

One-step steam pyrolysis for the production of mesoporous biochar from oil palm frond to effectively remove phenol in facultatively treated palm oil mill effluent

ABSTRACT

Conventional aerobic treatment of facultatively treated palm oil mill effluent (POME) containing phenolic compounds such as phenol, encounters difficulty because of microbial inhibition. In this study, adsorption of phenol in facultatively treated POME was proposed as a solution for mitigating the inhibition. Low-cost biochars produced from oil palm frond using nitrogen or steam pyrolysis at 600 °C were characterized and investigated for efficient and effective removal of phenol. Nitrogen and steam pyrolysis yielded mesoporous biochars with Brunauer–Emmett–Teller surface area of 368.4 m²/g and 461.3 m²/g respectively. Within 8 h, steam-derived biochar attained equilibrium capacity of 59.6 mg/L in distilled water, which decreased to 18.5 mg/L in facultatively treated POME. Steam-derived biochar exhibited slightly higher adsorption capacity for phenol in facultatively treated POME due to higher surface area, wider nanopore size distribution, a larger volume of mesopores and a stronger affinity for phenol. More than 90% of phenol was removed using 16–20 g/L dosage, yielding a facultatively treated POME with 0% inhibition to aerobic microbial growth. Overall, low-cost biochar produced from oil palm frond can be used as an efficient and effective adsorbent for adsorbing phenol in facultatively treated POME to enhance the performance of aerobic treatment system.

Keyword: Oil palm frond; Biochar; Facultatively treated palm oil mill effluent; Phenol