ABSTRACT

This thesis proposes a circular valorization strategy that integrates sugarcane leaves into the existing bagasse-based biochar value chain to produce high-performance adsorbents for the remediation of polycyclic aromatic hydrocarbons (PAHs) from wastewater. Activated biochars were synthesized from sugarcane leaves (SLAB), sugarcane bagasse (SBAB), and their blends via controlled pyrolysis (500-600 °C under nitrogen) followed by physical activation with CO_2 at 800 °C. Material characterization using Brunauer-Emmett-Teller (BET) analysis, scanning electron microscopy (SEM), and Fourier-transform infrared spectroscopy (FTIR) demonstrated significant improvements in surface area, pore development, and aromatic carbon content after activation. A significant improvement in porosity was achieved following the activation process, with the surface area of bagasse-based biochar increasing to nearly 762 m^2/g from its initial value of less than 71 m^2/g. Similarly, the optimized biochar derived from sugarcane leaves exhibited a surface area of approximately 392.1 m^2/g while maintaining a yield close to 23.8%. The biochar surface's abundance of oxygen-containing functional groups promotes adsorbate attachment through aromatic interactions, hydrogen bonding, electrostatic effects, and van der Waals forces.

Overall, the thesis demonstrates that sugarcane leaves can be effectively integrated into the established bagasse-based biochar value chain to produce cost-efficient adsorbents for PAH remediation under laboratory-scale conditions. By linking agricultural waste management with wastewater treatment, the study advances circular bioeconomy principles, supports carbon sequestration strategies, and provides experimental evidence, mechanistic insights, optimization frameworks, thereby providing a scientific basis for future investigations involving multicomponent PAH systems, continuous-flow operation, and pilot-scale validation for sustainable agro-industrial wastewater treatment.