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Determination of optimum polymeric coagulant in palm oil mill effluent coagulation using multiple-objective optimisation on the basis of ratio analysis (MOORA)

K. F. Tamrin[1] · **A. Y. Zahrim**[2]

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Abstract The main limitation of a conventional palm oil mill effluent (POME) ponding system lies in its inability to completely decolourise effluent. Decolourisation of effluent is aesthetically and environmentally crucial. However, determination of the optimum process parameters is becoming more complex with the increase of the number of coagulants and responses. The primary objective of this study is to determine the optimum polymeric coagulant in the coagulation–flocculation process of palm oil mill effluent by considering all output responses, namely lignin–tannin, low molecular mass coloured compounds (LMMCC), chemical oxygen demand (COD), ammonia nitrogen (NH_3-N), pH and conductivity. Here, multiple-objective optimisation on the basis of ratio analysis (MOORA) is employed to discretely measure multiple response characteristics of five different types of coagulants as a function of assessment value. The optimum coagulant is determined based on the highest assessment value and was identified as QF25610 (cationic polyacrylamide). On the other hand, the lowest assessment value was represented by AN1800 (anionic polyacrylamide). This study highlights the simplicity of MOORA approach in handling various input and output parameters, and it may be useful in other wastewater treatment processes as well.

Keywords Polymer coagulant · Coagulation · Dye · Ratio analysis · MOORA · Optimisation

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✉ K. F. Tamrin
tkfikri@unimas.my

A. Y. Zahrim
zahrim@ums.edu.my

[1] Department of Mechanical and Manufacturing Engineering, Faculty of Engineering, Universiti Malaysia Sarawak (UNIMAS), 94300 Kota Samarahan, Sarawak, Malaysia

[2] Chemical Engineering Programme, Faculty of Engineering, Universiti Malaysia Sabah, Jalan UMS, 88400 Kota Kinabalu, Sabah, Malaysia

Introduction

Production of palm oil requires large volumes of water, and the process subsequently discharges high volumes of wastewater that often described as palm oil mill effluent (POME). Without proper treatment, the POME can deteriorate quality of surface water. At present, the existing biological ponding systems are unable to decolourise POME due to the presence of lignin and other recalcitrant colourants (Liew et al. 2015; Zahrim et al. 2009). To remove the recalcitrant colourants, physicochemical method such as coagulation–flocculation could be applied (Zahrim et al. 2014a). The technique is relatively simple, inexpensive, relatively high efficiency of pollutant removal, easy on-site implementation and may enhance the biodegradability of the wastewater (Verma et al. 2012).

The addition of suitable polymer as flocculant could enhance the performance of the coagulation/flocculation by producing large flocs that are less resistant to shear stress. In principle, polymers enhance the rate of orthokinetic flocculation which is due to the bulk fluid motion either by charge neutralisation and/or bridging mechanism when added to a system destabilised with inorganic coagulants (Bratby 2006).

A polymer molecule is a series of repeating chemical units held together by covalent bonds. Polymers have been used in water and wastewater treatment for several decades. In water and wastewater application, organic polymers are water-soluble and can be classified in two broad categories: natural and synthetic polymers. Natural polymers are virtually toxic

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