



Waste of pine seeds as bio-removal agent for methylene blue from aqueous solution: regeneration and single-stage batch design

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ABSTRACT

The wastes of pine seeds after juice extraction were tested to remove the methylene blue from artificially polluted solution. The effect of heat treatment at various temperatures (100°C, 200°C, 300°C, 400°C, and 500°C) of these wastes, were investigated. These materials were characterized using Fourier transform infrared spectroscopy, X-ray diffraction, energy dispersive X-ray spectroscopy, scanning electron microscopy, and thermogravimetric analysis (TGA). The results indicated that their wastes were mainly composed of carbon, with a non-crystalline phase. Poly-functional groups on the surface were detected and were essential for the elimination of methylene blue dyes. The maximum removal capacity was estimated using the Langmuir model, and it was estimated to 110 mg/g at higher pH of MB solution of 11. The removal process was considered as endothermic process, and it occurred spontaneously. The regeneration process showed that the removal property was achieved after four cycles, with a decrease of removal percentage of 15%. A single-stage batch absorber design for MB removal has been suggested based on the Langmuir isotherm model equation.

Keywords: Pine seeds; Biosorbent wastes; Removal; Methylene blue; Mass balance; Single-stage batch design

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