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Synergism of *Pseudomonas aeruginosa* and Fe^0 for treatment of heavy metal contaminated effluents using small scale laboratory reactor

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HIGHLIGHTS

- It shows the feasibility of developing microbial bioremediation technology.
- Present work help in the identification of the opportunity of the effluent treatment in the industrial complexes.
- Scale up demonstration of small scale laboratory reactor to industrial scale reactor for industrial effluent treatment.
- This study leads towards the development microbial technology for precocious metals recovery from the waste stream.

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ABSTRACT

In this study *Pseudomonas aeruginosa* a metal tolerant strain was not only applied for heavy metal removal but also to the solublization performance of the precipitated metal ions during effluent treatment. The synergistic effect of the isolate and Fe^0 enhanced the metal removal potential to 72.97% and 87.63% for Cr(VI) and cadmium, respectively. The decrease in cadmium ion removal to 43.65% (aeration + stirring reactors), 21.33% (aerated reactors), and 18.95% (without aerated + without stirring) with an increase in incubation period not only indicate the presence of soluble less toxic complexes, but also help in exploration of the balancing potential for valuable metal recovery. A relatively best fit and significant values of the correlation coefficient 0.912, 0.959, and 0.9314 for mixed effluent (Paint Industry effluent + CETP Wazirpur, effluent), CETP, Wazirpur, and control effluents, respectively, indicating first-order formulation and provide a reasonable description of COD kinetic data.

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1. Introduction

The contamination of the environment with hazardous and toxic compounds such as heavy metal is one of the major problems which the industrialized nations are facing these days (Masoudzadeh et al., 2011). There are several industrial processes which can generate wastes containing heavy metal ions, the most common examples are the industries with electronic components, electroplating, metal mechanic processing, and mining (Mockaitis et al., 2012). Heavy metal, such as chromium (Cr) and cadmium (Cd) are released into the environment with industrial and domestic wastewater discharge. Due to high mobility and toxicity of hexavalent chromium as compared to trivalent chromium has gained more importance (Singh et al., 2011). The presence of cadmium in water and soil, even at very low concentrations is a serious environmental problem and may cause severe health problems like decalcification, arterial-hypertension, and anemia (Shiwen et al., 1990). Treatment of wastewater containing heavy metal ions is one of the growing requirements in environmental cleaning (Atar et al., 2012).

A wide variety of living and nonliving biological materials are capable of removing toxic and precious metals from the waste streams and offer an economical and effective alternative for sorption technologies (Vijayaraghavan and Yun, 2008). Biosorption by passive binding to microorganisms (bacteria, fungi, and algae) has more potential for treating industrial effluents due to environmental friendly, less costly, elevated metal binding capacity, less sludge generation, and high removal efficiency from diluted effluents (Marcano et al., 2009; Volesky and Mayphillips, 1995). The studies performed with chromium (VI) bioaccumulating microorganisms (Donmez and Koc-Berber, 2005; Dursun et al., 2003) have

Abbreviations: CETP, Common Effluent Treatment Plant; ORP, oxidation reduction potential; COD, chemical oxygen demand; NADH, nicotinamide adenine dinucleotide; NADPH, nicotinamide adenine dinucleotide phosphate; Cr(VI), hexavalent chromium; Cr_{add}, Cr added; Cr_{rem}, Cr removal; sCOD, soluble chemical oxygen demand; lpm, liter per minute; SVI, sludge volume index.

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