Course on Integrated Waste for a Smart City
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Module 12
Lecture No 59
E-Waste Management (Contd.)

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Okay so welcome back will continue our discussion that we were having in terms of doing representative sample. So when we are trying to collect the representative sample from the electronic waste, If you remember like this is these are some of the pictures some of the slide we were are looking at towards the end of the last video. So how to collect the representative sample and how to do the size reduction this was a discussion that we were having.

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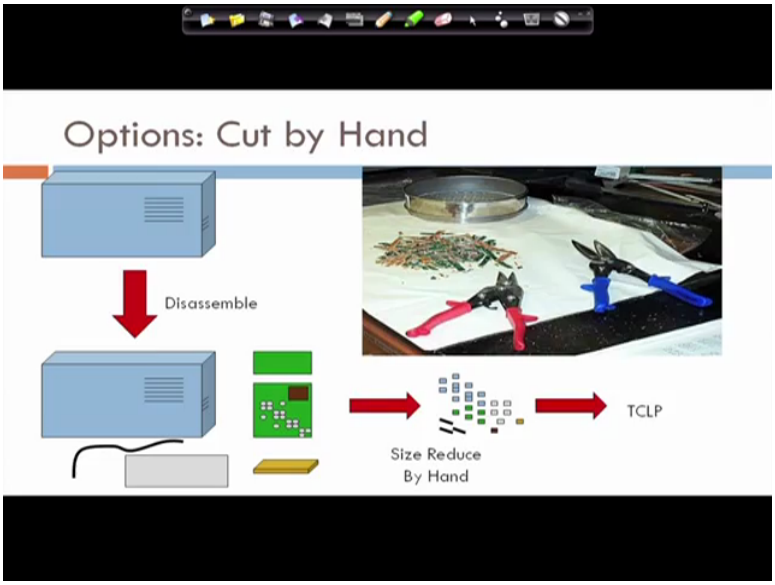

So one option I said was you can cut it by hand, so if you have cheap labour available you can cut it by hand where you can get the work of like different you can involve different people, you cut it by hand, but it is a very time consuming process and it is a hard process as well like you using those pliers and cutting through those and then but again in terms of this is for size reduction.

But in terms of the representative sample what I said was you look at the composition of electronic waste for that particular electronic waste that you have then you take say out of 100 grams that you have to do TCLP on because TCLP test requires 100 grams in 2 litres solution. So out of that 100 grams that you need to have for TCLP you take in proportion of the different waste of the individual component that you have.

Say for as you can see in the picture here for any waste that you pick it up from this pile it has plastics it has glass it has metals it has printed wire board, so what say if that composition is for the like simplicity sake say let they are all equal 25 percent, 25 percent, 25 percent, 25 percent, say there is only 4 components. So out of 100 grams we will take 25 grams of plastic, 25 grams of metal, 25 grams of printed wiring board, 25 grams of other material, so this is how you will come up with your 100 grams it has to be in proportion to the different component which is present in the electronic waste.

Say if you take the 100 grams just for the plastic that is not representing the whole e-waste, If you just take the printed wire board that is not also representing the total e-waste. So you have to take the sample in proportion of the individual components of in that e-waste that is present there. So once you decide what should be the proportion of 100 grams of course you need to size reduce, so you need to size reduce of different component and you can do it either by hand this is one way of doing it, off course it is time-consuming you require some labour requirement but it can be done in this way if you do not have the mechanical device with you.

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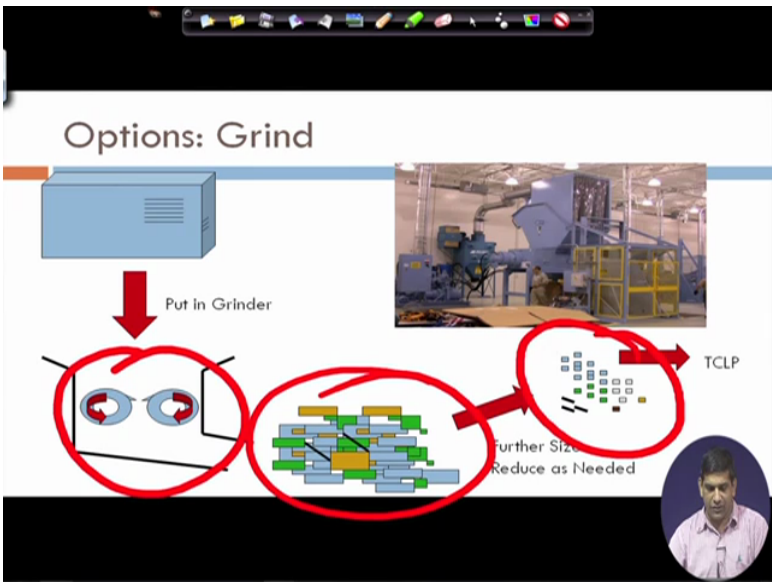

More common these days and more things you see that people try to use some sort of grinder and this kind of grinders are available in the market where you can take and put it in the grinder. So what happens here is you put your e-waste in here which is trying to grind those different components and then you have kind of like a size reduced and size reduced electronic and from here you take it e-waste and then from here you size reduce it further by hand or some other purposes as needed for TCLP requirement.

Because what is the TCLP toxicity characteristic leaching procedure the test requirement is the size has to be less than a centimetre, so less than 1 cm it should be there. So that is why it has to pass through the sieve which has a hole of 1 cm, so that is why we need to do the size reduction. If you remember what I said about size reduction for the very beginning like maybe second or third week of the class, size reduction is done to increase the surface area.

More the surface area better the reactions, so size reduction is to make it more conservative. So that you have bigger surface area more surface area the reaction will be faster and that way you can able to like a more and more things will move from the solid phase to liquid phase and that is what we want like we want to see the worst-case leeching scenario.

So that is why we want to creating a condition in TCLP test so that there is a worst-case leeching scenario of these heavy metals and organics from the solid phase to the liquid phase so that to see whether it has potential to contaminate the groundwater in the event that it gets disposed in a landfill municipal solid waste landfill. If it goes to the leachate from leachate it will goes to the if it passes through the liner system whether it will contaminate our groundwater or not. So that is the whole concept behind this TCLP test which we have already discussed earlier in what we were talking about municipal solid waste.

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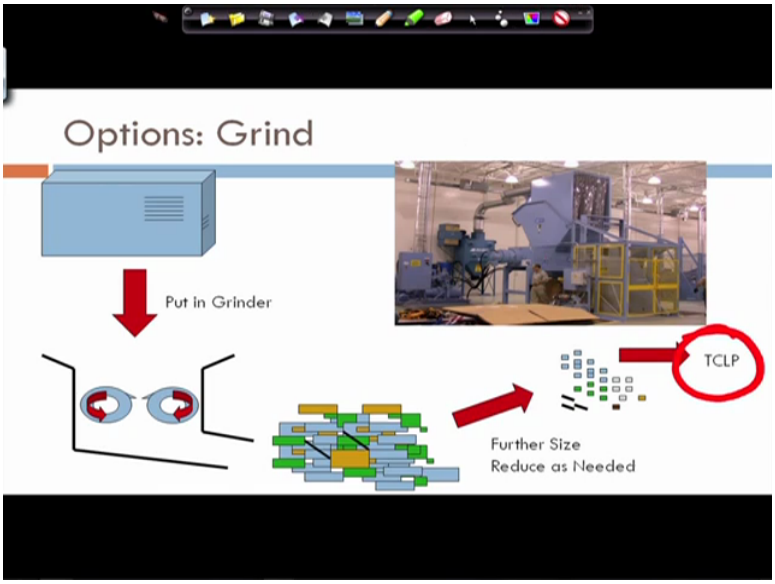

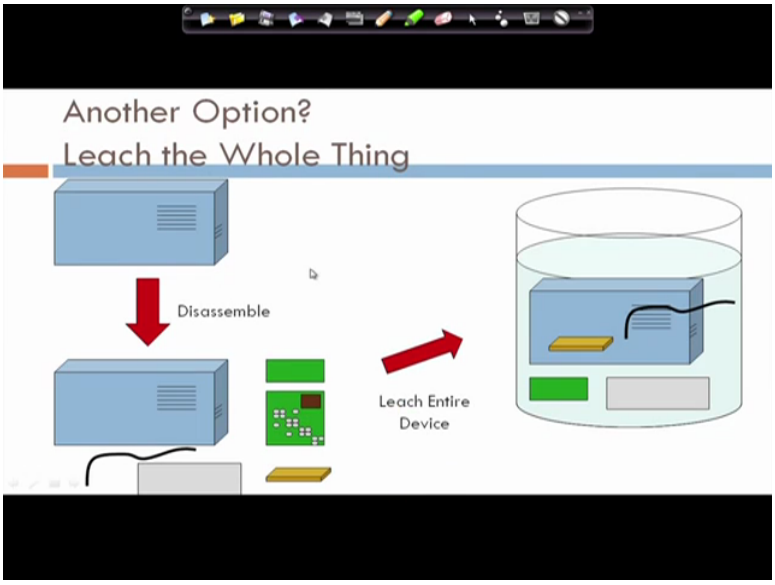

But this is how to get the sample this is how you can grind it and size reduce further if needed and then whatever you get the sample and you can do the TCLP test on those size reduce sample. Another option which is actually that is what many times if you go and talk give a talk like this where you have lot of electronics producers present there and also e-waste handlers are also present there, they will say why you are even size reducing it.

Because when you size reducing it you are making the that is not the realistic because what will happen say if I put a electronic waste in the landfill I am not going to cut it through those scissor that you showed me or I am not going to pass it to grinder, because why should I do it. It is a costly exercise to pass it through the grinder or to do the cutting through and that is not needed I will just take the e-waste and just dump it into the landfill but in that case nothing is going to happen maybe the contractor will go on top of that and the compactor may crush it a little bit.

So what you are doing by doing this the reality the way the TCLP is done the TCLP was when the TCLP was designed in late 70s and early 80s there was no e-waste. So they never thought about that there will be situation like this where people will have difficulty in even getting 100 gram of representative sample, it was mostly talking about regular industrial waste which is a pile of waste is there you take multiple samples and try to do like a sample mean, population mean, uncertainties, we have already talked about that in the class in the previous videos.

So they never got about this TCLP that there will be electronics which will have different component all will be together. So that is where it is so variety of components some is plastic,

some is glass, some is metal, some is so different type of material there. So they never thought about that and the whole thing together will become one-way stream which is electronic waste. So in that event that some thought process is that let us leach the whole thing, let us take the entire device and put it in a drum and then they will rotate a drum at that typical rotation, but since you have bigger drum it is difficult to the regular speed at what is required for TCLP. So some what was done this we took like we design this large extractor this was work done in when I was in US so we did it over there.

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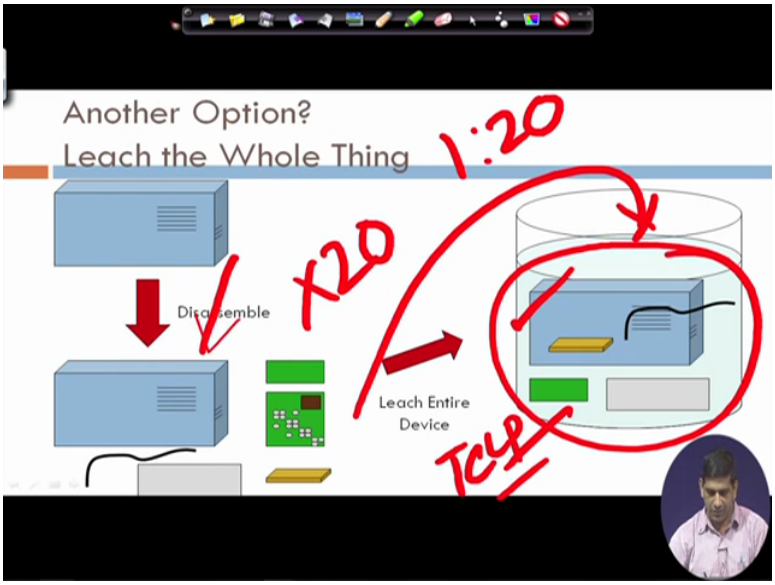

So we took so here the principle is you take the device, you disassemble , you just unscrew and you put the put the entire thing, so you disassemble it and then you put the entire thing into this drum when you have this TCLP Fluid is already there. So whatever is the weight of this stuff then you multiply it by 20 to get the 1 is to 20 liquid to solid ratio and that is the volume of liquid which is present over there then you put the entire thing and let it rotate, so that is the basic philosophy behind this.

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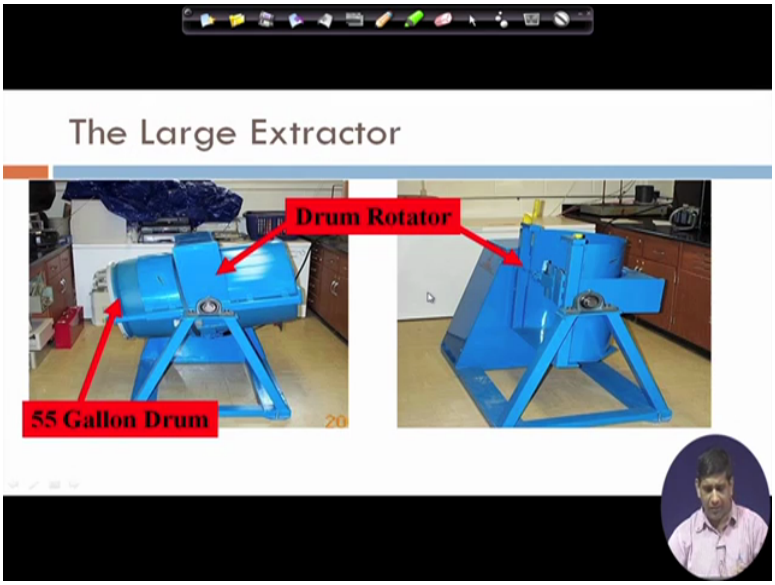

So here we had a large extractor which is a 55 gallon drum and be put it in there then we had the rotation. In terms of the rotation it was half of the TCLP standard TCLP rotation, because of a big drum it was difficult to rotate at 32 rpm it was at 16 rpm. So the testing was done to compare how the big compares with the small in terms of sorry how the rpm speed has an impact.

So those testing has also done it is already being published it is there in the literature, those of you interested to do research in this area we can talk about that off-line like you can send me an email or you can look at those papers first and then we can talk about those later. But in the case here what is just to since the big drum it was difficult to do 32 rpm it was reduced to 16 rpm and it was found that was okay to do that, so you can just take my word on it.

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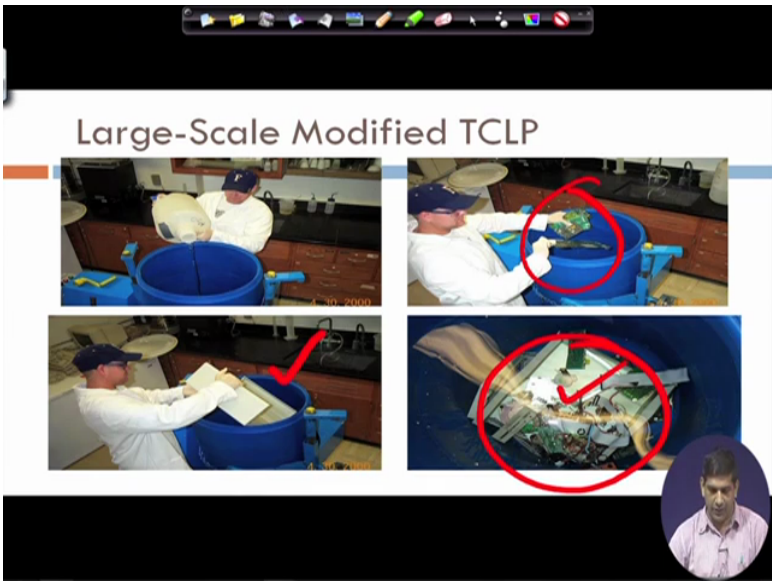

So it was again it was disassembled and this was this is Mr Cavin Van that was his master's thesis actually, so he did his master thesis on this particular project to. So it was disassembled and then we put it those in those drum rotators, where you can see the disassembled portion is being put down there, the TCLP fluid is being poured. So you have disassemble poured things are going in and so this is a you see things in the TCLP fluid with disassemble computer and things printed wiring board (())(09:39) things being put in and then water was also put in there.

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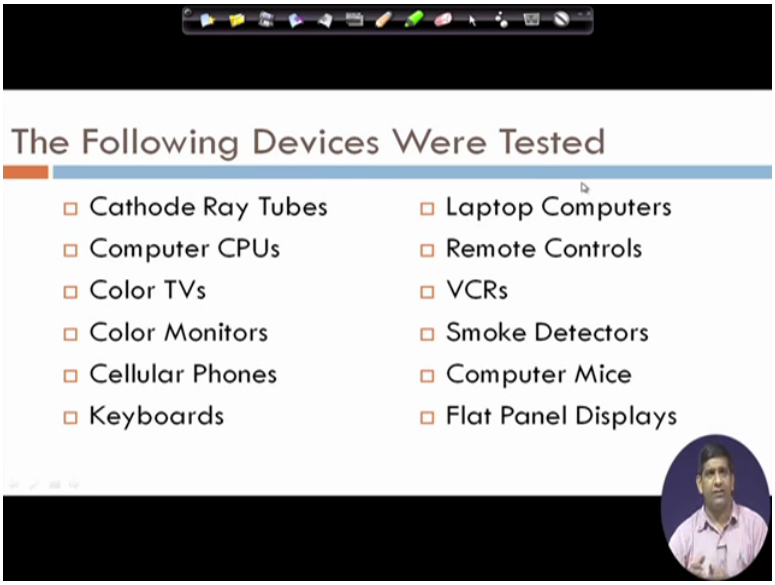

So with that like a stuff and then it was done on several devices it was done on cathode ray tubes, it was done on computer CPUs, colour TVs, colour monitors, cell phones, keyboards, laptop, remote control, VCRs, at that particular time whatever was there in terms of e-waste stream whatever the different things present there it was done on all those stuff including the cellular phones.

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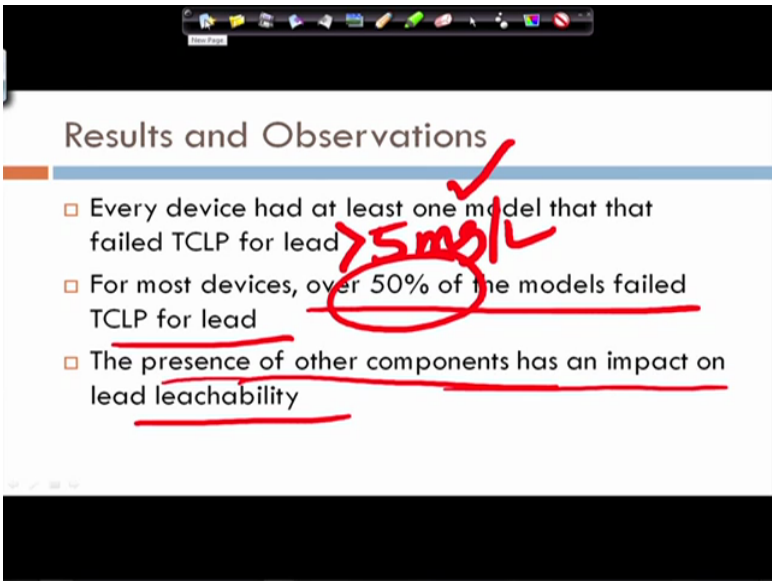

So what was found? It was found that every device had at least one model that failed TCLP for lead. So when we say failed TCLP, what do we mean? We mean that the concentration of lead in the fluid in the liquid that after rotation we take the liquid sample, so filter it through 0.45 0.7 micron and then take the liquid sample and then digests that sample and tested it on

ICP or AA as I have explain to you in the previous videos, if you forgotten go back and watch that video again. But and then we tested for lead and we found that lead concentration was greater them 5 milligram per litre. So this lead was more than 5 milligrams per lead was greater them 5 milligram is per litre, so that actually means that it has failed TCLP for lead so that is what it means.

And for most devices over 50 percent of the models failed. so for every device at least 1 model fail, for most devices over 50 percent of the model fail, again for lead. As I said earlier as well lead is the one which gets most of the attention in terms of e-waste disposal. And there were presence of other components has an impact on lead leachability. So there was some chemistry going on there as well, so those of you who love chemistry there is some interesting goes on e-waste when you look at e-waste leeching, there is lot of chemistry goes between the iron and the lead.

So higher the iron present, when we have more and more iron present the lead leachability is less as we are going to have less iron in the product, so that is what I was trying to tell that last year we had a e-waste conference in XLRI Jamshedpur I do not know if some of you were there, but in that conference I was discussing this, this are the some of the research work that I was involved with.

So I was discussing some of these work where I said that as we are going to newer and newer electronics as newer and newer electronics means less lead sorry less iron and more plastics. So where there is the presence of less iron lead leachability is more, so percentagewise lead leeches more in terms of when we have less iron present.

So there were certain generalist were present and in the next day in the Hindi newspaper they had a some news there which did not really make 100 percent sense to me technically it was not correct and it was not 100 percent wrong either. But they did not get it properly and when you are trying to explain like a technical term in a very simple way in a newspaper things does go wrong and that was a very good example of things went wrong.

They did not even talk to me they were just sitting in the audience back and wrote something and then it was kind of had a heading I think Dainik Bhaskar or Prabhat Khabar some newspaper I do not remember. It came in several newspapers in Jamshedpur it was in XLRI Jamshedpur and then they had the heading with a dash and my name next to it as if I am saying it but I did not say that. So I said something else but they thought I was saying

something else so those things happen, so whenever you talk to media be careful and we know we all know that.

So presence of other components also has a lead leachability more the more iron present lead leach come into water, lead leach come into the liquid form. And since this newer and newer electronics the percentage of iron present is going down, percentage of plastics is going up. So even with the same amount of lead if the even with the same amount of lead present in the newer model you see them the lead leachability to be higher because percentage of iron has gone down and that we have seen in many of the experiment that we have done associated with e-waste, so lead leachability increases in the presence of iron in the absence of iron not presence of iron in the absence of iron.

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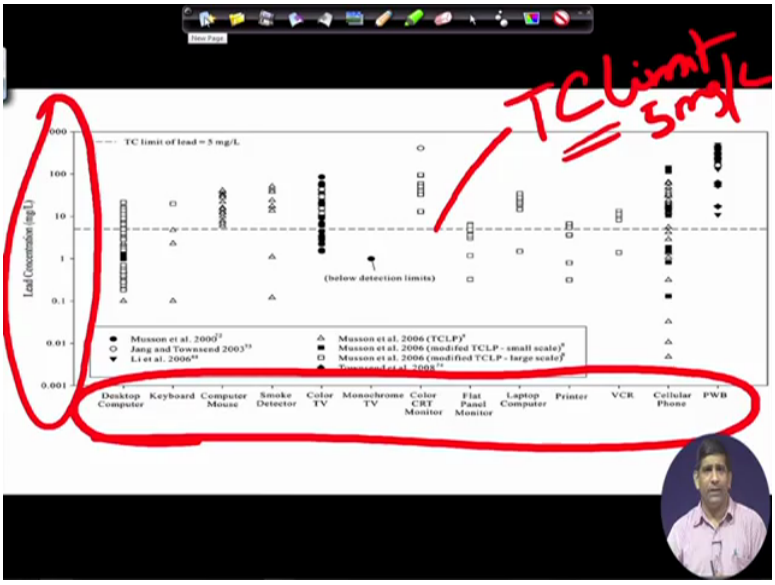

Here is the some like a like a literature review kind of different types of lead leachability that has been shown. This is a log scale and here these are the different types of electronics which is out there, we have different types of electronic items desktop, computers, keyboards, computer, mouse, smoke detectors, colour TVs, monochrome TV, colour CRT monitor, flat panel laptop, printer, VCR, cell phone, printed wire board, all these different type of electronic e-waste items and this is in log scale, so be careful here this is a log scale.

Lead concentration in milligrams per litre but expressed in log scale and this is the plot that you see here is actually we are showing the ranges. So since the concentration does vary over the several order of magnitude, so that is why it has been shown in a log scale the y-axis is in

log scale. And the middle dotted line is you TCLP limit, that is the TC limit for lead which is 5 milligrams per litres so that is what you see over there.

So that is the and as you can see for most of these desktop, computers, keyboards, computer, mouse, smoke detectors, you see that for most of these things are above for actually if you look at this dotted line and then you see for each one of these we have things above, we have thing above this we have things showing up above the TC limit for lead. So lead does Leach out in a TCLP test even with little bit of lead present in the solid phase.

The reason for that again if those of you who love chemistry, reason for that, if you remember TCLP solution that we used it is it was a mixture of sodium hydroxide and acetic acid. Why we use acetic acid? Again if you remember from the previous class if you do not remember I would kind of feel little bit sad but I do not but because I have said that so much times during that particular video acetic acid is the final acid in a whenever we have this food what we are trying to stimulate in TCLP test is a worst-case leeching scenario in a municipal solid waste landfill.

Municipal solid waste because of the food waste and other organics it decomposes it and finally you have the acetic acid being formed. So this acetic acid which is a that is why we use acetic acid in a TCLP test, because we are trying to stimulate the worst-case leeching scenario in a acetic condition of municipal solid waste landfill. We add sodium hydroxide to make it a buffered solution because landfill systems are highly buffered system.

So we make a buffered solution of 4.93 pH plus minus point 05, because you cannot have exact of 4.93. So pH is 4.93 plus minus point 05, you have acetic acid and sodium hydroxide, so when you have acetic acid and sodium hydroxide in the TCLP fluid you put the some electronic waste in there, electronic waste has lead, acetate which is there in the solution and lead they basically you can think if in a simple way if I can say lead and acetate they basically love each other and they make soluble complex of lead acetate.

So this lead acetate soluble complex it is a soluble complex it is not a it will not soluble, it will of course not precipitate it will be in solid liquid phase, so that is why you start using lot of lead. But you have iron present there is some competition goes between iron and lead so that much lead does not come out, that is where we talked about in your high school chemistry you have these competition between different elements in some sort of reactions.

So that is what happening in there, but lead and acetate they basically like to have be together and they produces soluble complex not insoluble complex it is a soluble complex.

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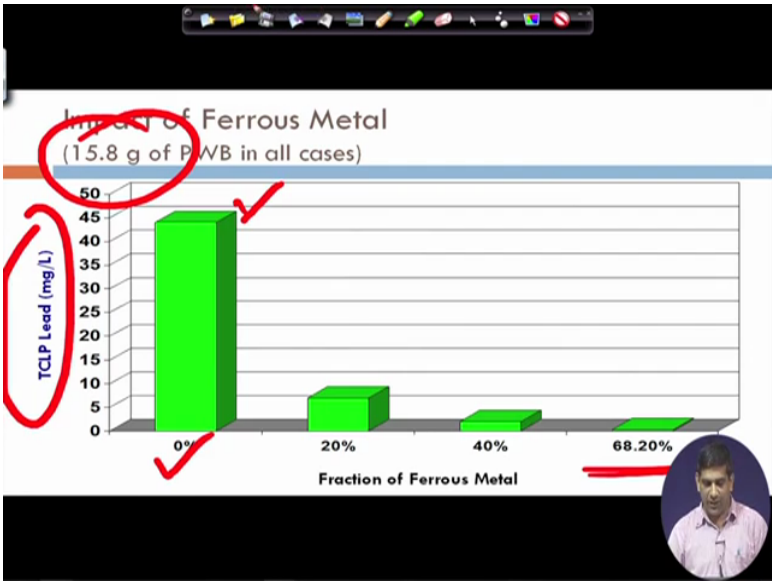

So impact of ferrous is present if you have increase the ferrous concentration as you can see over here, here the y-axis is not in your it is a nominal log scale again expressed in milligrams per litre. So lead in milligrams per litre as you can see if there is no iron present we get almost close to 45, but when 20 percent of iron it comes down to something between 5 and 10, 40 percent even lower, if you have 68.2 percent of iron present that goes very close to 0.

So again so as more and more iron is present less and less lead leach out with 15.8 grams of printed wiring board in all the cases, so amount of lead was same in all these cases amount of iron keeps on changing. So we kept the amount of lead similar in all these 4 cases but we changed the amount of iron present from 0 percent to 68.2 percent and as you can see there is a drastic impact of iron on lead leachability.

That is again those of you are chemistry experts you can probably explain it better than me, but that is what I already told you that there is some sort of reaction competition going on. Those who are not chemistry expert do not worry too much we are not go into like go into detail of this chemistry here we are just trying to show you that it does have an impact and of course the chemistry experts can help us to understand it much better you can use the discussion board and put some of your thoughts that why it is happening.

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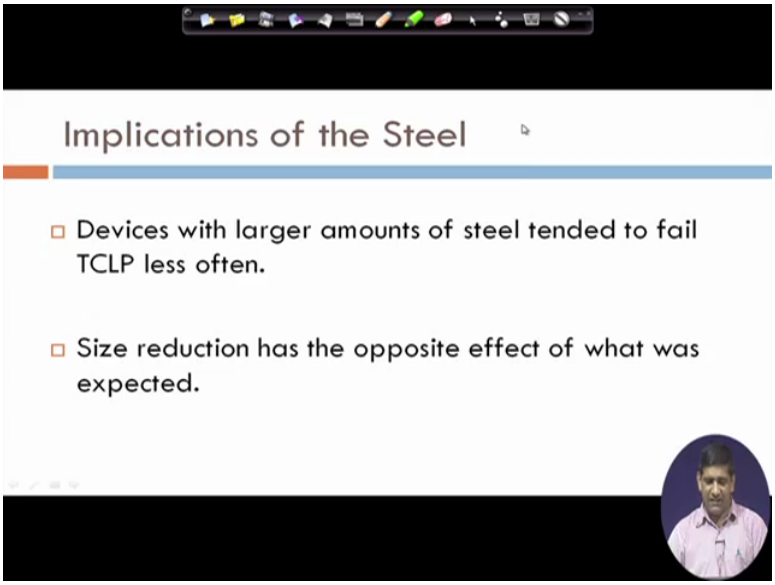

So implication of the steel we see the devices with larger amount of steel they tend to fail TCLP less often, because lead does not leach out because it is the lead which is causing the TCLP of in TCLP test for it to like fail. And size reduction has the opposite effect of what was expected, when we thought that if you do size reduction will have more lead coming out actually when you do the size reduction you are doing size reduction for iron as well you are doing size reduction of ferrous as well. So ferrous also has a bigger surface area now so it is a the impact that we actually saw that as we do the size reduction, more and there was more impact on less lead leachability, so that was it was seen as well.

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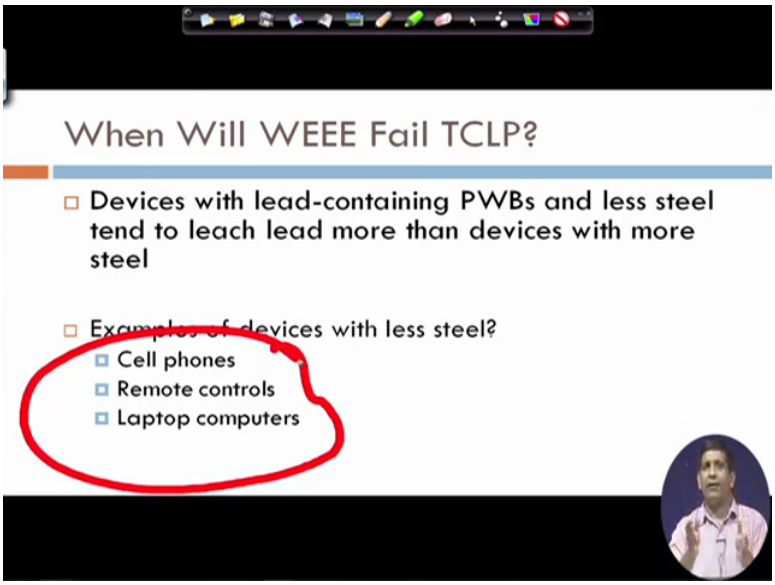

So when will so but when will this electronics will fail TCLP? What we saw that devices with lead containing printed wire board with less steel they tend to will leach lead more than devices with more steel. So this is what I was trying to say and that was I was quoted out of context in those newspapers that I was just mention to you after a conference in XLRI Jamshedpur last year.

So but examples of devices with less steel are cell phones, as we do not as you know we all carries a cell phones cell phones, remote controls, laptop, computers, so these things and we are using more and more of these, so these and these actually tends to fail TCLP more although they may have some amount of lead.

So again this is the drawback of the TCLP test, because although the TCLP test is supposed to tell us whether it is a what is the impact. But with the same amount of lead with since less plastic is present sorry less iron is present it is giving us higher concentration of lead coming out. But when it goes to a landfill environment, if we are doing a lab test when it goes to the landfill environment there will be iron around it, there would be other things going around, so it may not leach that much which you will see in a little while we will discuss that further, so that does kind of happen.

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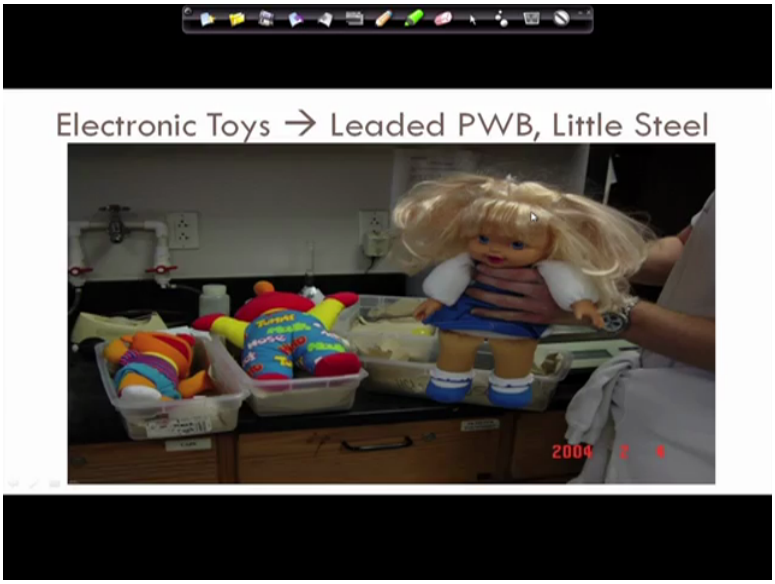

So even electrical toys which is leaded printed wiring board, little steel those all these electrical toys electronic toys which makes little bit of noise will make some music and other stuff has a small tiny printed wire board. If you even like a talking Barbie or any of these toys you take it out you will find that tiny printed wiring board and they do not have any steel,

because it is all called clothes, plastics, and other stuff. So since there is no steel there is no competition whatever lead is there it comes out in solution and becomes a hazardous waste can you imagine that?

So even the talking tray, when you are the railway station or an airport you see a small baby walking with that lightning in their shoes or having that like little bit of musical kind of things coming out from their shoes and that also if you do a TCLP test on that that also becomes a hazardous waste. So it is so TCLP test like a kind of become little bit of ridiculous in this kind of scenario. But it is a test and based on conditions it does give a result, so that is why it is any tool is out there we as a human being we have to make our decision whether how to take the data how to make use of that data.

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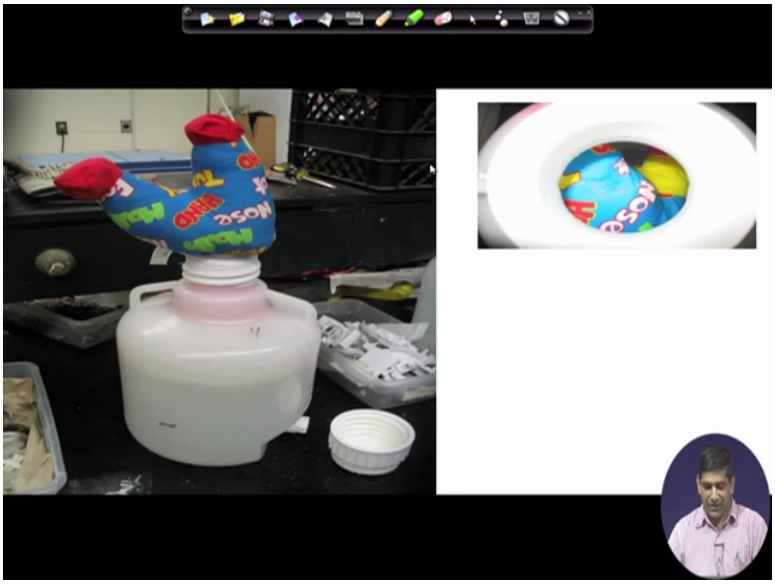


HAND
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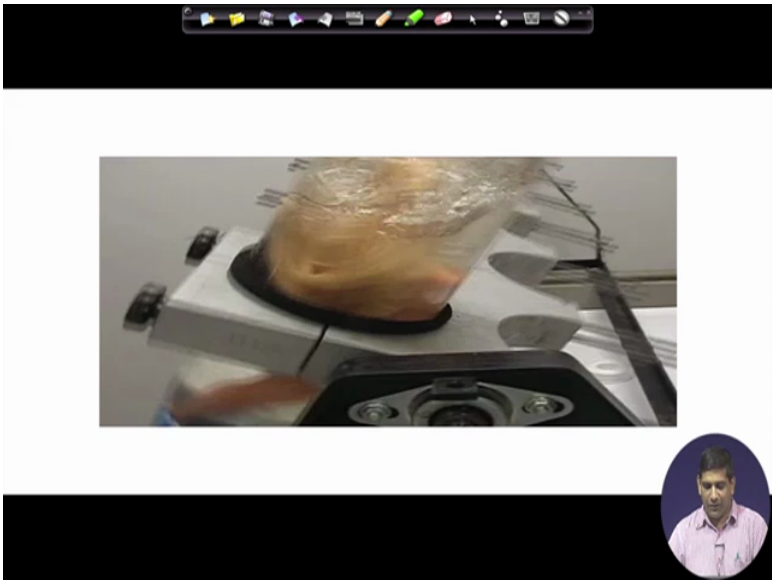
Nose



So you have these we did some this some of these toys we did some TCLP test on them. So size reduce we just putted whole thing in there and then rotated them through and to as you can see little bit of printed wire board here and that came out to be a hazardous waste. So all these toys were sorry we have to take it apart to do the TCLP test put it in there and then rotated it and we found that it was a hazardous waste so it came out to be a hazardous waste.

Which is again kind of talks about that we have to be careful in terms of how we interpret the information we get. So that is I want to show you that sometimes even test as good as TCLP test which is used many places like globally that test is used globally in terms of the waste management sector, when it comes to electronic waste it over predicts, the others reason for why it over predicts? Is as far as I know I am not a chemistry expert but as far as I know what based on my understanding of the chemistry in terms of iron, lead and acetic acid, acetate ion, Lead acetate solution which actually makes soluble complex and that leads to increase leachability of lead and although you see high lead leaching out but it may not as bad as it sounds from the results that we get from the TCLP test. So we have to use our brain and make decision on that, so that is kind of in terms of characterisation.

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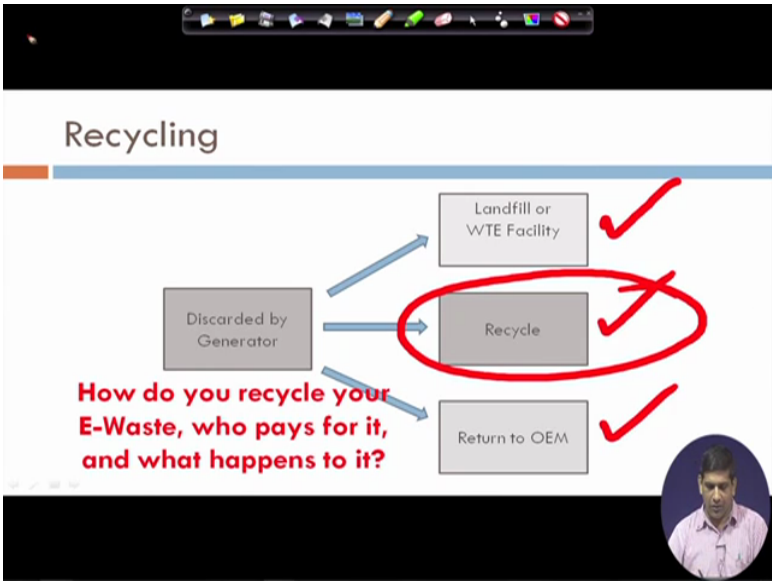

Now we will start looking at the recycling part. So how do you recycle? Who pays for that? What happens to it? How it gets recycled? So we will talk about those stuffs and here the concept of social responsibility and those comes in picture. So in terms of once the e-waste is discarded by the generator like me and you through the e-waste of the commercial area, institutions, wherever the e-waste is discarded it can either go to this 3 path, it can go to landfill or waste to energy plant sorry it can go to landfill or waste to energy plant, it can go to recycle system or it can be returned to like the manufacture, so these are the three path it can go. So let us look at the middle first recycling which is promoted a lot and then we will look at the others as well and then we will wrap up this concept with that.

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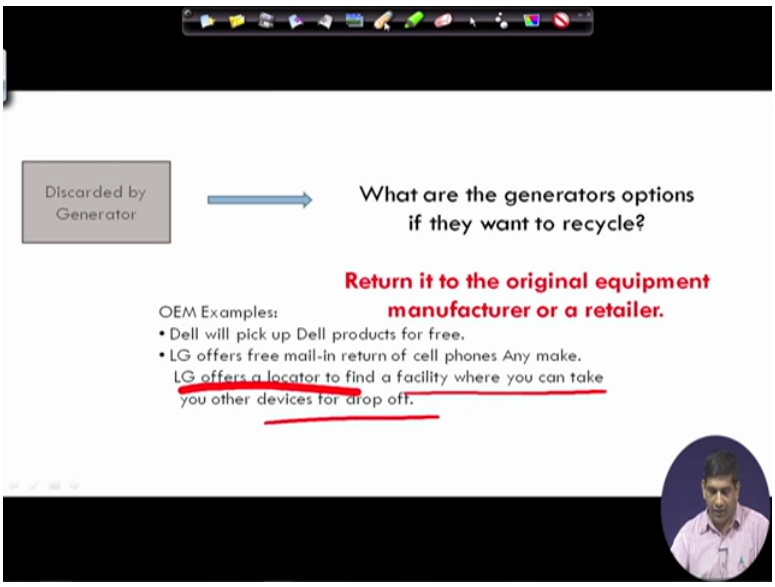

So in terms of recycle once it is discarded what are the generator options if they are recycle? In terms of recycling what are the options out there? The generator options if they want to recycle, first of all they can return it to the original equipment manufacturers or a retailer. There are even as per the extended producer responsibility as per the e-waste management rules which was from 2016 there is this manufacturers have to take your electronics back.

Say you bought a laptop from a particular store, later on after 2 years 3 years the laptop has gone bad you can give the laptop back to that people. Until now we do not do it because that person is not going to give you any money back it is basically he will take the laptop from you and send it to the register recycler and there recycling is done. He will also probably not make any money if he goes by the rule.

But what is happening right now is we are giving it to some kabadiwalas and other people to get few 100 rupees maybe 1000 rupees, I do not know, depending on the instrument and depending on how good your laptop is how bad it is how good or how bad it is and then how much bargain you can do. And but then it mostly ends up in the informal sector and that is we have already talked about that. It more some ends up in a informal sector does not gets managed properly, so in terms of human health and environmental impact.

As per the new rule, as per the extended producer responsibility and whatever is the global practice nowadays is to have a some sort of mechanism where either most of the places outside India the way they have done it wherever they have done it is they have try to come up with a pool of money getting the money from all these different companies and make a kind of e-waste stewardship program where there is a central location which is serving for all the different manufactures and you can take your e-waste and go and give it to them and they take it.

Some of the smaller item you can even do a mail back program where you can send your phone back. For example; cell phone, many companies they can take your cell phone back and they will give you some store credit, some online credit, for example, I do not know whether it happens but something like this can happen that if you bought the phone from Amazon for example and then after 3 years you want to sell it back to Amazon sorry send it back to Amazon, Amazon will give you like a online credit and then you can use it to buy another phone or something like that, another electronics depends on how this business model will work.

But in terms of there is that is one option that is one option there are different ways of doing that option is going around the world and in India also things are working in that line but still it is little bit of progress needs to be made. So but in some other places for example here this is a this example is from US where Dell has a will pick up Dell product for free.

So Dell will have certain location where the Dell products can be drop-off for free, LG offers mail in return for cell phone, any make they will take it. LG offers a locator to find the facility where you can take your device and drop off as well. Municipal people also do take electronic waste.

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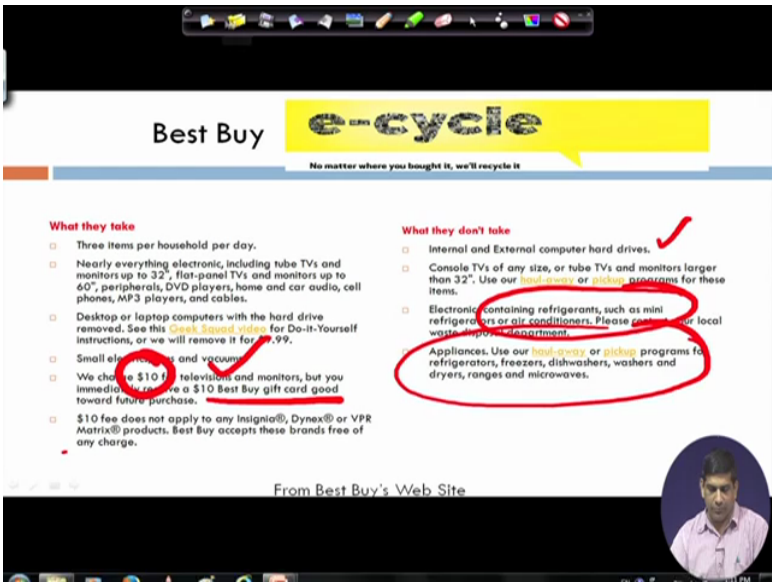

Best Buy which is another it is a chain of stores like something similar to reliance electronics store we have and there could be other electronic stores here too, I am not a shopping person so I do not really much. So it is in terms of but in terms of Best Buy some of you may know it is a big chain of electronics store in North America, also I saw it in New Zealand and it might be I think it is in Europe as well I am not sure.

So but in terms of this they have the e-cycle program where any of these any of their store you can take 3 items per household they are ready to take it nearly everything up to TVs and other stuff, monitors, they took DVD, home car audio, desktop and laptop, computer, if you want the hard drive removed then you will you can have you can get it removed if you want because many people do not want the hard drive they want the hard drive to be cleaned off.

So they will take the hard drive of and they will clean it for you and then they dispose it, because you do not want any of your information you may have your tax information, you

may have some personal photographs of your family, of your kids, which you do not want people to have access to. And small electric fans, vacuums and then they charge some televisions and monitors they charge 10 dollars, but they also give you 10 dollars Best Buy gift card, because just to handle that. And does not apply so there is some other product which does not charge so based on how they have arrangement with different companies.

What they do not take is the computer hard drive, internal and external computer hard drive, console TVs, electronic containing refrigerants, so because this is hazardous lots of hazardous chemicals there. Appliances they do not do it you can use your haul-away or pickup programs for these things can be done doing a like the one which I showed you where they have designated e-waste collection event, like I think in the collection chapter municipal solid waste I showed you some pictures of Best Buy parking lot if you remember that. So and this is from Best Buy website.

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And there is a this is how you can see the recycling at Best Buy. There are different component you put it in different stuff and they basically gets recycled. They also have you can help us, you can donate your old cell phones, and then that is the money generated from that goes in terms of boys and girls clubs of America.

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So and then this is your office depot, they also have certain stuff you can recycle, you can get box, ask special store for a recycling box. You pay certain money for those boxes, say you are paying money to recycle and this is kind of little uncommon in Indian context is not it? When you say people ooh! I will give you my electronics and I have to pay for it. So we do not have that mind-set, we think that we should make money for each and everything.

As I said earlier if you buy a laptop in Canada you pay around 30 dollars extra for a 1000 dollar laptop and to pay for the disposal fee. Here as also you can see there are small box, medium box, large boxes, there is a charge. Small box 5 dollars, medium box 10 dollars, and large box is 15 dollars, because always there is a there will be some to run this kind of program requires money and if you want to do it in a environmentally safe and sound way that requires lot of investments, so money has to come from somewhere.

We have a tendency to think that each and everything should make money for us and we it may make money for you in a upfront, but when you look at long-term environment impact, long-term human health impact, it is causing because of informal sector lot of lot no control things going into the water, going into the air, going into the soil. So we are paying for it not directly but indirectly through our health budget, through our health fees to doctor, fees to these big-big hospitals, so but you can as you can see there are recycling this kind of recycling does happen.

So and then we will be will stop here, so let us stop here at this particular point and then we will talk about the municipal government collection, how they try to fund it. And then we will talk about landfill site and I will show you another research example of however we have tried to do a stimulate landfill for electronic waste and what are the results came out and with that we will and with that and some other global issue will close this in the next video.

So with that thank you very much for being with us so long and it is really keep the discussion board active we are almost towards the end of the course, but do not forget still we have you have the exams those of you have registered. There will be some problem videos after this is the last but one video after this there would be another video of lecture and then we will have couple of videos of the problem solving, where you will be able to look at how to do the problem-solving it will be helpful to all of you, especially for those who are registered for the exam I would you should definitely go over that videos.

And then and then we will also have a video summarising those 2 surveys that we have requested your help with, one was on municipal solid waste we have got a very good response and if you have still not done it go ahead and do it. And the other one is on e-waste which is going on please do that please finish that survey as soon as possible and then we will and I will come back and do a summary.

The problem videos will be done by TAs and then I will come back and do a summary of those 2 survey videos. It will be a really fun to look at what we really found in terms of how the waste is managed municipal solid waste is managed in the country and with more than 6000 people in this course it will be really nice if all of you can give us the data it will be cool to see.

We will put it on India map, we will put all those graphical locations, like which location we got how much response. We will off course we will not tell your name in because we do not want you to get personally identified that is not our we just want to get the data from Eastern region, Southern region, Western region, how things are happening and how the Swachh Bharat mission and other things are happening in the country that would be really cool to look at. So with that let us close this video and I will see you again in the next video, thank you very much.