

Production of biochar from oil palm frond by steam pyrolysis for removal of residual contaminants in palm oil mill effluent final discharge

ABSTRACT

Advances in biochar production and modification have extended the applications of biochar to wastewater treatment. However, not all feedstocks produced porous biochar at a moderate temperature suitable for wastewater treatment. In this study, biochar was produced from oil palm frond using steam pyrolysis at 500 °C and pulverized to granular and micro-fine particles. Both biochar particles were characterized and applied as adsorbents for treating final discharge of palm oil mill effluent. The effluent was also filtered and treated to examine the effect of suspended solids on adsorption capacity. The biochar had Brunauer-Emmett-Teller surface area of 406.6 m² g⁻¹. Pulverization eliminated the residual macropores in granular biochar, created new external surface area, and exposed constricted nanopores, which resulted in increasing the surface area to 457.7 m² g⁻¹. The adsorption capacity decreased from 24.6 to 6.1 mg g⁻¹ for chemical oxygen demand and 49.0 to 10.9 Pt-Co g⁻¹ for color by increasing the dosage of micro-fine biochar from 5 to 30 g L⁻¹. The total suspended solids affected the adsorption capacity of granular biochar by blocking residual macropores that provide access to adsorption sites in micropores and mesopores. At 30 g L⁻¹, the micro-fine biochar exhibited an effective reduction of chemical oxygen demand from 224 to 41.6 mg g⁻¹ and color from 344 to 15 Pt-Co g⁻¹ making the wastewater suitable for reuse in palm oil mills and safe for discharge into the aquatic environment.

Keyword: Oil palm frond; Steam pyrolysis; Biochar; Palm oil mill effluent final discharge