Course on Integrated Waste for a Smart City
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Module 11
Lecture No 54
E-Waste Management

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Okay, so let us get started in the second video for this second module for electronic waste management. So we had looked at some like a definition, quantities from the Indian context, categories as we defined. Now, as I said, we will look at more on what is the environmental and health hazard, why we should even be worried about all this electronic waste?

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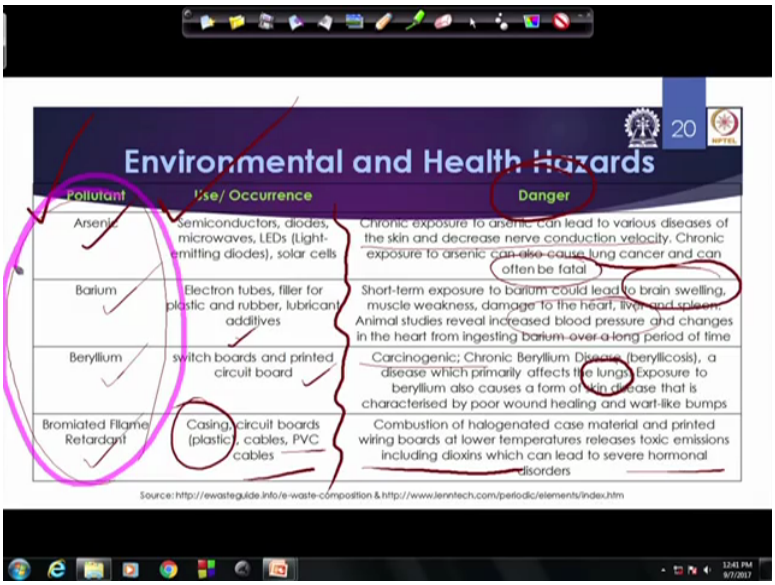

As I have been saying again and again we should always look at, what is the reason, what is the logic behind all these discussion that we are having. As identified in the previous video, we talked about that electronic waste has lot of non-ferrous or organic pollutant right there. So those are there once you look at they are arsenic, barium, beryllium, brominated flame retardant and all those different stuffs, in the next slide you will see some more.

And they used they have get used in different type of applications, which is listed over here. You have semiconductor, diodes, microwaves, LEDs, solar cells, that is where arsenic is getting used, we all know specially you are if you familiar with part of West Bengal and Bangladesh and several other places in the country and also abroad, arsenic poisoning is there like we are it is unfortunately arsenic is there in the groundwater in many of these areas and people get exposed to arsenic and then we are also using arsenic electronic, we are also using barium in electronics, which is electron tubes, filler for plastics, lubricants.

Beryllium; used in switchboards, printed circuit boards. Brominated flame retardants; as I said anything which gets flame retardant means anything which gets heated up there you will have BFR. If you just think logically it is flame retardant, retardant means to stop the flame, it will not let the flame proceeds. So even if you have little bit of say, because of things getting heated up may have a little ignition many times you see some sparks like things when it get really heated up the electrical wire catches fire on its own.

And so if it catches the fire there should be something which will retard that fire, so that will which will stop the fire before the whole machine gets blown up, so for that BFR is used, that is the brominated flame retardant. And then you see it in casing, you will see it in circuit board, you will see in the like a plastic casing, especially in the plastic casing, circuit board cables, PVC cables, so wherever things can potentially catch fire, you will have this BFR's present.

So this is a these are the like we look at the pollutant list where it is being used and why we are worried about that. What is the danger associated with these stuff, what is a danger right there, why we should be even thinking about these. If you look at the danger, off course arsenic everybody like if you have done any environmental course, even water or any course you know that arsenic is bad, it is a if you have a chronic exposure, chronic means long-term exposure.

If you have a long-term exposure of arsenic, it can lead to various disease, you will have the skin disease, you have nerve conduction, chronic exposure also leads some sort of cancer, it is a carcinogen and can often be a fatal as well if it is not detected early, so arsenic has that kind of exposure.

Barium again lead to brain swelling, it leads to brain swelling, muscle weakness, damage to heart, liver and all that. Annual studies have revealed that increase blood pressure, Barium exposure leads to increase blood pressure, changes in the heart for if you are getting a long period of time. Beryllium it is a carcinogen , chronic Beryllium disease like which is called like say Beryllicosis it is a disease which actually effects our lungs and exposure to Beryllium also causes a form of skin disease that is it is a poor wound healing and wart like bumps you get those skin problems.

Then BFR's if it is a halogenated brominated if you remember from your chemistry chlorine, bromine, all those things are called halogens as well. So it is a whenever you burn halogenated plastic, halogenated case material it releases toxic emissions, including dioxin which leads to severe hormonal disorder, so that is why dioxins and furans if you hear about the in the terms of air pollution.

So as you can see there are several all these is one and then I think we have several couple of more list in the next slide, but these have this is the reason why we are even discussing like this is the reason why I have included this in the course. So we love electronics, we cannot live without electronics these days, every time you get up in the morning even you alarm clock is now your cell phone, you put your alarm clock in your cell phone, you watch all like all these Whatsapp, Facebook everything without cell phone, you cannot even now imagine the life.

So think about if you do and do not have your smartphone with you and if you have no data connection these days it becomes really difficult to pass the time I do not and just maybe just 10-15 years ago it was peoples were okay, but now it is become a addiction, like everybody wants to have this smart phone. But and the many of these not only smart phones, smart phone itself like if you if whatever smartphone you have if you Google the details of the smartphone, you are actually carrying maybe 20 to 25 elements of the periodic table.

Everybody of you have looked at the periodic table you high school and maybe in the middle school itself, but the different elements from the periodic table at least 20 or maybe more

depends on model, depends on the newer ones are actually trying to get away with many of these heavy metals, but the as you the older ones used to have around 25-30 of the heavy-metals from the periodic table is there in your smartphone.

So you carrying 25-30 elements in your pocket all the time, off course if it is in the pocket, it is not harmful. I am not saying from your pocket things will leach into your skin, but that is not going to happen. But when it gets dumped into the environment when while you are making these smart phones when you are trying to get this extraction of these heavy metals that is mining pollution and all that, but in the industrial pollution.

But say when you dispose of this electronics this smartphone will not be with you forever you will probably buy a new one, every year iPhone 7, iPhone 6, 6 then 7, 7 as whatever 8, I do not know they keep on every 6 or 8 months there is a new version of phone is coming, Samsung whatever company you look at. And many times even if you do not want the new phone you buy it because it looks cooler or there is a peer pressure some of your colleagues have bought a new phone so how can you use the old one from 3G to 4G.

Just recently we saw that BSNL is going to start testing 5G now, so will have 5G coming up pretty soon and your old phone may not work on 5G, then you have to buy the new phone. So old phone you keep it in your drawer for a while but ultimately you will dump it because you cannot, how long you will keep all these in your place.

So you when it goes into the environment when people are trying to recover these heavy metals out of that and in the process what the people try to when the recycling, informal recyclers what they try to recover, is what is valuable for them. And the valuable materials are copper and to certain extent aluminium, copper, aluminium and gold, Gold is what they are really after. So as you know gold is pretty expensive, so gold is what they are really after so to in the process of extracting gold all these other pollutants are getting released in the environment.

So these are the other pollutants which is out there, it is getting into the environment in the process of extracting gold, because so that is they are not after these, because they are very minute quantities it is it does not make much sense, they do not know how to extract these, but they are more focused on gold, because gold is much-much more expensive and if they got little bit of gold that is what they are after and to some extent copper as well.

So that is why we are even talking about this and as you know more and more of these electronic are being made, more and more of these will ultimately come to the waste disposal stream and we need to think about this waste. If and as we are talking about smart city, one of the smart infact if you talk to a layman go to a railway station or a bus stop and ask people, what they think about smart city.

Most of the people when they think about smart city, they thinks everything online, everything I can do with my phone, but that is one part of it that is not entire part. As you remember from the earlier video we had on what is the different components of smart city, waste management, water management, those are also there. Say you may have everything online all nice Wi-Fi everywhere, but if you do not have water, that is not really a smart city, if you do not have a proper working toilet, if you do not have a proper waste management system, that is not a smart city.

In the waste management system also includes the electronic waste, because as people are getting if everything is on the Internet people more and more people needs those smartphone or a laptop to go on Internet to do your driver license and what all the different government activities that you need to do including banking and all that, so that means more and more of e-waste.

So we have to start thinking about property waste management, that is the reason that I included this portion at least to give you some idea of what is this what is the components of electronic waste. Off course more detailed course is actually needed in this area and may be provided in future, we will see about that.

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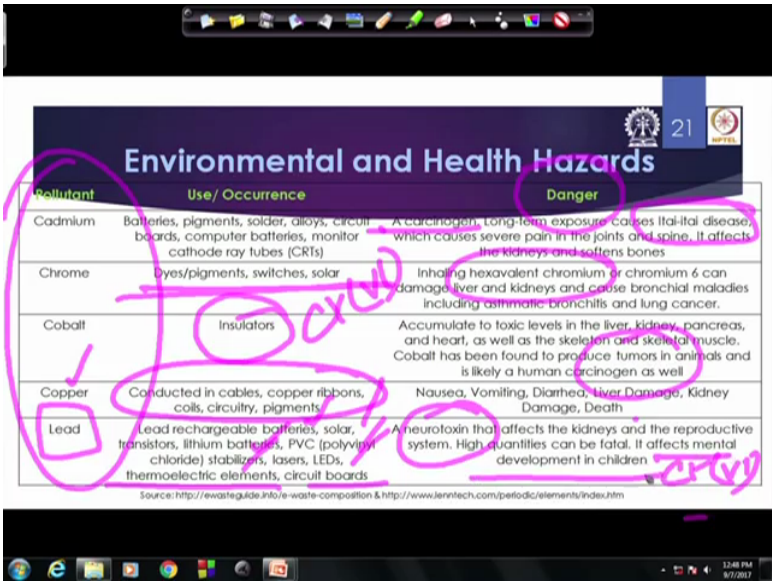

So that is the one list and other similar table here look at other pollutants, cadmium, chromium we have cadmium, chromium, cobalt, copper and lead. So here cadmium used, we all know cadmium batteries, remember that cadmium batteries which is being so cadmium battery is there, batteries, pigments, solders soldering iron, alloys, circuit board computer battery, monitors, CRTs, all used cadmium.

Then chromium is mostly used in dyes and pigments, switches solar panels. Cobalt is used as a insulator and copper is there copper wires, circuitry, pigments, copper ribbon and all those things are there. Copper at a as a it is not that much of a problem at low concentration and if it goes but otherwise it does have a some effect but not as bad as some of the other elements out there.

Lead which is used a lot and which gets most of the attention in terms of the electronic waste. It is a lead rechargeable batteries, solar transistors, lithium battery, PVC, stabilisers, LEDs, thermoelectric element, circuit boards, everywhere you see lead. And lead is also there in the glass panel which prevents you from getting the harmful rays, so coming to you when you are watching TV and other stuff.

So if you look at the impact again we have the dangers, what are the dangers from there. So similar as the previous slide that is again, cadmium is the carcinogen, you see the carcinogen long-term exposure cause the Itai-Itai disease which actually our body structure gets confused between cadmium and calcium. We all need calcium that is why we have been told to drink

milk, like when you will small kid, your parents, your mom will keep on saying like a have milk at least maybe once a day or maybe possible twice a day.

So because that helps us to have good bone and we need milk as part, milk or something which has calcium, if you do not like milk you can have something many people takes calcium tablet as well. So but we need calcium for our good bone health, but what happens is, if we have cadmium that is happened not from electronic waste from other scenario, in Japan long back there was a industry which has effluent coming into a rice growing paddy field, like a paddy growing field.

As you know paddy means it has to be on the standing water, water is always there in the paddy field, so there they have this water getting this industrial effluent and the industrial effluent had high cadmium, so the rice paddy gets confused between calcium and cadmium. If you remember from your chemistry class from the middle school your teacher must have said that, anything which is closer on the periodic table they have similar properties.

If you go back and look at the while you are watching this video if you open your periodic table if you or you watch it look at the periodic table later on, you see the calcium and cadmium are very close to each other, so that means they have similar properties. So the paddy gets confused, the rice plants get confused between calcium and cadmium, it up takes cadmium thinking it is calcium and the same thing happens to our bodies.

So if it comes into the rice and from the rice if it comes to our body when we eat rice during our lunch or dinner, it is that is our body also gets confused between calcium and cadmium and we get cadmium getting deposited in our bones rather than calcium if you have the cadmium exposure and this cadmium getting into the bones makes it more brittle.

Actually it does it do the job which calcium is supposed to do, calcium is supposed to make the bones strong, but cadmium makes it brittle, what does it do? It leads to more breakage of bone. So if you had fallen down, you will have breakage of your bones in the body and that is what it is that is what the Itai-Itai disease is, like peoples bone is getting weaker, so that leads to what is talking about here the Itai-Itai disease.

So that is what which causes severe pain in the joints and spine, because that is what it should be our calcium should be there, but cadmium is making way. Chromium especially the hexavalent chromium, when we say hexavalent chromium I think we talked about that earlier as well, it is the chromium 6 that is what the hexavalent chromium is. Which are chromium

with oxidation state of six, so chromium with a oxidation state of 6 is the hexavalent chromium.

So that is a potential carcinogenic, it can pass through our skin and can get into our body and damages the kidney, so those things are there in terms of hexavalent chromium. The whole air in Broke a witch movie, the Hollywood movie of Julia Robert was actually based on hexavalent chromium contamination. Then Cobalt again if it affects liver, kidney, pancreas, heart as well as the skeleton and skeleton muscles and it produces tumours as well in animals, likely a human carcinogen.

Copper if too much copper can cause you nausea, vomiting, diarrhoea, kidney damage and health. Copper at a low-level is actually good for health as well we do even many of this chromium if you look at the daily supplement like multiple vitamins supplement that you get, many times multivitamin and multi-mineral supplement that you get you have traces of these as well.

It becomes a problem when you have too much, anything toxic which is above the base like a about the like a what can be some at trace level some of these are good for health as well, but it goes to a higher concentration it becomes a problem. Lead, we all talk about lead a lot in terms of electronic waste. Lead creates neural problem, it is a neurotoxin and that affects the kidneys the reproductive system as well.

High quantities can be fatal. It affects the mental development of kid. So if you remember, if you go to the next time you go to the petrol pump, either with your own car or if you are just going where whenever like going in whatever way, when you be add the petrol pump, look at that sign and it says unleaded petrol. What does that means that means? That means there was to be lead in petrol earlier, now it is no more lead is there.

Why we got rid of lead? Because lead is not good for us, lead is a neurotoxin, it does not it helps the brain development. And if you think about petrol, diesel the exhaust coming out it exhaust comes out at lower level, that is the level most of the kids, say if the kid is walking on the by-lane or the lane next to the road and all these smoke coming out from these vehicles, they are at much the kids are at much at basically they come at lower elevation where the kids nose are and the kids are getting these if they get exposed to this lead, that will affect them brain development.

And there has been studies done, where they had people have looked at the blood lead concentration and all and the teeth lead concentration and their behaviour, the kids behaviour in the class we saw, it has been documented that people who have more lead in their blood or in teeth actually they did not cannot concentrate in the classroom and people when we do not understand we say that he is a rowdy person he cannot but it is not actually it is because of the lead it is affecting his brain, he is not able to, he or she is not able to concentrate and if they are not able to concentrate off course they will create some nuisance in the class.

So that is it affects the neuro development, so that is why we are get try to get rid of lead in everything that we use, we do not want lead, we do not want us getting exposed to lead. So these are so that is why again lead is one of the biggest source of lead in environment is coming from this electronic waste. So we that is why the initial session on electronic waste in early say just late 90's and early 2000's when it started in Europe and in US, people were mostly things was came from lead.

Because we got lead in our petrol most of the world does not use lead anymore in the paints the paints that you the Asian paints and Dulux paints and all that. Some of the Indian paints still use lead unfortunately, the lead is not banned in India in terms of lead base in paint which it should be, because many of the world country has already banned, because you are you may get exposed to some lead is there as well. But that is in electronics again this because of the lead it got most of the attention initially and then there are other heavy metals present there and organics present there as well.

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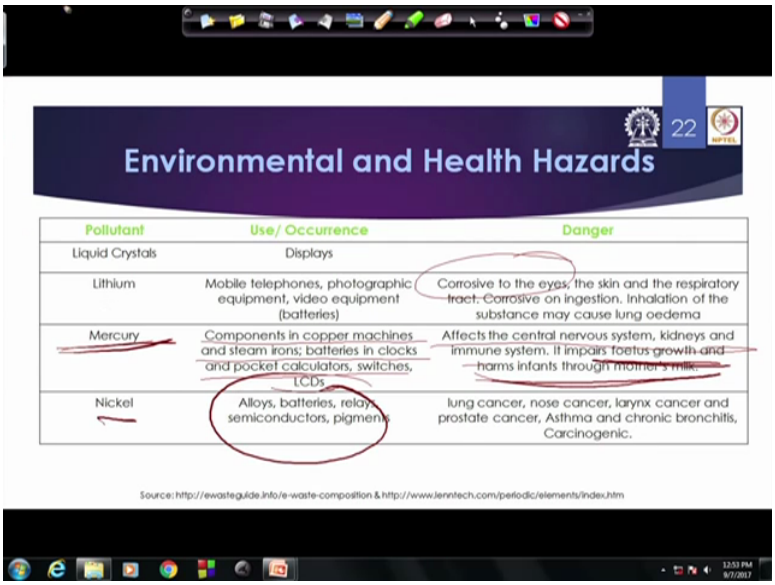

So another some more stuff in terms of the pollutants, we have liquid crystals, we have lithium, we have Mercury, Mercury another bad stuff. Mercury it is there, lithium is there, liquid crystals. Lithium is used in mobile telephone, photographic equipment's. Mercury it is there in copper machine, steam irons, batteries, clocks, pocket calculators, switches, LCDs, everywhere Mercury is there, that is another stuff we are trying to get rid of Mercury.

Nickel is there as well, so if you look at the dangers from them, lithium corrosive to eyes, skin and the respiratory systems. Affect the central nervous system, kidneys and immune system for Mercury, Mercury is a nasty stuff it affects the Mercury is one metal which can actually which stays in liquid, which stays in solid and can also get into the gaseous form, and in the gases from it can travel much faster.

So it is one of the dangerous elements which we are trying to get rid of Mercury in most of stuff. That is why in you may have as a kid you may have played with Mercury and as long as you do not it does not get into your body it is okay, but if you remember the Mercury thermometers, the thermometers that we used to use in our hospitals or in our house we used to buy earlier we used to have Mercury thermometer. Nowadays you get mostly digital thermometer, you do not have Mercury in them, we are trying to get rid of this thermometer as well, we do not want any like a people getting exposed to mercury.

So it affects the central nervous system, kidneys, impairs foetus growth. So that is why Mercury also has a chance to bio-accumulated, it goes bio-accumulated in fish. So some of the fish like Tuna fish and I am forgetting the name of other fish, there are certain categories of fish which is it is advised that pregnant women should not be that fish, because the Mercury has a tendency to accumulate in the flesh of those fish and that affects babies growth.

It also it can also if it is there it can also impact harm impacts through mother’s milk. That is why if Mercury gets into the body of mom and then it can go to the breast milk to the baby and then it will impact there nervous system development and all that. So then other thing is nickel, which is used in alloys, batteries, relays, semiconductors, it can cause lung cancer, nose cancer like a prostate cancer, asthma, chronic bronchitis, so it is essentially a carcinogenic. Nickel is a carcinogen which can cause cancer.

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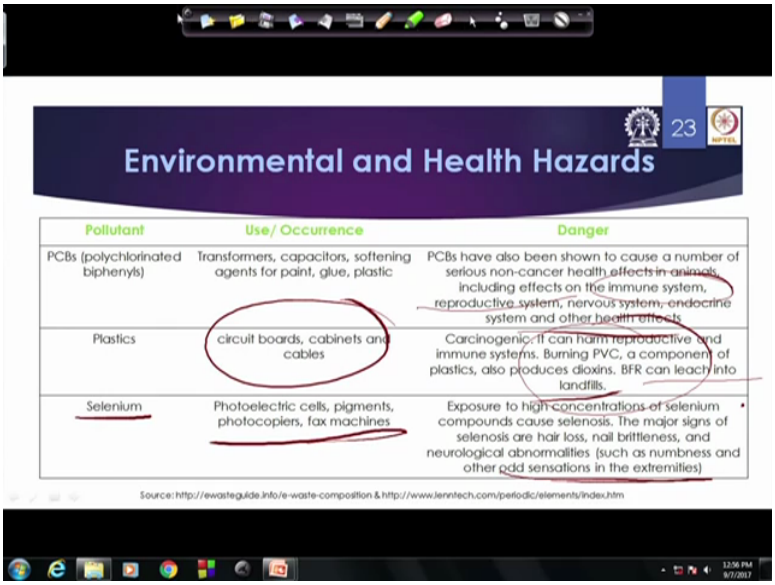

Then PCB's, now PCB's which is polychlorinated biphenyls, it used in Transformers, capacitors, softening agent for paints, glue and plastic. PCB's have been shown to cause a number of serious non-cancer health effects that effects in animals including effects on the immune system. It reduces your immune system, reproductive system, nervous system, and the crime system.

So plastics, circuit boards, cabinets, plastic we use a lot, carcinogen it can become it can harm reproductive system, immune system. Burning PVC releases dioxin, BFR can leach into landfills as well, so there is lot of issues associated with. Plastics are becoming a nuisance actually every once we have started using so much of plastics now, we cannot even think of life without plastic.

From the early morning when you when you take that brush in your hand that brush to do your toothbrush that is plastic, the toothbrush bristles are plastics and all the way when you go to home when you go to bed while going for sleeping most of the like you will throughout the day you we touch and use so much plastics. And plastic it is a nice material, it is very convenient material, but now after using it for last say two to two and half decade so that world is using a lots of plastics.

It is becoming a nuisance in terms of it is showing up in the oceans, it is showing up in our rivers. Just recently there was a study that it is even showing up in the groundwater, so think about that. Plastic getting into the groundwater that is then it is showing up in the tap water

and that is I do not know this is just initial study I hope we do not see so much of that, because plastics are not good.

Plastics are good outside our body, we do not want plastic inside our bodies because it is creates lot of problems. It is a carcinogen, it can harm reproductive system, it impair the immune system, burning plastics also releases lot of dioxin and furan disposal. Then selenium another stuff you can use in photoelectric cells, pigments, photocopiers, fax machine that is where selenium is used.

Again exposure to as you can see on the slide exposure here, exposure to high concentration of selenium causes selenosis, which is and major symptoms are you will have a hair loss, nails become brittle, neurological abnormality you start feeling numbness and ought sensation, so that is leads to problem from this.

So as you can see many of these stuff has some stuff sorry many of these have components that is used in electronics have some health impact and since we use them we are again electronics is something which everybody is fascinated about. So we do use lots of electronics, but at the same time we need to be careful in terms of the waste that is generated from electronics so that is managed properly.

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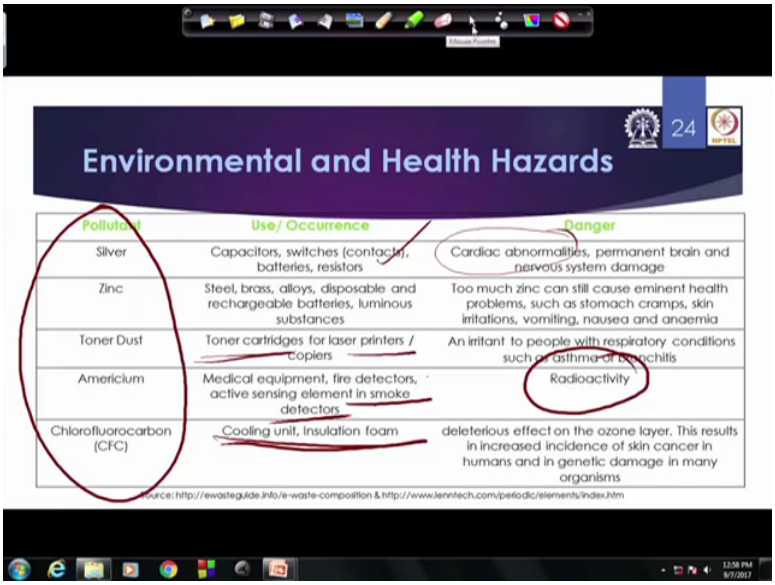

So another the last table in terms of pollutant, so let us look at that, silver, zinc, toner dust, Americium and CFCs. Those pollutants they are again, Silver used in capacitor switches. Zinc is used in steel, brass, alloys, disposable and rechargeable batteries. Toner dust, off course in toner cartridge, laser printers, copiers. Americium, which is a medical equipment,

fire detectors, active sensing elements in a smoke detectors, CFC off course cooling unit and insulating foam.

So in terms of Silver it causes cardiac abnormalities, permanent brain and nervous system damage. Zinc, too much zinc can cause imminent health problem, such as stomach cramps, skin irritation, vomiting, nausea, anaemia. Zinc is it is not that bad as some other elements it is harmful at higher concentration. Toner dust it leads us to respiratory problems, like asthma, bronchitis those kind of issues. Americium it is a radioactive element, so off course things needs to be managed properly.

CFCs we all know it is a it has a bad effect on the ozone layer, results in increasing incidents of skin cancer in humans, genetic damage in many organisms. CFCs we are trying to get rid of as well, in many of the electronics or electrical equipment we are not our goal is to get rid of CFCs. And that is what if you look at the International protocol on climate change and those global documents they are talking about like reduction in CFCs.

If you look at the CFC production over last few decades, you will see that there is a drastic reduction in CFC, we are using other materials out there. But in the waste stream still you will see CFC showing up. So that the last 4 tables were just to give you an idea about what are the different types of contaminants is there and what is the health effect related to those contaminants and where they are used.

Again this whole course like I keep on saying that again and again that whenever you read something of always think about why it is? What is the significant? So I think that now after looking at this four tables, you will appreciate that why this why in fact we worry about this electronic waste management, because of all these pollutants, different pollutants may have adverse impact if the waste is not managed properly.

If the waste is managed properly, be it is municipal solid waste or C and D waste or electronic waste, the level of pollutant maybe different, the type of pollutant maybe different, the concentration of pollutants maybe different, but from each of these waste stream and nature of the pollutant maybe different too. But for each of this waste stream if manages properly there are technologies out there to minimise the health impact, to minimise the environmental impact.

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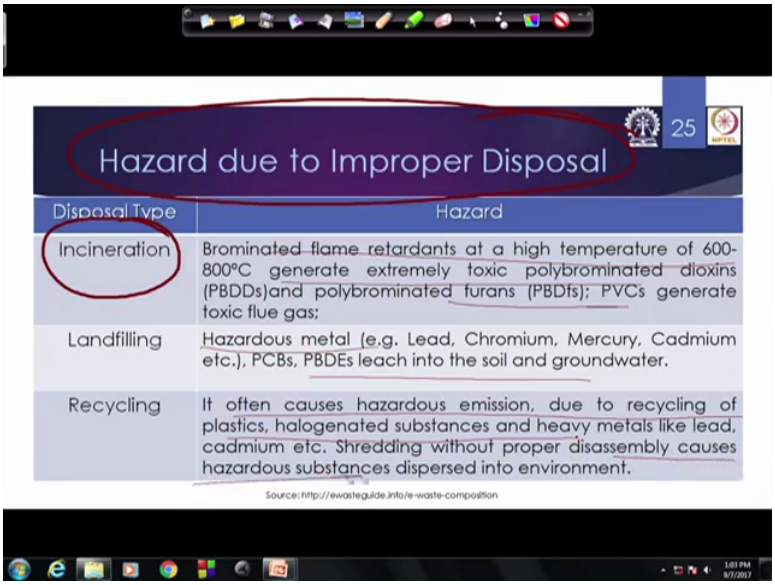

So if you do not do proper disposal, what is the problem here? Like if you look at the electronic waste, so in this table I am trying to we are trying to look at, what are the hazards due to improper disposal? What if the disposal is not proper? Just now I said that if disposal is properly we will not have the problem.

But as you know as I advise you to look at on YouTube, you can go and see how the e-waste is managed in India right now, unfortunately we the formal the sectors are being developed as I will show you the name of the some lots of companies are coming up, but unfortunately they are not running to their capacity. It is hardly many times they are not able to get the electronic waste of them.

The reason for that is people like you and me, we expects some money from those electronic waste. We want that if I give an old cell phone to the to the kabadiwalas I will get maybe 200 or 300 rupees, but those kabadiwalas will give you those that 200 and 300 rupees because they do not have to set up a nice plant, they do not have to manage follow the rules of SPCB and Central pollution control board, they are not audited, there is no staff, they will just send it they will give it to those people who are just after gold and other stuff and they will recover some of the material from there and but in the process they contaminate all the air, soil and water.

But we are getting those 200 but maybe later on we are spending 2000 in the hospitals because of getting that 200 at first place because of the all that pollution that is created because of it, but these companies they are setting up their plants, they are investing money.

So they do not have they cannot give you those 200-300 rupees for those mobile phones, because they already have spent in invested lot of money. If they gave you 200-300 and they have they have all the sophisticated tools to extract different material they have to follow, if they do it properly, they do it ethically, they should follow all these SPCB, CPCB guideline, the new e-waste management rules they will not be able to make any profit they may go out of business.

Maybe after 10 years when they have grown up, because initial investment has been they had made some money, then maybe possible. But any country you go to in fact if you are in European union especially the Western European countries or in Canada not in US yet but if you are in Canada or in Western European countries, when you buy a laptop you actually pay around 30 dollars 35 dollars extra as the waste disposal fee.

And here when I am going giving away my old laptop I expect that I will get some money back from them, so that is the difference and that is why the company is there in Canada they can or in Germany or Denmark and other places, they have a very good e-waste management system in place, because the companies are getting money to do that, government is giving some money for them to get those companies working.

Unfortunately in Indian scenario we always look things in a very suspicion and the industry is responsible for that attitude that common people has. Every time we look at industries that probably (kuch toh gadbad hai idhar) that is may-may not be there, but that has our attitude. But coming to here if you do not do the proper disposal, what is the impact of improper disposal?

If you go for incineration, incineration which we talked about earlier as like if you do a incineration which is happens like when they burn this electronics improperly, you have brominated flame retardants getting released, generates extremely toxic dioxins and furans. PVCs generates toxic flue gases that is what you see. Landfilling will have hazardous metals showing up there.

Recycling, it can cause especially due to recycling of plastic, halogenated or when they do it improperly. If you have a nice e-waste recycling plant, where you have a proper control of all the emissions, you have the control treatment systems out there, then these releases will not be there, but if you the way this recycled right now it leads to hazardous emission of halogenated substance, heavy metals. Shredding without proper disassembly causes

hazardous substance disappearing into the environment so all disperse into the environment, so all those things are shows up.

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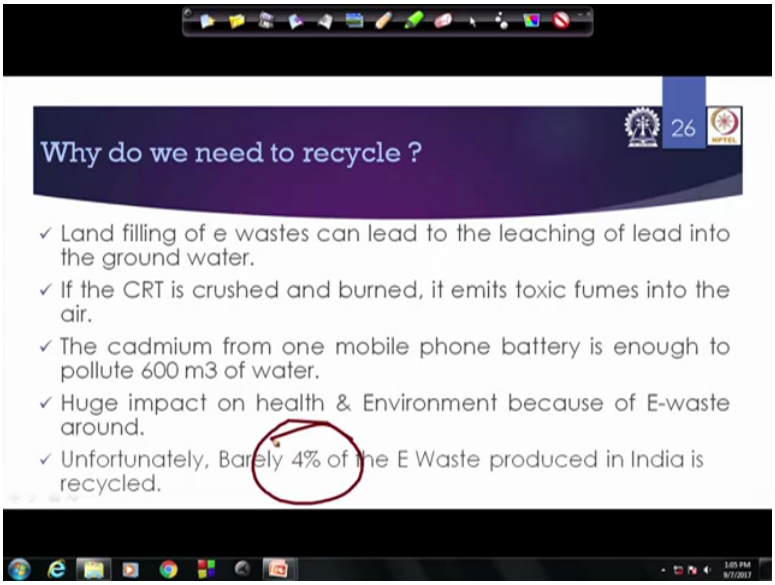

So that is leads to that we need to focus on proper recycling and we need to recycle it in a landfilling of e-waste, leads to leeching of lead into groundwater, could potentially leach. If the CRT is crushed and burned, it emits toxic fumes you can catch those toxic fumes, but you need to have the proper air pollution control. Cadmium from one mobile phone battery is enough to pollute 600 meter cube of water, can you think about that?

One mobile phone battery if it goes into the water that consumes 600 meter cube, one meter cube is 1000 litres, so 600 times 1000 litres, so almost so that much water it can be can be polluted, polluted means the concentration will be higher than the drinking water limit for cadmium, huge impact on health and environment because of e-waste around.

Unfortunately, barely 4 percent of e-waste produced in India is recycled and we are talking about proper recycling which is not the improper recycling. Only 4 percent of e-waste produced in India is recycled and that data is maybe around a year or year and half old, so not too much old, so we need to do much better. So in the next video will try to talk about how to go in a better scenario.

So in this video we talked about, what are the different contaminants, where how they are used, why they are used in electronics and electronics and electrical equipment and what are there adverse health impacts and we talked why this course is actually why this topic even should be studied, so we talked about those aspects. So in the end the need for recycle, need

for formal recycle, not informal recycling. And informal recycling is done in a very crude way which creates lot of environmental problem.

So next we will talk more in detail about okay what are the recycling in terms of in Indian scenario, what are how things are being done at present. So with that let us close this video, again I will remind you that we have posted one question here to get your feedback on how e-waste is managed in your area, how you are managing your e-waste say for last few years and do you see any improvement in last few years.

So we had put some very general, very small questions hardly it will not take you more than 10 minutes to answer those, please do that and all of you please do that so that we can share, collide all that information and share with all of you in the last video of this course and we will do that for electronic waste as well as in earlier form that you that we send you for municipal solid waste. So thank you and again see you in the next video.