Municipal Solid Waste Management
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Lecture No - 18
Recycling of Dry Waste Components

Hello, students, today we will go for last lecture on model 7 that was on suppressing and processing of solid waste. So we are in the same functional element. So in the previous two lectures I talked about unit operations for recycling process also talked about MRF material recovery facility. Now, we can conclude the two lectures like entire dry waste I can say that commingle dry waste has been segregated in different, different components.

So once the component like separate components like plastic, glass, metal or paper is getting segregated or separated then now we can go for recycling of that particular component. So here in this lecture, I will talk about the technical view about the recycling and how this paper or plastic or metal and glass is getting recycled and what kind of new products can come out from this recycling products.

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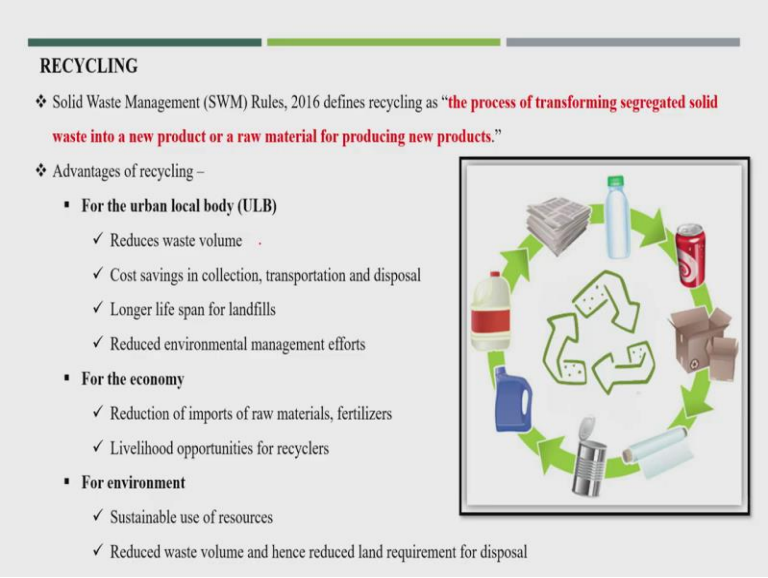

So based on the solid waste management rule 2016, recycling is the process of transformation of segregated solid waste into a new product or raw material for producing a new product. So what are the different advantages? So if you compare the advantages based on the users, we can see

the different advantage like this is special advantage for the local urban body or municipal corporation or ULB.

So what are the advantages? it will reduce the waste volume. Obviously the waste will go for recycling once volume gets reduced, cost savings will occur in the collection transportation. This was obviously not only at the disposal site waste quantity will reduce also during the collection and transportation also the waste quantity will get reduced. Obviously quantity is reduced means cost will also get reduced longer lifespan of landfills.

So that is the benefit so that the waste coming to the disposal site will get reduced obviously the landfill span also life and also will get increased and obviously reduce the environmental management efforts. So whatever the problem used to come up like for disposing such kind of ways that is also getting modified. So for the economy the reduction of import of the raw material fertilizer like from recycling we are producing another product.

So obviously the importance of the raw material for the similar kind of product will get reduced. So, it is very beneficial for the economy is also and livelihood opportunities for recyclers. Obviously lot of people will get the jobs and also they can get a lot of money by selling the recycle product, and for environment obviously sustainable use of products because this kind of material like paper, plastic, metal, glass is not possible to get degrade very easily, especially the metal and glass would not grade.

and plastic once it is going, not only to the disposal site, or is going to the any water is getting mixed obviously water will also get polluted and this kind of environmental problem also will get modified by having the recycling of this kind of waste. Reducing waste volume and has reduced the land requirement for the disposal that is one of the very important benefit of this kind of recycling of such kind of waste.

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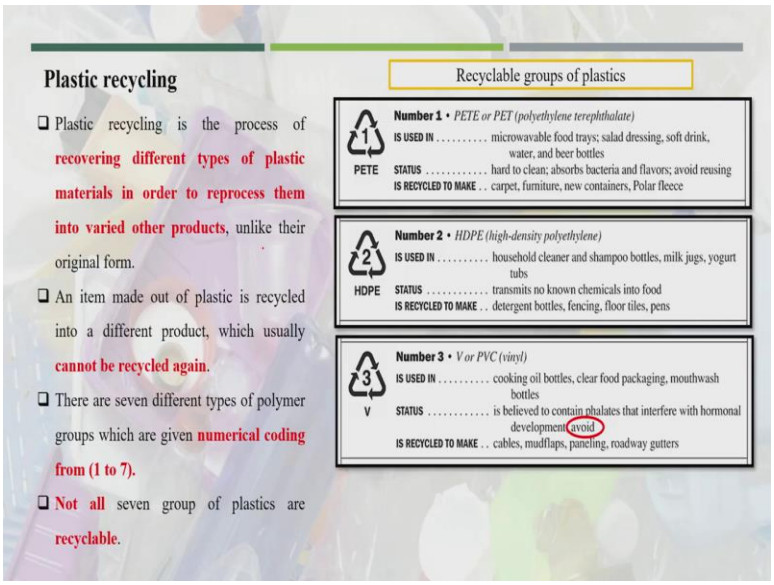

So now first we will go for plastic recycling so plastic recycle is the process of recovering different type of plastic material in order to reprocess them into various other products unlikely their original form obviously you will get the varied kind of product by preprocessing of the such kind of waste plastic. So one more idea made of the plastic is recycled into a different product which usually cannot be recycled again that is also but maybe this recycle plastic recyclable products also again getting recycled.

Maybe one time two times not more than that, and there are different kinds of polymers products like plastic. So do not see that the all of the plastics are same there are different kind of plastic and normally 7 different type of plastics are available. We can say Polymers are available in the city area and that is normally coded by 1 to 7. So, I will just explain here.

What are the different kind of polymers or plastic and what are the different products? Where we are getting out from such kind of Polymers and what are the different codes are given into such kind of polymers. And not all 7 group of plastics are recyclable that is also one of the very important point that all the plastics are not recyclable. I will show you one by one different kind of polymers of plastic.

So first is the PET that is PETE normally we call them as a PET and the products normally we get are soft drinks. The water bottle, beer bottle that is a PET bottles and see the status you see

hard to clean adsorb bacteria and flavors and avoid reusing. So what is the status of this kind of PET products and it is recycle to make it can be recyclable. We can produce furniture new container this kind of different recycle products we can make it out of that PET polymers.

Next is number 2 this is code. You can see that is a code is given to that is HDPE it is very hard plastic normally used in the household cleaners, shampoo bottles, like products were getting into the residential area and what is the status of that is not known chemical into the food people says that plastic is coming to the food, but I think HDPE plastic is not coming to the order is not getting mixing into the food. There are the recyclable and possible products like fencing, paints, floor title or detergent bottle could be possible to get produced from the HDPE waste material.

Number 3 that is you see the code 3 and word is given V or PVC. Normally this PVC used in the cooking oil bottle, clear food packaging, mouthwash bottle these all form the PVC and the status is believed to contain pellets and it is not good to use PVC and that is why saying please avoid to use the PVC and could be recyclable could be produced from cable, it can also be produced from some other products and can be produced from the PVC materials. But try to avoid the such kind of material.

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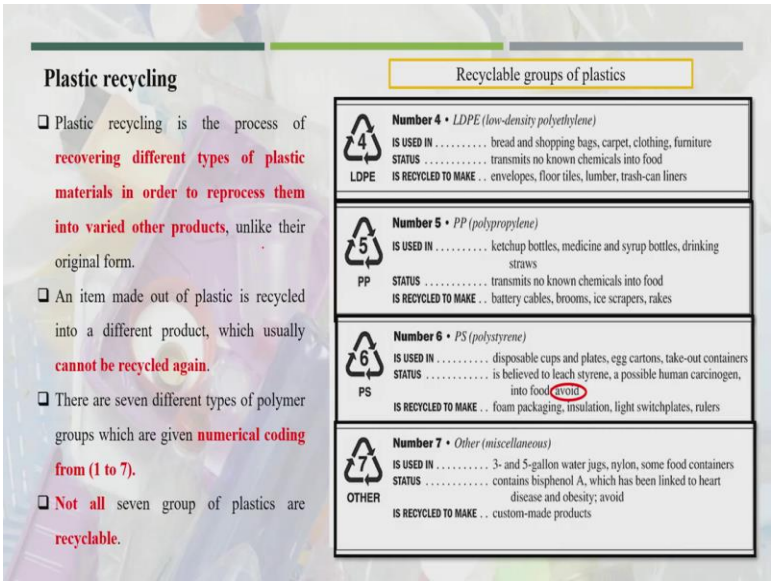

Next is the LDPE: It is low density plastics so it is used in the bread and shopping bags, carpet clothing or furniture. This is a low density plastic and the status is the transport known chemicals

into the food, also similar like PVC and is recycled to make envelope, floor titles are some other products can produce from this kind of plastic. Next is the PP that is poly propylene. So used in the different kind of material like medicine or drinking straws and the status also is similar to the other plastic and is possible to recycle that could be product could be the battery, cables, brooms would be produced from the such kind of plastic.

Next is the PS Polystyrene and so is used in the disposable cups plates. Ok that kind of product will come up from that, status is believed to leach, styrene's and possible to human carcinogenic into the food that is why try to avoid these kind of material and it is also recyclable so can be possible to be used in foam packaging and other products could be possible to come up. Last is a miscellaneous one.

So this is also used in the water jugs, nylon production. Some food containers also are possible there are also try to avoid. This is also creating some kind of problem to the humans and animals. And this recycle custom made products could be possible to produce from such kind of material. So these are the different 7 Types of plastic and mostly are the recyclable one.

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There are different stages in the plastic recycling process. First is the segregation. So for the segregation will be there proper, next is washing completely has to be wash there will be a not only one but there will be two or three different units for the washing there should not be any

contamination and contamination could be possible like soil could be possible there. Some kind of chemical could be possible or suppose if your packing the food into the plastic and such plastic is received by the recycling centre is obviously some contaminants could be possible from the food materials also into the plastic that has to be washed properly.

Then once it is getting washed will feed it into the different particles. Small particles and also the additional step to remove any non plastic waste that that could be possible into the plastic material.

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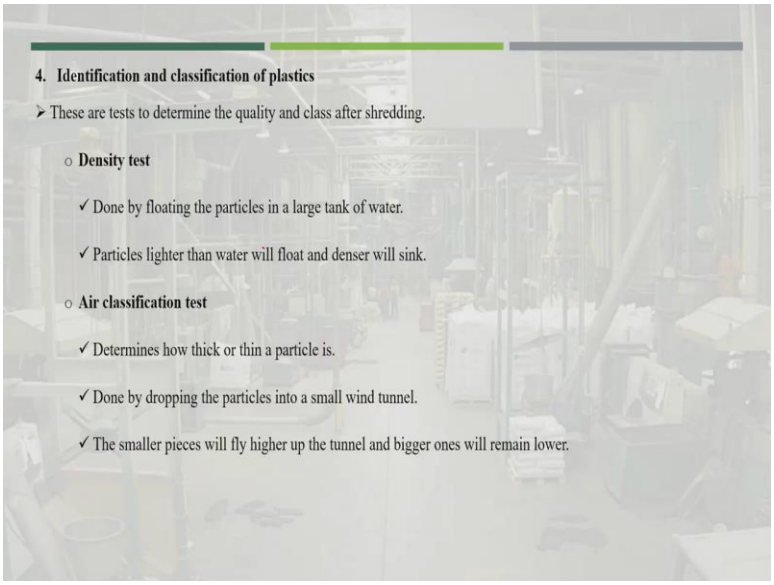

Then finally go for identification and classification of the plastic. So this is especially as reading process different sizes could be possible and the classification of testing also we do in the different way. Different quality and class is getting tested for the plastic. The first is the density test. This is simple and can be done like a floating the plastic into a large tank water. So obviously the lighter particle will be float and denser particle will sink into the water. And the air classification test. This also can be possible to lighter and very strong material or dense plastic we can segregate based on that.

And the few more additional features normally performed to know the classification of that plastic like melting point and colour this is also very important but it again depends upon the product. If such kind of product is not coming and the high-temperature to no need to the made

melting point and colour also I think it is not that important because again depend on the product and sometimes is possible by adding extra colour we can get it the one particular colour into the entire plastic material.

And the major process is extruding. That is very important process for recycling of the plastic. So here are the small particles are smashed and melted together into a plastic pellets. The small pellets get produced by the extruder method and the pellets can then be used in the production of other plastic product. So, this is the last process of plastic recycling one extruding method. So I had come up with one video we can we can see that how this plastic is getting recycled.

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This video is from Germany, plastic recycling plant, this is the plastic packaging the major are the packaged plastics being received in the plant. So this is what the entire plastic material. I need the entire material is coming to the plant. So this is bulky household plastic. Here all kind of materials you can see are made by plastics the household used material.

So once it is getting packed then it is getting dried up completely. So here I was talking about washing and density separation. So, washing for the cleaning purpose and density to segregate the material in the lighter in densest plastic material lighter denser plastic material, see this is shredded plastic again the secretion by the colour. Now this is this is the last unit extruding you can see here the smaller particle has been put it into the extruder. And finally, we will get the pellet plastic pallets.

You can see here the pellets are a small pellet. These are the pellets you can see the different colour palette. While in the extruder also the sum colour is adding by getting the final pellet colour. Now this quality, but I was talked about density and their classification on melting point and colour. Finally, these pellets are getting to produce the product. So this kind of products is produced from the recycled plastic.

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So these are few per plastic recycling plants in India like this is one in Ahmedabad. There are small units available in India and many units are informal units where plastic is getting recycled. Some government plants also available for plastic recycling. This is another program from the South India. This is one I was talking about the plastic pallets after compounding or excluding process.

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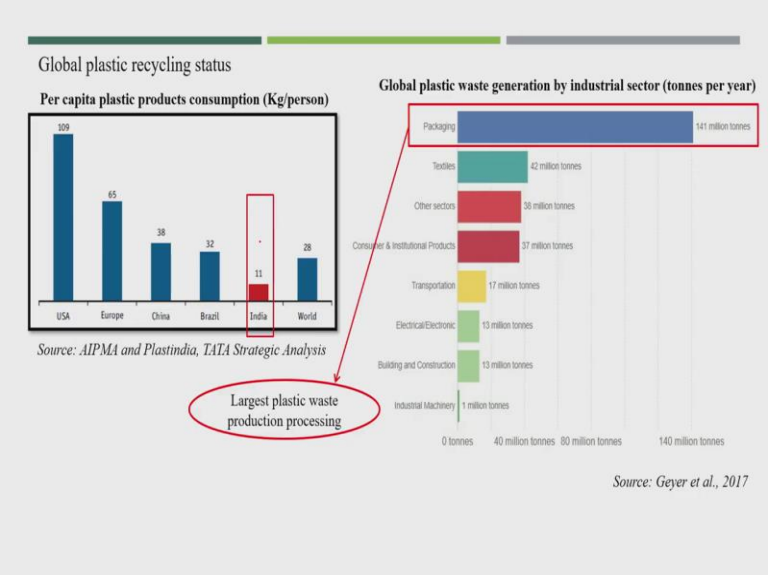

Now there is the Global plastic recycling status if you compared that India is only 11%. Now this is the per capita plastic consumption 11kg per person. But if you compare with the other country, like USA or enter Europe China and even for entire world the plastic consumption very high but in India the consumption is not that high. And this is global plastic waste generation by industrial

sector. So, here I put in the different sector like packaging, textile, consumer or institutional product, transportation, electronic building and construction industrial machineries.

So, you can see that how much plastic waste getting generated by the different kind of sector and here you see that the largest plastic waste production by the packaging. That is 141 million tons per year that much amount of plastic waste is generated by this particular sector.

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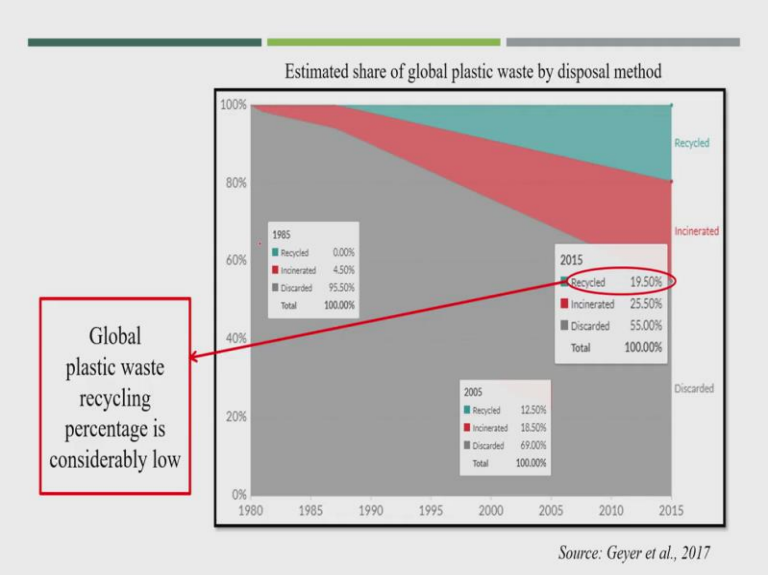

And now if you see the estimate share of global plastic waste by disposal method, so you here you see that in 1985, the recycling was 0% and the most of the material like 95.5% used to goes to goes to disposal site. But in 2005 globally, the recycle was increased and the was the 12.5% and integrated based also is around 20% and still was 70% used to go to landfill site but in 2015 again the recycle quantity has been increase and again, also the recycling of plastic also has been increased but still 55% is reaching to the disposal site.

So still is required globally required to increase the awareness about plastic recycling and the use of recycled material that kind of information also has to given to the user. Global plastic waste recycling percentage consider we low.

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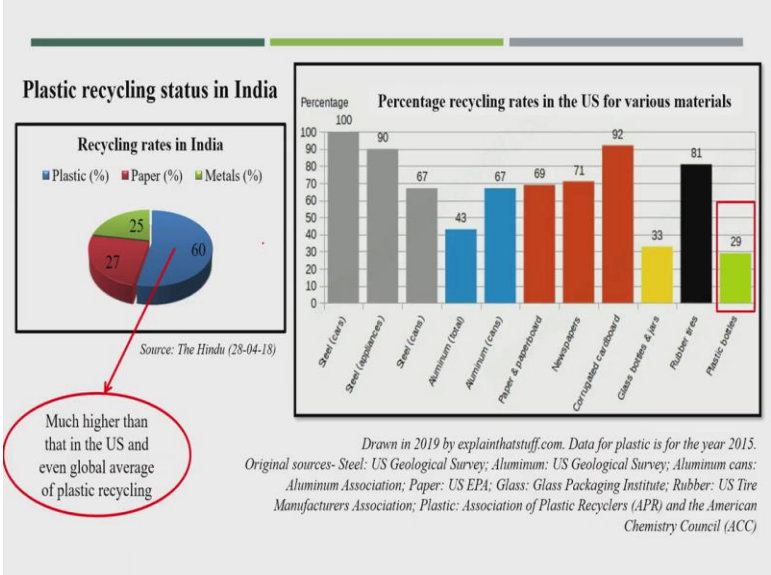

Now plastic recycling status in India you see here It is one of the news where recycling rates of plastic is around 60% is a very high see globally also is not more than 19 to 20%. But in India the plastic recycling rates are very high. Now here this is a one graph showing that percentage recycling rates in the US but various material and you see here the plastic material like in India 60% and in US only 29% plastic is getting recycled so much higher than the US and even the Global percentage compared to the Global average also is very high in India.

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So this was some news latest India recycle 90% of its PET waste it was very high compared to the Japan Europe in US.

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Now India's plastic recycling potentials that was one of the news was given that recycling plastic in India converting plastic waste to fuel the unrealized potential. India is already trying to recycle more plastic materials and that this also one of the news that could be the future be in India plastic recycling.

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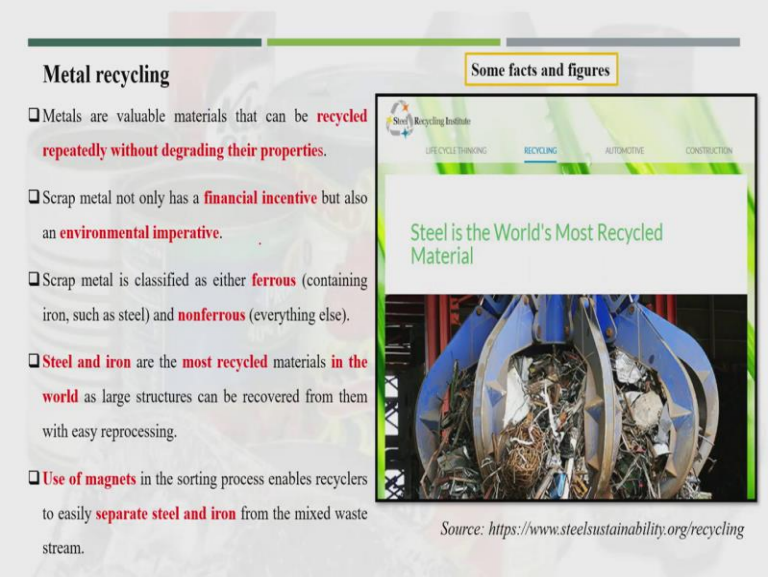

Now the Metal Recycling these and other material so metals are valuable material that can be recycle repeatedly without degrading its property. That is the very important one was the metal is recycled the property should be almost same. So scrap metals not only has a financial incentive but also its environmental imperatives. Scrap metal is classified idle ferrous ions such a steel and nonferrous. These are the two different kind of scrap metals, which can be seen that steel and

iron are the most recycled material in the world, the last structures can be recovered from them with easy reprocessing of the ferrous metal.

Ok and the non ferrous like the use of magnet in the sorting process enables recyclers to easily separate steel and iron that is also one of the benefit of having large recycling of almost recycling of steel and iron. So that was one of the news like steel is the world most recycled material., and around 400 million tons of metals are recycled worldwide every year.

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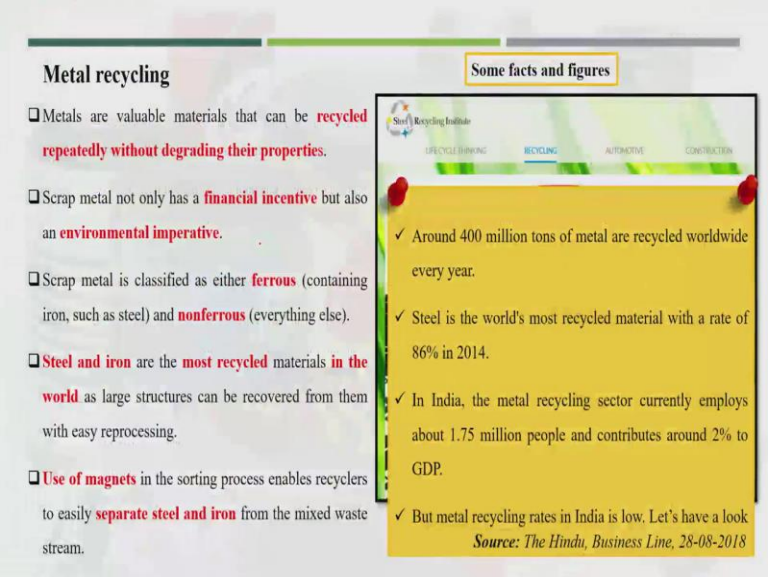

Steel is the world's most physical material with the rate of 86% in 2014 compared with the plastic in India the Metal Recycling sector currently employs around 1.7 million people and contribute around 2% to the to GDP also how beneficial of this Metal Recycling but rates in India is low, let us; you can read some of the news also here.

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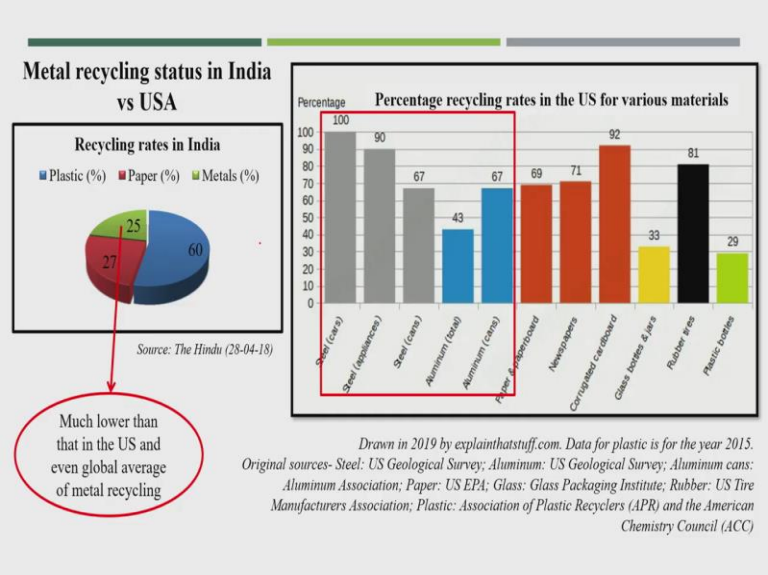

So, Metal Recycling status in India compared to US so recycling rates in India metals is 25% and if you compared with the US here these are different kind of ferrous metals. So their percentage is always the steel is 100% recycled and even aluminium also is more than 40% is there recycling. So in India much lower than the US and even Global average of Metal Recycling in India Metal Recycling is low.

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Look at India secondary aluminum status, currently aluminum recycling rates in India is 25% while the world average is 45% annual demand of secondary aluminium accounts for nearly 30% of total consumption. This is very important point. 90% of secondary aluminium consumed in the imported even though a significant amount of scrap is generated in the country still 90% of

secondary aluminum is getting imported to the country and obviously although we are producing a significant amount of scrap metal scrap in this country.

So this was one of the news India largest maker of aluminium based die casting alloy used by automobile in their equipment manufacturers by recycling scrap Aluminium. India also is trying to increase their Metal Recycling quantity. So, secondary Aluminium is anticipated to play a vital role in the automotive industry from 2020 onwards. So because of the India is one of the largest country to use the recycling scrap into the automotive industry industries. This is one of another news.

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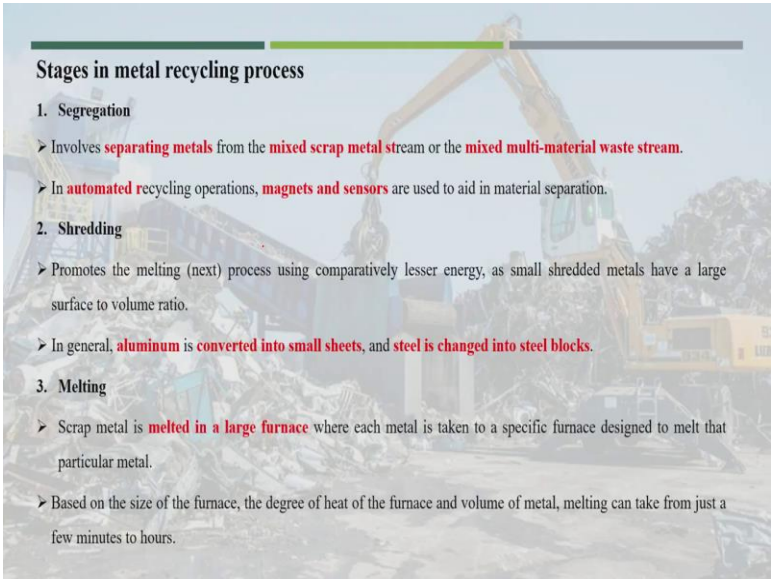

So, stages in metal recycling process similar to the plastic like first as to be segregated. Segregated from the mixed scrap metal to the particular kind of metal then shedding proper shading has to be based on the and then see promote the melting process using comparative lesser energy if the smaller is the size of the melting process will be somewhat more economical. So the small shredded metals have a larger surface to volume ratio easy to get combusted during the production of new material.

In general, aluminum is converts into a small sheets and steel is changed into a steel blocks then melting in the large furnaces.

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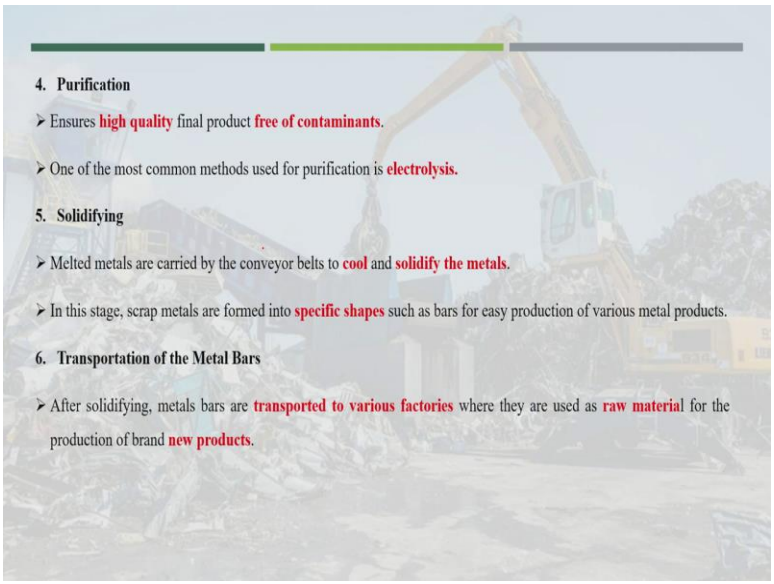

And then purification ensure high quality final product free of contaminants of the common method is a electrolysis, you can read on to electrolysis, and solidifying them then melted metals are carried out by the conveyor belts to cool and solidify the metal. So in this stage the scrap metals are formed into a specific shape such as bar for easy production of various metal product and then finally transportation of these metal bars for production of the new products.

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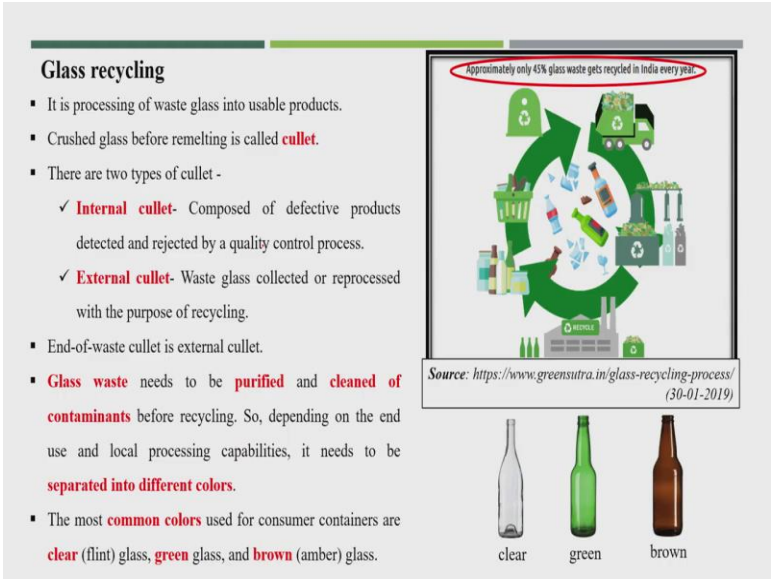

Now the glass recycling: It is processing of waste glass into usable product crushed glass before re-melting is called cullet that word you remember that your cullet. So there are two types of cullet like internal composed of defective product detected in rejected by the quality control process. So this internal cullet is producing what your products is getting produced from the

glass. is getting some defection or rejection based on the quality is finding and to such kind of product.

And external cullet like waste glass collected or reprocess with a purpose of recycling obviously use product that that called is in external cullet. So end of waste cullet is external cullet that was mix colour glass cullet you can see here in a different color. So the glass waste needs to be purified cleaned of contaminants before recycling. So to prepare the; final product or recycle product so the most common colour used for the consumer containers are clear glass, green glass and brown glass.

So this is the different three different colours clear, green and brown. Approximate only 25% of glass waste get recycled in India every year of the news.

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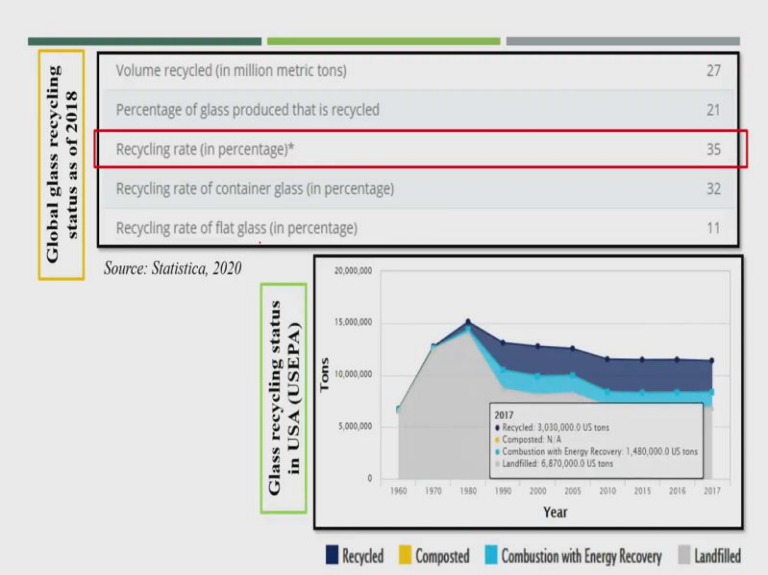

And global glass recycling status statuses of 2018 so volume recycle that 27 million metric tons percentage of Glass produce that is recycled 21 million metric tons recycling rate is 35% is also very low recycling rate here. So here in this is one of the graph the in USA the glass recycling.

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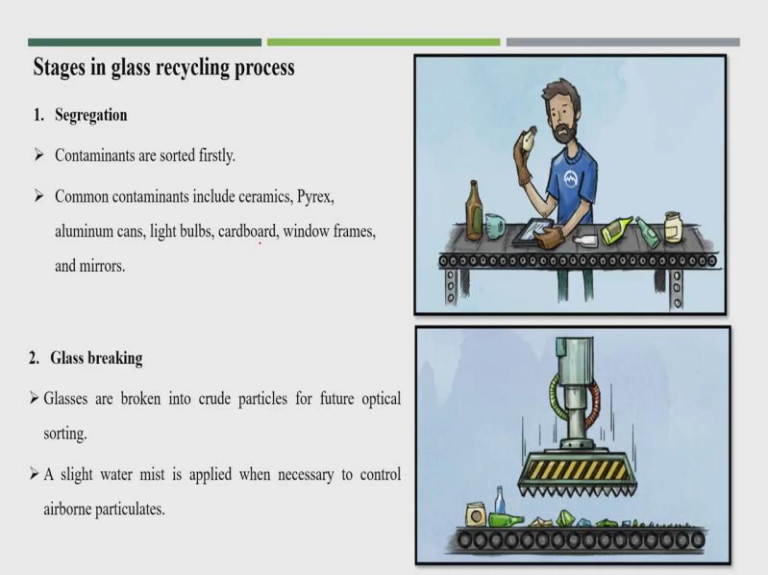

So what are the different stages in the glass recycling process? First the segregation, 2 is to remove the contamination like the segregation include ceramics, light tubes, cardboards, window frames, mirror that has to be segregated first. Then glass breakings are broken into the crude particles for future optical sorting.

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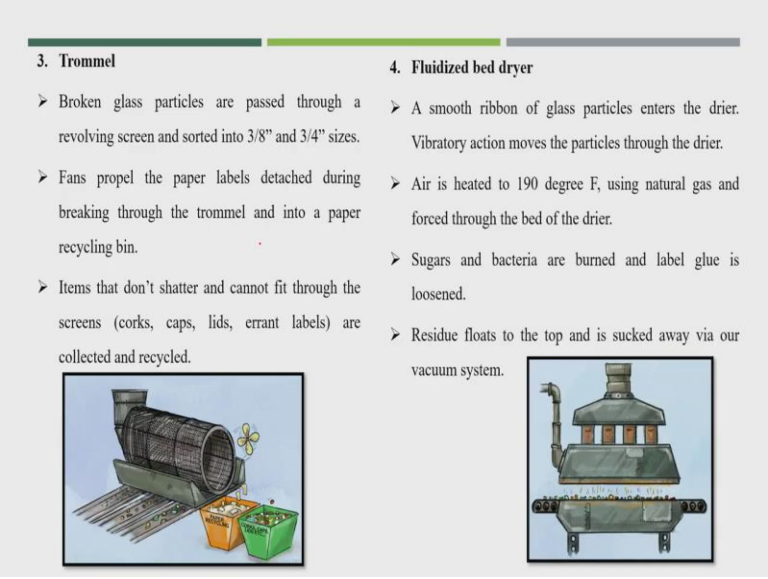

Then it is putting into the trommel to get the different sizes. So this is the trommel you can see and next is the processes once is the trammel from a different size is segregated that it will goes to the fluidized bed dryer where here is heated to 190 degree Fahrenheit using Natural Gas in force to the bed of the dryer. So here it enters, glass is getting dried out.

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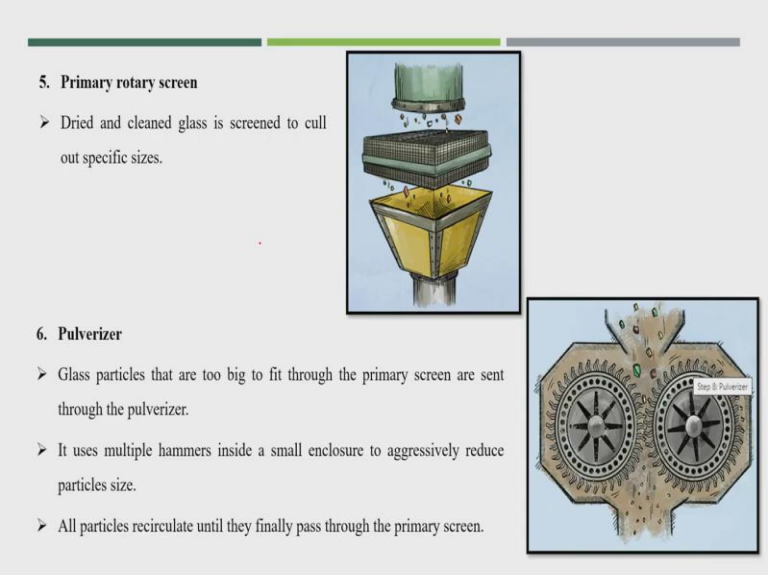

And finally primary Rotary screen. So there will be a different screens and different sizes again the dried and clean glasses screen to kill off rule out specific sizes, and then to the pulverizer. So final process is the pulverized glass particles that are too big to fit to the primary screen are sent through a pulverizer. It uses multiple hammers inside a small enclosure to aggressively reduce particle size. All particles recirculated until they finally passed through a primary screen.

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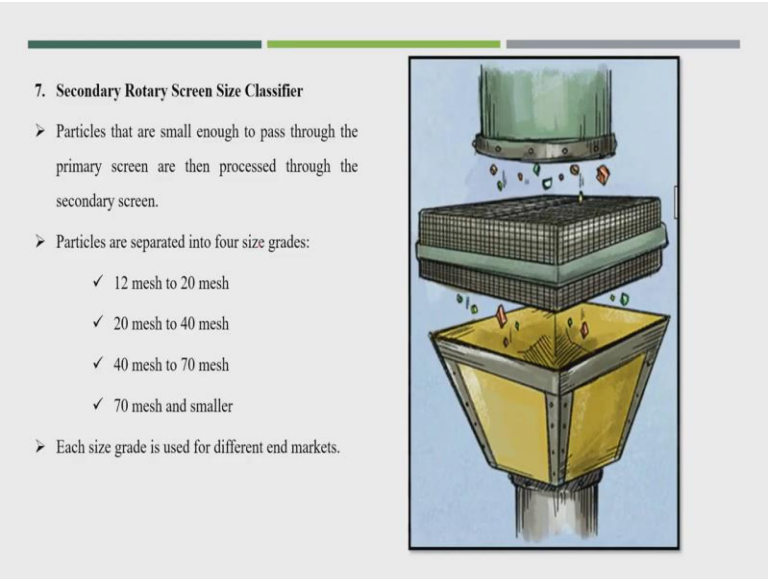

So idea is to produce different sizes and this finally goes to the secondary rotary screen size classified. So different sizes you can see hereby this is the physical unit by this different size of the glass material or different graded of glass material is getting segregated, and its size grade is used for different end product. So whatever the sizes are given this for the different product.

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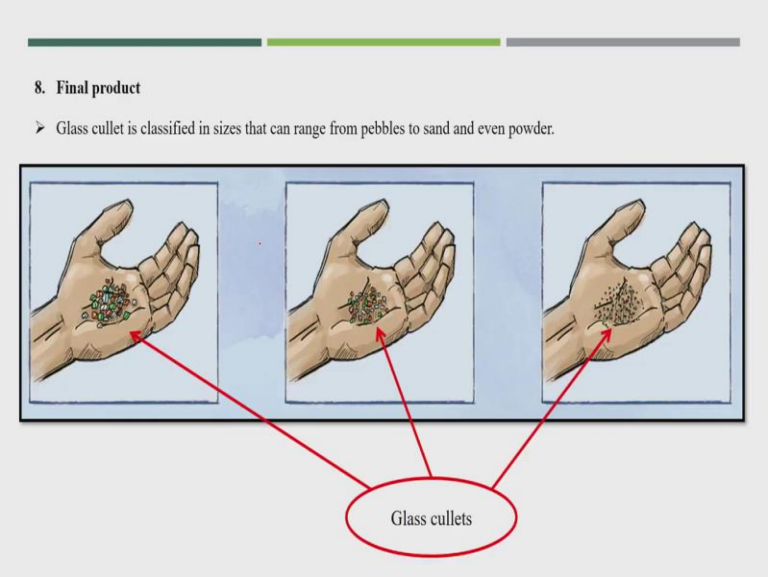

and final product that glass pellets is classified in sizes that range from pebbles to sand and even powder form. You can see here this is the pebble size larger size material. This is sand kind and finally this you can see is powder form of glass material. These are the glass pellets.

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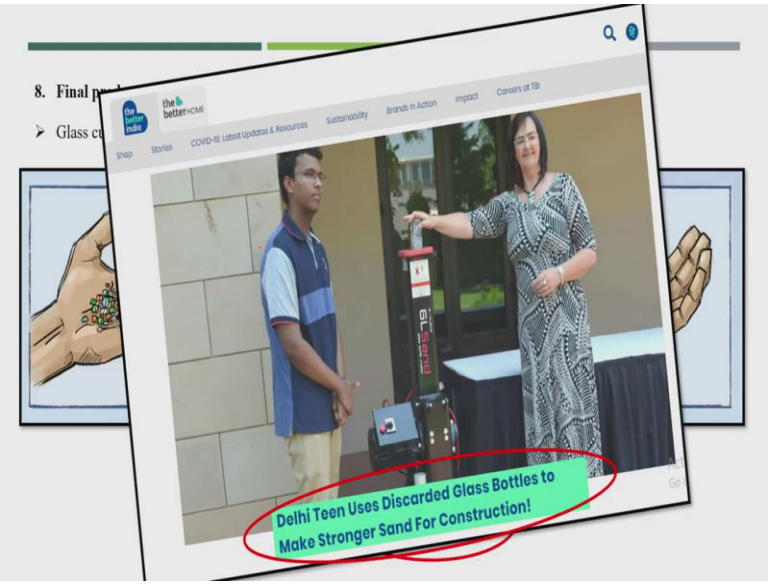

So this was a very known news in India, that Delhi teen uses discarded glass bottle to make stronger sand for construction and these glasses used in to the crushed glass is using into the construction purpose.

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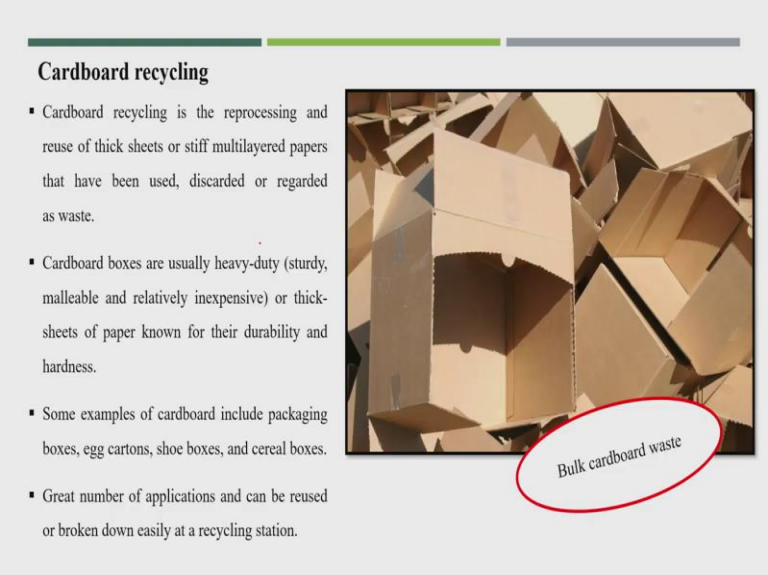

Now finally the cardboard recycling: So cardboard recycling is the reprocessing and use of thick sheets and different kind of paper. So there are different kind of cardboard sintered packaging boxes, carton, shoe boxes or cereal box, here you can see cardboard waste. This is the large percentage and specially used in the packaging industries this kind of products is coming into the larger quantity.

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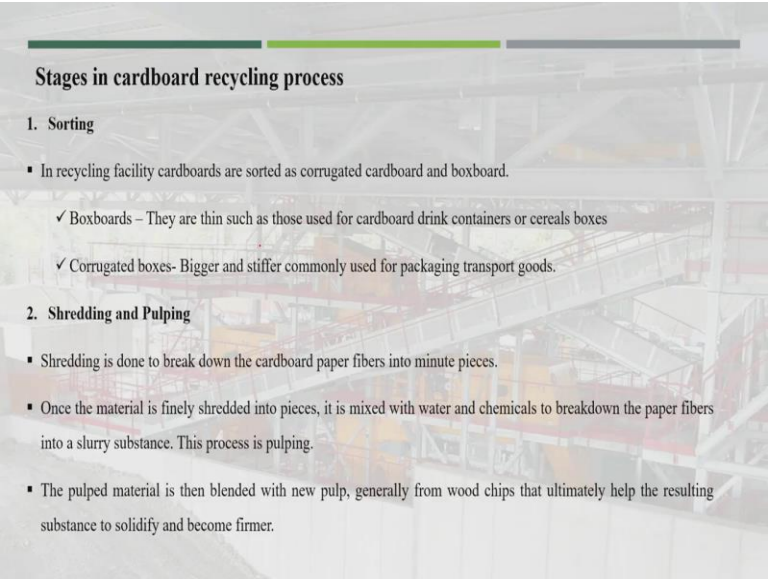

So there are different kinds of recycling stages: So, first is sorting. So here the 2 major sorting one is the cardboard they are thin such as those used for the cardboard drink container or cereal boxes and corrugated boxes bigger and stiffer commonly used for packaging transport goods. So

this is 2 different kind of cardboard material. Shedding and pulping: Shedding is to do and finally pulp is getting produced from the cardboard material.

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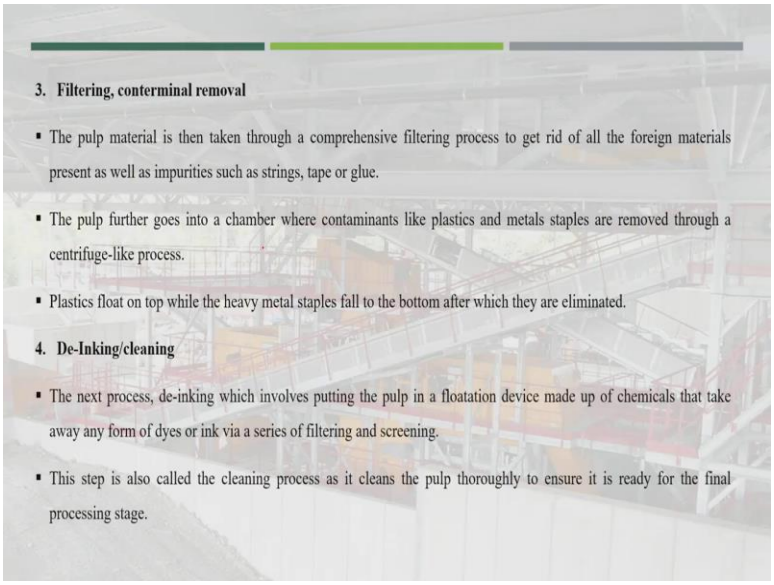

Then filtering and conterminal remove that process has to be run and finally De-inking and cleaning process. You can go to this write up for a proper understanding.

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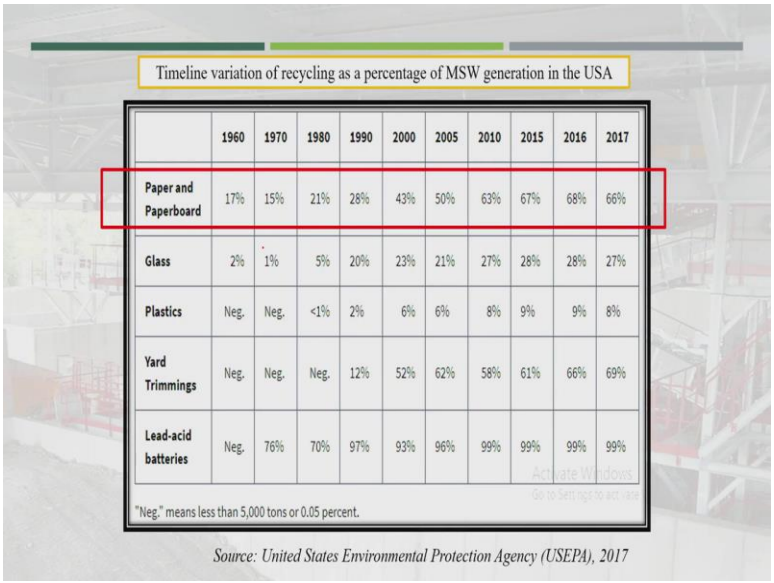

	1960	1970	1980	1990	2000	2005	2010	2015	2016	2017
Paper and Paperboard	17%	15%	21%	28%	43%	50%	63%	67%	68%	66%
Glass	2%	1%	5%	20%	23%	21%	27%	28%	28%	27%
Plastics	Neg.	Neg.	<1%	2%	6%	6%	8%	9%	9%	8%
Yard Trimmings	Neg.	Neg.	Neg.	12%	52%	62%	58%	61%	66%	69%
Lead-acid batteries	Neg.	76%	70%	97%	93%	96%	99%	99%	99%	99%

And finally finishing for reuse: The clean pulp is blended with the new production material after which it is put to dry on a flat conveyor belts and heated cylindrical surfaces. So this time line varies from recycling as a percentage of MSW generation in USA you can see here. Paper and

cardboard in 1916 was 17% and 1916 and 1917 was 66% how the recycling of paper and cardboard has been increased to very high percentage.

In this table you can see a plastic and glass remaining materials are very large quantity is getting recycled.

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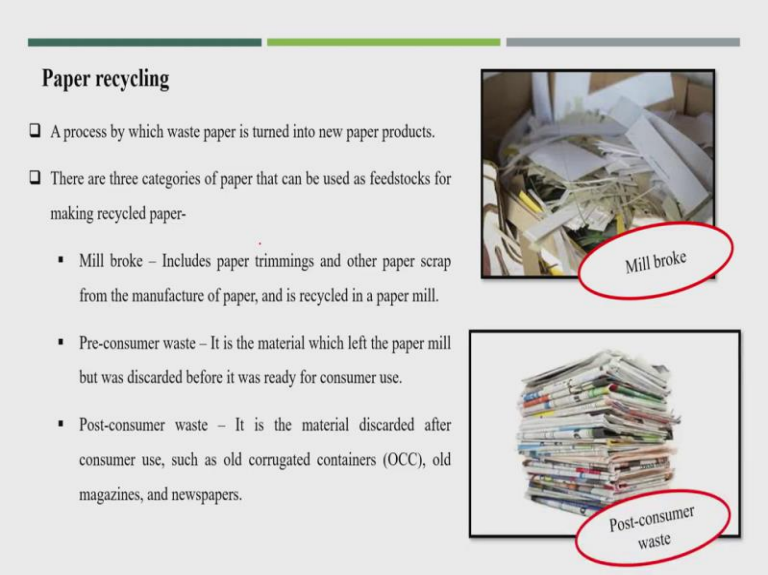

Now paper recycling: This is also similar to the cardboard recycling process by which waste paper it turns into new paper products. So there are three categories of paper that can be used as feedstock for making recycle paper that is first is the mill broke include paper trimming and other paper scrap from the manufacturing of paper and recycled into a paper mill. Pre consumer waste it is a material which left the paper mill but was discarded before it was ready for the consumer use.

It is both the materials are producing inside the paper industries itself. And finally post-consumer waste it is the material discarded after consumer use. So this is what I finally post-consumer waste.

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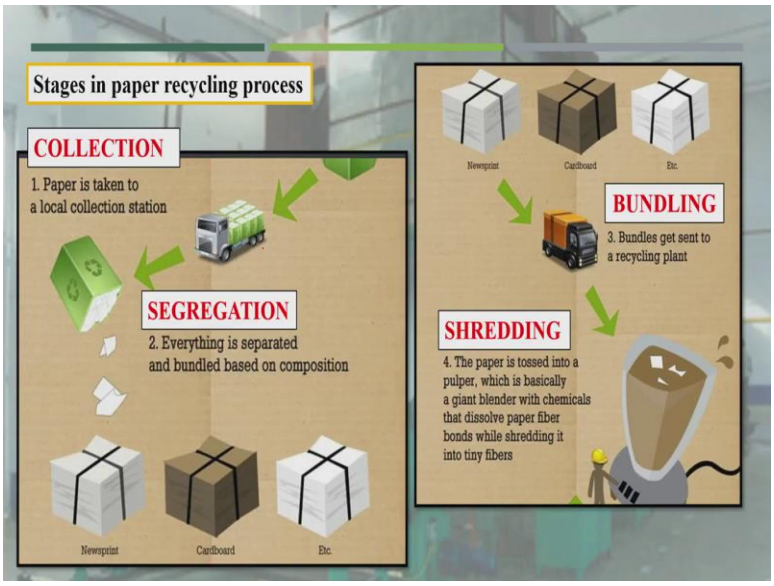

Give their different stages for Is the collection paper is taken to the local collection centre then segregation everything is separated and bundled based on the composition. You can see here different bundles newspaper, cardboard and different kind of paper material. Then bundling the same the bundling followed by shredding the paper is tossed into a pulper which is basically here giant blender with chemical that dissolve paper fiber bond with shredding it into a tiny fibers. The idea is to produce the smaller particle of that.

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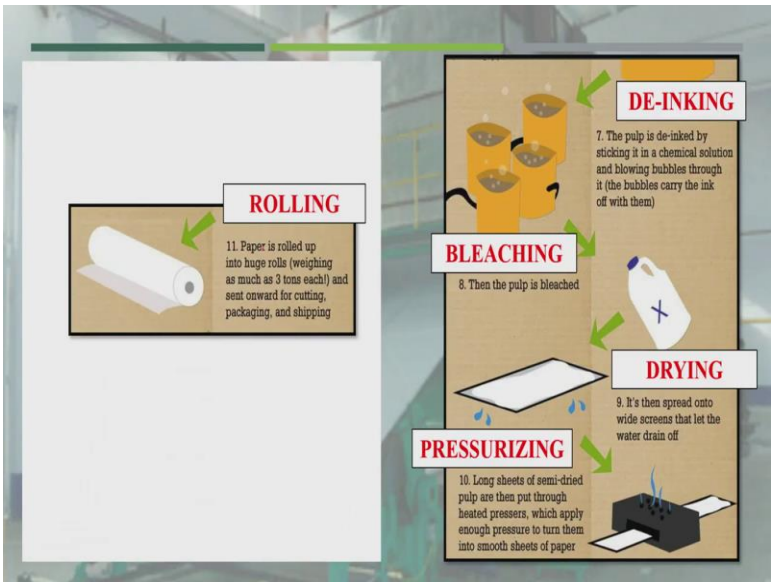

Next is pulping, ok the pulp is getting prepared and followed by this pulp is getting washed by cleaning chemicals are steered into a remove tiny dirt oil or other contaminants. Then De-Inking the pulp is doing by sticking it in a chemical solution blowing bubbles through it that is called as

de-inking process and finally bleaching then the pulp is bleach. Ok and then there it is then spread into a white screen that let the water drained of in the drying process.

and finally pressurizing process is the last unit that long sheet of semi dried fall for the input through heated pressure which apply in a pressure to turn them into small sheet smooth sheet of paper and finally rolling process paper is rolled up into a huge rose.

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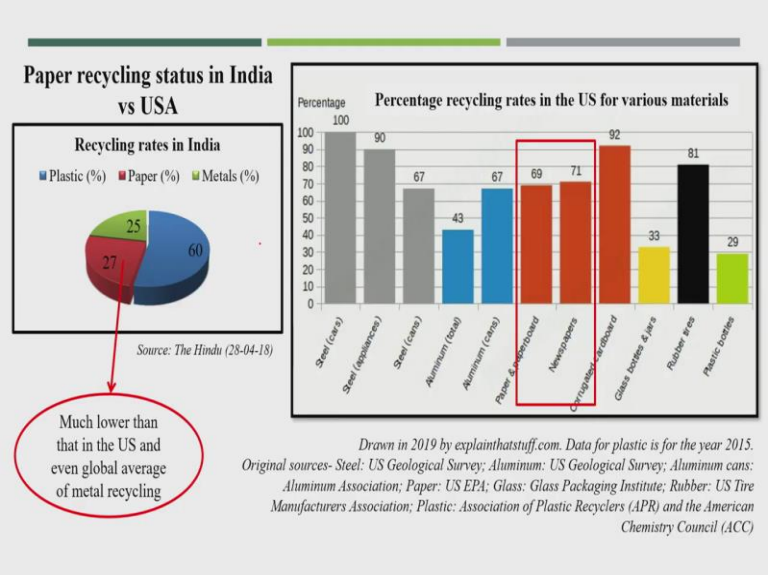

Now paper recycling status in India compared to US so in India 27% is the recycling rate and in US 69 to 71% see all paper cardboard newspaper and that is much lower in India compared to US and even Global average also is higher than India India's recycling rate, ok then so this is what I think here we saw that different kind of recycling stages for the different metal.

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So finally we believe that the reduce reuse and recycle should be the best idea behind the dry waste material and see here I give only few material stages, the different stages of recycling like paper, plastic, metal, glass few more components, like rubber leather, you know that tyre are easily recyclable and few more whatever components it mostly the dry components are recyclable components.

So suppose like India kind of country where this kind of materials are going up to 20 to 25% that what if it is getting segregated from the waste material then easy to get recycle also. And whatever stages I explained about the stages are very easy and you can find different plants recycling units in the smaller size or smaller capacity to a larger capacity also could be possible.

Now, I think will finish the recycling here, but also see that this dried material suppose if you are not planning for recycling because this again, the very important point of discussion is that the acceptability of recycle matter this recycled material specially for the human purposes are household purposes. This is one of the very important one. And suppose some of the country is not allowing to use the recycled material.

So we cannot run the recycling process so another technology could be possible for such kind of material specially the paper plastic material or cardboard material that could be possible like we can go for combustion of these kind of materials because these are dried material and once you

preheat properly this kind of material. These are highly combustible matter. The calorific value could be possible to get it around 3000 to 5000 kilo calorie per kg.

So this is another one more treatment could be possible for this kind of material. So from next module we will go for chemical transformation under that we will discuss the integration or combustion and the similar way the same dry material how best we can use as a fuel or how best we will be able to produce energy out of such kind of material. Thank you for today.