METALLURGICAL AND ELECTRONIC WASTE RECYCLING

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Week-5

Lecture-21

Greetings, I welcome you all to this new lecture and we are now going to discuss on the next set of metallurgical wastes that are basically generated in the zinc production industries. Now, when we think of zinc industries, we should note that there are wide variety of applications of zinc and zinc has its immense importance in human kind and human kind have been employing zinc as a very valuable metal in various wide range of applications. We will first discuss why it is so important and then we will be discussing on the first metallurgical waste of basically zinc and its original composition that in which the zinc is in large quantity.

This waste is zinc ash. We will first focus what are the applications and then we will be focusing on zinc ash and then we will be seeing how it is being characterized and why it is important to recycle. And in the upcoming lectures we will be continuing on zinc ash and then we will be focusing on zinc dross and other wastes like EAF dust and zinc scraps also. Like the cases that we have discussed previously, we have seen aluminium and copper, we will be looking at zinc as well. Some industrial wastes, some process wastes, right now zinc ash is basically a process waste wherein we will be looking at hot dip galvanization and we will be discussing some aspects on hot dip galvanization and then we will be focusing on how zinc ash is formed and how is it recycled. Similarly, we will have other wastes also. Now consider zinc ash and before that we will be focusing on the general applications of zinc.

We know that it is an important metal and it is serving the humankind in many folds, many applications and the key areas are basically galvanization. One of the most important areas is galvanization, then we have marine applications. and when we think of marine applications why exactly are we using? These are basically uses of zinc in various applications because of its corrosion resistance properties. We have marine applications because it helps us in prevention of corrosion and we have automotive sector.

We have energy storage so battery materials can also be made using zinc, it has very important application in medical and pharmaceutical industries, medical industries, and implants etc. We can also note that zinc compounds and alloys are used in various fields and we should also note that zinc is also acting as an important alloying element in various other metals and their alloys. Zinc addition provides wide range of properties to these alloys and then these specific alloys can be used in specific applications. Now that we know that zinc has its wide range of applications, we can expect large variety of wastes that can originate from these sources at their end-of-life.

Just like when we are looking at aluminium scraps or copper scraps, we can still expect that these sources are going to provide us with end-of-life materials that can contain zinc as raw material. Contamination will be a problem and one has to really think of removing the contaminants and then bringing back the metal to its original state so that it can be reused. Zinc wastes can be reused for recovery of metal, metallic values. Now we are just going to focus on one of the most important wastes that are that contains zinc. We will focus on a waste that is containing good amount of zinc so that we can directly reuse it. One of this wastes as we have been discussing is zinc ash. What exactly is zinc ash?

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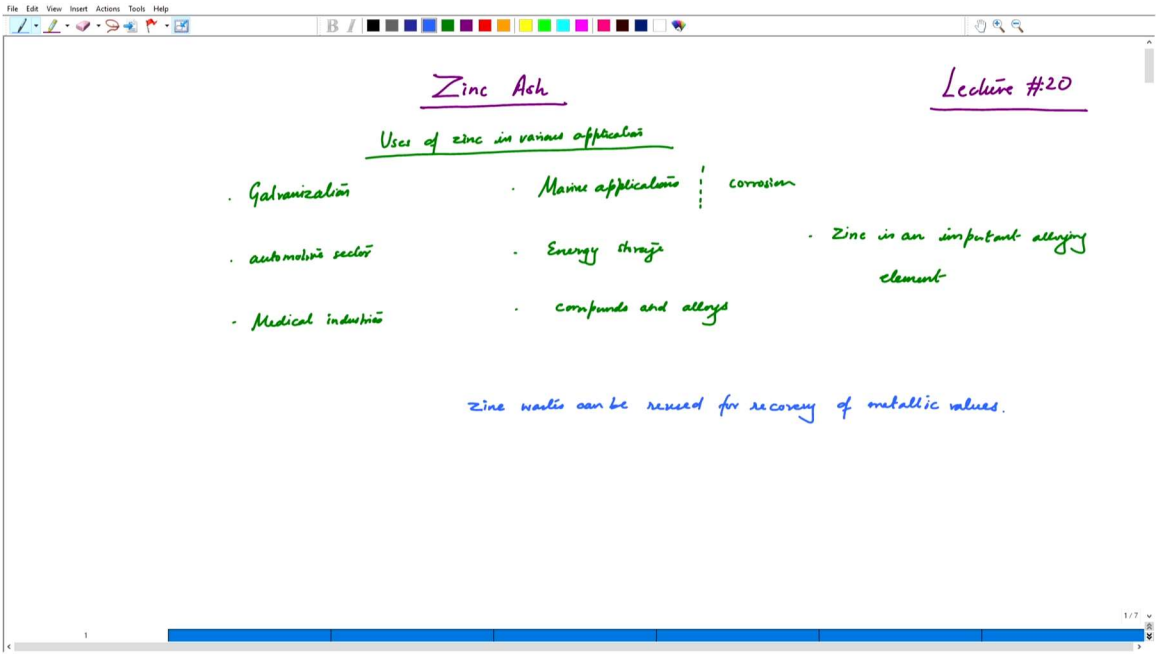
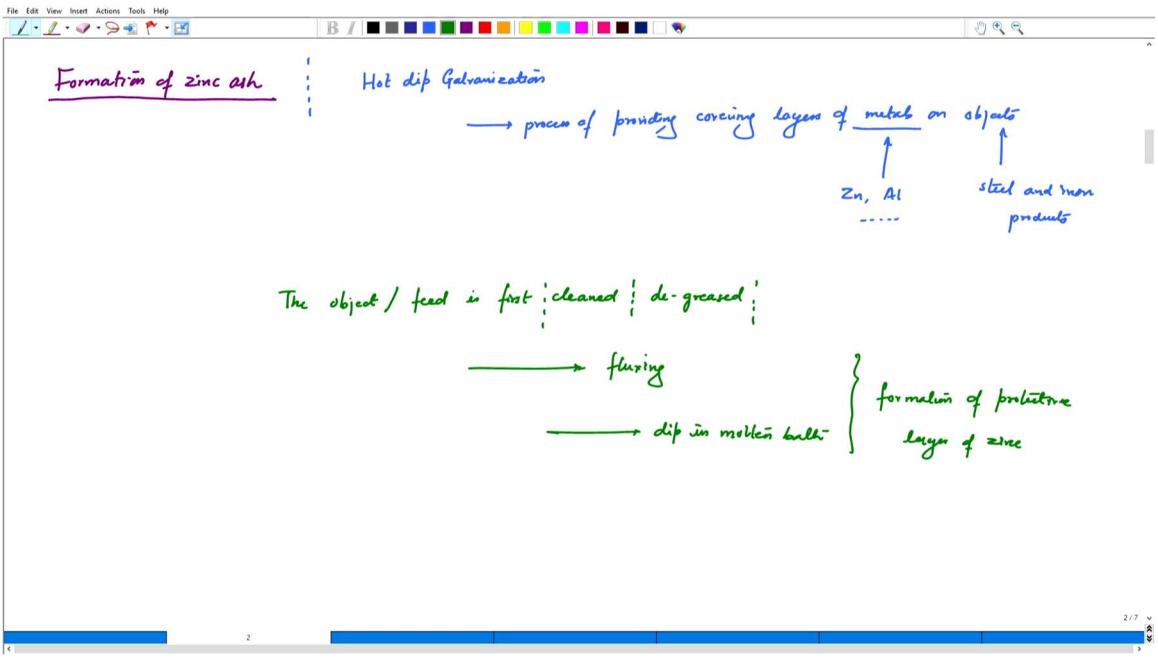


We will be looking at it a bit later. Just let us first focus on hot dip galvanization, which is the process in which zinc ash is produced. So, formation of zinc ash is basically understanding hot dip galvanization. Hot dip galvanization is a process of providing covering layers of metal on objects. Now, what metals? If we are specific, we can have zinc, aluminium and others. And what objects? Normally, these objects are steel and iron products. These could be sheet, this could be other shaped products. But normally these are of iron and steel.

These metals are being used as the objects that are galvanized. And what are the protective layers? These are zinc and aluminium. In this case right now we are focusing on hot dip galvanization using zinc as the molten bath. Now we will first see how it is done. The object or feed is first cleaned or let us say degreased. We can have degreasing also. We have the cleaning and degreasing and then we will have fluxing. Various types of fluxes are used before it is brought into the molten bath. The cleaning is done.

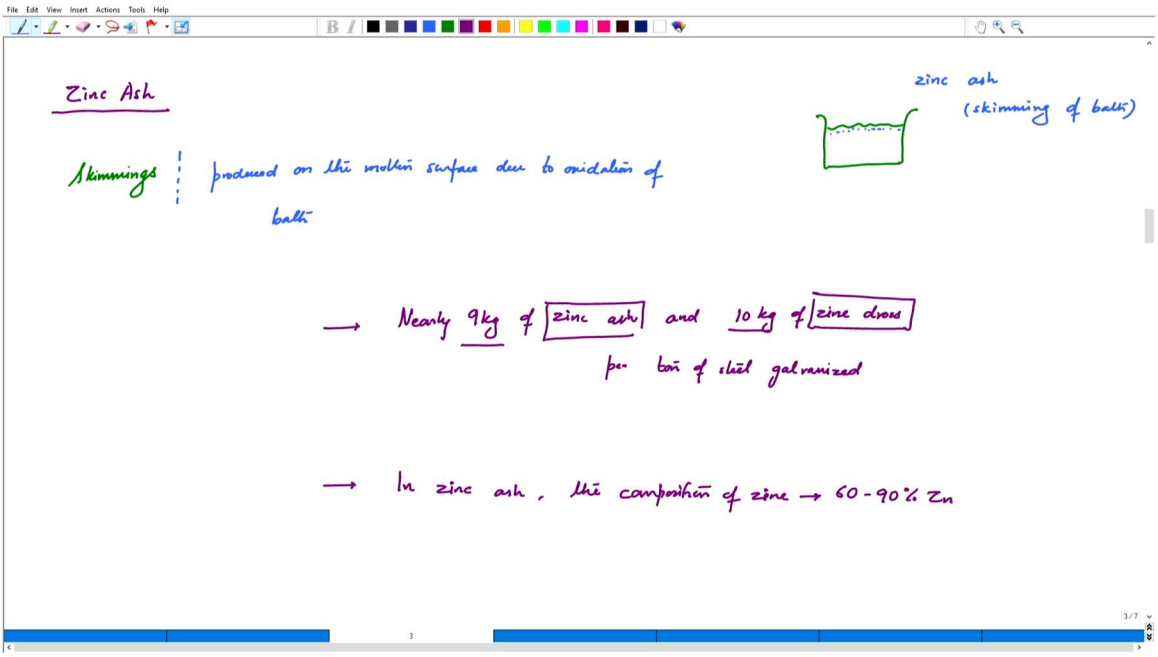
At times we can have etching also. And then degreasing is done. If at all it is required, suppose that the finished product, the raw field itself has some grease or other dirt material attached to it. The zinc layer may not be able to attach on it properly. These greases and this dirt material, these dirt surface coatings are basically removed. And then we have fluxes that are added onto the surface followed by, followed by dipping in molten bath. This helps in the formation of protective layer of zinc and when this is done, when the dipping is done, it is removed and it is allowed to solidify so that the zinc layer is getting attached onto the object of either steel or iron or whichever material is being used. **(Ref. 10:28)**



Where exactly is zinc ash forming? Zinc ash is basically forming as the skimming of the whole molten bath. When we think of zinc ash and where does it come in the hot dip galvanization process, it is basically at the surface. If this is the molten bath and we have molten zinc there is the formation of zinc ash will be at the top because zinc ash is basically the skimming of the bath and what exactly is the composition skimming is basically produced on the molten surface due to oxidation of bath. One might want to say zinc ash and zinc dross are more or less colloquial. Zinc dross happens to form at the bottom of the whole hot-dip galvanization system.

It is settled at the bottom and zinc ash the skimming part is floating at the top. Both hot zinc dross as well as zinc ash both are produced in hot-dip galvanization but now we are of course focusing on zinc ash and zinc ash is basically collected at the top. It is basically the skimming that is produced at the top of the molten bath. And of course it is formed due to the oxidation of the bath. What exactly are we looking at when we are thinking of metallic content? We are seeing nearly 9 kg of zinc ash, 9 kg of zinc ash and 10 kg of dross thus hot dip galvanization can really produce this quantity per ton, per ton of steel that is galvanized.

9 kg of zinc ash and 10 kg of zinc dross for 1 ton of steel that is galvanized is generated. And in zinc ash the composition of zinc can vary from nearly 60 to 90 percent zinc which means it is a very good raw material for zinc recovery. It's a very good raw material for zinc recovery which has nearly 60 to 90 percent of zinc available in it directly. **(Ref. 14:30)**



If we are utilizing this raw material for metal recovery, that is a nice raw material. And due to the presence of various other elements that can be in the system, the composition can fluctuate. Now we will be looking at some of the composition variations that can be present in zinc ash and we will see how it affects the recycling process. We will have the zinc ash composition. We can see that this is the chemical composition of zinc ash and the references have been mentioned and we know that these chemical compositions can vary from sample to sample and from production unit to production unit. It is important to note that in this given waste stream we can see that about 50 to 60 to 62 percent of zinc is already available and it is important to note that this zinc composition is very valuable for determining what we are supposed to recover and it is important to note that zinc is an important element in this waste. Let us target the recovery of zinc.

And of course there are other elements that are also present. We have iron, aluminium, manganese. But none of these elements are present in large quantities. What else is present here? In literature, it has been mentioned that chlorine is present in really large quantities. It can range from around 18 to 20 percent, or 12 to 20 percent of chlorine can be present. That is also available in zinc ash along with oxygen itself. Let us now look at important phases that are present in zinc ash. We have seen the elemental composition. Let us now look at the phases.

Important phases that are present are $Zn_5OH_8C_{l2}.H_2O$, this is called zinc chloride hydroxide. We can have zinc metal and zinc oxide. We are expecting these two phases and since I have just mentioned that chlorine is also present, we can also have zinc chloride hydroxide and some amount of silica can be present. Similarly, some amount of aluminium and aluminium oxy hydroxide, oxychlorides and such phases can be present. But due to the presence of chlorine these phases can also be present apart from zinc oxide and zinc chloride, zinc metal itself and zinc chloride hydroxide can be present as it is an important phase.

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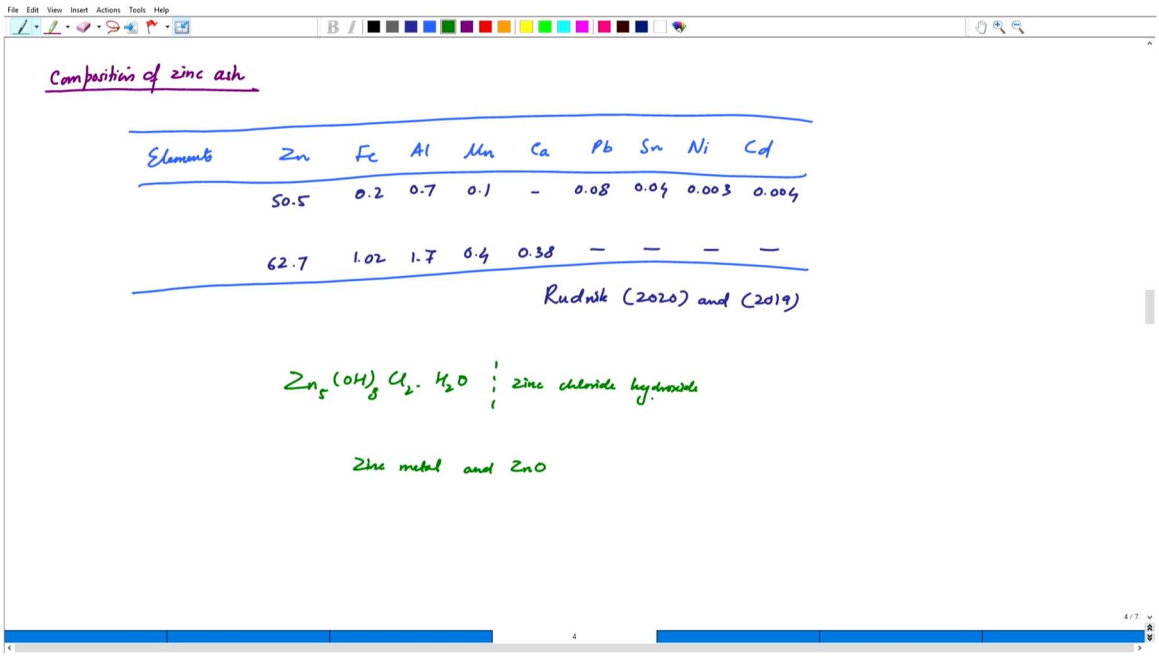

With this we need to understand so now that we know the chemical composition and the important phases that are present in it we must note what are the important raw materials in zinc ash that we should be focusing on? It's not chlorine.

It is basically zinc. If we can selectively remove chlorine and make other valuable products, that is also nice. But at the same time, zinc is present in really large quantities. Zinc has to be recovered. The most common method of recycling zinc ash has been

in hydrometallurgical route of recycling. How do we go about it? One has to understand that high concentration of zinc in the zinc ash makes it a good raw material for metal production. Most of the recycling processes

are hydrometallurgical in nature. What does that mean? It means that zinc ash will be taken up and it will be subjected to leaching and, first one has to go for pre-treatments, understanding that zinc ash is to be crushed, ground and it has to be brought down to its smaller particle sizes so that the leaching process becomes more efficient and then we can think of

leaching it with suitable reagents. Most common reagent that people have tried is H2SO4 and we can have variation of leaching reagents followed by concentration or purification of leach liquor and after that we can think of extracting or separating out the impurities and extracting out the zinc that is present in the leach liquor and finally if at all it is

possible we can think of precipitating it as zinc carbonate or any other phase or using the whole system of solution as a raw material for electro winning and then we can produce the pure zinc cathode.

Basically, winning it from the solution that is also possible. When we are thinking of hydrometallurgical route we have all of these possibilities we will try and write. And of course, most of the recycling processes of hydrometallurgical in route and we are talking of hot dip galvanization zinc ash. We have leaching. And then we will have separation and purification and we can have precipitation.

And or finally we can also have electrowinning. Finally we will have the zinc metal that is how mostly zinc ash is used as raw material for recovery of zinc. In today's class we have been focusing on what exactly is zinc ash, how it is produced in hot dip galvanization, what exactly was hot dip galvanization. We've seen the process, we've seen that it's an important method of introducing a layer of molten zinc over the objects that need galvanization

let's say iron or steel and we've also seen the chemical composition that in the whole process, we can have around 18 kgs of waste, which includes zinc ash as well as zinc dross. And zinc ash nearly contains around 60 to 90% of metallic zinc that can be recovered. And we have also seen the important elements that are present in zinc ash, the important phases that are present in zinc ash which, apart from zinc metal and zinc oxide, can be zinc chloride hydroxides.

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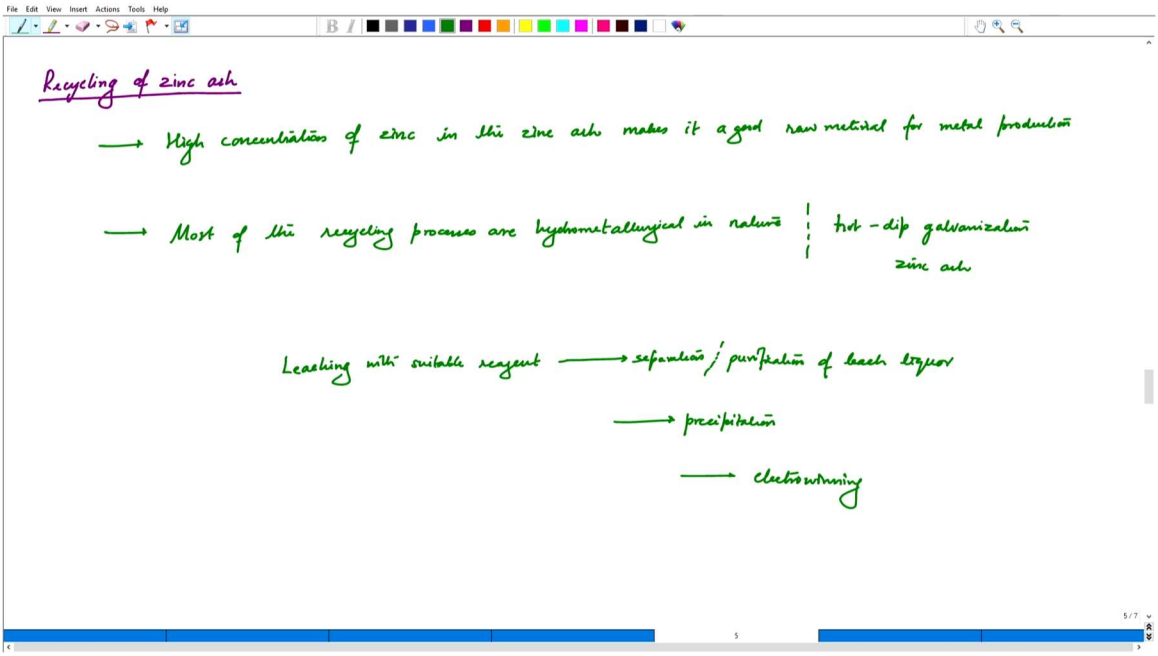

And we know that these phases are important raw materials for extraction of zinc and hydrometallurgy is one of the key dominant routes using which we can extract zinc and we have seen how after leaching we will be going into purification of solution and then electrowinning finally to get the finished metal product. In the upcoming classes we will be continuing more on zinc ash and we will be focusing on the next metallurgical waste that is on zinc. We can have zinc dross, EAF dust and zinc scraps. We will be continuing. Thank you.