RESPONSE SURFACE METHODOLOGY AND PARTICLE SWARM ALGORITHM OPTIMIZATION OF DONNAN DIALYSIS FOR ALUM RECOVERY.

J. Darmey[1*], S. Rathilal[2], E.K. Tetteh[3], J. C. Ahiekpor[4], and K. E. Tabbicca[5]

[1*] Chemical Engineering Department, Durban University of Technology, Berea-Durban, 4001, South Africa and Chemical Engineering Department, Kumasi Technical University, Kumasi, 854, Ghana.

[2]Chemical Engineering Department, Durban University of Technology. Berea-Durban,4001, South Africa.

[3]Chemical Engineering Department, Berea-Durban, 4001, South Africa.

[4]Chemical Engineering Department, Kumasi Technical University, 854, Kumasi, Ghana.

[5]Chemical Engineering Department, Kumasi Technical University, Kumasi, 854, Ghana.

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[*]Presenting Author email: 22290157@dut4kife.ac.za/james.darmey@kstu.edu.gh.

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Abstract

Purpose: Approximately 50–65% of the sludge produced in water and wastewater settings ends up in landfills, which is extremely dangerous for the environment and public health. According to Ahmad *et al.* (2016), the majority of this sludge is made up of complex salts based on Fe/Al as well as other hazardous substances like barium, lead, arsenic, and other heavy metals. Notwithstanding the intricacy of sludge, attention is being paid to the recovery of important resources like coagulants, rich nutrients for fertilizer, and biogas energy potential. Herein, a lab-scale study by the Donnan dialysis process for the recovery of Al-based coagulant from portable water sludge has been reported to be effective. (Asante-Sackey *et al.* 2021; Asante-Sackey *et al.* 2018; Prakash and SenGupta 2005). Although Asante-Sackey et al. (2021) further optimized the donnan dialysis (DD) process, little is known about the industrial use of recovered Al-based coagulants for wastewater pre-treatment. The goal of this research is to better understand the use of Donnan dialysis and how to recover aluminum from potable water treatment residue (PWTR) using Box Behnken Design (BBD) and Particle Swarm Optimization (PSO).

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Design/ Methodology/ Approach: The experiment was designed, ANOVA was conducted, and process optimization was carried out using Design Expert Software and MATLAB. The BBD was conducted under random conditions with 16 experiments for each of the three factors. The response was the percentage recovery, and the RSM was employed to assess how the components of three degrees of concern: low (-1), medium (0), and high (+1). The low and high extremes were 50–99%. For feed flowrate, 200–900 mg/l for feed concentration, and 0.1-0.75 M for sweep concentration. After, optimisation was done on the data obtained using BBD in design expert software and PSO in MATLAB

Findings: The impact of each factor and the ideal circumstances for high coagulant recovery are clearly shown using RSM in conjunction with BBD in this investigation. An interactional effect is clearly established and a distribution point that is fully at the regions of interest is provided using BBD to develop the experimental run. The generated quadratic statistical model was significant with a low P-value (<0.001) based on the experimental results. According to the statistical prediction based on the experimental results, high recoveries up to 89% are possible. Also, optimisation done with BBD in design expert gave a Al recovery of 89.24% (from feed flowrate of 55.77%, feed concentration of 250.677 mg/L and sweep concentration of 0.1 M) which was small than the optimised Al recovery obtained from PSO, that is 91.15% (from feed flowrate of 50%, feed concentration of 308.96 mg/L and sweep concentration of 0.1 M)

Practical Implications

This study is to explore the potential of recovering coagulants from waterworks sludge by DD process for the pretreatment of wastewater, optimize and modelled the data obtained for the development coagulant recovery plant for industrial wastewater and water applications.

Social Implications: Recovery of coagulant residue from PWTR will go a long way to minimize environmental problems, such as land and water pollution, and economic commitments to uncontrolled and controlled disposal of

PWTR.

Originality and Value: This study contributed to the pool of knowledge on how recycle our waste into useful products.

References

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