HYBRID MEMBRANE BIOREACTOR FOR BIODEGRADATION AND BIOFOULING OF PALM OIL MILL EFFLUENT

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ABSTRACT

Palm oil mills have significantly contributed to the generation of wastewater in Malaysia. Using palm oil mill effluent (POME) as the wastewater, the objectives of the present study were, first, to develop respirometric analysis of activated sludge modeling (ASMs) by determining oxygen mass transfer coefficient (K_{La}), Chemical Oxygen Demand (COD) fractionation, heterotrophic yield (Y_H), and other parameters for Activated Sludge Model (ASM). The second objective was to identify the effect of mixed liquor suspended solid (MLSS) on biofouling in hybrid membrane bioreactor (MBR) by analyzing the critical flux, (J_c), determined by flux- step-method. Third, to verify the effect of BFR in hybrid MBR by comparing biofouling reducer (BFR) effect based on its adsorption capacity and analysing BFR effect on short-time operation, J_c, and effluent quality. Continuous stirred tank reactor (CSTR) was used as respirometer with continuous flow for COD fractionation study. In addition, a lab-scale 100 L hybrid MBR consisting of anaerobic, anoxic, and aerobic compartmens was used with flat sheet microfiltration (MF) submerged in the aerobic compartment for the biofouling study. Activated Sludge Model 1 (ASM1) and Activated Sludge Model 2 development (ASM2d) were used to verify the performance of the experimental results. The biofouling on membrane cross-section was then analyzed using microscopic PAXIT and scanning electron microscope (SEM). Microbial dynamic in MBR was investigated using polymerase chain reaction (PCR). The $K_{La,}$ COD fractionations, Y_H, and other coefficients, such as μ_A, $\mu_{H,}$ $K_{s,}$ $b_{H,}$ and $b_{A.}$ were calculated and verified experimentally. Oxygen utilization rate (OUR) data were compared

between ASM1 and experimental results and were found to fit well. A set of model parameters was determined, and able to describe the behaviours of the OUR. This study has indicated that the membrane biofouling rate increases with the increase of MLSS concentration, as observed through the critical flux analysis and extensive experimental results. However, effluent quality increased as MLSS increased. In general, there is a need to balance the biofouling tendency and effluent quality to reduce operation and maintenance cost in wastewater treatment plant, especially POME treatment. The results showed that membrane biofouling was reduced by using powder acvtivated carbon $(PAC)_1$, PAC_2, zeolite $(Ze)_1$, Ze_2, *Moringa oleifera* (Mo), and granulated-activated carbon (GAC) on the surface of membranes. It was observed that the higher the concentration of BFRs used, the higher the biofouling reducing effect will be.