METALLURGICAL AND ELECTRONIC WASTE RECYCLING

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Week-1

Lecture-2

Greetings, I welcome you to the second lecture of this course where we will be discussing about classification of metallurgical and electronic wastes. So, in the previous lecture we had gone through some of the basic introductions as to why metallurgical waste is metallurgical and electronic waste need to be recycled. What are the various aspects of recycling and how normally people would like to invest when they are involved in materials recycling and what are the advantages of developing a good recycling process.

So, in today's class we will be thinking on the lines of classifying metallurgical and electronic wastes. So, this part and the next lecture, these are going to get be connected in the sense that we'll think on recycling, classifying metallurgical waste and electronic waste. So, this class will be focused on electronic waste and the next one will be on metallurgical wastes. So, again the main question still remains, why even classify wastes? So, previously we had thought of looking at municipality solid wastes.

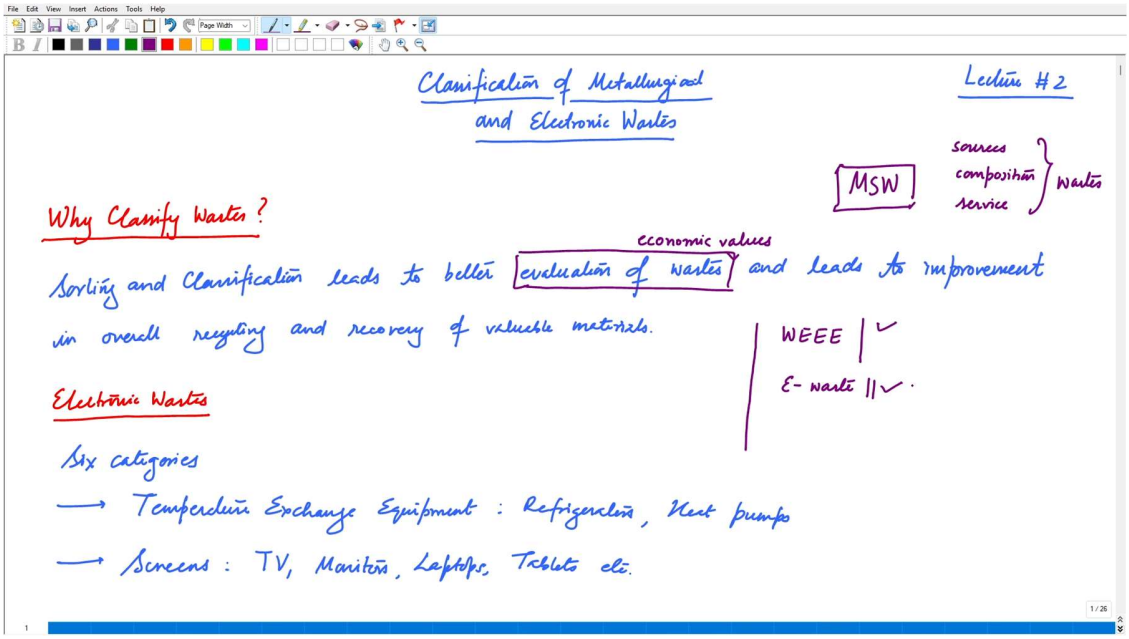
So when we think of MSW, it can comprise of large segments of various wastes that can originate from different sources. So the sources are the defining parameter as to what type of waste it is and then the composition. So one has to really think on what is it really made of and of course the service that the commodity has done during its lifetime and what are the changes that it experiences during the service. These are important aspects when we think of wastes. So these are important aspects.

Now, when we have a stream of MSW or any other different type of waste, we would now think of how to categorize it so that when we do the characterization, we characterize this waste stream, we are at least able to identify what is valuable in this waste stream. So, why classify wastes? Sorting and classification leads to better evaluation of wastes And leads to improvement in overall recycling and recovery of valuable materials. Again, evaluation of wastes.

When we think of evaluation of wastes, we will try to put some economic values. And then when we know that a given waste stream has, let's say, X gram of gold or Y gram of silver or any other valuable material, then we can think of devising a method or a recycling route that can help us target those valuable materials. So, the overall recycling and recovery of materials, valuable materials is also improved when we have good classification of materials. Now the next part that we should be focusing on is what are different categories of wastes. So since we are doing this course on metallurgical and electronic waste we will be looking at the classification of electronic wastes.

At this point, we would also note that there are various terminologies for electronic and metallurgical wastes. Waste, electrical and electronic equipment, that could be termed as WEEE. This term could be found in various research articles and the books that are focusing on electronic wastes. And of course, electronic wastes or some people call it e-waste is another terminology that helps us describe the end of life electronic and electrical devices. Of course, people have deliberated and coined these terms based on the common understanding.

Now, we will be calling electronic wastes as e-waste in the upcoming lectures. So, e-waste has six different categories. Temperature exchange equipment, first one. The first one is temperature exchange equipment. What do we mean by that? **(Ref. 5:42)**



We mean the regulating equipment, environment regulating equipment. So, for instance, we have refrigerators, we have heat pumps, air conditioners. So, these equipment are basically categorized in temperature regulating equipment, temperature exchange equipment. Screens. So, the screens that we have all around us, televisions, monitors, laptops, tablets, all of these screens, even digital watches that we have, all of these containing screens can be categorized in the second segment.

Third one, lamps. So, all types of lamps that we have around us that we use, say for instance we have LEDs, high intensity discharge lamps, we have tube lights, we have CFLs, we have different categories of lamps altogether. So, all of these lamps when they have reached their end of life will be categorized in the third part. Large equipment. So, the household equipment that we have is these can be like washing machines, stoves, we can have electric dishwashers.

These commodities are relatively larger in size and they are generally used by a wide majority of human society. And so, they are categorized as large equipment. Similarly, there are smaller equipments. So, smaller equipments could be vacuum cleaners, toasters, we have mixer grinders and food processing equipment. These type of equipment can be categorized as smaller equipments that are generally used in our households.

So, the last category of equipments that we should be looking at is the telecommunication equipment wherein mobiles, PCs and other devices that we generally see around us, these are basically put in the last category. So, we can have mobiles and PCs and to some extent people might want to categorize tablets and laptops in these segment as well. So, now we look at various devices and how we would like to classify them. There are some other wastes that are very crucial, which may not fit in these conventional categories. So, these could be categorized as other wastes.

So, for instance, we can have spent batteries. We can also have photovoltaic modules, end-of-life EOL PVMs, photovoltaic modules. And similarly we can also have let's say complex electronic devices which could be used in industries. Now, of course, these devices are not generally visible in our common day-to-day lives, but these are also being generated and recycling these wastes is very crucial because they may contain hazardous materials or materials of our importance. Now, what are the hazardous substances in e-waste?

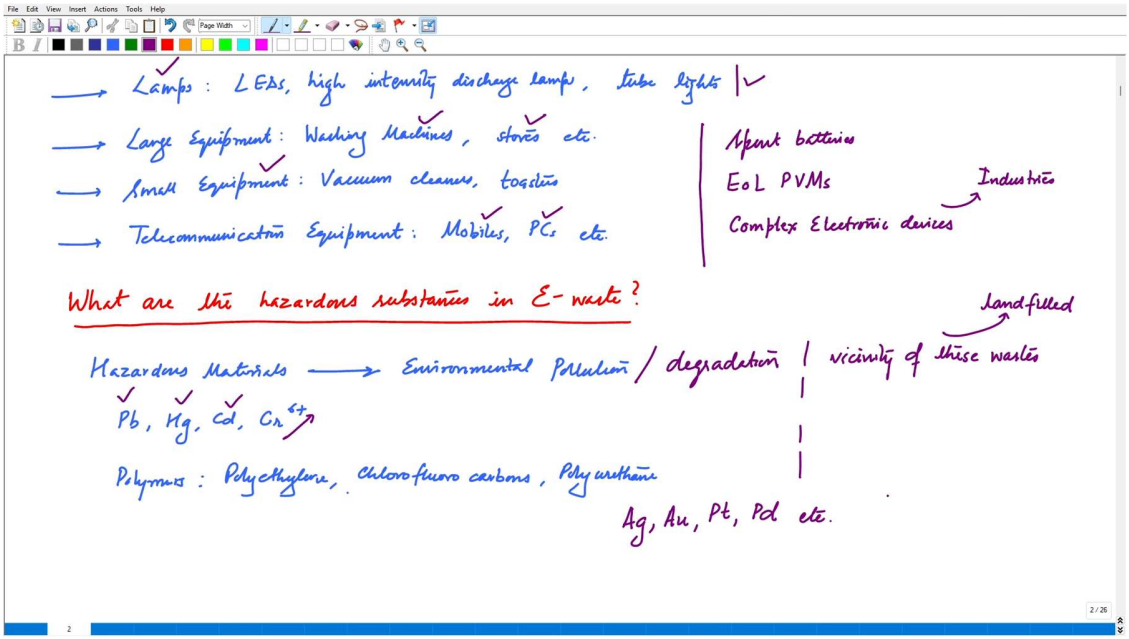
When we think of hazardous materials, the first thing that should actually come to mind is why are they hazardous at all? So, they actually lead to the pollution, environmental

pollution, environmental degradation and harm the vicinity of these wastes. And of course, we are right now assuming that these wastes are being landfilled. So, for instance, if these wastes had been categorically recycled and the valuable materials and hazardous materials are taken care of, then the vicinity of these wastes would not be as hazardous or as polluted as, let us say, in the present scenario. So, for instance, we can have Pb, Hg, Cd, Cr^{6+}.

So, these types of metals and metal ions are present in electronic wastes, e-waste. And these can be present in different concentrations in different categories of materials. Similarly, we can have polymers like polyethylene, CFCs, polyurethane and many more. So, and I have just jotted down some of these waste materials that are present and these can be hazardous to the environment. And of course, since we all are right now talking of hazardous materials, the presence of important valuable materials is also crucial.

So, for instance, if you think of So, if you think of silver, gold, platinum, palladium, these types of metals are also present, although these metals are present in relatively smaller fraction. So, it is fair to assume that our electronic waste that we generate in large quantities have valuable materials as well as hazardous materials. How we deal with these metals and materials is totally going it is going to define how we are supporting the environment by or are we just letting these wastes pollute the environment.

Therefore, developing good recycling route is very important. **(Ref. 13:40)**



So, we can have one more question as to why indeed are categorizing wastes. So, the third question could be why categorize wastes? Now, we already know that by classification and sorting and categorizing waste, say for instance in this case we had six categories. We can clearly define the fate of a given waste stream and fixate the fate of that particular waste.

Say for instance if we have, if we begin with let's say laptops and mobile phones. So, we can we know that in these waste streams we can have printed circuit boards, PCBs which are rich in numerous metals. This we will be discussing in the upcoming lectures but just for the starters I am trying to describe. So if we have laptops and mobiles we will have PCBs, printed circuit boards in them which are rich in valuable metals. So we would like to target some important metals like copper or aluminium or nickel and so on and so forth.

Since we know that these materials have these metals, we can think of targeting the recovery of these metals. Now, this is possible only when we categorize these wastes and classify these wastes and we have proper characterization data with us. That for let us say a standard PCB will have such and such concentration of copper, aluminium and nickel. So, we can have let us say 30% metal and so and so forth. But what happens if we do not categorize the wastes?

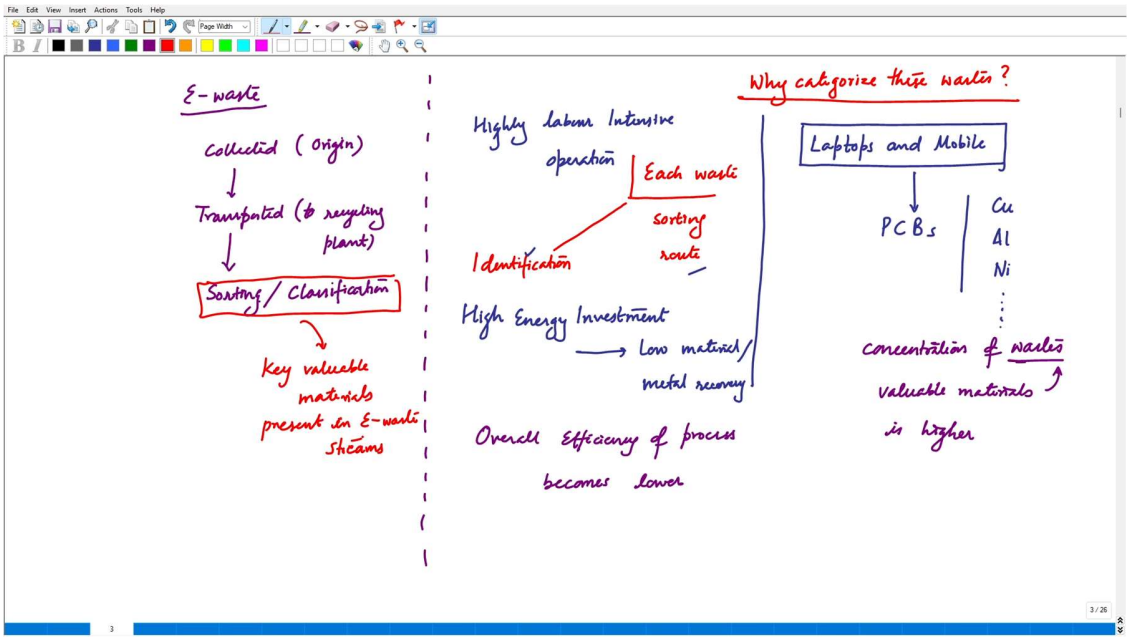
So, let us take a counter example. So, assuming that we do not have a good classification of wastes and we are just looking at a conveyor belt that is bringing us all sorts of electronic wastes. Now, it becomes highly difficult to categorize highly labor intensive operation, highly labor-intensive operation which means now that we do not know what we are dealing with we'll have to look at each category, each waste and then device a sorting mechanism sorting route so this will depend upon how we are able to identify. So again this part is basically identification.

This also is important in the sense that one has to think of employing energy. Of course all of these activities are going to say for instance sorting and identification. These are going to take lots of energy investment. High energy investment and what exactly are we really targeting? We are really not sure because we did not categorize and classify and sort.

So, the output could be low material/metal recovery. Since we are simultaneously categorizing and sorting the chances of recovering something valuable gets reduced and also because we know that this is a process that should be done at the beginning itself

categorization, sorting and classification should be done at the beginning itself if we try and do it at the end the overall efficiency of process becomes lower because when we think of categorizing wastes beforehand the concentration of wastes concentration of waste and of course the valuable materials in it inside these wastes is relatively higher but that may not be possible when we are trying to do it afterwards so when we have the whole conveyor belt of e-waste coming to us and we are trying to sort it

and simultaneously you process it, it becomes very difficult and the overall efficiency of the process may go down. So, in this part we have learned why we need to classify things, classify the wastes, what are the principles on the basis of which electronic wastes are classified and how can we improve the overall efficiency. So, to give a brief of what we have done to this point we will just see that e-waste would be collected and of course this could be at origin. Transported. **(Ref. 21:00)**



This could be done by in a different location to recycling plant and then we can have the sorting and classification sorting/classification. This helps us identify what are the key materials key valuable materials present in E-waste stream. In the next lecture, we will be discussing on the categorization of metallurgical wastes. Thank you.