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Microbial processing of apatite rich low grade Indian uranium ore in bioreactor

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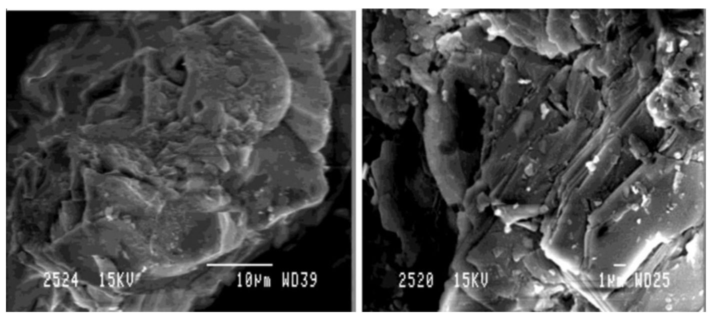
HIGHLIGHTS

- ▶ Bioreactor leaching of uranium by *Acidithiobacillus ferrooxidans* and *Leptosprillium ferrooxidans* improved the kinetics.
- ▶ Uranium leaching was 57% and 63% in 5 days with pure culture of *A. ferrooxidans* and *L. ferrooxidans*.
- ▶ Biogenic Fe(III) with *L. ferrooxidans* and *A. ferrooxidans* leached 90% and 87% uranium in 10 h.
- ▶ Fe(III) biogenically enhances the kinematics of uranium dissolution in bioreactors.

GRAPHICAL ABSTRACT

Leach residues after bioleaching by *A. ferrooxidans* at 35 °C (left) and *L. ferrooxidans* at 40 °C (right) in 10 h.



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ABSTRACT

Bioreactor leaching using enriched culture of *Acidithiobacillus ferrooxidans* and *Leptosprillium ferrooxidans* was investigated for the apatite rich Indian (Narwapahar) uranium ore. Bioreactor leaching of Narwapahar ore of <45 μm size at pH 2.0 and 10% (w/v) PD using 10% (v/v) inoculum of the bacterium at 35 °C (*A. ferrooxidans*) and 40 °C (*L. ferrooxidans*), solubilised 57% and 63% uranium in 5 days, respectively; the E_{SCE} values being 561 and 588 mV. Leaching kinetics improved so much so that ~83% uranium was recovered in just 10 h with 10% inoculum of *A. ferrooxidans* containing biogenic Fe^{3+}; at 20% PD uranium recovery rose to 87%. Role of temperature (25–40 °C) was noticed with 90.3% uranium bioleaching in 10 h at 40 °C with *L. ferrooxidans* as against 77% leaching with *A. ferrooxidans* at pH 2.0, 40 °C and 20% (w/v) PD.

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1. Introduction

As of 2010, India had 20 nuclear reactors in operation in six nuclear power plants, generating 4780 MW power (Abhilash and Pandey, 2013) while seven other reactors are under construction and are expected to generate an additional 5300 MW. India is poised to increase the contribution of nuclear power to overall electricity generation capacity from 2.8% to 9% within 25 years (Abhilash and Pandey, 2013). Uranium as energy source, contributing to nuclear reactors in India, was found at Jaduguda (quartz–chlorite–biotite–schist type) in 1951. The first uranium processing plant was commissioned in 1967 at Jaduguda, Jharkhand. Uranium is conventionally recovered from its ores by chemical method following acid or alkali leaching using an oxidant, and is enriched by ion-exchange/solvent extraction process to precipitate magnesium diuranate (Dwivedy and Mathur, 1995; Abhilash and Pandey, 2013). The continued depletion of high grade ores and growing awareness of environmental degradation associated with the traditional methods have provided impetus to explore simple, efficient and less polluting biological methods in uranium mining, processing and waste-water treatments (Dwivedy and Mathur, 1995). Hydrometallurgical methods have some disadvantages such as lower recovery, involvement of high process and energy cost and increase in pollution load of water resources (Dwivedy and Mathur, 1995). For a country with limited energy resources and for long-term

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