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Comparative study on membrane distillation application between raw POME and POMSE

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ABSTRACT

The palm oil industry is considered the traditional pillar of Malaysian industry that plays a key role in the domestic economy. In addition to the high incomes generated by this industry, it generates large quantities of effluent. To solve this problem, the purpose of this work is to introduce membrane distillation (MD) technology for the effluent treatment system. Polyvinylidene fluoride (PVDF) -bentonite hollow fiber membranes were tested in an MD system using raw palm oil mill effluent (POME) and palm oil mill secondary effluent (POMSE). Preliminary test was carried out using deionized water to evaluate the maximum permeate flux achievable in the absence of fouling problem before continuing with POME and POMSE as the feed solution. Membrane performance was evaluated in terms of permeate flux and rejection rate of several water quality parameters. The average permeate flux obtained while using raw POME is much lower than that obtained in the POMSE test which was recorded as 1.41 ± 0.62 kg/m^2.hr and 3.45 ± 0.51 kg/m^2.hr respectively. The membrane tested for POME experienced a significant decrease in flux relative to POMSE due to the excessive amounts of biological compounds blocking the membrane pores. In terms of removal efficiency of the PVDF-bentonite membrane, the membranes were able to achieve more than 95% removal efficiency for chemical oxygen demand, nitrate nitrogen, total suspended solids, total dissolved solids, color and turbidity. The results proved that the DCMD system was able to eliminate almost all pollutants in the effluent from oil palm industry. However, raw POME without pre-treatment is not suitable to be used directly in the DCMD process because it will cause a serious fouling problem. In conclusion, it can be said that MD has shown excellent performance in the treatment of palm oil wastewater and can be applied to other types of oil industries.

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1. Introduction

Membrane distillation (MD) is a heat-driven separation process by which the vapour molecules are transferred by a porous hydrophobic membrane. The driving force is the difference in vapour pressure due to the difference in temperature through the membrane [1,2]. In theoretical point of view, MD can lead to an essentially complete separation (near pure components), or it can be a partial separation that increases the concentration of the selected components of the mixture due to its vapor–liquid equilibrium mechanism. The pollutant rejection rate of the MD process is absolutely high, theoretically as close as possible to 100% [3]. A part of high removal efficiency, MD technology may reduce the operating cost of the treatment process whereas the technology requires low operating temperature and pressure and can be compatible with renewable energy like solar energy to supply the thermal energy [4,5]. There are several MD configurations applied in the world, however, the most common configuration is direct contact membrane distillation (DCMD) due to its ease of operation and less maintenance. In DCMD setup, the feed is always in direct contact with the membrane while the other side will be filled up with the condensing medium acts as condenser. Although MD was applied in many countries specially to recover potable water from seawater, Malaysia is still lack of focus on this technol-

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