METALLURGICAL AND ELECTRONIC WASTE RECYCLING

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Week- 5

Lecture-25

Greetings, I welcome you all to the next lecture of this course. We will be continuing on Zinc Dust that we had discussed in the previous class. And we know that zinc dust has been an important waste that is containing zinc, it can have good amount of iron and zinc in it and there are the other elements that are coming into picture. And we have seen that apart from various types of wastes that are produced in different streams of production, it is important to note that zinc dust is raw material for lot many valuable products. And we have also seen different types of processing routes, pyrometallurgical completely, or pyro-hydro combined or some other routes that involve briquetting or agglomeration which are basically the unit operations involved in handling the EAF dust/the zinc dust. One of the most important ways by which we can have the extraction of iron and zinc from EAF dust is the Rotary Kiln process, the Waelz process.

This process is supposedly one of the most important process that can help in recovering zinc from the EAF dust/the zinc dust. Let us just focus on the Waelz process, the rotary kiln process of extraction of zinc from EAF dust. As you just noted, major portion of EAF dust or rather we can have zinc dust is processed through Rotary Kiln process, the R.K. process, Rotary Kiln-Waelz process or we can also have Waelz-Kiln process, its most widely used. What is the dimension? We can have 50 meter long. That's a very long kiln with a diameter of 3 to 4 meters and as mechanism of rotation. Rotation operations.

And the rpm that can be present is around 0.5 to 1.6 rpm. We have 50 meter long, diameter is 3 to 4 meters and the kiln itself rotates. This long and huge kiln is used for zinc dust/EAF dust processing. What it really does is basically it consumes the EAF feed with the carbon source and the carbon source is coal. The carbon source is coal used for the combustion operation. And how really does this process go on? It goes in various steps. We will discuss the steps one after the other. Step 1. Moist material is sent to the kiln.

And one more point is important to note that it takes around 4 to 6 hours of operation. Once we feed it we will have to sit for around 4 to 6 hours for the finished product. We have the moist material feeding, then we have reduction and of course, we note that the carbon source is also fed inside. Reduction is done at 1100 to 1200 degree Celsius and what we get here is metal oxide start to reduce.

High vapor pressure zinc, other alkali metals are removed. High vapor pressure metals due to their volatile nature are removed. What really happens here is when we are having the reduction operation, we have the oxide formation and its reduction. And when that happens, the zinc and other alkali metals are removed due to their volatile nature. These are getting collected into the gas phase. What happens after that? So we can have step D. Separation. When this part is done, we can have separation. Separation of Waelz oxide.

This Waelz oxide is basically the slag and the other gases. This Waelz oxide is important for material balancing. We can have some amount of zinc getting entrapped in the oxide phase as well. Most of the zinc is getting removed, but the oxide is also getting generated and that can be used as a raw material for other processes. The slag is discharged by deslagging and we have separation of phases phases. This itself is a very complicated process. Not just the kiln, it is the gas phase that is also very important and the gas phase is going to give us zinc. EAF dust/zinc dust being processed in rotary kiln will give us waelz oxide that is the solid product. It is the solid product that will be obtained after this slag is removed, but the gases products that are generated in the rotary kiln have to be collected for metal recovery and dust recovery. Although we are processing a dust it generates a secondary dust, secondary bag house dust which could be used for other metal recovery that is what we are trying to understand here. We have coarser particles. Step A of separation of gas phases, coarse particles are removed.

These coarse particles are removed by mechanical means, so one has to catch these coarser particles and again these are used as raw materials. It means that we can see imagine that this raw material is going to be reused here. One could think that this is just a circular application, but that is how it is being reutilized and material is not discarded. The second way, the second step is the dusty catch, dusty gas is cleaned by precipitator. This helps in removal of the dusts that are present in it. And finally, dust-free gas is used. Dust-free gas is used for recovery of mercury, cadmium, etc. We have different types of routes in the glass cleaning stage as well so that we are able to extract zinc and other metals from it and we are able to process every step efficiently and take care of the

materials that are generated in the process in the rotary kiln operation. We will now continue our discussion on zinc scraps.

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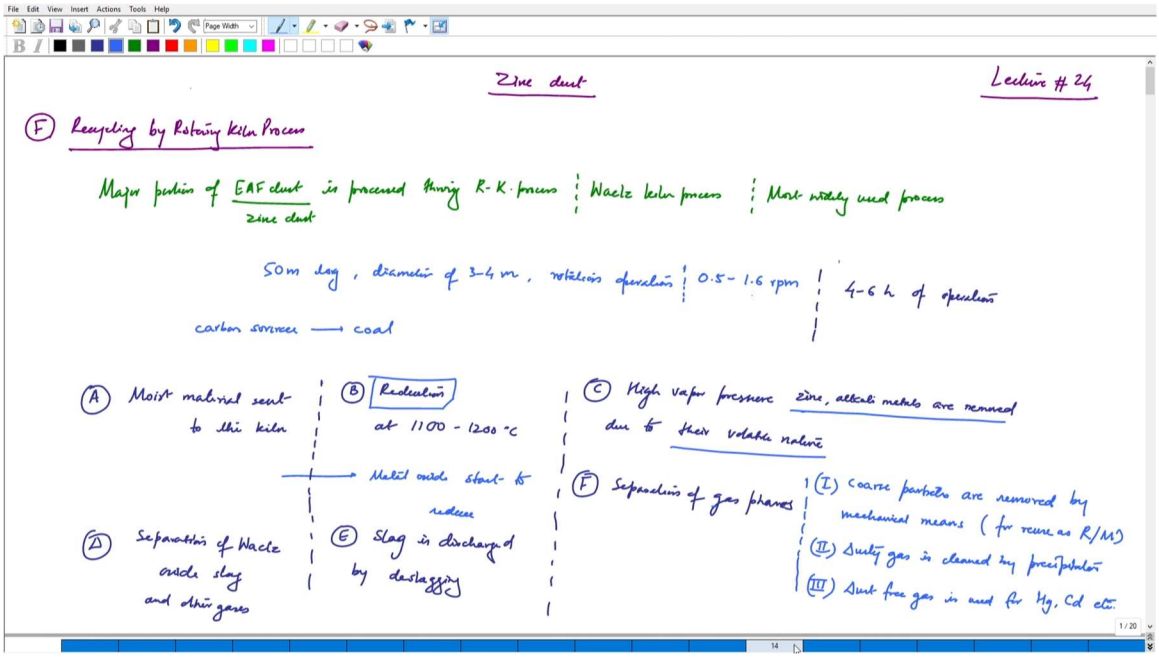

We have till now discussed various types of zinc wastes, we have discussed zinc dross, zinc dust and now we will be focusing on the last aspect of this course for that is pertaining to zinc that is and it is zinc scrap. Let us now focus on the next aspect which is zinc scrap. We already know that zinc has a wide range of applications in various fields. It is expected that zinc that is in service will eventually come back after its use back for recycling in the form of scrap. One has to really understand what is the source of the scrap for understanding what could be extracted from it and the source of scrap is basically the area in which zinc is being applied.

Let us now have a quick recap of what are the areas in which zinc is used and what are the potential areas of scraps where we can extract our zinc from. One has to think of applications of zinc. Applications of zinc, why is this important? Because this helps us in understanding the raw material which is basically the scrap for zinc recovery.

The different categories of applications are listed. The chief one is hot dip galvanization. We already discussed that. Hot dip galvanization. Zinc ash formation is happening here.

We have alloying of brasses, alloyings and production of brass and bronze. And other zinc alloys as well. We have die casting alloys as well, rolled alloys, zinc based chemicals and rolled metals, rolled zinc metals and so many other areas in which it is produced. We can also have some important applications that important alloys that are in service. Let us just put some of the examples. Rolled zinc alloys and we have die cast. For rolled we can have these are the specifications of the rolled alloys and similarly die cast would be and so on so forth.

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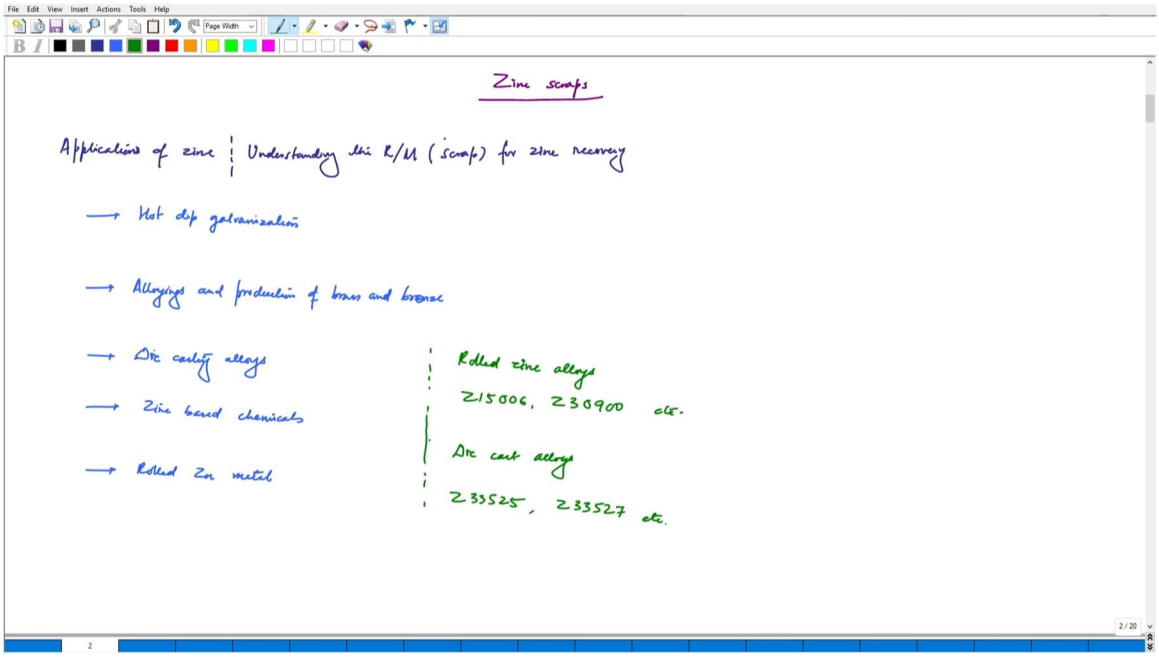

These are the various alloys that are normally produced using zinc as one of the main constituents and we know that these applications are using zinc. Eventually, we will get scraps from these sources only. The finished product of these applications are going to be used in different areas and after these products reach their end-of-life these will be discarded which will bring us the raw material for scrap utilization. The categories of scraps, we'll discuss some categories of scraps. And this is very interesting because the scraps are important feed but one has to categorize them before we even plan to use them. Categorized scrap are easier to use. Construction and demolition.

That is one area. End-of-life. EoL is end-of-life vehicles. One could also say ELVs. Waste electrical and electronic equipment which we already know as WEEE or at times it

can be also considered as e-waste which is an important part of what we are going to discuss in the upcoming lectures and Industrial electric waste, IEW. Industrial non-electric waste which is basically INEW.

These are some important categories that are present and one of the most important category that we have not written yet is municipal solid waste (MSW). When we have this categories of scraps we know that these are the potential areas from which we can easily extract zinc from. One has to really categorize the scrap when we are processing them but we have identified the broad categories and then it becomes a lot easier to process these scraps. We'll have further discussion on how to process them.

One of the most common methods, the most common method of reusing the scrap as remelting. What exactly are we doing with the remelting is what we are trying to figure out. It is dependent on what is the feed because at times we would be requiring refining as well we will see how. We will make a small table; source of scrap and zinc recovery operations. And we will just put reference. If you have brass, bronze we go for remelting, we have zinc alloys, we can go for remelting. We have galvanization. Galvanization products. We can have new scrap or old scrap.

In such a case, new scrap goes for remelting. The old scrap goes for refining. Rolled zinc remelting and we have others which may not be categorized in either of them, if it is new scrap that goes for remelting, if it is old scrap it goes for refining. And we have discussed previously in different scraps of aluminum and copper, what really new scrap and old scrap means. New scrap is used directly within the processing unit, it is generated in the processing unit, it is reused in the processing unit, it is not really reaching the consumers.

When it is reaching the consumer it is going to get used. The finished product that is reaching the consumer is going to get used. And when it is getting used it will reach its end-of-life and then return. In that case it becomes old scrap. New scrap is generated within the processing units itself and they are consumed by the processing unit.

It is important to note that the generation of scraps can happen in the unit itself. And that is why we have old scraps and new scraps and remelting operations. And it is important to note that apart from of course we know that remelting is the most important route. Apart from that the presence of trace elements or contaminants in the old scrap at times. The presence of the trace elements in contaminants in the old scraps at times make it important to refine the scraps. Those these trace elements are removed and then we are

able to extract zinc as per our requirement. Makes it necessary to refine the feed which is why refining is also included.

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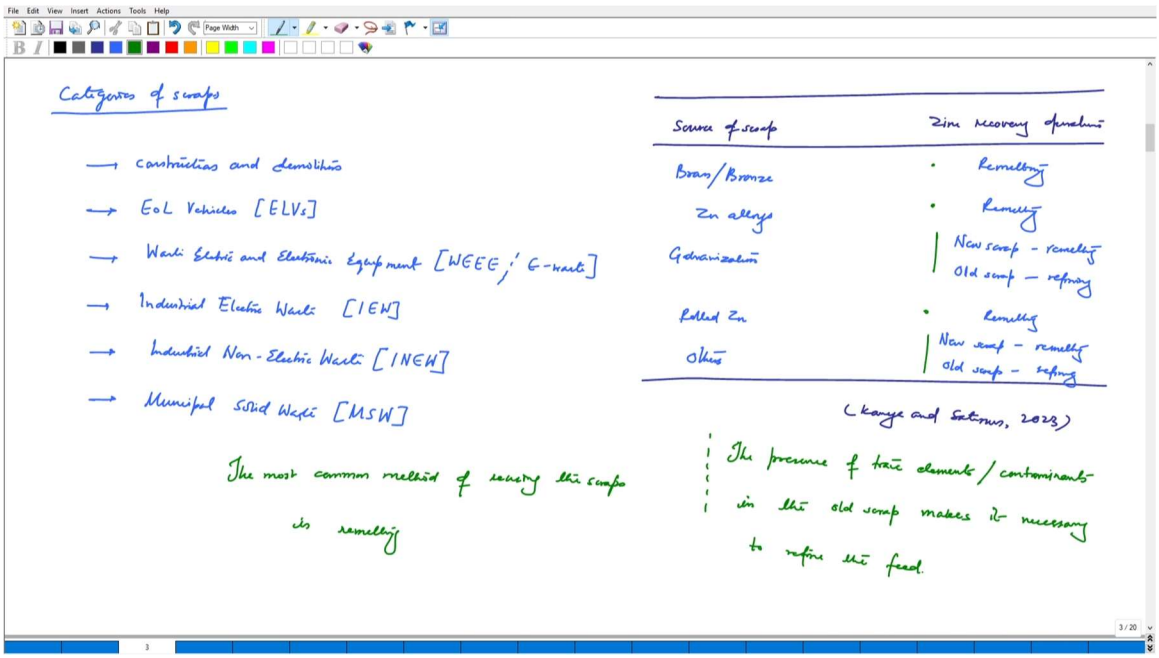

Let us just focus on recovery of zinc from galvanized products. One way of using this galvanized product is just subjecting it as a scrap, but then the zinc would be lost. One can go of a process called de-zincing. Now, de-zincing can be done through hydrometallurgical route. Let us just look at it. Recovery of zinc from galvanized products and it's a hydrometallurgical route and acidic as well as alkaline both routes are available, acid dissolution, we have acid with zinc and by being what do you mean by with zinc basically it is dissolved in zinc and it can lead to zinc salts. Similarly, when we look at alkaline routes, we have alkali dissolution, alkali with zinc and this can lead to zinc products.

Here is a generalized route. We have acid dissolution, we fed the galvanized product into the acid bath and we get acid with zinc. This acid leads to the generation of zinc salts and similarly we have the alkali dissolution again we fed the galvanized product, we get alkali with zinc, the zinc is getting leached into the alkali and then we are getting zinc products after it is getting removed and processed. In both the cases what are we getting. We are getting de-zincified, so this is important, de-zincified products which was the

original target. Many a times, it is this de zincified products that is what people are targeting but at the same time it is important to note that the alkali and the acids are going to give us zinc rich products also. One can think of both ways of extraction of zinc from acids and alkalis as well as de-zinc product.

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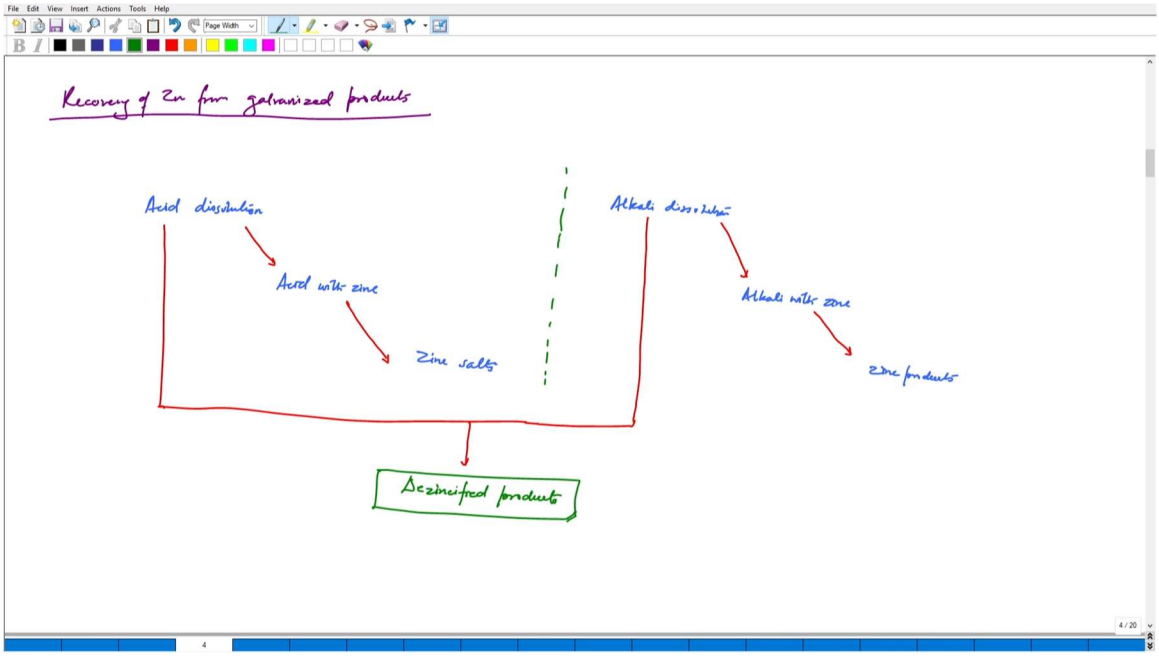


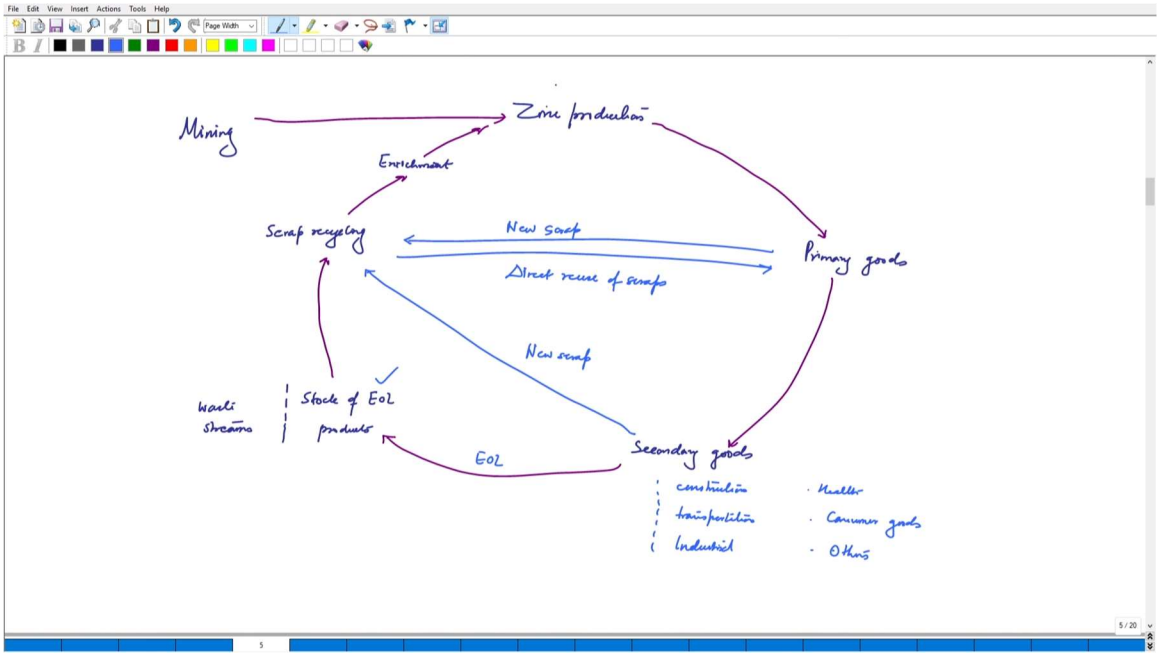
The generalized view of zinc recovery has to be noted. We have seen so many different types of zinc wastes and zinc scrap is also a good source of zinc. Let us just now try to put a generalized overview of how zinc products are available in society and how zinc products should be recycled. Let us just quick overview of how it flows, how material flows. We have the mining operation; we have zinc production. Primary goods, we have secondary goods, we have stock of EoL products which is basically the waste stream in scraps. And this is the scrap recycling and we have enrichment which is basically the Waelz process that we have seen just now we have mining it gives us zinc production and then we have primary goods and some of the processes can go back.

Some of the waste products can go back and then return as primary products. And when it is getting forward, you can have primary goods getting converted into secondary goods. These secondary goods lead to the end-of-life products which are getting stocked and collected and then finally we have this scrap recycling. We know that most common

method is remelting and refining and we also know that at times it can lead to the at times there is that EAF dust and we have the Waelz process accompanying the recycling process to give us zinc-rich products which are brought back to the zinc production, main operation of zinc production. There are some internal cycles also which are very important. So, we have, this is new scrap which is getting from the primary goods to the scrap recycling so it gets directly reused and we can have scrap recycling is going to primary goods so it is direct reuse.

Direct use of scraps. And this is also going into the scrap so this is also new scrap. Secondary goods and primary goods have not really reached the consumer. When we are actually producing and sending it, only after that we get the conventional idea of scraps which is basically the stocks of EoL that is product. We have already seen what type of products are present here. The WEEE, waste electrical and electronic equipment and so many different waste streams that we have discussed previously. Those are the stocks where zinc could be produced. Consumer products those are the areas where the scraps are coming from but primary goods and the secondary goods are producing the new scraps only.

What are the secondary goods after all? Let us just jot them down quickly construction applications, we have transportation, we have industrial applications, similarly healthcare products, consumer goods and other miscellaneous applications. These are the products that are about to reach and after end-of-life it is getting stacked and after the stacking it gets recycled. **(Ref. 33:30)**



One should note that this type of cycle that has been made for let's say this is specific for zinc, this can be made for copper, this can be made for aluminium, this can be made for steel, this can be made for any different type of material that we are interested in and it should be noted that efficient recycling of a process depends upon the optimization of every step that we are looking at. The production of goods primary or secondary, utilization in end-of-till end of life, its recovery from end-of-life to the scrap utilization or the recycling unit and then after recycling unit the metal or material should come back to the primary cycle. This involves optimization at lot many different scales within the unit operation itself and at the consumer end as well. Now we have completed the overall recycling of various wastes that we had to discuss on zinc. We will be continuing our discussion on different waste stream from other sources in the upcoming classes. Thank you.