Photocatalytic degradation of palm oil mill effluent over ultraviolet-responsive titania: Successive assessments of significance factors and process optimization

Kim Hoong Ng, Chin Kui Cheng

Faculty of Chemical & Natural Resources Engineering, Universiti Malaysia Pahang, Lebuhraya Tun Razak, 26300 Gambang Kuantan, Pahang, Malaysia
Centre of Excellence for Advanced Research in Fluid Flow, Universiti Malaysia Pahang, Lebuhraya Tun Razak, 26300 Gambang Kuantan, Pahang, Malaysia

1. Introduction

The demand for edible oil and fats is on the rise due to rapid pace of globalization. Report compiled by the Palm Oil Today (2015) shows that the global oil and fats production was expected to exceed 202 million MT in 2015, of which 62 million MT is from the palm oil sector. In Malaysia, oil palm sector is the biggest agro-industry. Indeed, the oil palm plantation occupies about 77% of the total cultivated land, with a total output of 20.09 million MT of crude palm oil (CPO) in the year 2015 (MPOC, 2015).

During the oil extraction stage, about 2.5–3.75 tonnes of highly polluting palm oil mill effluent (POME) is generated per tonne of CPO (Ahmad et al., 2003). Therefore, approximately 50.23–75.34 million tonnes of POME was produced in 2015. POME has high organic load (chemical oxygen demand, COD: 45,500–65,000 ppm; biological oxygen demand, BOD: 21,500–28,500 ppm) which is detrimental to the aquatic life (Wu et al., 2010). In Malaysia, more than 85% of the millers employ open ponding system for the POME treatment, and enforcement is carried out by the Department of Environment (DoE) based on the revised POME discharge standard that was enacted in the year of 1984. The safe level for POME waste to be discharged is fixed at 100 ppm of BOD level, while the COD level must be reduced down to 50 ppm before discharge into the waterway (Malaysia Environmental Quality (Sewage and Industrial Effluents) Regulations, standard A). However, the existing ponding treatment is obsolete and ineffective in meeting the permitted level for discharge (Ng and Cheng, 2015; Wang et al., 2010). After the ponding treatment, the COD and BOD levels of effluent are normally still higher than the discharge threshold. Consequently, several new technologies have been proposed. The most popular one is the sequential anaerobic-aerobic treatment as it possesses...