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Synthesis of granular activated carbon from biomass and correlation of its sorption properties with the pore space characteristics

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Granular activated carbon (GAC) produced from the thermochemical treatment of biomass wastes can be valorized as a low-cost adsorbent for the removal of various types of pollutants from water streams. Several GACs were prepared from banana peels and coffee wastes with their chemical activation by acids or alkalis and subsequent pyrolysis in a tubular furnace at temperatures ranging from 500 to 800 oC. The capacity of GACs to adsorb a mixture of a cationic (methylene blue) and an anionic (orange G) dye as well as a polyaromatic hydrocarbon (phenanthrene) was evaluated. To this direction, the sorption isotherms and kinetics were determined with batch tests and fitted with a variety of phenomenological models (e.g. Langmuir, Freundlich, 1st order, 2nd order, intraparticle diffusion). In addition, the pore structure properties of adsorbents were analyzed with Scanning-Electron-Microscopy (SEM), nitrogen sorption isotherms, and mercury intrusion porosimetry (MIP) so that the pore volume distribution over the macro-, meso-, and micro-pore sizes, along with the specific surface area distribution among the external surface of particles and internal pore surface were determined (Fig.1). This information was utilized to simulate the dynamics of pollutant sorption on the pore structure of GAC with the multi-compartment model so that the external and internal mass-transfer coefficients along with the effective pore and surface diffusion coefficients were estimated with inverse modeling. In this manner, the rate-controlling step of sorption process was correlated with GAC characteristics, pollutant type, and sorption conditions. The potential to regenerate the adsorbents by cold plasma was also investigated, and the various types of GAC were classified with respect to their sorption efficiency, and energy cost of production and regeneration.

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Participation

In-Person

References

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