Facile synthesis of $CaFe_2O_4$ for visible light driven treatment of polluting palm oil mill effluent: Photokinetic and scavenging study

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ABSTRACT

In this paper, a facile synthesis method for $CaFe_2O_4$ is introduced that produces a catalyst capable of significant photocatalytic degradation of POME under visible light irradiation. The co-precipitation method was used to produce two catalysts at calcination temperatures of 550 °C and 700 °C dubbed CP550 and CP700. CP550 demonstrated the maximum COD removal of 69.0% at 0.75 g/L catalyst loading after 8 h of visible light irradiation which dropped to 61.0% after three consecutive cycles. SEM images indicated that the higher calcination temperature of CP700 led to annealing which reduced the pore volume (0.025 cm^3/g) and pore diameter (10.3 nm) while simultaneously creating a smoother and more spherical surface with lower S_{BET} (9.73 m^2/g). In comparison, CP550 had a rough hair-like surface with higher S_{BET} (27.28 m^2/g) and pore volume (0.077 cm^3/g) as evidenced by BET analysis. XRD data indicated the presence of $CaFe_5O_7$ in the CP550 composition which was not present in CP700. The presence of Wustite-like FeO structures in $CaFe_5O_7$ are likely the cause for lower photoluminescence intensity profile and hence better charge separation of CP550 as these structures in $CaFe_2O_4$ have been known to increase resistivity and electron localization. The COD removal of CP550 dropped from 69.0% to just 7.0% upon adding a small quantity of isopropanol into the reaction mixture indicating hydroxyl radicals as the primary reactive oxidative species.

KEYWORDS:

$CaFe_2O_4$; Photocatalysis; POME; Visible light; Co-precipitation