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Comparative Evaluation of Operating Life for Phosphate-Specific Ion Exchange Resins

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Project Title: “Comparative Evaluation of Operating Life for Phosphate-Specific Ion Exchange Resins”
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Introduction

A long-term study of three phosphate-selective ion exchange resins will be conducted to determine phosphate removal performance after at least 15 operational cycles. Ion exchange (IX) for phosphate removal provides excellent wastewater effluent quality and a high concentration phosphate stream for recovery of phosphorus (P), a valuable agricultural resource. Three resins previously shown to selectively remove phosphate from large volumes of wastewater before requiring regeneration for the next operation cycle will be tested, including: LayneRT, Dow-HFO-Cu, and Dow-Cu^{1,2}. Fifteen or more cycles of IX and subsequent regeneration will be conducted in column mode using these resins. Secondary effluent filtered and dosed with P will be used as the column influent. Outcomes to be investigated include IX capacity during each cycle, P desorption, metal leaching, and an economic analysis. The goal is to determine the long-term viability of the resins through direct comparison.

Significance

Phosphorus is mined and applied as fertilizer to improve crop yields³. This process requires energy and the mineral P may be depleted within the next 50 years⁴. Some of this P is taken up by crops; humans consume the food and excrete P. During wastewater treatment, P is typically removed through settling, biological uptake, and/or precipitation⁵. However, biological removal requires energy to provide microorganisms oxygen and precipitation requires metal salts which affect the fertilizer quality of biosolids⁵. In order to reduce energy and material use for fertilization and wastewater treatment, why not recover phosphate from wastewater for use as a fertilizer? As phosphate rock becomes depleted, recovery of phosphate may become more economical than mining phosphate thereby producing a revenue source for municipalities, benefiting the environment and providing food security³.

Forward Thinking/Innovation

Testing the resins for multiple cycles provides more information regarding the potential to operate IX at full-scale. Short-term batch and column mode tests of the media have been conducted, but no long-term testing has been performed. The proposed work will determine the ability of the resin to maintain performance over a long period of time. If resins are to be economically favorable for use in wastewater treatment plants, the media must be able to remove P for many operational cycles. Running columns for 15 or more cycles will provide the change in IX capacity over time. This data can be extrapolated to longer periods of time as the rate of change should remain constant after steady state conditions have been reached following the first few IX cycles. Additionally, an economic analysis including capital cost, operational cost, and resin life span can be conducted to determine the most financially favorable media.

Student Involvement

Allen Williams will be the lead on the IX column testing with support and collaboration from Dr. Mayer. Mr. Williams will operate and maintain the column apparatus. An undergraduate student will help Mr. Williams in collecting and preparing sample, measuring sample constituents, and measuring influent and effluent phosphate. Mr. Williams and Dr. Mayer will be responsible for data analysis and dissemination of the results.

References

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