A Review of Literature on Copper Smelting and Its Environmental Impact

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Abstract: Copper Smelting is very vital process in the mining and extraction of copper, but at the same time it generates huge amounts of waste which includes slag, tailing, and emissions. These waste affects our environment very badly so managing waste of smelting has become very important. This review highlights the impact of it on environmental and human health. Effective management strategies are essential to manage the adverse effects of copper smelting waste and promote sustainable development in the industry of copper.

Keywords: Copper smelting, Slag, Tailing, Matte, Emissions, Waste, Health Impacts

1. Introduction

when the mining industries makes a large amount of contributions to the whole nation economy but it also causes emissions of a large amount of acidic gases which causes contamination of soil, air, surface water as well as ground water and add hazardous substances into the environment .Abandoned mining sites acts a serious source of pollution ,harming the public health as well as environment ,as copper is a very important metal ,its significance can be seen in various aspects of our lives.

Around 5000 years ago copper was only the metal known to man. Copper played a vital role in ancient times with its discovery from Stone age to Bronze age, earlier in ancient times copper was used in tool making because of its durability it is easier to shape it, it is used in making wire because it's Durability as well as it is a good conductor of electricity.

In the pre- history man uses various weapons made from Copper besides this it was also used in ornamentation and jewellery making. The Egyptians used copper in making jewellery, mirrors and many decorative items, they also used Copper in ship building, in making coins, copper pipes, furniture, utensils and other items.

Copper has also spiritual significance, Copper utensils are considered to be pure and are used for religious rituals and ceremonies.

Important facts about Copper Copper Latin name -Cuprum Symbol –Cu Atomic number -29 Atomic Mass -63.5 gm Electronic configuration -4s²,3d^{10.} Oxidation states - +1 and +2. Position in periodic table – Group number 11 and period number -4.

It is a reddish colour metal found in d block of the periodic table it is also known as Transitions element.

The important ores of copper are:

Ore	Formula
Chalcopyrite	CuFeS ₂
Malachite	Cu ₂ CO ₃ .(OH) ₂
Cuprite	Cu ₂ O

Most Copper Deposits are in open pits and because of these large operations which generate huge number of mines wastes and tailing each day.

The most important concern regarding copper production is the emission of SO_2 and those trace elements like Cd, Hg, as which easily get vaporizes from smelters .

This paper presents an outline to show the impact of the waste on environment produce from metallurgical Industries the physical and chemical process of metallurgy produces industrial waste and causes air, soil and water pollution.

Copper found in nature in the form of its sulphide ore and oxide ore.

Copper extraction globally.



In the above Figure no -1 it shows Copper production globally

Country	Copper extraction (millions tons)
Chile	5.6
Peru	2.4
China	1.6
Other Countries	10.4

Country like Chile produces 5.6 millions tons, while Peru produces 2.4 millions tons while China produces 1.6 millions tonnes and other countries produces 10.4 million tons.



Figure 2: Production capacity of copper in tons / Day from year 1900 to 2020



Figure 3: Energy consumption year wise

We can say that from year 1900 to year 2020 the production of copper increases the energy consumption decreases as well as the emission also decreases. Modern smelters have increase energy efficiency and decreases reduction of waste.

Copper is extracted from its sulphide ore by the process of Pyrometallurgy the process involves Concentration, smelting, refining, and waste management. Nearly 15 billions of tonnes of slags are produce apart from that slag, dust aerosols are produce.

Large amount of SO_2 gases release from smelting of copper SO_2 is an acidic gas and harm soil, trees, building.

Copper smelters during the process contains metals like zinc and lead these metals when are released in environment causing serious health hazards.

Lead and zinc are also found in ore deposits although these elements has different importance like zinc is required by human health and it is considered as essential element.

Whereas lead has no biological effects but lead causes serious health hazards. So, it is very much important to protect the life of people working in mines.

Lead compound like lead oxides and lead sulphate. These gases coming out from industries are more soluble in water and move to the deeper part of the soil. The most important use of lead is its electrical storage batteries. Apart from this As, Cd, also produce in smelters toxic elements.

Process of Copper Smelting

Smelting is a metallurgical process that involves treatment of the ore at a very high temperature the main objective of smelting is to separate the metals from other metals or impurities this is a crucial steps in the extraction of a metal. Smelting of copper involves the following steps:

- Copper ore is extracted from open pit mining
- Extracted ore is converted into smaller pieces.
- The crushed ore is grind into fine powder.
- 4) The powdered ore is then mixed with water and subjected to flotation.
- 5) Then the ore is roasted to convert its sulfides into oxides.
- 6) The roasted ore is smelted and produces copper matte.
- 7) The blister copper is then refined.
- 8) Then it is cast into various shapes.

Chemistry of smelting -

Roasting

The first step of copper smelting is roasting, the purpose of roasting is to convert the ore into its oxide form here the ore is heated in presence of oxygen.

 $\begin{array}{l} Reactions involve in the roasting process are as follows - \\ 2CuFeS_2 + 3O_2 -----2 CuO + 2FeO + 2SO_2 \\ Cu_2S + 2O_2 -----2CuO + SO_2 \end{array}$

The second step is the reduction of this copper oxides into copper here copper oxides is treated with carbon to reduce its oxide form.

CuO + C ----Cu + CO $Cu_2O + C ---- 2Cu + CO$ The third step is to produce higher purity form of copper the reactions involve are

 $\begin{array}{l} Cu_2S+O2 ---- 2Cu+SO_2\\ Cu_2O+Cu_2S -----4Cu+SO_2 \end{array}$

The final step is the refining of copper the chemical reactions involve are as follows - $Cu + O_2$ -----CuOCuO + C -----Cu + CO

The copper produce is pure copper

By Product of Smelting:

Slag is the byproduct of copper smelting process .it is formed by the reaction of silica with other oxides ,such as calcium oxide and iron oxides.

The process of slag formation involve the following steps - $CaO + SiO_2$ -----CaSiO₃ (calcium silicate) FeO + SiO₂ -----FeSiO₃ (Iron silicate)

Matte is also the byproduct of smelting of copper the reactions are as follows - $Cu_2S + FeS$ ----- Cu_2FeS_3 (copper iron sulphide)

IMPACT OF SMELTING

Copper smelters have significant environmental impacts,

Which are discussed below:

Pollution of air

Copper smelters releases sulphur dioxide which leads to acid rain and respiratory Smelting also emit particulate matter which also includes heavy metals like arsenic, cadmium, lead, mercury etc.

Smelters of copper also produces volatile organic compounds which are causing respiratory problems.

Pollution of water

Smelting of copper also generate waste water containing heavy metals which harm aquatic life.

The waste water of smelters seeps into the underground contaminates it. The release of sulfuric acid from copper smelters acidifies nearby water bodies making it toxic.

Due to increase in the concentration of nitrogen and phosphorous which leads to the growth of algae in the water bodies which leads to eutrophication in water bodies.

Pollution of soil:

Smelters wastes accumulate in the soil, the quality of soil gets affected by the disposal of mines tailing Which are acidic lowers the soil fertility, different elements have different retention time like Cd, Ni, Zn has shortest retention while Cu,Pb and Cr has longest retention leaching leads to soil erosion the pH to thew soil also gets affected.

Soil including Bacteria, Fungi, Algae Soil fauna contributes to the integrity of the soil.

As the quality of soil degrades so the growth of cyanobacteria also reduced which reduces the fertility of the soil.

Impact on Health:

Because of emission of SO_2 concentrations which is not good for human this deteriorating the lung functioning because of heavy load in air pollution and stagnant air masses which is very vital and problematic.

People suffer from heartbeat problems, respiratory problems, asthamatic problems, it also has been found that people specially women suffer from osteomalacia.

HC.L (Hindustan Copper Limited) located on the bank of Subarnarekha River has smelters which is used for extraction of copper from its ores.



Figure 4: Convertor (H.C.L)



Figure 6: Refinery Plant of copper (H.C.L)



Figure 8: Smelters (H.C.L)

2. Conclusion

Smelting and mining of metals causes degradation of Environmental quality.

Mining of copper is a very challenging task for the protection of environment. So, Management of smelting waste from copper is very crucial to protect our environment.

Proper strategies should be implemented for reducing smelters waste.

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