AgriCos e-Newsletter
ISSN: 2582-7049
AgriCos e-Newsletter
Open Access Multidisciplinary Monthly Online Magazine
Volume: 03 Issue: 01 January 2022 Article No: 09

Bioleaching: A Review

Swetha S. Meti
Assistant Professor, Department of Agriculture Microbiology, University of Agriculture Sciences, Raichur, Karnataka

SUMMARY

Microorganisms like Thiobacillus, Leptospirillum, Aspergillus, Penicillum are used to extract metals from low grade ores by using direct leaching mechanism where there is contact between metal surface and the bacteria following several enzymatic steps and in the indirect leaching mechanism metabolites are produced which help in solubilization of metals. There are certain limiting factors like nutrient supply, oxygen, carbondioxide pH, temperature, microorganisms, surfactants which play key role in leaching process. At laboratory level types of leaching methods are percolator, submerged, and column leaching and at industrial level there are different methods like dump, heap, insitu leaching. Metals that can be used to recover through bioleaching process are gold, copper, uranium etc.

INTRODUCTION

Use of microorganisms like chemolithotrophic bacteria, heterotrophic bacteria, fungi to extract the metals from low grade ores and minerals occuring in the nature provided by suitable conditions is called bioleaching. Microorganisms like *Thiobacillus* which are aerobic, gram negative chemolithoautotrophs and non-spore forming use carbondioxide as their carbon sources and derive energy from reduced sulfur compounds. They carrry out leaching process in acidic conditions and oxidize sulphur compounds which convert metal sulphides in to soluble metal sulphates.Another bacterium *Leptospirillum sp* which grow in acidic conditions help in oxidizing ferrrous iron and cannot oxidise sulphur compounds and it is a mesophilic bacteria. Sulfolobus bacteria oxidize ferrous iron and sulphur and sulphide mineral. Heterotrophic microorganisms like *Bacillus*, fungi like *Aspergillus*, *Penicillium* act on non sulphide ores by the production of organic acids which help in dissolving the heavy metals.

There are different types of laboratory level leaching methods available:

1) Percolator Leaching: perecolator has a glass tube and the bottom is supplemrented with sieve plates which consists of ore particles. The ore particles are flooded with bacterial suspension containing nutrients. the tricklingof leach liquor from the column is pumped up by using sterile air which is compressed to the top of the column for recirculation. At every interval liquid sample of leached suspension is taken to examine the pH, microorganisms, chemical nature of the materials which are passed in to the solution. In this process supply of oxygen will be inadequate, surface ratio also not favourable, this method is slow process lasting 100-300 days and are not unusual.

2) Submerged Leaching: due to the disadvantages of percolator leaching technique it is not practised. In its place submerged leaching take place by using materials which are fine grained having size less than 100 micrmeter. This particle size is suspended in leaching liquid and will be kept in motion by stirring or shaking. Here aeration is of higher rate and control of other parameters helps in growth of bacteria. as a result, reaction time will be lessened and extraction of metal increases.

3) Column Leaching: columns are made either of glass or plastic or concrete lined or steel. Its capacity may range from few kg to tons. This column has devices which can take samples and to control pH, oxygen, it will work on the principle of percolator leaching.

Bioleaching process at industrial level includes 1) dump leaching: here tons of ore is dumped and top of it is sprinkled with material solution continuously. lixiviant is added and the leachate is made to pass through oxidation basin where bacteria is regenerated 2) heap leaching:it is used for fine grained ores. It is done in large basins here the process is same as of dump leaching. But here pipes are placed within heaps for proper supply of oxygen. After every leach heap pile solution of bacteria is sprinkled and the solution is collected and processed for recovery of metal 3) insitu leaching: deposits of ore that cannot be mined by conventional methods are used for insitu leaching. In the fractured ore body bacteria solution are injected in to boreholes then it is collected from pumping at the surface.

Metals which can be extracted from bioleaching are Gold, Silver, cobalt, Uranium, Nickel, copper, Zinc etc, in direct leaching bacteria are found to the sites of the metals and oxidation to sulfate occurs through enzymatic reactions. Hydrogen ions will be produced, pH will be reduced due to direct attack on mineral surface. Redox potential will be increased and sulphide minerals are oxidised in indirect leaching there is no physical contact with mineral surface but bacteria produce a lixiviant which oxidize the sulfide mineral.

Factors affecting Bioleaching

- Nutrients: microorganisms require inorganic compounds for growth since they are chemolithoautotrophy
- Oxygen: oxygen is required for growth and activity of bioleaching by microorganisms
- Carbondioxide: CO_2 is required as a carbon source
- pH: Acidic pH is required for metal solubilization and also required for the growth of bacteria
- Temperature: optimum temperature required is 28-30℃ for ferrous iron and sulfide oxidation. Thermophilic bacteria can be used for leaching at higher temperature.
- Surfactants: reduce surface tension and transfer of oxygen hence these surfactants have an inhibitory effect on bacteria
- Microorganisms: indigenous microorganisms are best adapted and suited and have higher leaching capacity and use of mixed bacteria cultures show higher leaching rate than single bacterial culture and higher number of microorganisms have higher leaching activity.

Advantages of bioleaching: it is simple and cost effective and reduce energy consumption than traditional techniques. Helps in extracting valuable metals from low grade ores

Challenges: at industrial scale bioleaching technologies are used which has some limiting factors. The mechanism between minerals and microorganisms is still not properly understood and it is a complex process. Growth of microbes are highly depended on experimental conditions at laboratory scale.only few genes of acidophilic microorganisms are published. In large scale industrial production, oxygen concentration, pH level and distribution of microbes cannot be maintained as the reaction centres are large which leads to decrease in bioleaching activity. Follow up treatment of the filter residues which contain unleachable heavy metals is also an limiting factor.

CONCLUSION

As the bioleaching process occurs naturally in the environment microorganisms can be easily grown and are found to be naturally adapted to natural conditions. But during the process toxic chemicals are released in to the environment hence biosafety measure should be involved properly and optimization of the process of bioleaching in the industrial productions is also very important.

REFERENCES

Bosecker, K.,1997, Bioleaching: Metal Solubilization by Microorganisms. FEMS Microbiology of Reviews:20:59-64

Gao,X., Jiang, L., Mao,Y., Yao,B., and Jiang, P,2021,Adsorption science and Tecnology:1-13

https://en.wikipedia.org › wiki › Bioleaching