ABSTRACT

Water pollution caused by dye waste such as methylene blue (MB) is a serious environmental problem due to its stable and hazardous nature. One effective method to address this is photodegradation using photocatalytic materials. This study synthesized CuO/γ-Al_2O_3 composites to enhance photocatalytic activity, where CuO is active under visible light but has the drawback of high electron–hole recombination, while γ-Al_2O_3 acts as a support that aids in charge separation, thereby reducing recombination. γ-Al_2O_3 was obtained from Lapindo mud extraction via the reflux method; XRF analysis indicated an Al_2O_3 content of 87.189% in the extracted sample. The composite synthesis was performed using the hydrothermal method with variations in the Cu/Al molar ratio, including 0.5:1 ($CA_{0.5.1}$), 1:1 ($CA_{1.1)}$, 1.5:1 ($CA_{1.5.1}$), and 2:1 ($CA_{2.1)}$. The successful formation of the composites was confirmed via FTIR by the appearance of characteristic Al–O–Al and Cu–O bond vibrations, as well as XRD patterns showing diffraction peaks for γ-Al_2O_3 and CuO without the formation of impurity phases. The XRD results also indicate that CuO is well dispersed on the γ-Al_2O_3 surface, with crystallite sizes in the nanometer range, and show an increase in the degree of crystallinity as the Cu ratio increases. UV-Vis DRS analysis reveals a narrowing of the bandgap in the range of 1.37–2.01 eV, confirming that the material is active under visible light. Photocatalytic test results show that the composite with a Cu/Al ratio of 1:1 ($CA_{1.1}$) provides the best performance with an MB degradation efficiency of 44.01% in 240 minutes and follows pseudo-first-order kinetics with a rate constant of 0.00176 min^{-1}. This study demonstrates that CuO/γ-Al_2O_3 composites have the potential to serve as effective photocatalysts for the degradation of MB dye under visible light.

Keywords: photocatalyst, degradation, CuO/γ-Al_2O_3, Lapindo mud, hydrothermal, methylene blue.