METALLURGICAL AND ELECTRONIC WASTE RECYCLING

Dr. Arunabh Meshram

Department of Materials Science and Engineering

Indian Institute of Technology Kanpur

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Lecture-19

Greetings, I welcome you all to this new lecture and in the previous lectures we have been focusing on metallurgical wastes from various industries and particularly we have been focusing on copper wastes. We are going to look at another aspect of waste that are dealt with for recycling copper. One of the most important aspects of copper recycling is basically recovering it from scraps. We have already seen a valuable material recovery from smelters slags, from raffinates, from electrolyte solution and now it is time to focus on a source that is readily available for recycling. Now, when we think of scraps, generally speaking, scraps can be generated in the industry itself. When we are producing a valuable material, finished product that is, there is a possibility that a big part of the initial feed that we are getting can end up as the scrap but this scrap is indigenous scrap, the scrap that is generated within the industry and it is reutilized within the industry.

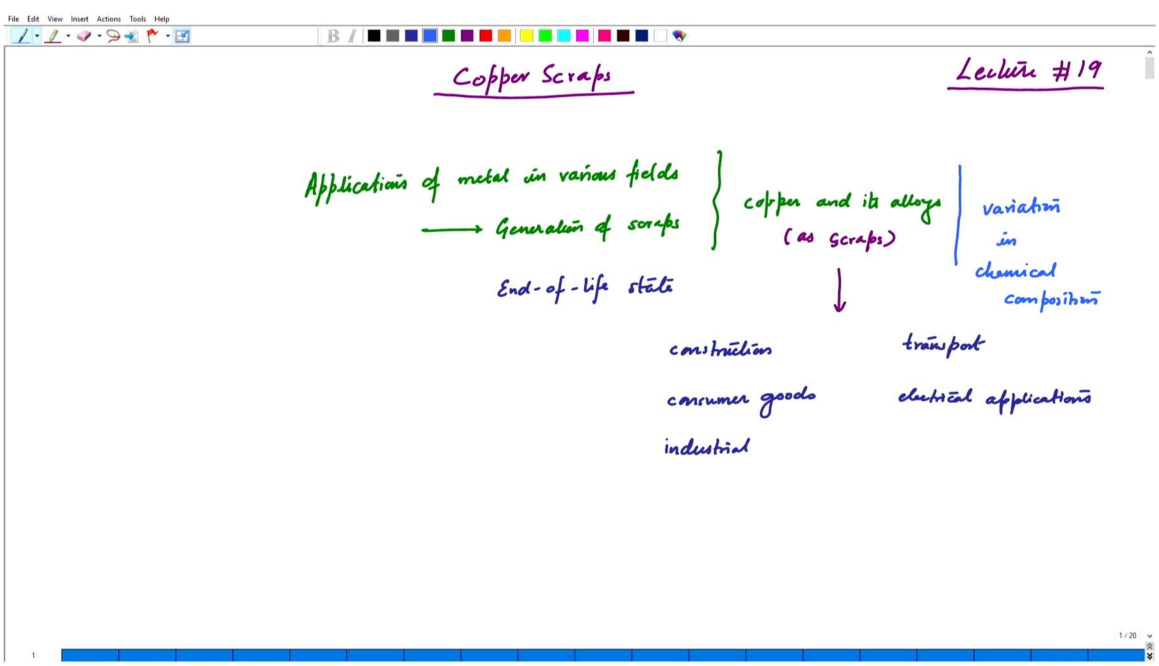
Essentially the scrap that never reaches the public is already getting recycled within the industry normally it happens. It is also possible that after the production of a given good, we are seeing sheets or blooms or billets, so when these types of finished goods are produced and they are applied in various areas, various applications, these reach their end of life after the completion of their service period. Then these materials, these products, these goods are reverted back as scraps. These scraps are generally called as old scraps because they have been produced only after the service period.

Before it reaches its application, it is called new scrap. New scrap is already being recycled within the industry. But old scraps are those scraps that are produced after the use of a given commodity. Sheet metal product or blooms or billets or whichever end finished product is that we are talking of. Depending on various types of applications, large types of scraps can be produced.

Let us look at them. The applications of metal in various fields lead to generation of scraps. It is just application oriented scraps so we can have copper and its alloys. These are the raw feed that we are expecting as scraps. What are the general areas of applications? We have already seen this, but just for a quick recap we have construction or building applications, we have consumer goods, they have industrial applications, there is the transport and the most important electrical applications. When we think of scraps, these are the common areas from which we are expecting, these are the common applications from which we are expecting scraps. And just as we had discussed previously when we were discussing pre-treatment and pre-processing of wastes, It is absolutely essential to sort the scraps. Scraps could be of any chemical composition.

It is also possible that scraps of various different types of metals are getting fused together. They are getting just collected together and they are ending up for recycling. It is absolutely essential to categorize the scraps, sorting of scraps, understanding the chemical composition is very important. It helps in determining whether a given scrap is directly usable or it has to be further processed because it is fairly possible that a given scrap can pick up contamination during its service.

When we are thinking of scraps, It has reached its end-of-life state. It is fair to assume that these products are basically having variation in chemical composition. The most common method of dealing with scraps is trying to bring it back to the original route of metal production. The most common place where scraps can be directly used is in a melting-remelting stage or if chemical composition needs to be altered then in a smelter stage. **(Ref. 7:15)**



If further chemical treatment is required then some pretreatment can be done on the scrap feed provided it is sorted and then it can be brought back for the melting remelting. The recycling route itself is pretty much fixed. How we deal with it beforehand is what we are really trying to focus. Let us now look at scrap remelting.

How can we normally go about with this? We can have mining... mining of ores and then we have pre-processing, we have smelting, converting, we have fire refining for that we have electrorefining again we can have smelting form casting, then we can have finely finished goods. This is the basic outline of the flow sheet.

Where can we have different types of scraps? Normally, if we see that we have 3 or 4 basic categories of copper scraps, we can have low grade scraps. Then we can have relatively higher grade scraps. So, low grade scraps can be anything for 10 to 88 percent copper. Then we can have medium grade or scrap number two LSG and medium grade is scrap number two so it can be it can have around 88 to 99 copper and then high purity scrap so we can have high grade so it can have above 99 percent. And there are the alloy scraps. If alloy scraps and high-grade scraps, 99% purity that contain only copper and the rest is just some other alloying element or trace elements. Such scraps can directly be subjected to remelting at the final stage before they are reintroduced into the metal stream. Normally, what happens is such high purity scraps are generated within the industry and they are directly reused. The other scraps, low-grade scraps and the scrap grade 2 which is medium grade scrap 88 to 99 percent copper scrap is basically brought in at different stages. Let us look where these scraps are used.

Low grade scraps are brought in at smelter stage. And it follows through the smelting, converting and fire refining stage. At fire refining, you can also introduce 88 to 99% copper. And finally, if you have high grade and alloy scraps, again, alloy scraps first has to be identified which type of alloy scrap are we looking at? If the composition of the scrap is completely matching or almost matching to the alloy that is being produced.

Under such circumstances, it can be directly reused at smelting form casting stage. With this we understand that the method of dealing with scraps is already fixed.

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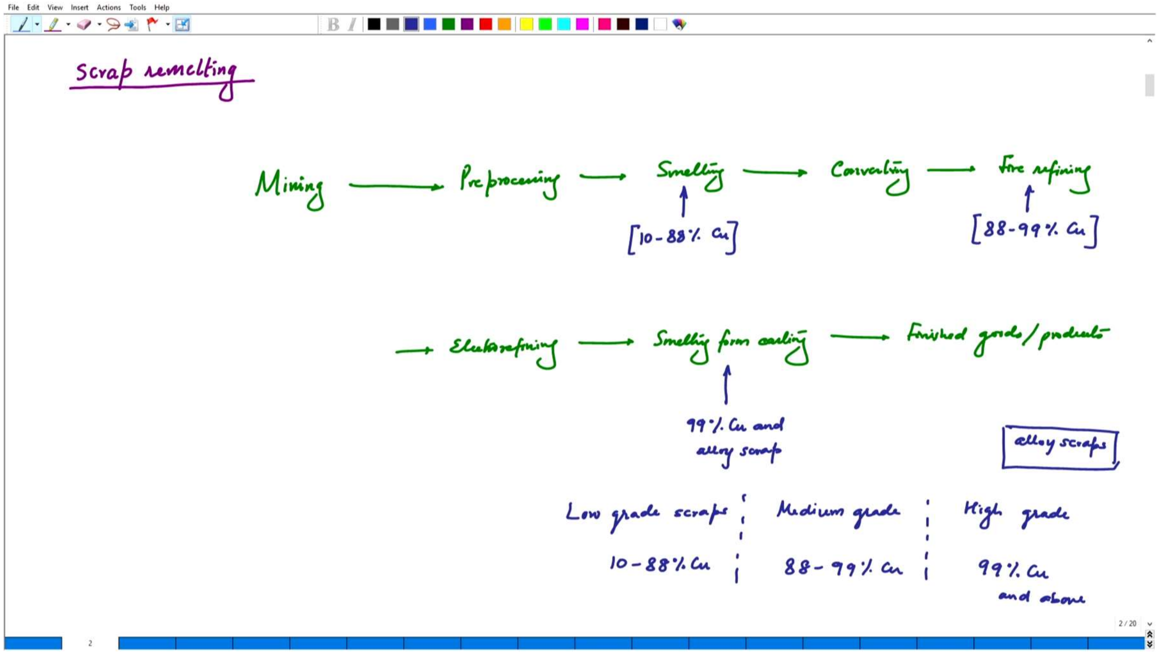

We have to bring it back to the original route of copper production and we will have to see where exactly the copper will be introduced, copper scrap will be introduced and how it will be brought back into the material cycle. The most important aspect of dealing with scraps is basically sorting of scraps.

One of the methods by which we normally sort scraps is by understanding the chemical composition. When we are thinking of chemical composition of end-of-life scraps, the methods that are available are XRF and LIBS which are commonly used. So, XRF is basically X-ray fluorescence, the sorting of alloys and its categories based on basically qualitative and quantitative analysis. LIBS is basically laser induced breakdown spectroscopy.

This is also giving us elemental analysis and the disadvantage of this process is like basically it is sensitive to contamination. If some element can contaminate this process, then LIBS method of understanding the chemical composition may not be very fruitful. XRF and LIBS both are being used with conveyor belt system and some of these systems are also handheld.

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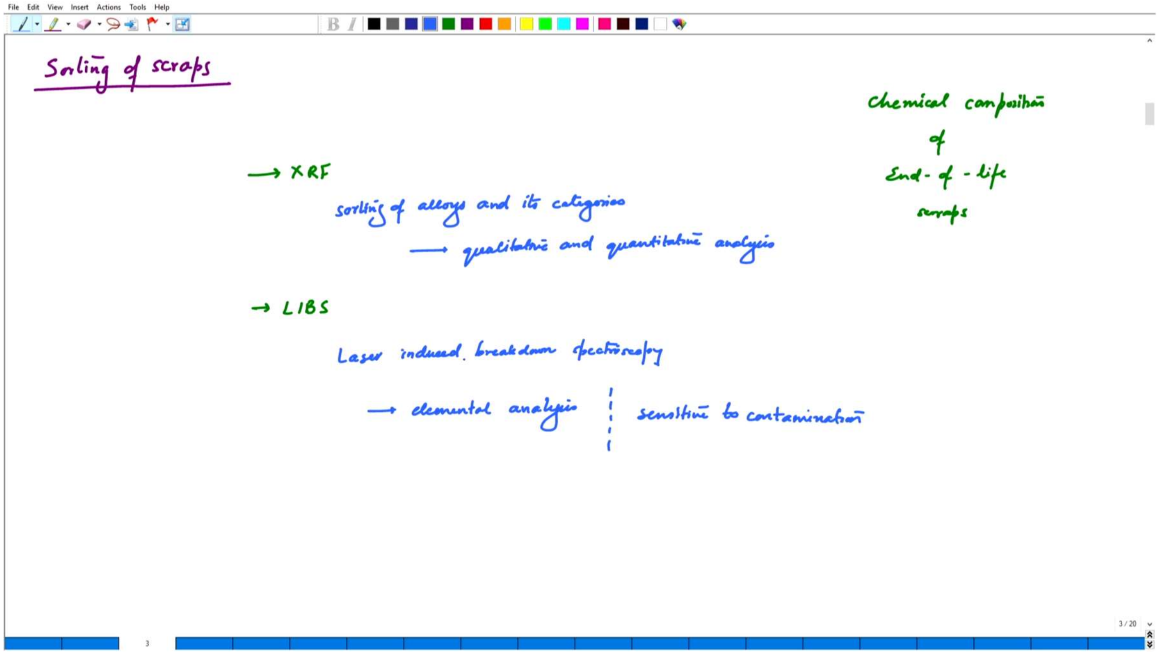


It is seen that these methods, these advanced methods of sorting the scraps have been very useful in understanding the chemical composition of the scrap. If we imagine a conveyor belt containing lot many scraps, these sorting methodologies will help us identifying the categories of scraps whether or not these are copper scraps or whether these are steel scraps or aluminium scraps basically it helps us in identifying these types of scraps and these methods tell us the elemental composition of these scraps so that we are able to identify which grade of scrap it is and where we are supposed to bring it back for basically recovering the metallic values.

We've also seen that the scraps have some sort of contamination. Why these contamination can come into picture? It comes in because the scraps are generated only after the finished products had reached the end-of-life. The end-of-life state itself means that the good has service. The good has basically completed its service life.

That means it was exposed to atmosphere, exposed to wear and tear, chemical corrosion and various physical and chemical environments. The chemical composition of the surface or the bulk of the good will change. That's why it has turned into a scrap. Contamination that is present in the goods have to be removed so that the chemical composition, the chemical purity of copper is retained.

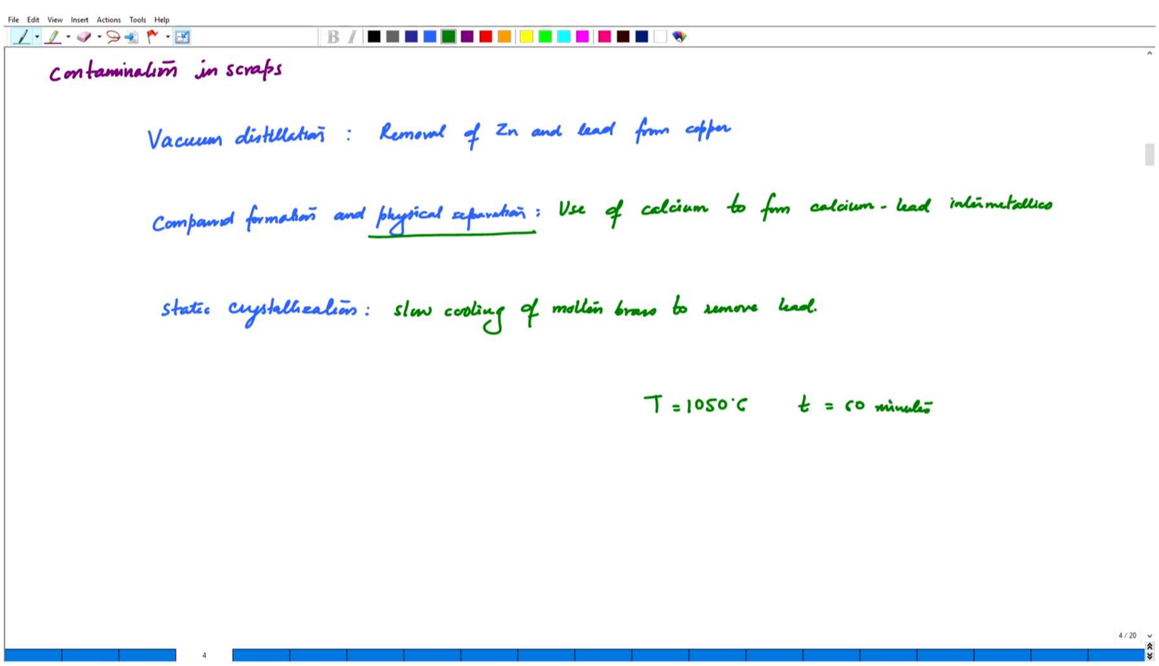
Removal of waste materials, waste trace elements like zinc, lead and so many other alloying elements and purification of copper. Some methods have been described that involve vacuum distillation. This helps in removal of zinc and lead from copper. One has to think of conducting this experiment in a vacuum environment and under molten state. We have compound formation and physical separation.

If you are using calcium suppose that use of calcium to form calcium-lead intermetallics. Calcium is introduced into the system when the scrap is in the molten state so that the intermetallic between the lead and calcium is formed and this intermetallic tends to rise and separated out physically. That's the reason why we have physical separation and this helps in enriching the copper scrap and removal of lead.

If we have lead in the copper molten bath this lead can be removed. We also have static crystallization. Static crystallization is slow cooling of molten brass to remove lead. Similarly, we can have the combination of vacuum distillation with sulfurization where we are adding sulfurizing agent let us say copper sulphide.

This basically helps in removal of the impurities by converting these phases into different phases. The trace elements are then removed and this is coupled with vacuum distillation. This helps in conversion of phases and removal. We are ending up with pure copper phase and this pure copper can be brought back into the material cycle and then again it can be brought back for the applications that we had discussed.

If we think of vacuum distillation and sulfurization we can have temperatures like 1050 degree Celsius and we can have holding time of 60 minutes and the proportion of the sulfurizing agent could be around 10 percent of the feed that we had initially considered. That is one of one another alternative to the conventional method of dealing with the contaminants. **(Ref. 21:26)**



When we have dealt with the contaminations again we can go back to the initial remelting stage where we can think of bringing back the metallic values into the stream.

Just finding the right place to introduce the scrap is very important. We have seen different types of wastes and how the metallic values can be recovered from different wastes. It is very important to note that the understanding of the scraps, the smelter slags, the raffinate solutions and the spent electrolyte solutions, all of these types of wastes are just generated in the industries and they are really valuable. One has to think of devising new methods for extracting valuable products from these wastes.

It is already seen in the previous lectures that one can go into pyrometallurgical method of recycling, hydrometallurgical method of recycling or electrometallurgical method or fusing these three methods one after the other or one before the other and trying to develop a process that is efficient enough to recover copper or iron or let us say in some cases sulfuric acid, whichever is the valuable material, we can think of devising methods to extract them. Metallurgical wastes in the case of copper are CSS 'copper smelter slag', raffinate solution, spent electrolytes and scraps and of course we know that these are just some of the wastes that are being discussed for copper and these wastes have either they are hazardous in nature because of chemical composition and you can't dump them in regular landfills so regular landfills is not advised and the chemical composition governs that is a good raw material. There are better raw materials for generation of these valuable products. But we are saying that these raw materials are good enough for developing these recycling routes so that these wastes can be brought back into material cycle.

Good raw material for valuable product formation. We know that the three routes of material production, the pyrometallurgical, hydrometallurgical and electrometallurgical route can be fused one after the other to make these valuable products by developing these routes. But the optimization of each step is essential. So, optimization of processes helps in higher metal recovery and quality product formation.

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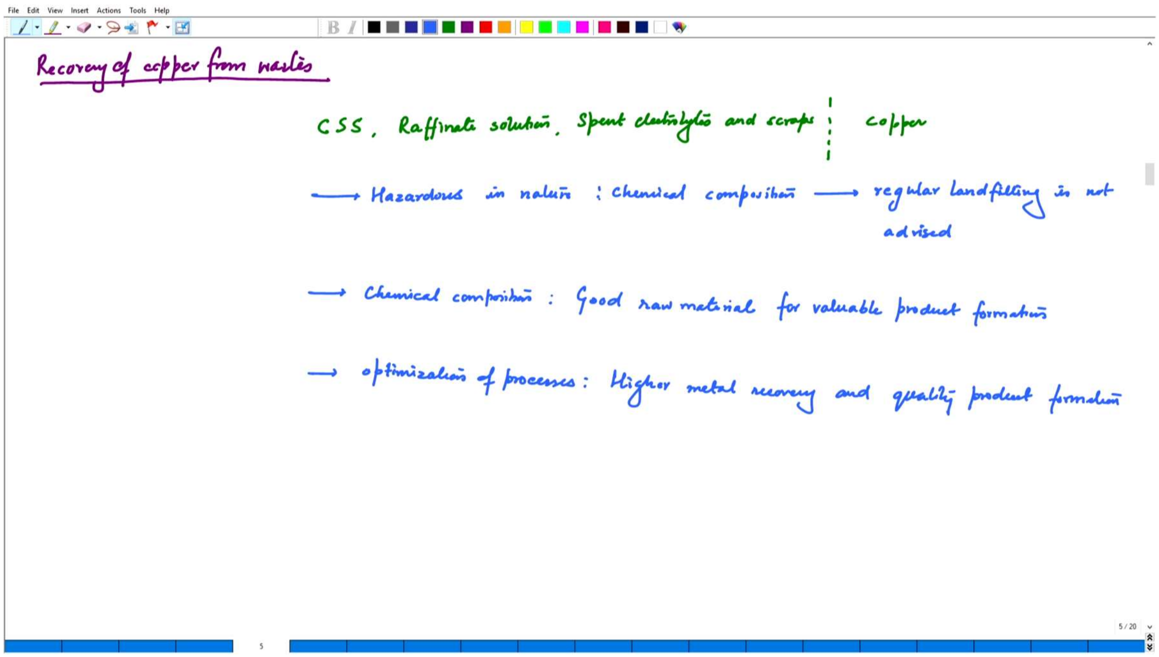

One has to think of characterizing the raw materials and the products and the intermediate phases that are produced so that one can really understand the flow of materials and whether we are really able to extract and produce the material that we have initially thought of. That is basically the optimization of the process whether we are investing in enough energy and materials in a given set of process.

With this we come to an end to this lecture and in the upcoming classes we will be discussing more on the metallurgical wastes. Thank you.