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Removal of Nitrate and Phosphate in Wastewater by Composite Rice Husk Ash and Dolomite

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Abstract

Excess nitrate and phosphate present in water contribute to water quality degradation, altering the structure and functions of aquatic ecosystems, and also induces socio-economic impacts by facilitating eutrophication. Although many techniques are available for the removal of nitrate and phosphate from wastewater, adsorption using solid materials as adsorbents is simpler, more effective, and cheaper process than other techniques due to the possibility of using any conventional or non-conventional material as the adsorbent. Therefore, this study was conducted to investigate the potential of composite rice husk ash and dolomite to remove phosphates and nitrates in wastewater by adsorption. Batch studies were conducted for composite rice husk ash and dolomite to determine the effect of pH, initial concentration, and contact time on the anion adsorption. For that, the sieved RHA and dolomite were mixed in 1:5 ratio and used as the adsorbent maintaining adsorbent concentration at 60 gL^{-1}. The adsorption capacity of composite rice husk ash and dolomite for the removal of phosphates and nitrates was evaluated in the range of pH 3 to 9, changing initial anion concentrations from 20-200 mgL^{-1} for 24 h contact time. According to the results, overall adsorption of both phosphates and nitrates onto composite rice husk ash and dolomite was increased with the increase in pH. The adsorption of both phosphates and nitrates reached highest level at pH~8. Furthermore, isotherm studies showed that the adsorption of both phosphate and nitrate onto composite rice husk ash and dolomite was well fitted to the Langmuir isotherm model indicating a monolayer adsorption. The dimensionless constant was ranged in between 0 and 1 for both phosphate and nitrate adsorption indicating a favourable adsorption with a strong affinity between the solute and the adsorbent. The maximum adsorption capacities of phosphate and nitrate were 5.59 mg g^{-1} and 1.84 mg g^{-1}, respectively. According to the kinetic studies, adsorption of both phosphate and nitrate was well described by pseudo second-order model suggesting chemical sorption. Importantly, the equilibrium for phosphate and nitrate adsorption was achieved within just 60 minutes and 45 minutes, respectively under the experimental conditions. In summary, this study concludes that rice husk ash and dolomite composite is an effective adsorbent for the removal of phosphate and nitrate in wastewater, offering an eco-friendly and cost-effective alternative for addressing water pollution challenges, thereby contributing to the restoration of water quality, and associated socio-economic well-being.

Keywords: Adsorption, Isotherm models, Kinetic models, pH, Phosphate, Nitrate