ABSTRACT

Industrial wastewater pollution caused by synthetic dyes such as methylene blue has become an environmental problem requiring effective dan environmentally friendly technological solutions. Lapindo mud, which contains 87.189% Al_2O_3, holds potential as a raw material for synthesizing γ-Al_2O_3 that can be further modified with copper oxide (CuO) to enhance the photocatalytic performance of the material. This study comprised three stages: extraction of Al_2O_3 from Lapindo mud via acid reflux, synthesis of CuO/γ-Al_2O_3 composites using the sonication-hydrothermal method with Cu/Al molar ratios of 0.5:1, 1:1, 1.5:1, dan 2:1, dan evaluation of methylene blue photodegradation activity under visible light irradiation. Material characterization was performed using XRF, FTIR, XRD, dan UV-Vis DRS. FTIR analysis confirmed successful composite formation through Al-O-Al vibration Bands at 1017 cm^{-1} dan Cu-O absorption Bands in the range of 688–738 cm^{-1}, while XRD diffractograms revealed monoclinic CuO phases alongside γ-Al_2O_3 with crystallinity values ranging from 37.43% to 77.95%. UV-Vis DRS characterization yielded composite Band gap values between 1.42 eV dan 2.46 eV, with the 1:1 ratio composite exhibiting a Band gap of 1.94 eV, indicating optimal visible-light absorption. Photodegradation testing in a two-stage batch system showed that the 1:1 Cu/Al molar ratio composite achieved a dark-condition adsorption efficiency of 18.49% dan a light-irradiation photodegradation efficiency of 24.78%, with a total decolorization of 46.32% over 240 minutes following pseudo-first-order kinetics with a rate constant of 0.0018 min^{-1} (R^2 = 0.9963). These results indicate that the CuO/γ-Al_2O_3 composite derived from Lapindo mud holds significant potential as an effective visible-light photocatalyst for dye wastewater treatment.

Keywords: *CuO/γ-Al_2O_3, Lapindo mud, sonication-hydrothermal, photocatalyst, methylene blue, photodegradation*