UNIVERSITI TEKNOLOGI MARA

MEMBRANE PERFORMANCES AND COST ANALYSIS OF INTEGRATED MOVING BED BIOFILM REACTOR-MEMBRANE SYSTEM FOR PALM OIL MILL EFFLUENT (POME) TREATMENT AT UKM-YSD PILOT PLANT

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ABSTRACT

Reclamation and reuse of water from palm oil mill effluent (POME) becomes an alternative towards achieving sustainability compared to present conventional ponding system in mills. Therefore, a pilot plant study using an integrated system consisting of a moving bed biofilm reactor (MBBR) and membrane filtration system conducted at the UKM-YSD pilot plant presents a viable technique in POME treatment which requires less energy, maintenance cost and space. The study mainly focused on the acclimatization of the MBBR, permeate flux trends in analysing membrane performance of different configurations as well as assessing capital costs of each configuration. Acclimatization of MBBR was conducted prior to membrane filtration to reduce COD concentrations in pre-treated POME which stabilized to 150 mg/L to minimize chances of membrane fouling in reverse osmosis (RO) unit. However, final COD concentration did not achieve below 500 mg/l as required which may be due to probable reasons such as carrier floatation, fouling, settling and operational problems. Therefore, manual dilution was conducted as alternative to reduce COD concentration of feed POME. Certain units were bypassed to create four different configurations in analyzing RO flux behavior as basis of membrane performance. Configuration I which bypassed MBBR showed the least flux decline of about 15% and greater flux recovery between physical cleanings. Configuration II bypassed MBBR and RO 2 had 20% flux decline. Configuration III which bypassed MBBR and ultrafiltration (UF) unit while Configuration IV bypassed MBBR, UF unit and RO 2 both presented higher flux decline with 35% and 40% respectively. Higher flux decline is not preferable in membrane system since this represents fouling occurrence in the membrane system. Cost analysis of all four configurations showed Configuration I had the highest total capital cost for construction (with GST included) of approximately RM142,835 and Configuration II with RM114,935.8. Therefore, Configuration I and II were concluded the most cost-effective system through cost analysis of each configuration whereby both configurations yielded the highest permeate flux with good flux recovery with lower maintenance for fouling.

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CHAPTER ONE

INTRODUCTION

1.1 RESEARCH BACKGROUND

Wastewater reclamation and its reuse in the industrial scale has become an essential step towards achieving water sustainability for future economic development. The industry positions itself as the second largest consumer of water (Fadzil *et al.*, 2018) and in light of rising water demands, lack of action towards effective water management could adversely affect Earth's finite supply of water as well as may diminish national growth rates (Hogeboom, Kamphuis and Hoekstra, 2018). Treatment of industrial effluents has emerged as a trending role in water resources management in providing efficient water reclamation and reuse as environmental legislations have also become increasingly stringent. The birth of advanced technology and developing researches have made wastewater treatment viable as well as developing cost-effective methods to be more economically attractive for industrial applications.

The industry in focus for this research is the palm oil mill industry where the wastewater produced is known as palm oil mill effluent (POME). The palm oil mill industry in Malaysia has been recognized as producing the largest pollution load into the rivers throughout the country (Abu Bakar *et al.*, 2018). The wastewater produced mainly comes from water and sludge separation in palm oil extraction processes. Generation of this effluent in huge quantities shows potential in water reclamation and reuse in mill operations. Hence, treatment of the palm oil mill effluent is a promising solution in reducing the amount of effluent discharge and potential source of water for mill operations.

Membrane filtration technique emerged as one of the most significant methods in POME treatment (Poh and Chong, 2009). Due to the consistency in the quality of the treated water, membrane treatment is a highly viable option as it requires less energy, easy to operate and does not require much space. However, this method is not widely applied in the industry due to the high installation cost of the membrane set up and maintenance. The membrane technology coupled with pre-treatment of POME would