CLEANER TECHNOLOGY FOR MANGANESE RECOVERY FROM ITS ORE THROUGH BIOTECHNOLOGICAL METHODS

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Abstract

Biohydrometallurgy or bacterial metal leaching is the technology which utilizes biochemical oxidation process, catalyzed by living organisms for extracting metals from ores. In India, which has vast resources of various minerals, for both high as well as low grade ores, biohydrometallurgy could be well exploited with the use of suitable microbes. In the present study enrichment of bacteria in nutrient broth is carried out by inoculating mine water samples, soil samples and pipeline deposits. Using streak plate method and pour plate method the enriched bacteria were isolated based on biochemical and morphological characteristics. Acclimatization of bacteria in manganese ore is in progress. Industrial waste was used as the leaching medium and the parameter studied include

- Effect of dilution
- Effect of pH
- Effect of different concentration
- Effect of FeSO4

Keywords: Biohydrometallurgy, Bioleaching, manganese, Periodate

Introduction :

Autotrophic as well as heterotrophic bacteria and fungi play an important role for the industrial recovery of metals from low grade ore or, in general, from low grade mineral resources. The same inorganic bacterial pathways that are responsible for huge and expensive corrorrsion problems can be used for economical biohydrometallurgical applications. Metals and metalloids can be microbially transformed by oxidation reduction, alkylation dealkylation. Solubilization, and precipitation mechanisms Biohydrometallurgy, a branch of classical metallurgy and is not as widely publicized as other areas of metallurgy. e.g.

Biohydrometallurgical processes have a high relevance for cleaner technology. Recycling of materials and waste minimization. And will become a very important subject of research in the future. Uncontrolled microbial activity, e.g. in mine dumps, represents severe environmental hazards. For instance in Sweden. 60% of the release of metals to water occurs as a result of natural weathering processes and microbial activity in mine waste deposits

The expected shortage of raw materials is one of the essential problems currently faced by the world, in general. the perception is focused on the depletion of oil as an energy source, thereby neglecting the exhaustion of mineral ore deposits that are necessary to obtain metals. Since high-grade ore deposits are becoming *rare.* importance of processing low-grade ore has been recognized since the seventies.

Today. biohydrometailurgy is an interdisciplinary subject combining geomicrobiology, microbiology. microbial biogeochemistry and hydrometallurgy.Biohydrometallurgy is a new and promising technology, useful for obtaining valuable metal compounds from ores or for detoxifying industrial waste products. It includes the solubilization of metals Contained in ore, solid residues and others by the aid of microorganisms. The recovery of these metals.

Review Method :

In India, which has vast resources of various minerals, both high as well as low grade ores, biohydrometallurgy could be well exploited with the help of suitable microbes.

Present Status of Work

Water samples collected from Sandur mines, garden soil, manure, sewage and pipeline deposits from NEERI, Nagpur were added to the nutrient broth for enrichment of manganese leaching bacteria. Manganese ore was also added to the nutrient broth.

Using streak plate method and pour plate method, the enriched bacteria were isolated and purified on nutrient agar. Acclimatization of bacteria to

Manganese ore solutions to promote adaptation to higher levels is in progress.

Industrial Wastes as Leaching Solution

Industrial waste was used as a leaching medium and the manganese was estimated in the supernatant. Industrial wastes have the following advantages- Easily available. pH is low which is suitable for Bio-leaching and use of industrial effluent can help in reducing the pollution.

Nutrients required for microorganisms are available in the industrial effluent Experimental Design for Optimizing different parameters for Manganese(Mn) Leaching using Mixed Culture from Industrial Effluents

Parameters Studied (Table A & B)

Effect of dilution

Effect of pH

Effect of different concentration

Effect of $FeSO_4$

TABLE A

EFFECT OF DIFFERENT PARAMETERS ON BIOLEACHING USING INDUSTRIAL EFFLUENTS (DAIRY WASTE) AS LEACHING MEDIUM BY MIXED CULTURE

Sr.No.	Parameters	Condition	Manganese Leached in mg/L			
			0th	7th	14th	21st
				(in days)		
1.	Inoculums size	10% 20% 30%	ND ND ND	30 28 32	10 10 60	ND ND ND
2.	pH	3 5 7 8	ND ND ND ND	60 60 30 40	70 70 40 50	ND 40 50 30
3.	Different Concentration	5 g 10 g 20 g 30 g	ND ND ND ND	10 ND ND 45	50 ND ND 30	110 ND ND ND
4.	Effect of $FeSO_4$		No Leaching			

TABLE B

EFFECT OF DIFFERENT PARAMETERS ON BIOLEACHING USING INDUSTRIAL EFFLUENTS (DISTILLERY) AS LEACHING MEDIUM BY MIXED CULTURE

Sr. No.	Parameters	Condition	Manganese Leached in mg/L				
			0th	7th	14th	21st	28th
				(in days)			
1.	Inoculum size	10% 20% 30%	ND ND ND	10 30 32	10 10 60	20 60 36	ND ND ND
2.	pH	3 5 7 8	ND ND ND ND	140 350 310 140	70 70 40 50	300 640 500 250	310 650 510 260
3.	Different Concentration	5 g 10 g 20 g 30 g	ND ND ND ND	90 30 ND ND	100 60 ND ND	120 70 ND ND	ND ND ND ND
4.	Effect of $FeSO_4$		No Leaching				

Experiment I

The different dilutions studied were 10%, 20% and 30%. Sludge was prepared in the Lab. and to maintain the population of microorganisms the same was used as inoculums.

It was observed that comparatively the experiment with 30% dilution (inoculums size) showed good results.

Experiment II

Similarly the IInd experiment was conducted by varying the pH.

Working volume - 100 ml

pH — **3,5,7,** and 8

Mn added - 20 g

Inoculum - 20%

In this case the Mn leaching was found to be highest in the acidic range, thereby confirming that acidophiles are best suited for bioleaching.

Experiment III

Effect of different concentrations on bio-leaching

Working Volume - 100 ml

pH - 7

Inoculum - 20%

Mn added - 5 g, 10 g, 20 g, 30 g

Mn leaching was found to be highest 5 g Mn experiment thereby proving that leaching is effective in very dilute solutions

Experiment IV

Effect of $FeSO_4$: It was observed that no effective leaching took place.

Distillery Waste (Table B)

Experiment I

Effect of Dilution : It was seen that the best results were observed when the inoculum size was 30%.

Experiment II

Effect of pH : It was observed that Mn leaching was effective when pH was maintained between 5 and 7.

Experiment III

Effect of Different Concentration : Mn leaching was effective when the Mn concentration was 5g.

In general, it was observed that the Distillery waste showed better Mn leaching than Dairy waste thus giving more weight age to the use of Distillery waste over Dairy waste.

Manganese Estimation and Standardization

Manganese estimation was standardized by using Periodate method (Vogel). Using standard curve the amount of manganese present in the leaching medium was estimated.

Results & Discussion

Dairy Waste (Table A)

Dairy waste was collected and its initial characterization was done. It was observed that COD value of the sample was high.

The experiment was set—up in conical flasks and the working volume, pH and Mn added were fixed. The effect of dilution was studied by varying the inoculums size working volume : 100 ml, pH : 7 ml, Mn : 20 g.

Conclusions

Biohydrometallurgical techniques are widespread in the mining industry. Transformations of' minerals by microbial action have been known, especially in the iron industry, since 1888 (Torma 1988). Nevertheless. only a few processes involving the treatment of low-grade or cut off grade ore have been patented. For other mineral resources, such as fly ash, galvanic sludges. soil, or coal fly ash, only a very few patents on biohydrometallurgical.

In future biohydrometallurgy will become more important to support sustainable development future . Bioleaching, as a clean technology has advantages in comparison to conventional thermal solid-waste treatment techniques used in the pyro- or hydrometallurgical industries.

Biohydrometallurgy or bacterial metal leaching is the technology which utilizes biochemical oxidation process, catalyzed by living organisms for extracting metals from ores.

Presently bioleaching is found useful for extracting metals like copper, uranium, molybdenum, lead, gold, zinc, cobalt, nickel, antimony and manganese from their ores.

The main advantages of bacterial leaching technique include

The reaction takes place at room temperature and pressure

- Investment is low
- Energy requirements are nominal
- The process is practically free of pollution

- The process is cyclic and almost continuous

The limitations of the process are :

i) The process is slow

ii) The metal is to be recovered from very dilute solutions.

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