Electronic Waste Management - Issues and Challenges

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Lecture – 11
Recovery of Materials from E-Waste

Welcome back. So, we are starting the week 3 material now. So, this is the we have finished 2 week of this course. So, this is the third week and towards the end of the week 2 the last module if you remember we started talking about recovery of metals from electronic waste. So, that is where we will start. So, far we have had a good overview of electronic waste management, we talked about different ways the waste is being managed, what are the health implications what are the chemicals from there and how to find out estimate the quantity of E waste that is being produced.

So, all those things we looked at we also looked at some of the global issues not only in India, but we also visited using photographs a some of the city a some of the countries in Africa. So, being said all that now the focus in this week will be on say we want to recover this electron we recovered the precious metal essentially, when we say metals we are looking at the precious metals like gold or silver and copper those what first of all we look at what kind of metals are there and what proportion they are there and then we will start talking about the different processes which is used to recover the metals from electronic waste.

So, those of this is a lot of discussion goes on in the academic circle also in the industrial circle today is that how to read say we all know that E waste possesses several precious metal, but what are the what how we can get it out what are the process. So, these lectures this particular week will kind of focus on that.

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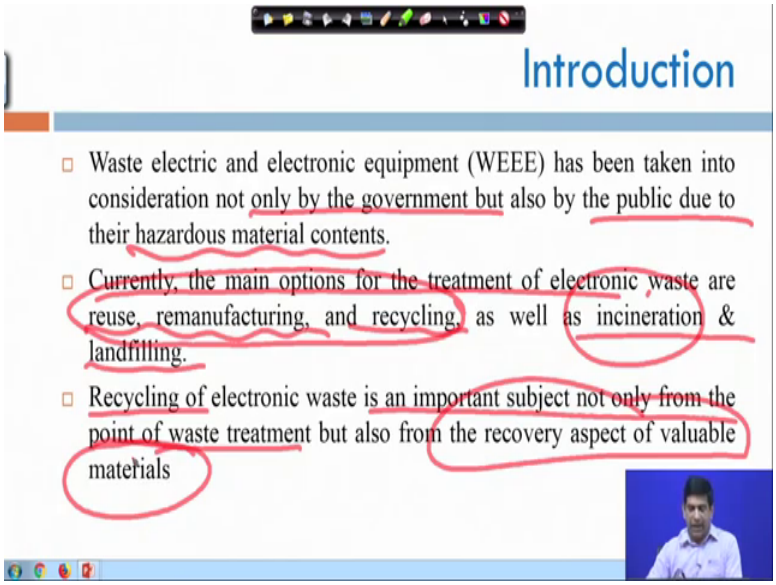

So, waste up is has there is a lot of concern not only from the government side, but also public people in general people are also worried about. So, it is a not only the government, but the people are also worried about because it has several hazardous material.

So, if you remember in the week one we talked about that the hazardous material is there, but at the same time it is a previous material is also there. So, main options for treatment currently for electronic waste is basically we are looking at reuse remanufacturing and recycling, some incineration and land filling is also happening, but the focus I think I should put it in this way that although the regulation focuses more on reuse remanufacturing and recycling, but due to the mostly informal recycling happening in country like India. We have some recycling have taking place, but most of the E waste after getting some of those recoverable material is being dumped in landfill or I will say even not an engineered landfill it is mostly on the dump sites and, but in generation mostly happening in a informal sector.

So, these are causing a lot of air pollution issues 2. So, recycling it is an important subject from point of view of waste treatment, but also from the recovery of the valuable material that is it actually getting lot of traction these days how to recover a valuable material as I was telling you few minutes back, how to get this valuable material out of E waste.

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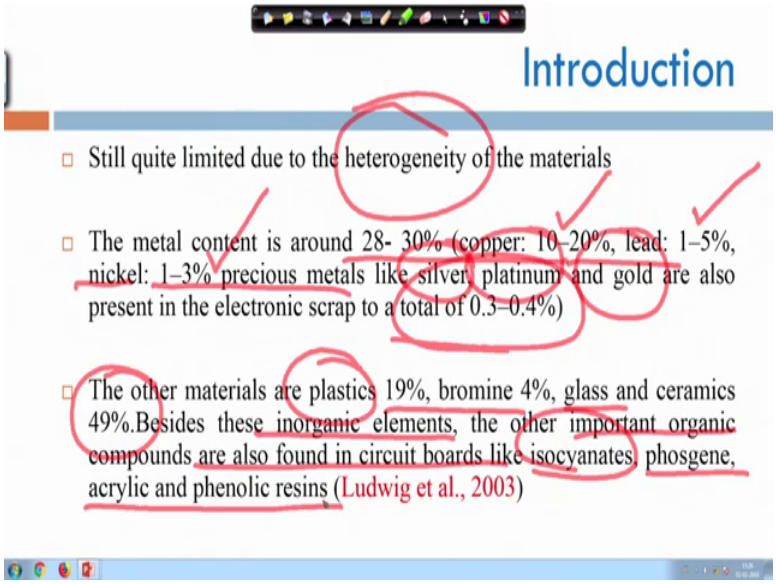

So, that is what we will try to talk about in this particular lecture. So, it is still not worth like we are not seeing too much of recovery happening and the reason for that is the heterogeneity of the material. The waste as if you remember from the week 1 lecture I have mentioned that there are several materials all mixed together in the printed white board or on those chips and even the plastics that we have is mixed plastics. So, all these are causing a because of the heterogeneity it is a lot of heterogeneity of the material. So, this heterogeneity is causing in a big problem in terms of the proper recovery.

So, that is that is there. So, that is one concern and in terms of the different metals what is present we have around 28 to 30 percent copper, 10 to 20 percent lead, 1 to 5 percent nickel and 1 to 3 percent precious metal which is like silver, platinum and gold. So, these are which is present oh sorry it is 1 2 3 copper is 10 to 20 percent lead is going to 5 percent, nickel is going to 3 percent and silver platinum and gold is around 0.3 to 0.4 percent.

So, if 0.3 to 0.4 may not sound a lot, but if you look at the total amount of waste that is generated it is actually a substantial quantity. So, other is we have plastics when 90 percent bromine 4 percent glass ceramics can be recovered as well and there is has been a lot of use of recovered ceramics in different applications, just recently I was attending one wastewater treatment workshop where they were talking about the microbial fuel cell and also MBR and the in terms of the membrane that is being used they have been

talking about using of ceramics in the membrane. So, that is a lot of applications of ceramics are also coming up ceramics as we know is pretty expensive stuff 2. So, those are so bist and other than that we have several inorganic elements in terms of organic and then organic compounds are also there in circuit boards like isocyanate phosgene acrylic and phenolic resins. So, a lot of these materials are there in in our electronic waste which has the potential to be recycle and to be reused.

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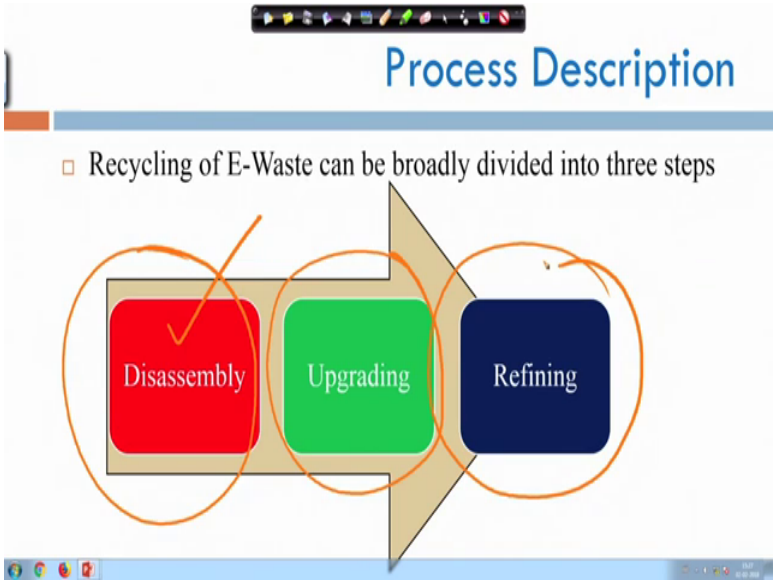

So, recycling is of can be broadly divided into 3 steps first of all you take the electronics and you disassemble.

So, that is your number 1 task is to disassemble it. So, you disassemble the electronics so basically taking it apart. So, if you have an old CPU you have your several a screws up there you just unscrew it and take it apart that is your disassembly part then and what is you try to salvage. So, you try to look at the salvaging of the material. So, if you have 3 4 old computers you try to take those different parts and make 1 computer out of that.

So, that is upgrading is also go going on like this is also one of the aspect that is taking place, then refining to get the material out you use the refining process as well. So, those are we will talk about each one of them a little bit detail in this particular now like a lecture.

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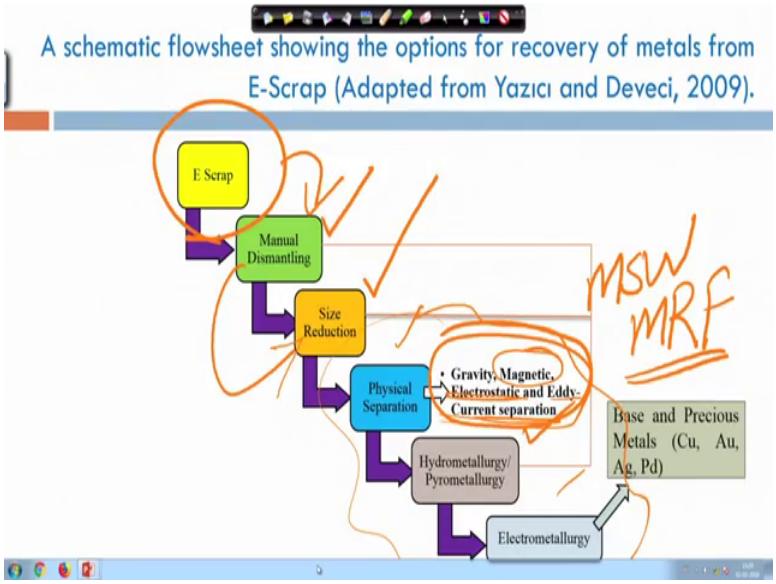

So, in terms of the flow, if you look at how the flow is happening of a schematic flow of showing the options of recovery of metal so we have in we have a need to start with we have a scrap, the electronic scrap, which is called E scrap then first step is manual dismantling. So, you just take it apart you have use the screws and you take it apart. So, that is your manual dismantling after that most of the process requires some sort of size reduction.

So, you will have some sort of crusher and other stuff where you need to reduce the size again size reduction is needed, because we are trying to use either physical separation or chemical separation or this this separations require some sort of reaction or some sort of sieving and other stuff or some sort of a physical phenomena or chemical phenomena, that requires a smaller particle size the bigger political size creates problem in terms of the working of that.

So, size reduction and once the size reduction is done you can go for physical separation if you look at the physical separation here this is very much similar to what you will typically see when in a municipal solid waste murph; murph is the material recycling facility. So, if you look at the material recycling facility of a municipal solid waste there also you will see very similar when there are in gravity; gravity why we use gravity basically to separate 2 fractions which has different weight something which is a heavier will settle at the bottom, something which is lighter will be on the top. So, we can use

their gravity separation magnetic based on the magnetic property we can have the magnetic property electrostatic property we can make use of that ad current separation we mostly use for say taking the aluminum out that is a very very common way of taking the aluminum out even in a municipal solid waste a stream when you try to recover that aluminum cans.

So, see there is nothing very fancy here. So, all of these technologies that we are talking about in terms of the gravity separation magnetic electrostatic and eddy current these are well established technology. These are being this have been being used for quite some time in different applications. Then you have the hydro metallurgical hydrometallurgy and pyro metallurgy this is basically to recover different types of different types of metals or electrometallurgy and we will talk about one of these they had like some of these in detail as we get. And the reason the what we want to do here is to get the base and precious metal copper, gold, silver, platinum for that we need this kind of like cyanide leaching and there are different types of my methodology out there.

So, we will talk about that subsequently in this particular video or subsequent video. So, this is say typical straps. So, these as you can see this is what this this flow chart is what you will typically see in any complete E waste management sis E waste recycling or recovery system.

So, if you are planning to established a say E waste recycling plan these are all the steps that you need to have. Now thinking in terms of the management side what is happening today we have mostly people are we have this rack pick I would say an informal recyclers, they are collecting the E scrap, they do this manual dismantling some size reduction maybe and then they are doing. Some of these and here they use lot of assets and other stuff creating lot of environmental issues and all that.

So, in terms of when we talk about the management of E waste there is always a discussion on like what will happen to the informal sector, because the informal sector has been pretty good in collecting the garbage and bringing the garbage to one location. So, they have been doing a great job in terms of the collection part where they do really lousy job in terms of the trying to recover the heavy metals and others to have the precious metal or whatever.

So, if there is a merger like if there is a nice marriage between the informal sector and the formal sector and for that actually some government or swimming government agencies has to come forward and do that. So, if there is a more because the business model needs to be worked out as well because the money is made in the previous metal there is not much money when you are looking at the manual dismantling and other stuff.

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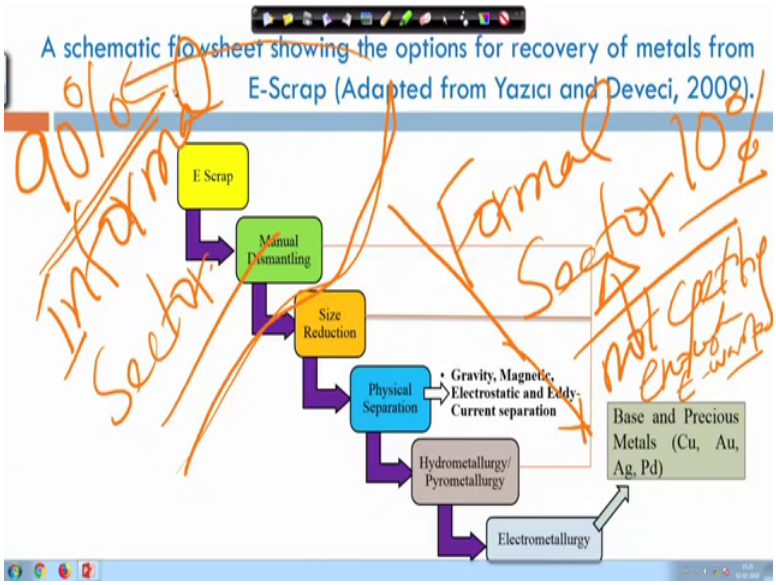

So, if we can kind of have a system where this portion and the portion on this side is taken care of by this informal sector the informal sector does the collection and other stuff and they become the registered collection agents and whatever as per the E waste management rule and this portion is this side, which is a high tech side, which can which has a lot of potential of contamination of environment if not then properly needs to be managed by formal sector.

So, of course, I am not an expert in terms of the business methods and all that how this business model will work that somebody has to work it out and I think government agencies needs to get involved to make it work it out because unless the government comes in picture, many times we are really afraid that government means something like corruption will come this will happen that will happen, but at the same time getting the different stakeholders on board the people will only learn to only listen to a government agencies people will not listen to any other agency because that is we do not have any other option.

So, we have to have some sort of mechanism I will give you an example in terms of Ontario in Canada where they in terms for the E waste management program they have E waste it stewardship Ontario. What that is E waste stewardship Ontario is it is a semi government organization which whatever is the E waste electronics sold in Ontario based on the electronics sold from the different companies they get a certain fraction of money there is a percentage, I do not know exactly how what the percentage we can there is somebody who is interested can is can find those out.

So, and that money comes to that particular body and that body looks at the E waste management for the entire of Ontario and it is a semi government kind of body it is not like pure 100. So, 1 or 2 government employees and some apprise some like a non-government employees getting together and, but they have the backing of the government in terms of enforcing the regulation.

So, here we have the SPCB SEPCB those organizations are there. So, within that need something needs to come up or they have to support this kind of organization. So, then only it will be done like if you just leave it our rules are great our rules sometimes are more perfect than what infrastructure we have, but at the same time to implement the rule we need to create the infrastructure, we need to create the it environment and the government has to make the at least the initiator to do that. So, when I say government I am talking about some government agency I am not talking about the ministry or anything it is a some government agency has to take the initiator that is my point of view.

I may be wrong and if I have somebody tell me that I have I convinced me that this is not correct I will be more than happy to accept that, but at this, but based on my experience looking at electronic waste in different countries like 3 4 countries personally, I think this is what needs to happen and again we can always debate on that discussion forum is for their go ahead and say send your view we will be happy to listen your view and then we can go back and forth and have a nice debate on that particular topic through the discussion forum.

So, here as I said the informal sector and formal sector they need to come together and that would be a nice right what is because what is happening, today almost 90 to 95 percent nearly 90 percent of the waste is being managed in informal sector in India only 10 percent is reaching to the formal sector and we have the formal sector, but they are

not able to meet they are not getting enough E waste not getting enough E waste. So, they are not getting enough E waste can you think about that we have E waste treatment facility, but they are not getting enough E waste and the E waste is going over here why because they have a nice collection in for infrastructure they also pay money a little bit these companies the formal sector since they have invested. So, much money in there they are not in a position to pay to the regular customer in terms of like 400 500 rupees for one old computer or a laptop or like that which a form informal sector can do that.

So, there is a lot of debate there is a lot of issues on that in terms of the business in terms of how it needs to happen, but that that discussion has to take place, then only unless we start first of all for any problem to be solved irrespective or whatever the issue we need to identify the problem, we need to acknowledge that yes the problem exists then we can work towards the solution for everything in the world solution is available if we sit down on a table and talk. That is the that is number one thing identify the problem sit down on a table and have a honest discussion and that can solve most of the problem that we have in the world today.

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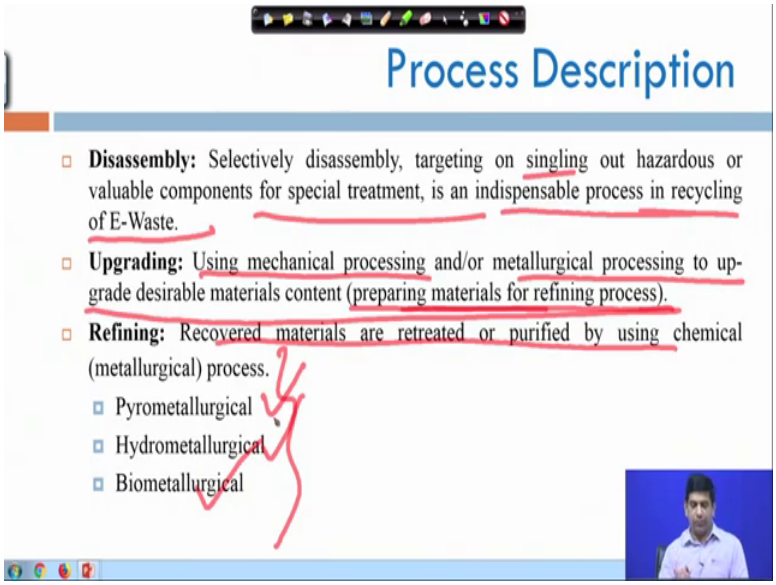

So, let us look at so we had so look at some of the details of each one of those disassembly means what we are selectively looking at we take out any hazardous material from there we single out any hazardous material singling out the hazardous material or valuable component for a special treatment. So, that is an indispensable

process and the recycling of E waste, upgrading you can use mechanical processing in a metallurgical process in to upgrade the desirable material content like you can prepare the material for refining purpose.

So, basically you are concentrating it refinering is you can recover the material or you re treat it purified by using chemical processes like pyrometallurgical process hydrometallurgical process or biometallurgical process. So, those are different processes that are being used.

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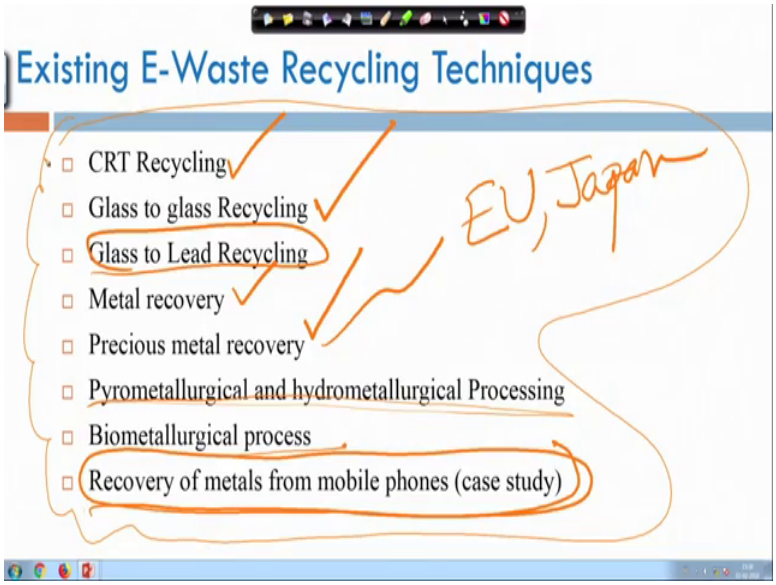

So, we look at some of these processes in a minute. So, what are the existing E waste recycling technique what we are doing with that we are doing CRT recycling cathode ray tube recycling is being done glass to glass recycling, the glass is being recycled into glass from the glass the lead is also recovered. So, that is called glass to lead recycling.

So, of the metal recovery is happening, precious metal recovery is happening, mostly in European union and Japan they are leading the pack in terms of the precious metal recovery, pyrometallurgical and hydrometallurgical processing is going on bio metallurgical process is going on there is a recovery of metals from mobile phones some case studies are happening on that and that is that is also going on.

So, if you look at some of these are happening in a industrial scale some of these are happening in a pilot scale. So, lot of research is also going on in terms of the recovery of

heavy metal recovery of electric B precious metal recently DST actually had a call in terms of is essentially on this how to take recover this precious metal from electronic waste. So, that is. So, government of India is also getting interested in this particular area so which is really good.

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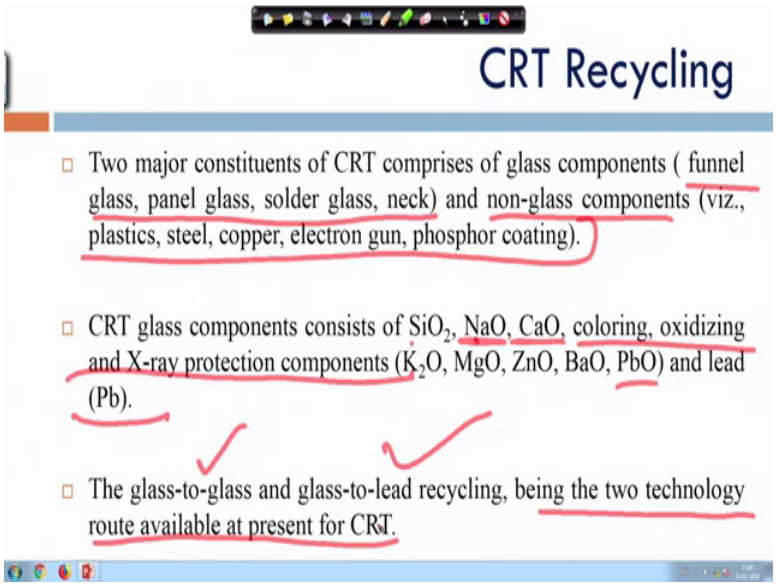

So, CRT recycling what is happening how it is there what is there it is a 2 major constraints of CRT is what we have a glass and where the in the glass components we have funnel, glass panel, solder glass neck, then there are some non-class component like plastic steel copper electron gun, phosphor coating and all those things are CRT. That is a cathode ray tube what is cathode ray tube you many of your if you are very young and you may not have though and we are talking about the a cathode ray tube which had say remember those T V which has the long back in the back in the that is your cathode ray. So, you had that a screen on top and then you have the big box in the in the behind that is a CRT.

I showed you the picture of CRT earlier in nothing week one and also in with the nigeria picture of week 2. So, CRT and also for the monitor we used to use the CRT there. Nowadays everything is flat panel probably you are watching it on a flat panel monitor on your YouTube or your probably you are looking at your phone or Ipad whatever. So, mostly we are using flat panel now.

So, it is which we do not use CRT that much, but it is still in if you look at in the disposal stream mostly we still see a lot of CRTS coming out because from the old from the houses and all that and from offices for the old computers. So, CRT in terms of the glass components it has silica sodium oxide calcium oxide coloring oxidizing X-ray proton X-ray protectionic components, the K 2 O, M g O, Zinc Oxide, Barium Oxide lead oxide and lead is also there.

So, CRT has lot of these things present. So, in terms of the glass to glass or glass to let recycling there these are the 2 technology route available at present for this year for the cathode ray tube. So, these are the 2 technologies that is used in terms of in terms of recycling of the cathode ray Tube.

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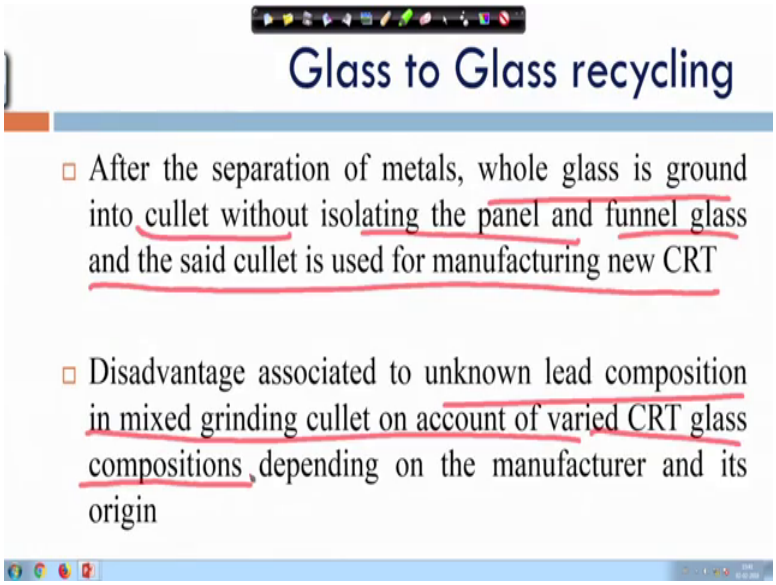

So, in terms of glass to glass glass recycling what is done after the separation of metals first of all you try to separate the metal otherwise your glass will be contaminated you separate the metal, then whole glass is grounded you ground the whole class into cullet. So, small small pieces without isolating the panel and funnel glass and the set cullet is used for manufacturing the new CRT.

So, you can use that for making the new CRT or any other product nowadays since CST is are not made that much. So, you can use for any other product as well disadvantage here is because of the unknown lead composition in mixed grinding cullet. So, depending on the in varied CRT glass composition because there are if you have variety of CRT

glass depending on the manufacturer and it is origin you have you can have different types of different amount of lead present there.

So, that uncertainty is there in terms of what is coming up in your in your waste stream see all of these are becoming it is a process now the process has an input. So, any industrial process or any chemical process when you have input feed has to have of certain grade or certain quality, but if there is a lot of variability in there. So, of course, your process will get affected if you are a chemical engineer you will probably understand it much better that any process requires certain level of certain certain level of homogeneity in the input. So, if you have a lot of variability in your input stream of course, things will get affected in terms of your industry performance of in of your of the recycling process.

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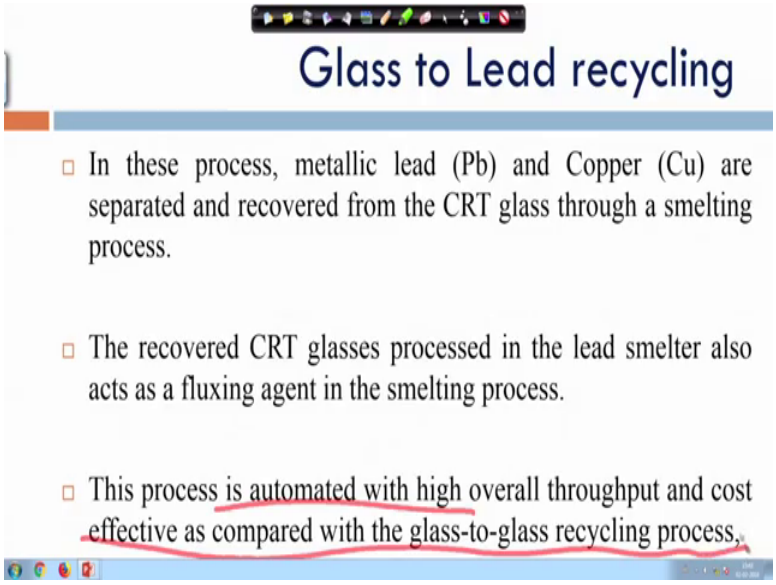

Glass to lead you in this you try to recover metallic lead and copper for recover from the CRT glass through a smelting process you have a smelting process. So, recovered CRT glass is a process into the lead smelter also acts as a fluxing agent. So, process is automated you put an automated process with a high over thorough put. So, it is you have it is a try to or make it an automated process I try to make it cost effective as compared to glass to glass recycling process. So, glass to lead is actually comes out to be cheaper more easy to do and it is overall you can do it in a much faster rate. So, that is what it is kind of glass to lead recycling is also done. So, these are the 2 ways typically

you see the CRT glass is being recycling that glass to glass or glass to lead. So, those in terms of getting the glass out by the which is actually one of the important component in E waste stream.

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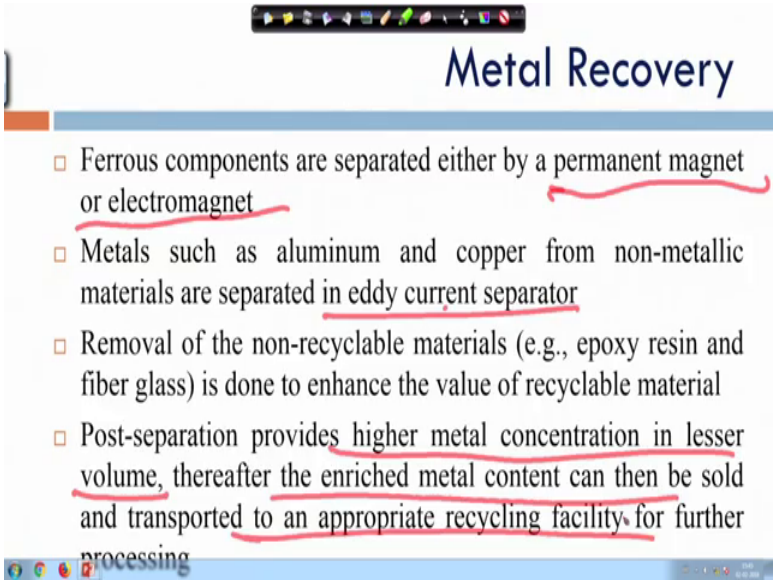

So, after you have this glass if you are trying to look at the metal metal and you think about metal of course, the number one things if you think if you remember your own electronic waste in terms of the metal you will see the ferrous iron. We remember the old CPU or of the old monitor which has a lot of iron casing and lot of iron things even inside you have those motherboard that what is that cd rom and with older ones probably will have the zip disk as well or a floppy disk, all of that had a met metal casing in there.

So, you will have the main drive in there, but the things will be in a metal; metal casing and some of them will be ferrous based metals. So, ferrous component it is you can always use the magnet or a electro magnet. So, that is a easy part you can use a magnet or electromagnet to get read of a 2 take the ferrous metal out for aluminum and copper which separated in eddy current separator eddy current separator comes in handy for aluminum and copper.

So, that is it is used for aluminum and copper we can use the eddy current separator. So, for ferrous we can use permanent magnet permanent magnet or electromagnet. So, those are you can be used for ferrous. So, non-recyclable material like a poss series in

fiberglass they are they are also done because we if we can remove those I see if you remove this material if they are non-recyclable.

So, if you remove it and then make it that in that increases the value of recyclable material. So, that is removal is always helps in terms of increasing the value of the recyclable material. So, you if you do the post separation it is a it is therefore, if you separate them and then it provide it provides higher metal concentration, higher metal concentration in lesser volume.

So, if you have the higher metal concentration; that means you have the better you can. So, you can solved it you can sell it at a higher price. So, enriched metal content can be sold and a to an appropriate recycling facility for further processing. So, you can remove this a non-recyclable material like epoxy raised in fiberglass and other stuff. So, now, you have the enriched metals which can be either recycled within the same plant or if the plant does not have the facility can be sent to a different plan for the further processing and further recycling. So, that is also done in terms of the metal recycling.

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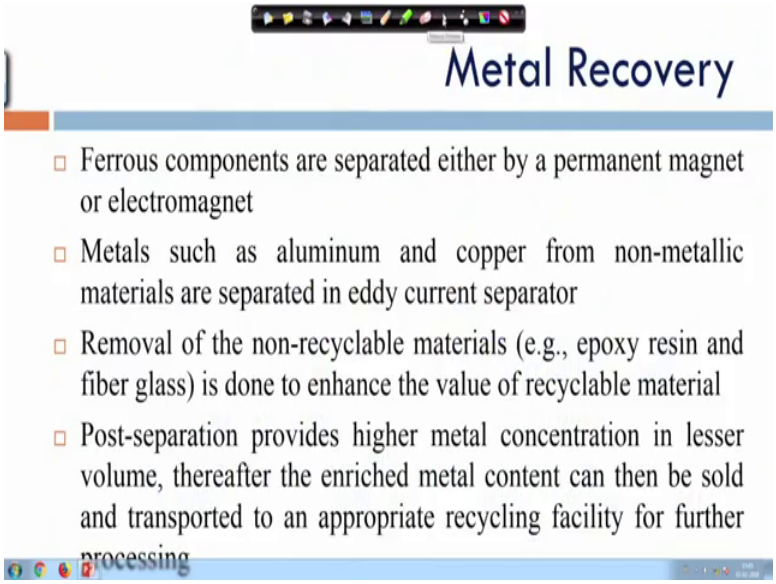

So, let us look at a few examples of metal recovery process.

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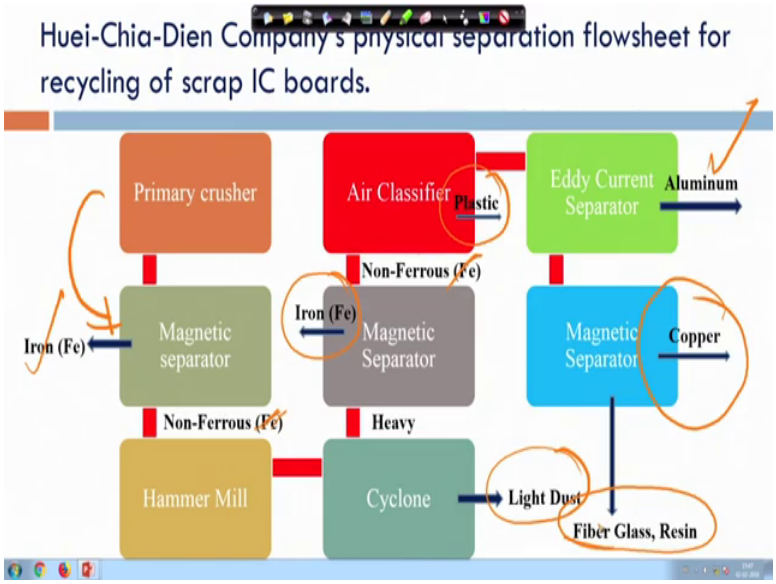

So, this is one example again these are from different reports, different countries, different companies, per detail. So, let us we will look at few of those. So, this one is from Huei Chia Dien company it is it is a physical separation flow sheet for recycling of a scrap IC board. So, it is say looking at the IC boards. So, it is starts with the primary crusher. So, it has primary crusher and then you have magnetic separator, after you do the primary crusher that is your first step.

So, you take the IC board and then you crush it again if you remember from excuse me, if you remember from the just discussion we had few minutes back we need to crush it to increase the surface area to make it more reactive and then. So, that it works better. So, from the primary crusher we can go for magnetic separator the magnetic separator will help in removing the iron from iron after later getting the iron out we will go to look at look at look we will have nonferrous, we look at the non-ferrous metal should be non-ferrous not iron non-ferrous metal after removing the non-ferrous metal will take it to a hammer mill where we will try to make it even more a fine powder. And the fine powder again whatever is the in terms of the cyclone the light dust will be collected because in terms of the air pollution we have to be careful, then the heavy material will go again to a magnetic separator where the powdered from the powdered form iron will be removed, then non-iron non-ferrous material will be removed as well, then it will go to air classifier to take it to get rid of the plastic and from after plastic is removed will take it the eddy current separator to take a get rid of the aluminum.

So, to remove to the cover aluminum I should not say get rid of? So, basically we are trying to recover all these material and from there again will go in terms of separation in terms of getting the copper out and finally, whatever is left only the fiber glass and raise it. So, some of this this is how a typical process will work around the boxes could be different this is just for an example. So, your different you can have different processes going on so, but this is how it is all done in a sequential extraction process.

So, in a general way what we can say that they walk on a sequential extraction process you target one particular type of material at first get remove that if you cover it then target the second, then the target the third, then target the fourth. In this way and make use of either the magnetic property, electromagnetic property, eddy current separator and all those different potential way of separating different fractions. So, this is how a typical I would say the recycling process works and then the final material that you will you may have to go for some of those metallurgical like a chemical based leaching and all those things as well which we will talk about in the next video.

So, I hope this is you are kind of trying to a my goal in this particular video and the subsequent few videos is to help you understand, how the recycling system is typically works in if in a formal E waste recycling facility in a formal E waste recycling facility what are the process.

So, as a consumer we also have to understand we also have to appreciate that these processes does require certain amount of money certain amount of capital cost to set up. So, that is why to expect that this formal companies will actually initial will be paying us some money to get the E waste from us it is a little bit I would say we our expectation is unrealistic, because if you think about in the western world where the E waste resettling is working in a little bit better way there most of the places as a consumer you and I have to pay as a E waste disposal fee we do not get any money, now when we get our E waste when we dispose our E waste. In fact, we pay money to dispose the E waste.

So, which is not unlike in Indian context where we always expect money when we get rid of our any garbage now not only E wastes for other wastes as well. So, with this let us close this video and I hope you are having a good time with this course. So, far you are following it you are the course is meeting your expectation, again we have crossed 50 percent of the material. If you have any questions, any queries, discussion forum is the

place to raise that if you have any suggestions for us to help and if you need if you think that there is something you want to you want to have a part of this course we can try we cannot promise you right now, but we will try that if there is a great demand of certain part in terms of electronic waste management which, we have not covered in the course and needs to be covered we can always post some additional videos as well.

So, with this let us close this video and then let us close this module and I will see you again in the next module.

Thank you.