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Low-cost Treatment Method for Organic Matter and Nutrients in Landfill Leachate-Batch Sorption Experiments

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Abstract

In this study, the ability of a low-cost composite adsorbent prepared using Washed Sea Sand (WSS), Dewatered Alum Sludge (DAS), Zero Valent Iron (ZVI), and Granular Activated Carbon (GAC), to treat Organic Compounds in terms of COD, Total Nitrogen (TN) and Total Phosphorus (TP) was investigated. The percentages of the materials used for the composite are DAS 40%, WSS 40%, ZVI 10%, and GAC 10%. The results of the study indicated that the removal efficiency of COD in landfill leachate by the composite adsorbent was $79.93 \pm 1.95\%$, which was followed by DAS (10.1%), WSS (51.3%), ZVI (42.0%), and GAC (100.0%). The corresponding adsorption capacity was 8.5 mg/g by the composite adsorbent and adsorption capacities of GAC, ZVI, WSS, and DAS were 24.39 mg/g, 2.27 mg/g, 7.01 mg/g, and 1.70 mg/g, respectively. Further, the maximum removal efficiencies of the composite adsorbent for TN and TP were 84.9% and 97.4%, respectively, and the respective adsorption capacities were 1.85 mg/g and 0.55 mg/g. A study on the behaviour of the equilibrium data of COD and nutrient adsorption revealed that Elovich and Langmuir isotherm models provided the best fits. Further, batch studies on the composite adsorbent media indicated that the optimum COD removal took place at a temperature of 35°C , an initial concentration of 398 mg/L, and pH of 5.55. The importance of the composite lies in the fact that it can treat more than one contaminant simultaneously. In addition, the application of used materials is sustainable as proper disposal sites are highly limited. According to the results of the study, 200 times diluted leachate having a COD value of 380 mg/L can be treated up to a percentage efficiency of 80%, by the composite adsorbent. The data were statistically analyzed. The result showed the ability of the composite adsorbent to be used as packing media in any landfill-leachate treatment system or any treatment system targeting COD of any given wastewater of the same characteristics as landfill-leachate. Packing media can be either filtration media in pump-and-treat treatment systems or reactive media in permeable reactive barriers. This research was based on a mass range of 3-18 g within 180 minutes. However, further research on a widened mass range within a longer time period is needed.

Keywords: Adsorption, Batch sorption experiments, Composite adsorbent, Landfill-leachate, Organic matter