M.Sc. IV Semester

MBT- 4003B (Optional)

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Dr. Madhulika Singh

Bioleaching of Metals

Leaching process was first observed in pumps and pipelines installed in mine pits containing acid water. This process was later on employed for recovering metals from ores containing low quantity of the metal. Presently certain metals from sulfide ores and other ores are extracted by employing only leaching method

Copper and Uranium are presently produced commercially by employing bioleaching process

Metals extracted from bioleaching include:

- **Gold**
- **Copper**
- **Silver**
- **Cobalt**
- **Uranium**
- **Zinc**
- **Nickel**

What is bioleaching or biomining?

Extraction of metals from low-grade ores by employing microorganism is called as bioleaching.

Large quantities of low-grade ores are produced during the separation of higher-grade ores and are generally discarded in waste heaps. Metals from such ores cannot economically be processed with chemical methods.

Mechanism of Bioleaching

The process of bioleaching is accomplished by two ways:

(i) Direct bioleaching

(ii) Indirect bioleaching

Direct Bioleaching

Direct bioleaching uses minerals that are easily receptive to oxidation to create a direct enzymatic strike using the microorganisms to separate the metal and the ore.

Thiobacillus ferrooxidans is oftenly used in microbial leaching. It is an autotrophic, aerobic, gram (-) negative rod shaped bacterium. It synthesizes its carbon substances by CO_2 fixation. It derives the required energy for CO_2 fixation either from the oxidation of Fe^{2+} to Fe^{3+}or from the oxidation of elemental sulphur or reduced sulphur compounds to sulfates.

Thiobacillus *thiooxidans* oxidizes insoluble sulphur to sulphuric acid, which takes place in the periplasmic space. It is possible to dissolve iron through direct bacterial leaching

Indirect Bioleaching

Microorganisms are not in direct contact with minerals during the process. However, leaching agents are created by microbes, which still oxidise the ore.

It can be explained by the process of oxidation of pyrite. Pyrite is a common rock mineral that is found in association with many ores. The pyrite is initially oxidized to elemental sulphur, which is subjected to further oxidation by *Thiobacillus ferrooxidans* due to which sulphuric acid is formed

Microorganisms in Bioleaching Process

Thiobacillus thiooxidans **and** ***T. ferrooxidans*** **are generally used in bioleaching methods.**

However, a number of other microorganisms such as ***Thiobacillus concretivorus, P. florescens, P. putida, Achromobacter, Bacillus licheniformis, B. cereus, B luteus, B. polymyxa, B. megaterium*** **and several thermophilic bacteria like** ***T. thermophilica***, ***Thermothrix thioparus***, ***Sulfolobus acidocaldarius*** **etc. may significantly accelerate the bioleaching process.**

Factors influencing Bioleaching

- **Nutrients**
- **O_2 and CO_2**
- **pH**
- **Temperature**
- **Mineral Substrate**
- **Heavy Metals**
- **Surfactants and Organic Extractants**

The Commercial Process

Commercial metal extraction is a quicker process that can be optimized through humidity, potential hydrogen (pH), temperature, and chemical elements.

The 3 most common commercial biomining processes are:

1. **Slope leaching**
2. **Heap leaching**
3. **In situ leaching**

Advantages of bioleaching

- **Bioleaching can stabilise sulphate toxins from the mine without causing harm to the environment.**
- **Poisonous sulfur dioxide emissions harm the environment and can cause health problems for miners, and bioleaching avoids this process entirely.**
- **Bioleaching is more cost-effective than smelting processes.**
- **Some Bioleaching offers a different way to extract valuable metals from low-grade ores that have already been processed**.

Thanks