Goldschmidt 2025 Abstract
https://doi.org/10.7185/gold2025.26126

Waste-to-resource conversion: sludge derived hydrochar for contaminant removal and wastewater treatment

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This research investigates the possibility of developing hydrochar produced from sewage sludge as an advanced mechanistic adsorbent for treating wastewater in the context of sustainable resource management and pollution mitigation. The sewage sludge was collected from two sewage treatment plants, Jagjitpur, Haridwar, India from 18 MLD Activated Sludge Process (ASP) reactor and 68-MLD Sequencing Batch Reactor (SBR). The sludge was converted into hydrochar through washing, drying, and hydrothermal carbonization at three different temperatures: 180°C, 210°C, and 240°C-for three hours. The comparative study aimed to evaluate the adsorptive performance of hydrochar generated at 180°C.

The hydrochar was tested for its adsorption capacity against seven dyes: crystal violet, indigo carmine, methylene blue, malachite green, tartrazene yellow, orange-G, and Congo red. Adsorption behavior was determined using different adsorption isotherm and kinetic models. Maximum adsorption capacities calculated from adsorption isotherms and kinetic modeling respectively 25 mg/g and 4 mg/g. The optimized hydrochar derived from the 180°C treatment can remove >95% of malachite green, methylene blue, crystal violet, and Congo red from aqueous solution. Most importantly, hydrochar derived from the 18 MLD ASP has better adsorption performance than hydrochar from the 68 MLD SBR plant.

This research study prospect hydrochars as cost-effective eco-friendly alternatives to tertiary wastewater treatment. It also contributes to environmental management approaches aimed at the dye pollution and sludge disposal problems while promoting environmental waste-to-resource conversion and circular economy principles.

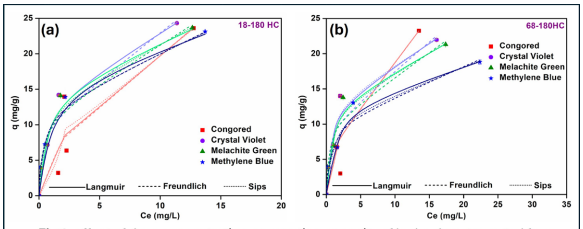

Fig 1: effect of dyes concentration on sorption capacity of hydrochar generated from (a) 18-MLD and (b) 68-MLD plant sewages