to Plastic and essentially we will be looking at the Greener Alternatives what are the environmental friendly alternatives which are being proposed from different countries.

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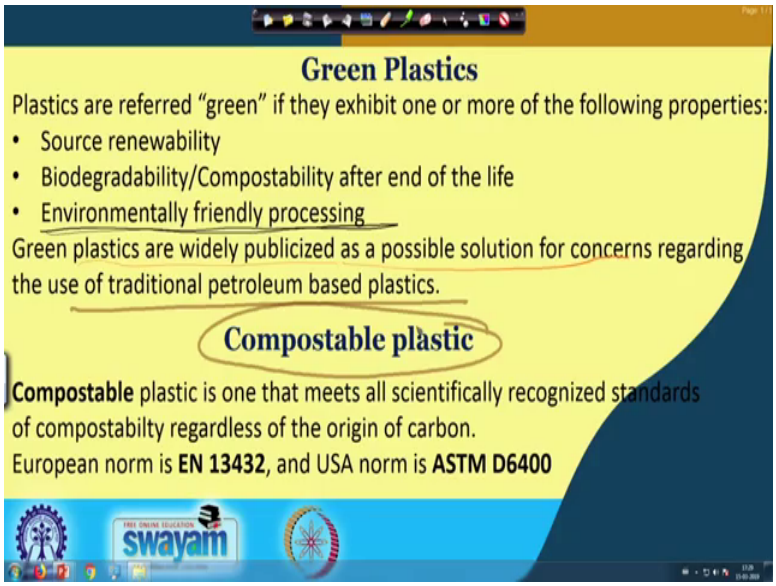

So, what is green plastic? Plastic are referred as green, if they are exhibiting one or more of the following properties like they can be renewable that is the renewable plastic, biodegradable or compostable at the end of the life. So, once you throw away the plastic after its use it is biodegradable or compostable and will talk about what that mean. Environmental friendly processing, so even while it is not only the end product you are also looking at during the making of the plastic it is environmental friendly.

So, you are not we are looking at the ones which are environmental friendly product not only just towards the end it becomes better. So, green plastics they are widely publicized as a possible solution for concern regarding the use of plastic in use of petroleum based plastic. So, the green plastic is one of the alternatives that is being proposed and biodegradable compostable those are what majority that is what the green plastic is all about.

Now compostable plastic as you know for every material we have an ASTM standard which is the American Society for Testing Materials. So, we have an ASTM standard, we have a European Union standard, so the compostable plastic is considered the plastic which meets its; it meets all scientifically and recognized standards of compostability regardless of origin of carbon.

So, there is a European Union a 13432 there is a US ASTM of D6400. So, those are the it has to follow those two, guidelines those two kind of norms before we can call it a compostable plastic.

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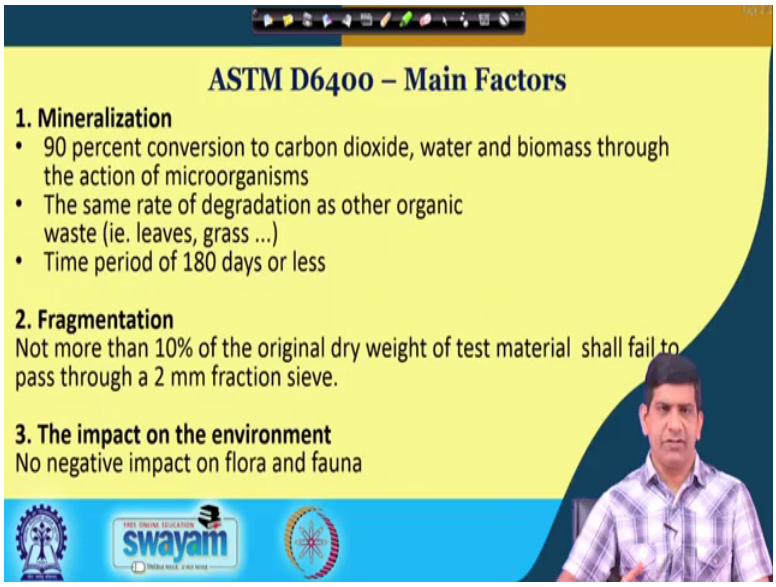

Now, what is ASTM D6400, what are what does it mean? And it means that 90 percent conversion to CO 2 water and biomass through the actions of microorganism. So, if there is any material which can through the action of microorganisms 90 percent of it converts to CO 2 water and biomass that is meets the criteria of ASTM 6400. Same rate of degradation as other organic waste for example, leaves, grass and those kind of wastes, so it is similar; similar rate of degradation. Time period of degradation 100 180 days or less.

So, it should not that it will take longer, so 6 months so within 6 months it should degrade, it should biodegrade and that is what and this whole together is called mineralization. So, it will be mineralized within 140 days with 90 percent of it converted to the carbon dioxide water and biomass. The second one is the fragmentation; fragmentation is not more than 10 percent of the original dry weight of test material self shall fail to pass through 2 mm fraction sieve.

So, when you have original dry weight of the test material and you make it will have it pass it through you break it down like a smaller pieces and they should easily pass

through 2 mm fraction sieve if not 90 percent of it should pass through that and no negative impact to flora and fauna.

So, pretty strict guideline for anything to be called compostable. So, that is why these are the guidelines which is there for say if any plastic new plastic is coming out in the market and they claim to be compostable they has to meet these criteria then only it will be ASTM satisfied, so ASTM 6400 compliant for a bioplastic.

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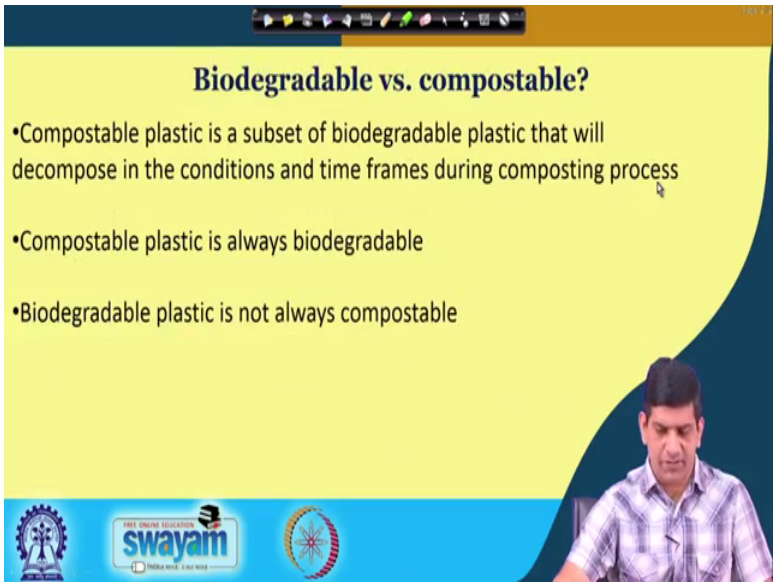

Now, there is always we get these two terms coming up biodegradable versus compostable and these are sometimes used interchangeably, but there is a difference there, so we I just wanted to highlight the difference. Compostable plastic is essentially a subset of biodegradable plastic. So, the compostable that we just talked about using ASTM or the European Union standards it is; it is a subset that will decompose in conditions and time frame during the composting process.

So, compostable plastic has to be biodegradable, but biodegradable plastic does not; not always compostable because it may not meet that ASTM standard, it is a still biodegradable it will biodegrade in the in certain scenarios, in certain like industry great composter or some scenarios it will biodegrade. And in nature it will biodegrade, but may take more than 6 months; it may take a longer period to degrade. So, that is so that is not compostable, but it still it is biodegradable.

So, biodegradable is a much bigger area and compostable is a small subset of that so that is what we are trying to. So, anything compostable you can call it biodegradable, but anything biodegradable you may not call it compostable unless it meets the compostable it takes guideline of ASTM and as well as the European Union which we just looked into.

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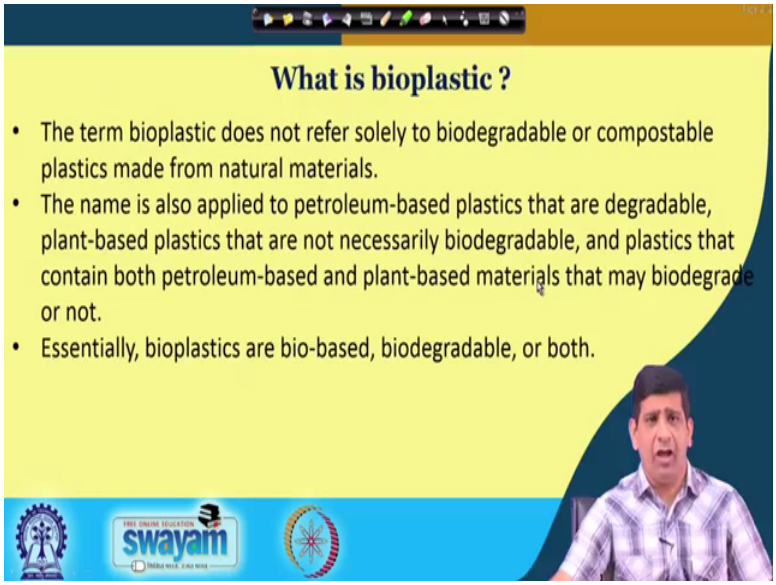

Now, there is also a concept of bioplastic, bioplastic is it is a term which is referred, not only for biodegradable or compostable, but it a plastic made from natural material. Name also implies to petroleum based plastic that are degradable, so there are some petroleum based plastic which are degradable, plant based plastics that are not necessarily biodegradable and plastic that contain both petroleum-based and plant-based material that may biodegrade or may not.

So, essentially bio plastics are bio-based and biodegradable or both, so it is either you it is a biodegradable it will degrade and it may take longer time to degrade, but it is degradable as per its a properties and its and either or it could be bio-based.

So, that is a bioplastic again is a much broader term that way in terms of like a bio plastics that you talk about. So, bioplastic is something different, biodegradable plastic is different, compostable plastic is different, so there is a differentiation between. Many times we uses these terms very interchangeably, but technically they mean different stuff, so that is what we were trying to highlight.

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Now, looking at little bit deeper bio-based plastic then there is something called there was one bioplastic, now there is a bio-based plastic and bio based plastic means that at least part of it came from biomass. So, it may not be 100 percent, but part of the product means that material or product is at least partly derived from biomass.

So, it is a part of this is coming from biomass, it can be natural polymer, it can be synthetic plastic made from organic macromolecules that are derived from biological sources, so part of it has to come from biomass. And to be classified as biomass based plastic or bio based plastic they must be of organic origin and it should contain a certain percentage of carbon derived from biological sources.

So, the definition is actually from they are coming from ASTM D6866. So, as per ASTM D6866 bio-based plastic must be organic in nature organic origin and they contain a certain percentage of new carbon derived from biological sources, so that is a what called bio-based plastics.

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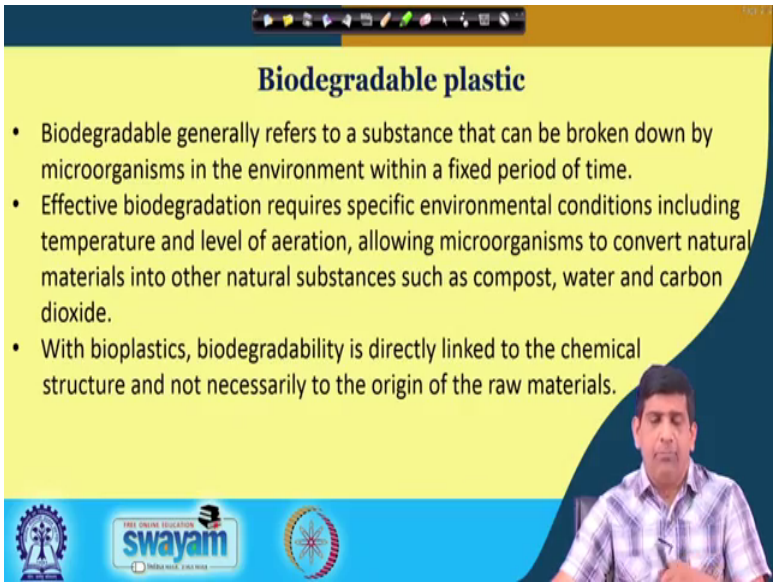

So, again lot of terminology, biodegradable plastic refers to a substance that can be broke down by microorganism within a fixed period of time. So, again it is a fixed period of time, but it could be more than 180 days; 180 days is what we have given to compostable plastic. So, it is can be broken down by microorganism in the environment within a fixed period of time.

Effective bio degradation requires a specific environmental conditions including temperature, level of variation, allowing microorganisms to convert natural material into other natural substance such as compost, water and carbon dioxide. With bioplastic biodegradability is directly linked to the chemical structure and not necessarily to the origin of the raw material.

So, it is a when we look at the bio plastic the biodegradability is linked to the chemical structure because the complex structure takes a longer time to degrade sometimes with too much of benzene ring things does not degrade it as well. So, there is ad and depends on how they are how the structure has been is formed, so, some are easy to can be broken down, some it is difficult to broken down. So, based on that biodegradability is linked to the chemical structure which is true for other biodegradability as well; even when we talk about bioremediation we looked at that too.

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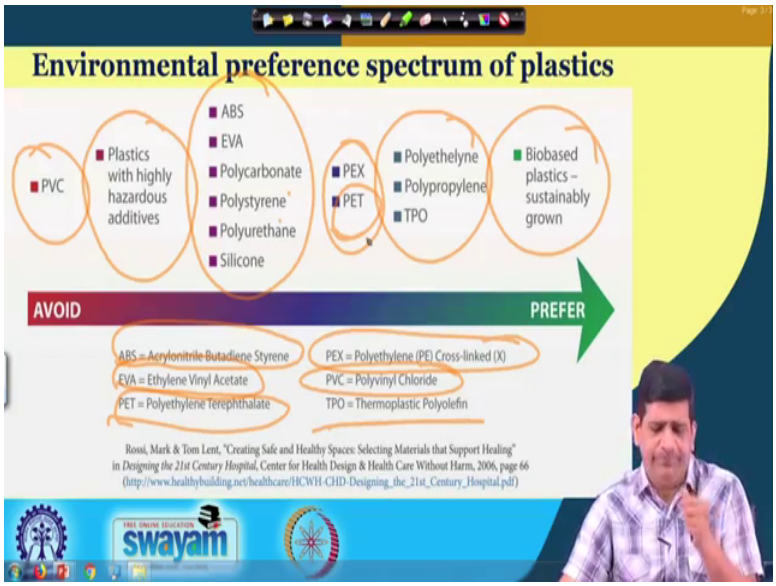

Now since there are different types of plastics out there and so from an environmental point of view if you have to look at from environmental perform environmental preference in terms of different plastic how they will rank. So, as here as we go from if you can see here as we go from left to right, left one is avoid the right one is prefer.

That is why if you look at the color coding as well, left is red in color red usually we kind of denote something in danger or something in stop kind of things, so you go from red in the middle you have a blue kind of getting better for the environment and then finally, it is going towards green which is preferred from environmental standpoint.

So, from a environmental performance spectrum of plastic we are looking at what are the things which are for avoid PVC which is what is PVC? Polyvinyl Chloride which is right here and we use lots of PVC pipes, so we actually we should avoid using lots of PVC from an environmental point of view. This is PVC plastic; then there are plastics with highly hazardous additives, so we have some plastics which is highly hazardous and additives. ABS which is Acrylonitrile Butadiene Styrene, so that is your ABS plastic type. Then we have EVA which is the Ethylene Vinyl Acetate, we have polycarbonate, polystyrene, polyurethane silicon. So, that is the kind of third category which is getting a little bit better, but if we can we should still avoid these type of plastic.

Then we are coming in here in the bluer range which is PEX and PET, PEX is Polyethylene Cross-linked; Cross-linked Polyethylene like a chemical structure, so that

your PEX, PET is Polyethylene Terephthalate. So, that is your PET which is kind of getting towards better then even better, then that we have polyethylene, polypropylene and TPO which is Thermoplastic Polyolefin.

So, that is over there and then finally, if we have bio based plastics sustainability grow; sustainably grown, so that is considered better. So, this is how you go from left to right for different types of plastic is still most what we use more is PET like all those water bottles are PET bottles, you many times people got to talk about that give me a PET bottle.

PET is what that names refer to PET and HDPE those are also used quite a bit then we also use polypropylene, polyethylene and, but we are also using polystyrene PVC those plastics are also still being used. But as per from if you look at from an environmental point of view we should try to avoid the ones which is on the left side and we should try to use the one which is on the extreme right side, so that is the what it kind of talks about.

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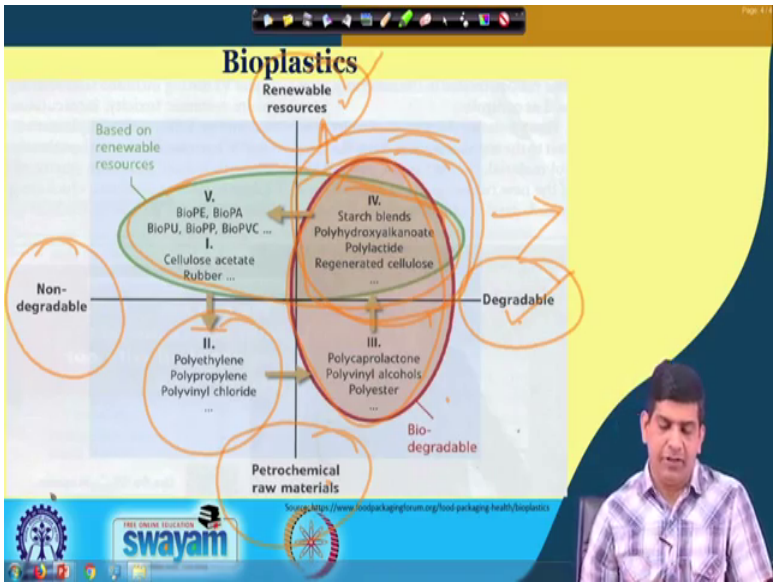

Now, bio plastics it is it there are if you look at the bio plastic it is there not if you look at the different kind of the different aspects of a bioplastic, we can put it in kind of in four big areas like renewable, it is a renewable resource sorry it is you can have a renewable resource you can have non-degradable, degradable petrochemical raw material.

So, in this four broad area say as if like four quadrant if you put an x as x; x axis and y axis like kind of scenario where non-degradable to degradable, renewable to fossil fuel, so that is your x axis and y axis. So, y positive is on top basically more renewable is better, x positive is on this side like we use four x axis and y axis more degradable is better. So, in this 4 quadrant if you look at what kind of comes in; in quadrant 1 which is a cellulose if it is based on renewable as well as on this side we are looking at based on renewable, but non-degradable.

So, there are some BioPE, BioPA, BioPU, BioPP, BioPVC because they are based on renewable sources that is this circle like a oval that you are looking at these are all kind of based on renewable sources, but it is still non-degradable. Here on the right hand side this kind of is the best area because here we have degradable as well as renewable sources.

So, if that is in the preferred area which is starch blends polyhydroxyalkanoate, polyactide regenerated cellulose. So, that is on this particular side and then here on at the bottom on this side we have degradable like a biodegradable, but coming from petroleum raw material like polyvinyl alcohol, polyester polycaprolactone.

So that is your biodegradable and this is this sector is all what we are looking at biodegradable sector. So, this here we have biodegradable as well as, but coming from the petroleum as a raw material. On the last one which is will be the most which is list wave preferred in terms of bioplastic it is polyethylene, polypropylene, polyvinyl chloride.

It is neither degradable and it is coming from it is non biodegradable non-degradable and it is also coming from petroleum raw materials. So, that is kind of if you look at different types of plastics, so we can if you put it on four quadrant system so that is how it looks like.

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So, bioplastic as you saw earlier the range of biodegradable plastic available include a starch based product which kind of makes sense including thermoplastic starch, synthetic aliphatic polyester blends and starch and other blends out there. Then we have the water soluble polymers such as polyvinyl alcohol and ethylene vinyl alcohol.

Naturally produced polyesters including PVB, PHP, PHBH, renewable resource polyester like a PLA, synthetic aliphatic polyesters, Aliphatic-aromatic co-polyesters, hydro-biodegradable, photo-biodegradable, control degradation of additive master batches. So, there are variety of different types of plastics which kind of cluunder the big broad criteria of bioplastic that we have.

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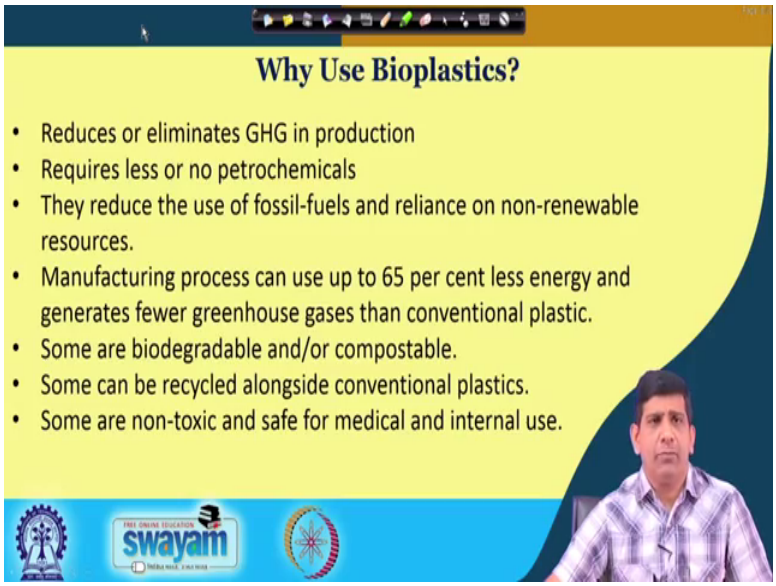

So, but why we use bioplastic, what is the plan of using bioplastic? Again there are lot of discussion on is bioplastics is this biodegradable plastics are really good for environment to the extent that we think they are. So, our for example, when you put these biodegradable material in the place of a regular plastic, many times in a blended form today in a mixture of regular plastic and biodegradable plastic.

Thing is that the regular plastic since it comes from the fossil fuel, the production of that is you are you are helping in reducing the production of those fossil fuels. So, you are helping in the greenhouse gas emissions and all that that is that is well taken care of. But when this biodegradable plastic ends up in the waste disposal site and if not managed properly if it goes into a landfill where it will degrade and produce methane and that methane goes to the atmosphere again it is creating greenhouse gas emissions.

So, anything biodegradable in anaerobic system will create methane and CO 2, anything a biodegradable in an aerobic system will create CO 2 water and energy like a heat and all that. So, it is a biodegradable means it finally, it will be either CO 2 or methane depending on whether it is a aerobic situation anaerobic situation. So, they do contribute to the greenhouse gas emissions as well, effectively they will contribute less because the fossil fuel production itself contributes quite a bit in terms of greenhouse gas emission, so we have to look at that.

So, let us say that whole issue of like having a kind of discussion with it LCA kind of theme lifecycle analysis kind of theme is essential whenever we make decision whether that one particular policy matter whether it is really going to help the environment or not. Many times they look to be helping the environment, but probably we could do something much simpler and get the same environmental benefit, so we do not have to make the complex.

So, there are you know ways to look at it and LCA is one of the way to look at it which we keep on talking about referring to in this course, but that is that is a that is a good course to take that lifecycle analysis as well and we had that run on NPTEL and I hope it will be again running in future. So, this is a, so bioplastic will help reduce in greenhouse gas emission they are kind of eliminating the use of petrochemicals trying to reduce the use of plasto chemicals.

They reduce the use of fossil-fuels and denying and in reliance on non-renewable sources. Manufacturing forces can use up to 65 percent less energy and generates fewer greenhouse gas emissions than conventional plastic. Some are biodegradable and are compostable, some can be recycled along conventional plastic, some are non-toxic and safe or medical and then internal use.

So, that is; that is also there in terms of bioplastic could be used for internal for the medicine delivery for a lot of because a lot of things in if you go to any hospital most places you find lots and lots of usage of plastic.

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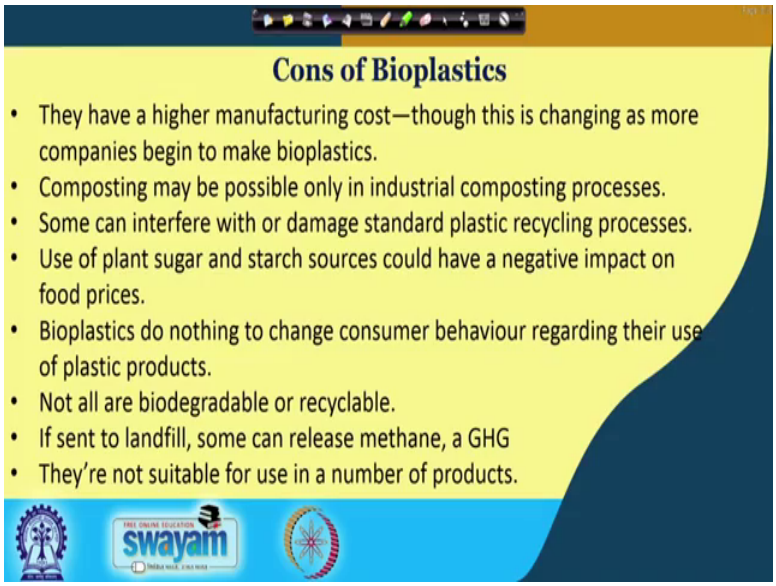

So, this material has to be good enough to go into our body and at least temporarily during any surgery and those kind of process. Now what is that we looked at the benefits of bioplastic, what are some of the challenges or where like a pros and cons of bioplastic it is costly; it is a costly now the cost is coming down, but it's still may incur in comparison to traditional plastic it comes out to be costly.

And the reason is very simple say any new process, any new product first when it is launched it is costly because the all the r and d that went into, you set up a new system in place, you whatever may be set up a new factory in place. So, there are lots of cost incurred and that cost has to get transferred to the product otherwise the company will not breakeven.

So, that is the reason why you see a lot of cost in the initial, but as the as the product gets popular as there is a lot of use of that product, lot of market for that product gradually the price comes down quite a bit and that is will happen in this sector as well. So, because right now the manufacturing cost is pretty high because that is also changing as it mentions.

Composting bioplastic composting has not really worked in a in a regular composter. So, because we had I had kind of tested it by myself it is although the backs there were certain chips bag; for potato chips bag or some sort of chips bag which claim that it is a compostable bag. So, it was so I took some of those bags and put it in my home

composter, way back when I used to live in Canada. So, put it in I have a home composter that black big black barrel where you put all those waste and then you put some nutrients and other stuff and then you rotate it every couple of days and then your compost is prepared in 15-20 days time period, you take that compost out and use it in your yard for a flowering plot or even for kitchen garden and all that.

So, since it is the waste that is going in I am totally aware of the waste going in and as long as I keep my e waste away, I keep my plastic away it comes out to be a very good compost which can be used in that in locally in the yard. So, so that is that is already there, but ah, but at the same time when we look at this bio plastics composting it does not really gets degraded very easily, so it needs some sort of industrial scale composter to do that.

So, in term and then composting becomes compost and then the one of the problem is some of this bioplastic can interfere with or damage a standard plastic recycling process because for the standard plastic it becomes a contaminant and that level of bioplastic present in those is not also very in a very high concentration; very high quantity.

So, to set up a separate line to remove that bioplastic is also costly because that is not there is not enough, but whatever is there it becomes a nuisance for plastic waste to resettle because it creates problem for them in terms of if you have a mixing of material because this; the line is not designed to handle the mixing of mixed material, so it has to be kept as clean as possible.

So, some kind to interfere as with damage they standard plastic recycling processes, use of plant sugar and starch sources could have a negative impact on food prices, so if you use a lot of plants sugar or the starch sources. Bioplastic do nothing to change the consumer behavior regarding their use of plastic products, so there is no really change in behavior because of that. Not all our biodegradable or recyclable, not all of this plastics are biodegradable or recyclable. If it goes to a landfill it can release methane which is a greenhouse gas.

So, it again you are kind of rather than putting your nose like this you are going through that, but it is still you; it is you are producing greenhouse gas.They are not suitable for using number of products because again it is the strength becomes an issue anything that is why we do not have any product at 100 percent bioplastic yet; maybe some smaller

items, but any real, tangible and piece of big item like a chair or something which is 100 percent biodegradable plastic it is still not there because that is that researchers are still going on to get that strength.

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So, application where it is used; it is in film like over wrap, shopping bags, waste and bin bags, composting bags, mulch film, silage wrap, body bags, coffin liners, coffee liners sorry coffin liners, landfill covers and that is where all these are used packaging oxygen and nitrogen barrier, bait bags, nappy backing sheet and cling wrap.

So, all those places it is used, so also it is flexible sanitary products that is your bio plastic, sheet and non woven packaging bottles, liquid paper board, plant boxers and fishing nets, foodservice cups, cutleries, trays, loose fill foam, so all these are where this bioplastic can be used.

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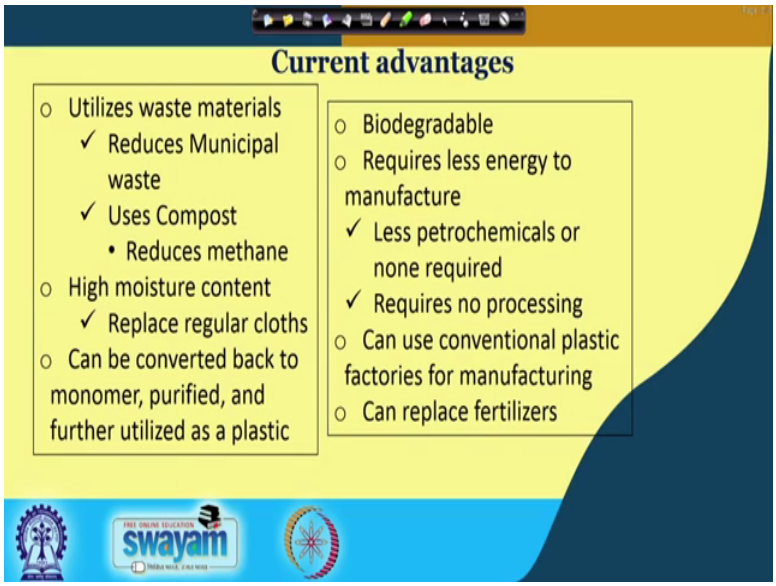

So, that is; it is already there where application of bioplastics can be done in these different products and right now in terms of if it is a biodegradable it reduces municipal waste you use you can do composting, what if it does properly you will have less methane.

High moisture content, so replace it helps in replacing the regular cloth, can be converted back to monomer or purified for the utilized. If it is a biodegradable required less energy to manufacture, less petrochemicals or prop and require no processing can use conventional plastic factories for manufacturing can replace fertilizer. So, there are lot of applications in terms of this plastic type.

So, let us stop kind of here we can of covered quite a bit in this particular video. So, let us stop here and we will continue our discussion on the alternatives to regular plastic and which does include several different types of plastic which we just looked into. And we will also continue our discussion in the next video about how what are the different types of plastics out there, what are the other things which is used instead of plastic.

So, overall I think it is this week as I said it is an alternative material focused weak alternatives to plastic. So, we will do that discussion I hope you are enjoying the course so far, 6 weeks is already gone just 2 weeks left, so this is the 1st video of the 7th week. So, you I suggest again those of you who are active on face book good very good, but those of you are not you also get active get whatever query you may have just put it up

there, will try to answer and of course, among yourselves also you can if it says something simple you can also somebody can also help there that is fine, but make sure you know the correct answer really well, then only you give the answer because you do not want to give a wrong answer to somebody and then that other person get confused.

So, keep taking the assignments; I hope, so you have registered for the exam and so that you can get the certificate.

So, thank you and keep watching it and will see you again in the next video.