

Catalytic oxidation and removal of thallium(I) by zero-valent Al

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Abstract

Thallium (Tl) is a highly toxic trace element that has been applied in industrial activities. Due to intentional or unintentional discharges of wastewaters from the industries, Tl can be found in agriculture fields, aquatic environments, or even in the drinking water systems. Consequently, Tl may enter the food-chain and threaten human health due to its high toxicity. Tl(I) and Tl(III) are two major oxidation states of Tl in the aqueous environments. The oxidation of Tl(I) to Tl(III) followed by precipitating Tl(III) to Tl(OH)₃ via pH adjustment is considered as an efficient strategy for the remediation of Tl contaminant. Therefore, we aimed to apply the Fenton-like reaction with the amendment of zero-valent aluminium (ZVAL) to trigger the Tl(I) oxidation. Results showed that approximately 67-94% Tl(I) could be oxidized using aluminium beverage can pieces and powder in the ZVAL/O₂ system within 360 min at pH 1.0. Upon Tl(I) oxidation, the solution pH was adjusted to pH 8 to precipitate Tl simultaneously with Al(III). The Tl-Al(III) co-precipitates were then examined using the Tl L₃-edge X-ray absorption near edge structure (XANES) technique. The results of linear combination fitting (LCF) proved Tl(I) oxidation and confirmed that Tl(III) was the only Tl species in the co-precipitates. Chemical analyses will be conducted to evaluate the stoichiometric reactions of Tl and ZVAL and the removal efficiency of Tl through the oxidation-precipitation processes.