Life Cycle Assessment of Fluidized Bed Biofilm Reactor for Palm Oil Mill Effluent Treatment

W.L. Liew\textsuperscript{1}, K. Muda\textsuperscript{2}*\textsuperscript{*}, M.. A. Kassim\textsuperscript{2}, S.K. Loh\textsuperscript{3}, M. Mohd. Hanafiah\textsuperscript{4}

\textsuperscript{1}Universiti Teknologi Malaysia (UTM), Malaysia
\textsuperscript{2}Universiti Teknologi Malaysia, Malaysia
\textsuperscript{3}Malaysian Palm Oil Board, Malaysia
\textsuperscript{4}Universiti Kebangsaan Malaysia, Malaysia

Abstract

Fluidized bed biofilm reactor (FBR) is a high-rate wastewater treatment process demonstrating several advantages over the conventional activated sludge or suspended growth. Rapid removal of pollutants, smaller footprint, high biomass hold-up, extremely long sludge retention time (SRT), and high removal efficiency are among the well-known benefits. The aerobic version has remarkably good performance in secondary treatment, nitrification, and denitrification, and polishing of various wastewaters. However, high energy consumption to achieve fluidization of the carrier material and to provide sufficient oxygen has been a major drawback for the technology, especially the aerobic version. Also, environmental impact associated with the palm oil industry is unique and rather important among the Southeast Asian countries like Malaysia, Indonesia, and Thailand. A study was hence formulated to address the environmental pollution-related issues of treating palm oil mill effluent (POME) using aerobic FBR. A 12-litres FBR system comprised of storage tank, FBR column, and clarifier was operated for a period of 6 months in continuous mode to determine its efficiency in POME treatment. Using activated carbon derived from palm kernel shell, the system was fed with partially-treated POME to resemble a wastewater polishing process. The wastewater quality and biomass concentrations were periodically monitored to determine the removal efficiencies. To evaluate the subsequent environmental impacts, a gate-to-gate life cycle assessment (LCA) was conducted on the basis of per cycle bioreactor run. Impact assessments were calculated with Gabi 6.0 software by using ReCiPe version 1.07. Experimental data obtained from the bioreactor operation were used to accomplish the life cycle inventory (LCI) analysis, and the following impact categories were highlighted: climate change, ozone depletion, freshwater ecotoxicity, freshwater eutrophication, fossil depletion, and metal depletion. Finally, a prospective is made about which FBR design criteria require further consideration to minimize the environmental consequences besides accomplishing wastewater treatment.