

Abstract

India is one of the largest producer of sugarcane and sugar industry is one of the major agro-industries. Bagasse, the fibrous residue obtained after juice extraction, is used as a fuel in boilers for steam and electricity generation. Bagasse ash is produced as a result of combustion of bagasse and creates disposal problems. Bagasse ash contains mainly silica (49-65 %) and unburned carbon (16-33 %) both of which if utilized properly can prove to be very useful.

The present work focused on utilization of unburned carbon present in bagasse ash for the synthesis of activated carbons and monoliths. The unburned carbon was separated through floatation technique and was used as-such and for the preparation of activated carbons in a rotary kiln and high temperature muffle furnace. The monoliths were prepared using these starting carbons and four types of binders (three phenolic resins and one cellulosic based) by adopting slurry based procedure using different carbonization conditions. The prepared carbons and monoliths were characterized by means of various techniques such as TGA (Thermal Gravimetric Analysis), nitrogen adsorption/desorption, SEM (Scanning Electron Microscopy), FTIR (Fourier Transform Infrared spectroscopy) and Boehm titration to determine the thermal, textural, morphological properties and the surface functional groups present.

The separated carbon showed surface area of 362 m²/g which was increased in activated carbons (up to 601 m²/g). Among monoliths, the box monoliths showed better results when prepared with activated carbon and solid phenolic resin binder (P3) whereas reactor monoliths showed better results with separated carbon and P3 binder showing BET surface area up to 800 m²/g. The starting carbons and monoliths were tested for aqueous phenol adsorption and removal of volatile organic compounds (VOCs). The box monoliths showed 36-80 % of phenol removal at low phenol concentration whereas reactor monoliths showed 128 mg/g maximum phenol adsorption capacity. The adsorption isotherms were marginally better fitted to Freundlich model than Langmuir model. The adsorption kinetics followed pseudo-first order model and intraparticle diffusion was one of the rate controlling steps in the adsorption process. The phenol adsorption was found to be feasible and spontaneous and showed exothermic nature of adsorption. Activated carbon monoliths showed adsorption capacities as high as 22.5, 31.1, 27.5 and 25.0 g/100g for toluene, benzene, xylene and hexane respectively. The adsorption capacities were reduced for the corresponding monoliths. The AC7 and reactor monoliths that were tested for dynamic adsorption of toluene showed 213 mg/g and 109 mg/g adsorption capacity respectively. The experimental results were best fitted with pseudo-first order model showing good agreement with calculated adsorption capacity. The adsorption capacities could be correlated to the textural properties and the surface groups.