Ferrous bio-oxidation by *Acidithiobacillus ferrooxidans* in hydrochloric acid pickling waste liquor

Songyan Qin\(^{a,b,*}\), Yonglei Xie\(^{a}\), Lina Guo\(^{a}\), Dan Shan\(^{c}\), Shumei Li\(^{a}\), Lin Xue\(^{a}\), Jufang Xiao\(^{a}\), Fang Ma\(^{b,*}\)

\(^{a}\)School of Environmental Science and Safety Engineering, Tianjin University of Technology, 300384 Tianjin, China, Tel. +86 22 60214184; email: qinsongyan@tjut.edu.cn (S. Qin), Tel. +86 18822397656; email: xyonglei@gmail.com (Y. Xie), Tel. +86 13821132195; email: glnjy120689@163.com (L. Guo), Tel. +86 13801073182; email: yimei1988@163.com (S. Li), Tel. +86 13822467503; email: 815108915@qq.com (L. Xue), Tel. +86 13802164399; email: 649070349@qq.com (J. Xiao)

\(^{b}\)State Key Laboratory of Urban Water Resource and Environment, 150400 Harbin, China, Tel. +86 451 86282107; email: mafang@hit.edu.cn (F. Ma)

\(^{c}\)Sino-Japan Friendship Centre for Environmental Protection, 100029 Beijing, China, Tel. +86 10 84665906; email: shandan1031@126.com

Received 1 April 2014; Accepted 18 October 2014

**ABSTRACT**

Hydrochloric acid pickling waste liquor (PWL\(_{HCl}\)) is generated in the steel surface cleaning treatment. This process is used to chemically remove the iron oxide scale from steel. PWL\(_{HCl}\) is classified as toxic and hazardous waste in many countries because it contains high concentrations of corrosive hydrochloric acid, ferrous irons, and other heavy metals. These properties pose difficulties for PWL\(_{HCl}\) reclamation and bioavailability of toxic metals in general. The oxidation of ferrous to ferric sediment is a possible route for PWL\(_{HCl}\) reclamation. In this study, *Acidithiobacillus ferrooxidans* (At.f) was applied to PWL\(_{HCl}\) to investigate ferrous oxidation efficiency under low pH and high chloride ion stress. Results indicated that the oxidation ability of At.f remained relatively high when PWL\(_{HCl}\) and 9K medium mixed ratio to 60% (V/V); the species was able to endure the extreme conditions at pH 1.4, ferrous ions 0.04 mol/L, chloride ion 800 mg/L, and maintain the ferrous oxidation rate at 90%. The pH was a critical factor impacting the ferrous oxidation efficiency. Different types of mineral crystal shapes, determined by SEM, illustrated the possibility of a new mineral formation. XRD analysis revealed main composition of minerals as (NH\(_4\))Fe\(_3\)(SO\(_4\))\(_2\)(OH)\(_6\) and infrared spectroscopy indicated that the existence of C–Cl bond promoted the adaptation of bacteria to PWL\(_{HCl}\).

**Keywords:** Hydrochloric acid pickling waste liquor (PWL\(_{HCl}\)); *Acidithiobacillus ferrooxidans* (At.f); Chloride ion stress; (NH\(_4\))Fe\(_3\)(SO\(_4\))\(_2\)(OH)\(_6\)