Process optimization of methylene blue adsorption onto eggshell-treated palm oil fuel ash

R. Hasan[a], C.C. Chong[a], H.D. Setiabudi[a,b], R. Jusoh[a], A.A. Jalil[c,d]
[a]Faculty of Chemical and Natural Resources Engineering, Universiti Malaysia Pahang, 26300 Gambang, Kuantan, Pahang, Malaysia
[b]Centre of Excellence for Advanced Research in Fluid Flow, Universiti Malaysia Pahang, 26300 Gambang, Kuantan, Pahang, Malaysia
[c]Department of Chemical Engineering, Faculty of Chemical and Energy Engineering, Universiti Teknologi Malaysia, UTM, 81310 Johor Bahru, Johor, Malaysia
[d]Centre of Hydrogen Energy, Institute of Future Energy, Universiti Teknologi Malaysia, UTM, 81310 Johor Bahru, Johor, Malaysia

ABSTRACT

Palm oil fuel ash (POFA) and eggshell (EG) were explored towards efficient methylene blue (MB) removal. Calcined EG, with a high content of CaO was used as a low-cost activation replacement for the alkali treatment of POFA. The adsorption performance of EG–POFA was studied by comparing its performance with untreated POFA, calcined EG and commercially treated Ca–POFA, and the competency was following the order of EG < POFA< EG–POFA ≈ Ca–POFA, indicating that EG effectively enhanced the efficiency of POFA. The response surface methodology (RSM) was executed to optimize the operating conditions of MB adsorption onto EG–POFA by investigating the effect of EG–POFA dosage (X1), initial pH (X2) and initial MB concentration (X3) towards MB removal (Y). X1 = 1.18 g/L, X2 = 6, and X3 = 182 mg/L, with Y = 80.36% were found to be optimal conditions. The experimental data disclosed that the MB adsorption onto EG–POFA was in accordance with the Langmuir isotherm model (qm = 714.29 mg/g) and followed pseudo-second-order kinetic model. The thermodynamic study discovered the endothermic and spontaneous natures of MB adsorption onto EG–POFA. This study discovered the feasibility of EG as an eco-friendly activation alternative for the alkali treatment towards remarkable MB adsorption.

KEYWORDS: EG–POFA, Low-cost adsorbent, Methylene blue, Adsorption, Optimization