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Abstract

Green Processing of Porous Biomass Fly Ash Monoliths with Methylene Blue Adsorption Capacity †

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Water contamination by dyes is a major worldwide issue. Intensive research has therefore been carried out to develop new materials for wastewater treatment.

In this work, biomass fly ash (BFA)-based monolithic porous adsorbents were produced by a cheap and green process. The monoliths were obtained after 14 days of curing just by mixing BFA and water, taking advantage of BFA's self-hardening ability.

The BFA was characterised in terms of chemical (XRF) and mineralogical (XRD) composition, particle size distribution (laser diffraction, COULTER), and morphology (SEM). To increase the total porosity of the monolith's aluminium powder (AP), it was tested as a porogenic agent. The effect of AP content on the porosity (total and open), density, compressive strength, and structural characteristics of the synthesised porous monoliths was investigated. The starting monoliths' total porosity was ~59% with a high rate of open porosity (almost 100%). The total porosity was increased up to ~73% by adding 0.09 wt.% of aluminium powder.

The produced monoliths were tested for methylene blue (MB) adsorption, one of the most commonly used colouring agents in various industries such as textiles or leather. For the highest porous samples, the MB removal efficiency, within 25 h, reached 80% and 50% for an initial MB concentration of 1 ppm and 15 ppm, respectively. The results also showed that the equilibrium adsorption data were well characterised by a Langmuir isotherm equation Type 2 (R^2 ~ 0.98) with a monolayer sorption capacity that ranged from 0.22 to 0.66 mg/g.

Thus, the obtained results validate the possibility to valorise the BFA in an added-value application. This is particularly important considering the huge quantities of BFA generated worldwide in heat and power production units and the fact that they are generally disposed of in landfills, a practice with a high economic and environmental burden.

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