

METALLURGICAL AND ELECTRONIC WASTE RECYCLING

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Week-1

Lecture-1

So, I welcome you once again to this course on Metallurgical and Electronic Waste Recycling. When we think of metallurgical waste recycling, the most important part should be understanding the waste streams. Materials recycling encompasses the understanding of materials and then bringing the ideas to characterize the waste stream, understand what is valuable in it and then try to extract something that is meaningful and economical and valuable to human beings. That having said that, the most important part of materials recycling is understanding the waste stream.

So, when we think of materials recycling understanding the waste streams. So The waste streams could be generating from lot many different sources. So, it is also important to focus on what source? Source of waste.

What was the source of waste? When we think of source of waste, we will also see what happened to it before it became a waste. So, it should be, the next point should be Service of material. Under what circumstances was our product functioning and what really happened during the service period so that it actually reached the end of life.

End of life state. When it was in this service state and what happened to it and how it has reached its end-of-life state. So, when we understand this stream of our waste, we would be now focusing on what we can do with these wastes. Now since this course is essentially focusing on metallurgical and electronic wastes, we'd like to delve into deep, deep into those streams. We'd like to again question one of the most important parts that why really are we interested in recycling wastes.

Now when we think of answering this question, the reason solely is coming into the hazardous nature of this waste. What are the adverse impacts that these wastes create on our natural environment, on our living environment, on the flora and fauna? These questions basically drive the recyclers to focus on various waste streams that are originating from different sources.

So, when we think of answering questions like why recycle? So, the first thing could be well we want to bring back the materials back into the material cycle, reintroduction of material into its cycle so that we can reuse it. That is one good answer, but adding on to that there are various materials that can have hazardous impact on the environment. So, when we think of hazardous impact, it could be on land resources, it could be on water resources. And this collectively is going to pollute the environment.

So when we are thinking of discarding any waste, what does ultimately happen to such waste when it is getting collected and stacked as a municipality solid waste or any other different other category of waste? What really happens to it is the question. While most of the wastes now are getting sorted into different categories, there is a big possibility that the waste that we dump will be ending up in various landfills or oceans, when it is getting ending up, when it is getting collected in a landfill or getting discarded into the oceans, the biggest possibility would be that it is going to pollute the land or water resource.

To avoid such harm to the environment, it is essential to re-channelize, to reconstruct to redefine the material processing and appreciating that the wastes are not essentially waste. Wastes could be visualized as valuable resources. So, one has to characterize these materials. The waste streams have to be characterized to understand what exactly can be efficiently extracted and what can be efficiently marketed so that the whole recycling process becomes economical, not just on a laboratory scale, we could go on an industrial scale as well. So, first when we now understand the motivation behind developing a recycling route, we would like to also understand what are different aspects of recycling. So, the first question that we should be focusing on is what are the five R's? One, refuse, reduce, reuse, repurpose and fifth one, recycle.

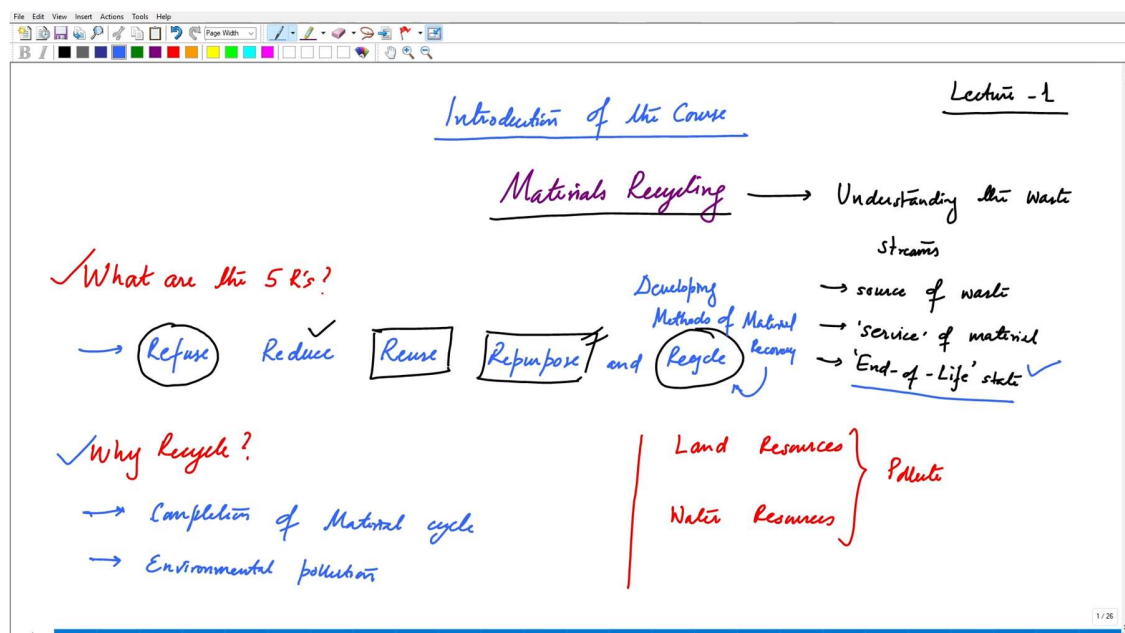
Refusing. When we think of refusing, it means stopping a particular commodity or stopping its use at our end. Of course, this has to be done normally at the individual interaction and it totally depends upon whether we as individuals are able to do it or not. The second one would be reducing

So, if we know that a particular type of material is going to end up a lot more because we are continuously using it, then we can think of reducing our application of such materials. So, that we can simultaneously reduce the waste generation. Reusing. So, when we think of reusing, it is basically reducing. trying and reusing a given material as many times as is possible so that the function of the given commodity is achieved so that we can reutilize that particular commodity as many times as we can without losing its functionality.

And the last, the next one would be repurposing. Repurposing is basically when we have seen some damage or some wear and tear on a given commodity and we think that maybe the given application of a given product is not fulfilled. Maybe we would like to reuse a given material too. some other application maybe we can divide some other application for a given material that is basically repurposing and then finally recycling it now recycling it would be the ultimate the final call that we can take that okay a given commodity has reached its end of life as we had previously described we were thinking of end of life state So when we know that a commodity has reached its end of life, for instance, it could be a broken cell phone or a broken computer, broken monitors, spent batteries or industrial wastes.

Originating from different industries, let's say metallurgical industries or chemical industries. So when commodity has reached its end of life, we are now thinking of recycling it. Recycling it, bringing back the components to its original state. So, we will have different types of materials, let us say metals, composites, ceramics and different other types of materials. So, these types of materials have to be brought to their initial states and then refurbished in such a way that they are brought back into the materials utilization cycle, the whole material cycle, it is getting reintroduced there.

So, one has to think of devising, developing methods of material recovery when we think of recycling. The next question in line was why recycle? So, we have already understood that the motivation of developing any materials recycling process is to first bring back the material into its original cycle and second because it may cause environmental pollution, the material itself could be hazardous. So, it is absolutely essential for recycling any recycler to think of a good recycling route to develop a recycling process. (Ref. 11:48)



Now what could be the barriers of recycling? When we think of barriers to recycling we should be thinking of methods that the steps that hinder the recycling process and then of course we should be developing some methods by which we can overcome the barriers so at the same time we would also think of overcoming collection sorting and storage facilities now most of the waste that we see around us have to be collected stored and sorted such a facility is very difficult to muster normally because the types and categories of waste that are generated by human society is very large. These can range from industrial wastes to metallurgical wastes to electronic wastes to municipality solid wastes to hospital wastes.

So, the collection of wastes and sorting. Sorting would be looking at a huge waste stream and fragmenting these waste streams according to their origin. So, it could be based on origin of waste, it could be based on materials or it could be based on economic value. What exactly are we thinking of when we are developing a sorting strategy?

That is very important. So, normally it is advisable that we choose a particular type of sorting mechanism so that the wastes that we are generating can be treated in a befitting manner. And of course, the storage facilities. When we think of storage facilities, it is very difficult to develop a storage facility that is free from any hazardous impacts. So, what normally it means is when we think of a material that can lead to the inclusion of heavy metals and plastic waste and hazardous metals into the land resources due to leaching and the pollution of the flora and fauna that is surrounding the landfills. It becomes very difficult and challenging to develop a storage facility specifically designed for such wastes. What are the malpractices followed during recycling? So, what normally happens is when we think of let's say waste electronic and electrical equipment that is WEEE. When we think of WEEE, now people have developed various recycling techniques that may not be following the norms, the conventional norms of practices. Now, such malpractices are followed by unorganized recyclers. This can help in recovering some materials but that can also lead to some environmental pollution. So, it also is a barrier to conventional recycling routes.

Heterogeneous nature of waste streams. So, this again is just coming back to this point that collection, sorting and storage facilities and heterogeneity of waste streams that we see these are again interrelated and one has to really think of devising good methods by which we can collect and sort different waste streams based on their characteristics. So here comes one important aspect that it becomes essential to think of characterization.

The characterization of wastes and when we think of characterization of wastes, One can develop a route of sorting just based on characterization of the waste streams. Normally, in the recent years, people have installed various cameras and x-ray facilities and infrared cameras and facilities to characterize the wastes so that the sorting of the wastes is done at the entry level itself. So, this will do benefit in many ways so that basically increasing the concentration of the material and this helps us in understanding that the net worth of a given waste could be improved just by devising a good sorting mechanism we can increase the concentration of a given waste and then devise a process that is following it so a pretreatment route followed by a processing route followed by refining route all of these steps can be developed after we have a very good and concrete sorting mechanism. Health and safety of recyclers. So, people who are engaged in recycling of various waste streams, it is absolutely essential to think of their health and safety because they can get exposed to a wide variety of hazardous materials and this can have adverse effect on their health. So, developing a good mechanism, a good overall route for recycling is absolutely essential to develop a good and safe, good and safe healthy environment, healthy environment for the recyclers.

Location and logistics. Now, the generation of a waste is generation of a waste stream and its collection and its recycling. These all three steps could be done in a different location. So, we can have generation of waste let's say at city X. This could be collected in the same city.

But then some the collection of this could be also done at various other state, other cities. So, we can have different other locations for collection. But the recycling facility could be in a different city altogether. So, it is essential to think of location and logistics. How much

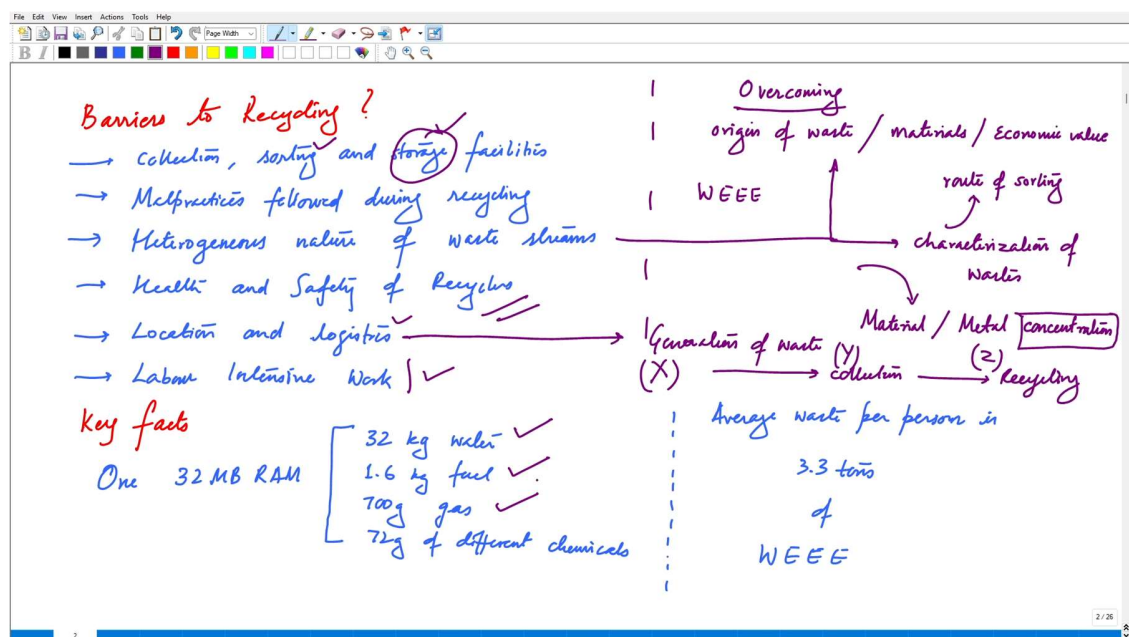
difficult it is to generate a facility that is taking care of waste generation, its collection and again the sorting as well as taking it to the recycling facility. So, assuming that if we have a dedicated industry or dedicated facility that is taking care of let us say plastic waste. If a mechanism of collecting all of these wastes and transporting these wastes to the facility is there, then this problem could be taken care of. Normally, it is very difficult to have a dedicated logistic facility for such application. Now, recycling is also labor intensive work.

Because not just it is that we are trying to employ some advanced technologies to help us sort and collect the waste. It is the hard work of labours and personnel who collect the

waste and bring it to the recycling facilities. So, one has to devise some route of covering up these barriers. Now, we will just look at some key facts that are really very interesting when we think of metallurgical and electronic wastes and when we think of devising some recycling routes. 132 MB RAM can use

32 grams of water, 1.6 gram of fuel, 700 grams of gas and 72 different chemicals for its manufacturing. And it so happens that this waste is getting land filled. So what we are actually doing is we are wasting resources just by wasting our finished product. We must understand that all of the electronic devices that we make consume resources and this is just an example.

It is important to device recycling routes so that the recovery of material is possible and we don't invest more resources in making such electronic or metallurgical commodities. (Ref. 23:59)



On the other hand, if you look at the average waste per person, of course, this value is given for a whole lifetime. The average waste per person is 3.3 tons and this waste is basically of WEEE, waste electrical and electronic equipment. So,

with these facts we must appreciate the fact that developing a good recycling route for any given waste stream becomes essential and when we think of developing a good

recycling route, it should be done in harmony with the environment and also since it has to be done on a larger scale, so industries and industrial economics also comes into play.