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Removal of Organics and Phosphate from Rice Mill Wastewater using Crab Shell Biochar

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Abstract

Exponential population growth drives increased demand for rice, causing a surge in rice mill industries. Unfortunately, the effluent from these mills, although lacking toxic compounds, contains elevated levels of Chemical Oxygen Demand (COD), nitrate, and phosphate, posing an environmental threat. This paper explores the use of crab shell-derived biochar to purify rice mill wastewater by removing organics and phosphates. The objective of the study is to meet environmental standards through wastewater treatment using crab shell derived biochar. In this study, crab shell biochar was prepared via controlled slow pyrolysis, involving cleaned and dried crab shells pyrolyzed at temperatures between 350-400º C for 3 hours. Adsorption isotherm tests used varying crab shell biochar doses (2.5-20 g/L) in 100 mL glass flasks filled with rice mill wastewater. The control experiment was done without biochar. Agitation lasted six hours at 150 rpm; samples were filtered through Whatman grade 1 sheets. Kinetic experiments examined the adsorption rate with 15 g/L of crab shell biochar in 100 mL of wastewater for varying contact times 30 mins to 1,440 mins. Then the samples were filtered through Whatman grade I papers, and primarily analysed for COD, and phosphate. Crab shell biochar achieved optimum removal efficiencies, i.e., 76.8% of COD at 15 g/L, and 64.4% of phosphates at 15 g/L dosage were observed. Kinetic study revealed the optimal contact time for the optimum removal organics and phosphates was 400 min at 15 g/L at the 150 rpm shaking speed. The adsorption capacity of crab shell in treating rice mill wastewater for COD and phosphate were 1040 mg/g and 4.9 mg/g respectively. The Langmuir and Freundlich models revealed the correlation coefficients (R^2) were 0.9475 for COD and 0.91059 for phosphate. The Pseudo 2nd order model best fits both COD and phosphate adsorption, with correlation coefficients (R^2) of 0.99978 and 0.99976, respectively, suggesting the removal mechanism as chemisorption with electron sharing or exchange. This study underscores biochar's potential in treating rice mill wastewater and reducing pollutants, aligning with zero-waste principles for sustainable water pollution control.

***Keywords**:* Bio sorbents, Biochar, Paddy straw, Crab shell biochar, Rice mill wastewater