

Photocatalytic treatment of palm oil mill effluent by visible light-active calcium ferrite: Effects of catalyst preparation technique

Ashwin Charles^a, Chin Kui Cheng^{ab}

^aFaculty of Chemical & Natural Resources Engineering, Universiti Malaysia Pahang, Lebuhraya Tun Razak, 26300, Gambang Kuantan, Pahang, Malaysia

^bCentre of Excellence for Advanced Research in Fluid Flow (CARIFF), Universiti Malaysia Pahang, Lebuhraya Tun Razak, 26300, Gambang Kuantan, Pahang, Malaysia

ABSTRACT

Palm oil mill effluent (POME) is a serious and expensive environmental problem in Malaysia. In this paper, CaFe_2O_4 is introduced as a novel photocatalyst for the degradation of POME under visible light irradiation. Two synthesis routes, auto-combustion and co-precipitation, and two calcination temperatures 550 °C and 700 °C were used to produce four CaFe_2O_4 catalysts AC550, AC700, CP550 and CP700. CP550 exhibited the greatest photocatalytic degradation at 56% chemical-oxygen-demand (COD) removal after 8 h of irradiation which dropped to 49% after three consecutive cycles indicating reasonable conversion and high recyclability. BET analysis indicated CP550 had the highest S_{BET} (27.28 m^2/g) and pore volume (0.077 cm^3/g) which dropped precipitously for CP700 upon increasing the calcination temperature to an S_{BET} of 9.73 m^2/g and pore volume of 0.025 cm^3/g due to annealing which created a smoother surface area as evidenced by the SEM images. UV-Vis DRS indicated CP550 had the highest band-gap (1.52 eV) which is likely due to the presence of a highly crystalline pure CaFe_2O_4 phase compared to the other products which existed as a mixture of Fe oxidation states evidenced by the XRD data. The PL spectra for all catalysts indicated significantly lower recombination rate for both CP550 and CP700. Introduction of IPA into the reaction mixture to eliminate hydroxyl radicals resulted in a diminishing of COD removal from 56% to 7% proving hydroxyl radicals to be the primary reactive species responsible for photodegradation of POME.

Keywords

Calcium ferrite; Photocatalysis; POME; Visible light; Co-precipitation; Auto-combustion

ACKNOWLEDGEMENTS

AC is a grateful recipient of UMP Fellowship. CKC would like to acknowledge Universiti Malaysia Pahang for funding this project via UMP Leap 3 Flagship ([RDU172202](#)).