ALTA 2024 28
27 - 31 May | Perth, Australia

PHOSPHATE REMOVAL FROM WASTEWATER USING CALCIUM SILICATE BY-PRODUCTS DERIVED FROM THE LIENA® PROCESS

By

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ABSTRACT

Phosphorus is an important nutrient for living cells. Phosphorus is present in soils, sediment, and water in various chemical forms, most commonly as the phosphate (PO_4^{-3}) species. High phosphorus concentrations in aquatic environments may result from agricultural and urban runoff, leaking septic systems, or discharges from sewage treatment plants. Phosphorus abundance can cause eutrophication of water bodies and may lead to algal blooming which can be toxic to humans and animals. On the other hand, phosphorus is a finite resource. Consequently, phosphorus removal is important and in addition the recovery and recycling of phosphorus for applications such as fertilizer manufacture would be beneficial. This study evaluates the use of calcium silicate by-product (CSB) residue derived from the LieNA® process to remove phosphate from wastewater systems.

LieNA® is a novel technology, developed by Lithium Australia Limited, to extract lithium directly from α-spodumene without the requirement for high-temperature conversion to β-spodumene. XRF, SEM, and TIMA analysis reveal that the CSB residue mostly comprises calcium, sodium, silicon, and oxygen. Phosphate removal experiments using CSB were conducted under a variety of conditions. The CSB showed good adsorption properties for the removal of phosphate from simulated phosphate-containing wastewater. Phosphate removal efficiency was strongly controlled by the dosage of CSB, the initial pH of the solution, and the adsorption time. Phosphate removal efficiency reached 99% after 24 hours adsorption time, at a temperature of 25°C, adsorbate dose – 20g L^{-1}, initial pH of 12, and a 100-rpm stirring speed. The phosphate adsorption had reached equilibrium after 24 hours and the adsorption capacity under these optimum conditions was 4.93 mg PO_4^{-3} per gram of CSB.

The data from adsorption kinetic measurements were well fitted by a pseudo-first order model. The phosphate recovery efficiency with CSB was compared to that for other calcium compounds, specifically laboratory-grade calcium hydroxide and calcium meta silicate, both of which have been proven effective for phosphate removal in different research studies. In the present research, CSB exhibited 57% removal efficiency for Hg whereas the removal efficiency of selected toxic metals (Zn, Cu, Cd, Pb and As) was observed to vary between 10-20% after 24 hours adsorption time, at 25°C, with adsorbate dose of 5 g L^{-1}, initial pH of 5, and stirring speed of 100 rpm. This investigation has therefore clearly demonstrated the potential for using CSB to reduce the concentration of phosphate and toxic elements from wastewater.

Keywords: LieNA® residue, adsorption, wastewater treatment.