METALLURGICAL AND ELECTRONIC WASTE RECYCLING

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Week- 5

Lecture-24

Greetings, I welcome you all to the next lecture of this course. We will now be discussing on Zinc Dust. In the previous classes, we have gone through lot many waste streams that are associated to Zinc and now we will be focusing on Zinc Dust and we will be continuing this discussion in this class as well as we will be continuing it to some extent in next one as well. It is important to note how releasing dust is formed and we will be discussing some of the chemical compositions and how we are recycling it. Let us just start. We know that one of the most important utilization of zinc is basically in the area of galvanization. So, it is a crucial waste that is generated in the steel making unit. Actually it is generated in the steel making process.

One might want to argue whether this waste really is a part of the zinc stream or the steel stream. Since it is having significant quantity of zinc we can consider it as a waste stream of zinc because it is rich in zinc. The other way of looking at it is since it is generated in the steel making unit, you could call it as a steel dust, EAF dust. That is also one way of looking at it which is the way we would like to describe it is totally depending upon how we would perceive it. If we are looking at it from composition point of view then of course, we should go for considering it as a zinc dust. Generated in steel making industries and this EAF dust or zinc dust, EAF dust some might want to say in or the other common way of calling it is zinc dust is really rich in zinc. And what normally happens is nearly about 10 to 20 kg per ton of dust is generated per ton of steel is generated. And we'll see how much it really contains.

EAF dust is basically generated when we have splashing. Thin film splashing in the processing during EAF operation. When hot metal is getting splashed and this thin film splashing is happening, the fine dusts that are generated actually end up as EAF dust. And this thin film splashing is actually resulting in small size of the dust particles.

Because, the larger particles will never end up in the dust, they will recede back into the hot metal.

It is the final fine thin film particles that are actually removed because of the air flow convections, not the larger particles. The larger particles would really get reintroduced back into the molten metal bath. This is the generation of the EAF dust. We will now look at the chemical composition. For that we will just draw a table and we must note that there are various categories of dust, the high zinc dust,high zinc, medium zinc and low zinc dust. The chemical compositions are as such we have types and elements, types of dust we have elements of course, zinc, iron, some Palladium, Chromium, Aluminium and Calcium. These are references that are present and references are just general references. Just mention it like this.

High zinc is nearly 20 percent and above. Medium zinc is nearly 12 to 20 percent. Then there is low zinc which is lower than 12 percent zinc. We know that this broad classification is going to be with us. We can assume that this breakup of the zinc dust is going to be according to these broad classifications.

We will just have the internal divisions done. In high zinc we can have 26.66, 16.93, 2.71, 0.12, 0.59, 30.5, 27.6, 0.37, 0.12, 0.43, 2.1. Similarly, we have 51.6, we can have a really large value here 51.6, 16.5, 8.8, 2.0. In now we are looking at the medium zinc bracket it can have 19.4, 24.6, 4.5, 0.3. And the lower zinc bracket, the low zinc we can have as low as 5.2, 6.5, 19.37, 8, 1.4, 1.8, 10.9, 10.9.

We see that the breakup of zinc is really varying with the type of category that we are looking at and the compositions of iron and zinc are the most important in these types of dusts and apart from that we have other elements chromium, aluminium, calcium and lot more other trace elements are can also be present depending on what is the composition of the raw material that was used in the EAF itself. What is being used in EAF will be coming out as dust. Apart from zinc and iron itself, all these elements can be coming up with the dust and these are getting observed in the EAF dust when we are characterizing it. So, let us just mention some of the important references.

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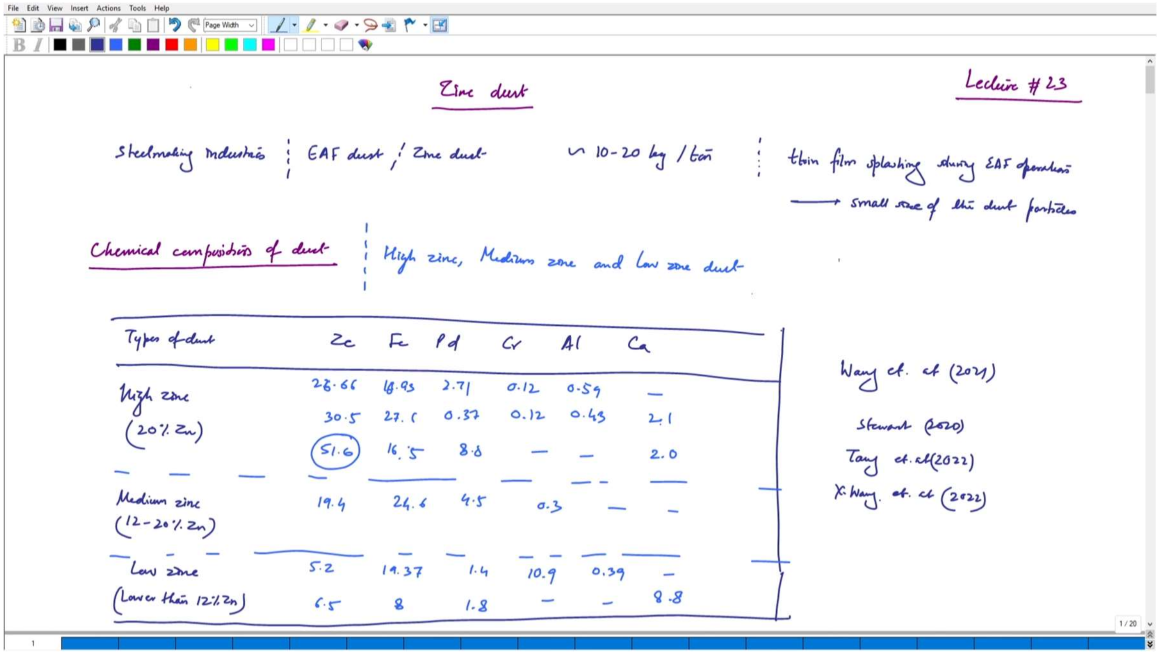

When we know that these raw materials are fluctuating based on their composition, we can think of devising good strategies for efficient utilization of zinc from these dusts. We know that these dusts are very fine in size, so one has to really think of how to utilize fine zinc dusts as a raw material for their process. Let us just look at some of the recycling ways and before that we would also like to have a question, why recycle zinc dust? We know the obvious answer that should come to mind is hazardous elements are present Hazardous elements are present like, lead, tin, iron, chromium, etc. Hazardous, of course, iron may not be considered as hazardous, but of course, the other elements that could be present.

At times, we can have mercury and cadmium also. These types of elements, when are present, these can make the zinc dust hazardous. And these are detrimental to health and one should be very about how it affects the environment also and we know that significant quantity is generated. In the production of steel, its a significant quantity that is a generated per ton.

One can think of you using these wastes as a raw material. How do we recycle it? Recycling. One of the ways is Rotary Hearth Furnace Operation. What it does is EAF dust or zinc dust is added with flux. Flux material is added and you need coal because it is a furnace and we can easily guess this is a pyrometallurgical operation. We are going to have flux with dust with coal, coal acting as the agent for combustion and it is going to give us some valuable materials. That is very easy to guess right at the beginning. What exactly happens is we will do mixing and we will go for pelletization. Because we know that the size of zinc dust is very small.

One has to go for agglomeration process. This is mixing and this is agglomeration. And after that we will have the Rotary Hearth Furnace. And the operation is going to give us DRI, HBI (Hot Briqueted Iron) or molten metal. At the same time. We have waste heat generation. From where Waste heat generation and collection which basically helps us in extraction of the Zinc and other volatile materials. Zinc and other materials are separated in this process. What it normally does is we take the hearth; we add the feed after pelletization and it gives us the metal and this process is actually targeting iron.

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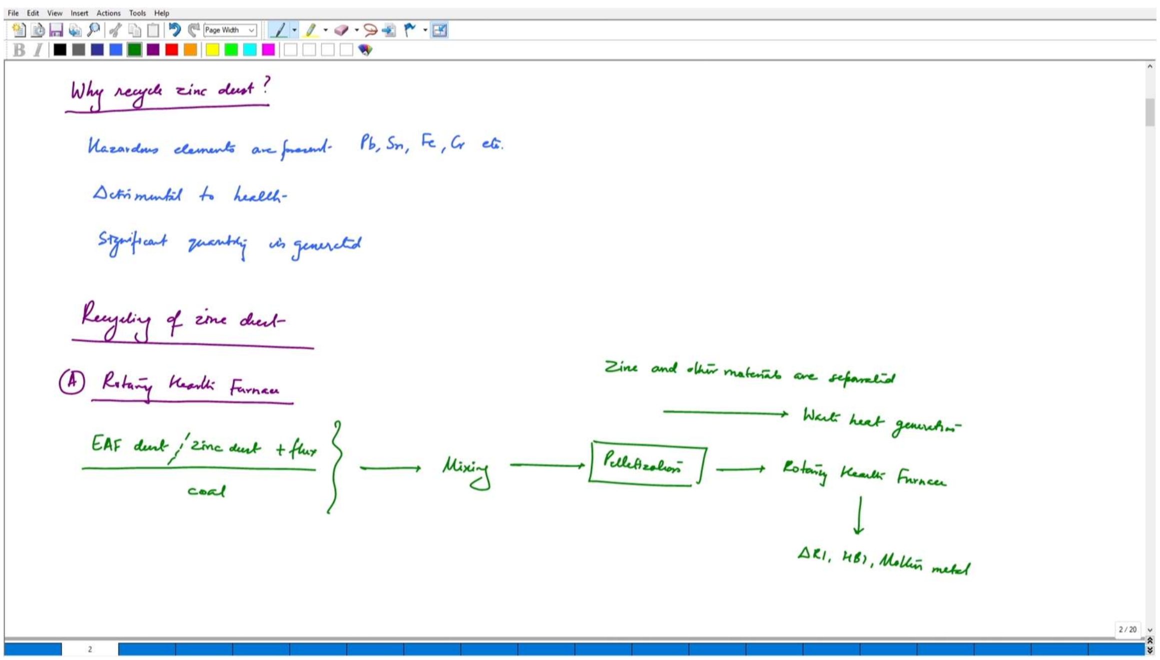

The waste product in the form of zinc is getting extracted in the gas phase. Let us look at the second route. We have electric smelting reduction furnace ESRF, electric smelting reduction furnace. Here we are feeding it, we have the ESRF and it is going to give us metal and slag. The normal operation of a common furnace. What normally we should also be expecting the combustion chamber that is attached to it and gas cooling. This is an important step.

This step actually helps us in extraction of zinc and this gives us bag filter. These operations that are after ESRF, of course, we are getting metal and slag which is targeting iron and the iron related product. What we are getting beyond that is where we are where we should be looking at the zinc output. We are getting gas cooling and bag filter give us ZnO extraction and separation after ESRF operation.

This is very important because one might just expect we can just directly feed The raw material and get zinc. It is done only after the ESRF. ESRF gives us metal and slag. But the gas that is getting collected is actually processed elsewhere and there you are getting zinc oxide. And we are still not getting zinc. We are getting zinc oxide. One has to process zinc oxide.

And then get metal. The third route would be. Roasting for development of products. Another pyrometallurgical route of handling. What we can see here is we have EAF zinc dust and we add Fe_2O_3, we go for ball milling and briquetting, we have vacuum drying and then we can have roasting. Roasting is done at a higher temperature and we can have leaching. Till this part, we can consider that it is pyrometallurgical till this part, but now we are also introducing hydrometallurgy, which can give us nano bead milling of the finished products. We can have nano bead milling followed by zinc ferrite.

What really zinc ferrite looks like $Zn_xFe_{3-x}O_4$. Zinc is getting attached to the Fe_3O_4 and how does it really happen. It is followed after leaching and you are doing milling one more time after that. These types of raw materials can be used for making zinc-rich products that are of course, attached to the iron component.

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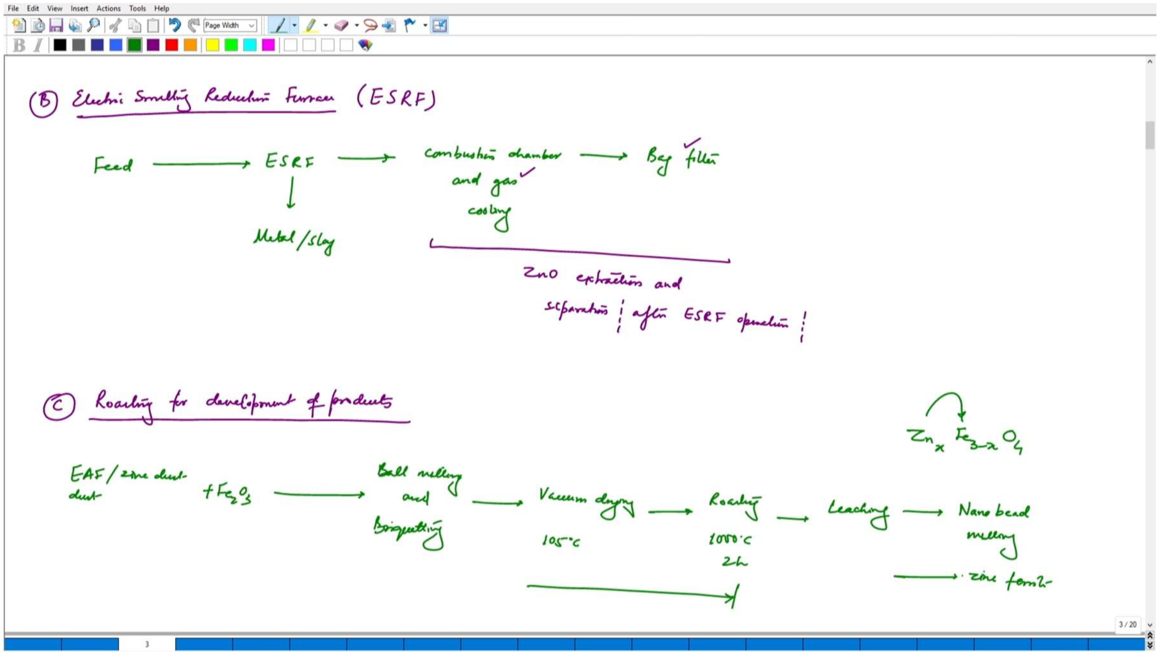

One has to add Fe_2O_3 to zinc dust and then you can make these types of products. The other important alternatives for using zinc dust are basically hydrometallurgical let us say leaching. Leaching with iron powder addition and, iron powder is used as an additive here it is not used of course, it is not used as a reagent. One should really mind what we are adding when and what is its purpose. We can have zinc dust and, zinc dust is coming from various sources not just steel making.

One of the key areas where zinc dust can originate from is also from brass smelters, from lead-zinc smelter also. If we have zinc dust coming from lead-zinc smelter and such a smelter product is added with iron it becomes a raw material. In this raw material we could be using as a feed for leaching with H_2SO_4 and and, we are going for ultrasonication. What we can get is we go for the characterization of finished products.

And we know that apart from the zinc leaching itself, zinc leaching from the zinc dust and addition of iron it can also give us Germanium recovery Zinc is getting leached in the process, but Germanium recovery is also reported by using such processes when we are having different types of waste streams, we can have different types of finished products as well. Germanium recovery from zinc oxide dust. One more process would be reduction roasting and leaching.

We note that most of the processes really have to be connected to pyrometallurgy and some parts of hydrometallurgy can be brought in. If we have high zinc. High zinc dust could be simply leached with water and this is done to remove dissolvable parts only and use solid residue for reduction roasting. We have nearly 50 percent hydrogen at around 700 degree Celsius that type of operation can be done and, this has to be followed by leaching with acids, and then we can have leach liquor and solid residue. Again, one can use these types of products for making various types of raw materials.

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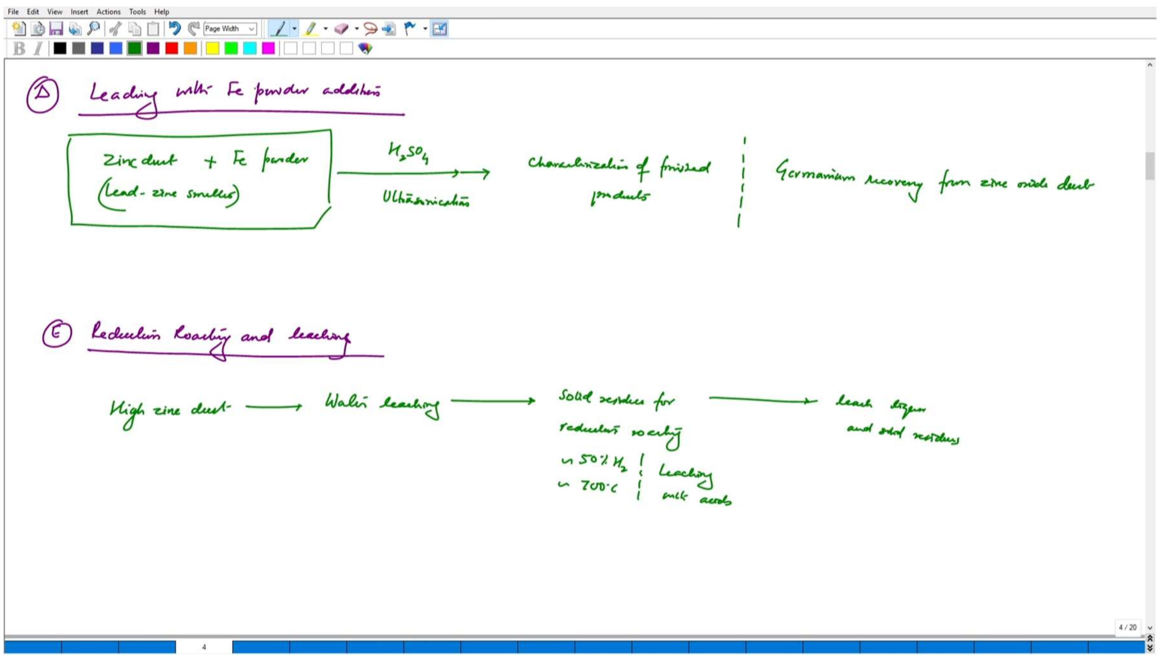

What this really means is you can have a wide range of applications connected one after the other such that your raw materials are used properly. In this case it is zinc dust. We have seen that most of the processes are involving pyrometallurgy. But apart from that if we are still involving, if we wish to involve a hydro-hydrometallurgical operation, we can have parts of pyrometallurgy and hydrometallurgy coming into play, combined one after the other. And this can give us wide range of valuable materials. We will be continuing in the next class. Thank you.