ABSTRACT

Lapindo mud is a disaster by-product that contains valuable minerals, particularly alumina (Al_2O_3), which can be processed into high-value functional materials. With an alumina content of 18%, this study utilized Lapindo mud as a precursor for synthesizing mesoporous alumina, known for its high surface area and favorable pore distribution, making it effective as an adsorbent. The synthesis was carried out using the sol-gel method with dual surfactants, cetyltrimethylammonium bromide (CTAB) and stearic acid, serving as pore-forming and size-controlling agents. The experimental procedure involved alumina extraction using NaOH solution, followed by sol-gel synthesis, aging, filtration, washing, drying, and calcination to obtain stable mesoporous structures. Characterization results revealed that FTIR confirmed the presence of characteristic Al–O groups and the removal of surfactants after calcination, while XRD analysis indicated the formation of γ-Al_2O_3 phase. Gas sorption analysis (GSA) demonstrated that sample AM05 exhibited the best performance with the highest surface area (31.86 m^2/g), largest pore volume (0.059 cm^3/g), and highest acidity value (9.61 mmol/g). This increase in acidity indicated that the use of surfactant templates successfully enhanced the number of acid sites. Methylene blue adsorption tests showed the highest adsorption capacity of 13.32 mg/g for AM05, with optimum conditions achieved at 15 minutes (7.7 mg/g). Kinetic studies confirmed that the adsorption process followed the pseudo-second-order model with a rate constant of 0.025 g/mg·min. Overall, the findings demonstrate that Lapindo mud can be utilized as an alternative raw material for synthesizing mesoporous alumina with excellent adsorption properties, particularly for dye removal applications such as methylene blue.

Keywords: Adsorption, Lapindo mud, methylene blue, sol-gel, γ-Al_2O_3.