Available online at www.sciencedirect.com

Chemical Engineering Research and Design

journal homepage: www.elsevier.com/locate/cherd

Intensified photocatalytic degradation of methylene blue over Fe supported on dendritic fibrous SBA-15: Optimisation, kinetic, isotherm, and reusability

R.S.R. Mohd Zaki[a,b], A.A. Jalil[c,d], H.D. Setiabudi[a,b,*]

[a] Faculty of Chemical & Process Engineering Technology, Universiti Malaysia Pahang Al-Sultan Abdullah, Lebuh Persiaran Tun Khalil Yaakob, 26300 Gambang, Pahang, Malaysia

[b] Centre for Research in Advanced Fluid & Processes, Universiti Malaysia Pahang Al-Sultan Abdullah, Lebuh Persiaran Tun Khalil Yaakob, 26300 Gambang, Pahang, Malaysia

[c] School of Chemical and Energy Engineering, Faculty of Engineering, Universiti Teknologi Malaysia, 81310 UTM Johor Bahru, Johor, Malaysia

[d] Centre of Hydrogen Energy, Institute of Future Energy, 81310 UTM Johor Bahru, Johor, Malaysia

ARTICLE INFO

Article history:
Received 29 March 2023
Received in revised form
5 September 2023
Accepted 6 September 2023
Available online 9 September 2023

Keywords:
Photocatalytic degradation
Methylene Blue
DFSBA-15
Reaction optimisation
Reusability

ABSTRACT

A novel photocatalyst, Fe supported on dendritic fibrous SBA-15 (Fe/DFSBA-15), is synthesised and employed for methylene blue (MB) photocatalytic degradation. The DFSBA-15 was synthesised by applying a microemulsion technique and SBA-15 crystal-seed crystallisation approach. The TEM and FESEM of Fe/DFSBA-15 revealed the revolution of rod-typed SBA-15 into dendritic fibrous-structured (DFSBA-15). The characterisation analyses using FTIR, XRD, BET, PL and UV-Vis DRS, confirmed favourable properties of Fe/DFSBA-15 compared to Fe/SBA-15. Fe/DFSBA-15 exhibits superior properties, attributed to its unique dendritic fibrous morphology that increases the surface area, pore accessibility, and mass transfer. These exceptional features establish it as a highly promising and efficient photocatalyst for diverse applications. Optimisation of MB degradation (*Y*, %) by using Fe/DFSBA-15 was conducted by employing response surface methodology (RSM) of independent parameters such as catalyst loading (X_1, 0.5 – 2.0 g/l), pH (X_2, 6 – 10) and initial MB concentration (X_3, 10 – 50 mg/l). The model was significant, and MB degradation was optimised at 99.54% (X_1 = 1.66 g/l, X_2 = 9, and X_3 = 27.5 mg/l) along with validation experiments (3.62% error). The research outcome was in agreement with the Langmuir second-order ($R^2 \geq 0.99$), indicating a predictable trend of the MB degradation process. Interestingly, the excellent degradation and reusability performance of Fe/DFSBA-15 offered a prospective approach for industrial wastewater treatment.

* Corresponding author at: Faculty of Chemical & Process Engineering Technology, Universiti Malaysia Pahang Al-Sultan Abdullah, Lebuh Persiaran Tun Khalil Yaakob, 26300 Gambang, Pahang, Malaysia.
E-mail address: herma@ump.edu.my (H.D. Setiabudi).

https://doi.org/10.1016/j.cherd.2023.09.009