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TECHNICAL ARTICLE

Biological Removal of High Loads of Thiosulfate Using a Trickling Filter Under Alkaline Conditions

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Abstract Uncontrolled release of thiosulfate can cause high oxygen demand, or generate toxic compounds under anaerobic scenarios. Biooxidation of thiosulfate in a biotrickling filter (BTF) colonized by an alkaliphilic sulfide-oxidizing bacterial consortium was studied at pH ≈ 10. Inlet thiosulfate concentrations were varied from 3.5 to 21.3 g L^{-1}, with a residence time of 216 s, emulating conditions encountered in wastewater from mining processes. Sulfate production, oxygen concentration, and biomass in both packing and effluent were periodically analyzed to characterize bioreactor performance. Removal efficiencies near 100 % were obtained during the entire experimental period, with a maximum elimination capacity of 242 g thiosulfate m^{-3} h^{-1}. Although the BTF was able to transfer large amounts of oxygen to biooxidize thiosulfate to sulfate, under high initial thiosulfate loads, thiosulfate was not completely oxidized to sulfate, since biooxidation was conditioned to oxygen supply. Respirometric tests performed to investigate biomass adaptation and activity revealed oxygen consumption values of 0.5 mmol O_2 (g protein)$^{-1}$ min^{-1} for the period with the highest thiosulfate inlet load.

Keywords Alkalinity · Alkaliphilic bacteria · Bioreactor · Thiosulfate elimination

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Introduction

Reduced sulfur compounds (RSC) in wastewater or gaseous streams can have adverse effects on human health and the environment. RSC are frequently found in effluents from mining operations, petroleum refineries, tanning, the paper industry, and coal processing (Janssen et al. 1997; Sahinkaya et al. 2011). The undesirable emission of wastewater containing thiosulfate is mostly related to the leaching of metal ores. Indeed, the most promising alternative reagent to cyanide for gold extraction is thiosulfate, normally in ammonia solutions and catalyzed by Cu(II) (Abbruzzese et al. 1995; Grosse et al. 2003; Muir and Aylmore 2004). A wide range of conditions have been reported for the leaching of copper-silver-gold bearing materials with thiosulfate, ranging from 10 to 220 g of thiosulfate L^{-1}, temperatures between 20 and 70 °C, and alkaline pH values up to 11 (Aylmore and Muir 2001; O'Malley 2002).

Thiosulfate is metastable; it can be readily decomposed either to polythionates and sulfate under oxygen consuming conditions, or to toxic sulfide ion under anaerobic or reducing conditions (Dhawale 1993; González-Sánchez and Revah 2007; Tykodi 1990). As a consequence, uncontrolled thiosulfate disposal can cause de-oxygenation of waterways and potential formation of toxic compounds.