PVDF/TiO_2/PEG Hollow Fiber Membrane for Oily Wastewater Treatment at Various Concentration of Oily Wastewater

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Abstract-The purpose of this research is to enhance the performance of PVDF/TiO_2 membrane particularly permeate flux in the application of oily wastewater treatment by adding Polyethylene glycol (PEG). Various concentration of oily wastewater was conducted in order to investigate the influence of the concentration on the membrane performance. Results show that by adding the PEG into the PVDF/TiO_2 membrane, the permeate flux of oily wastewater was increase compared to PVDF/TiO_2 membrane without PEG. The permeate flux was affected by concentration of synthetic oily wastewater. Increasing the concentration of synthetic oily wastewater, decreasing the flux of oily wastewater.

Index Terms-Oily wastewater, Hollow fiber membrane, Polyvinylidene fluoride (PVDF), Titanium dioxide (TiO_2), Polyethylene glycol (PEG).

INTRODUCTION

Increasing number of car and motor vehicle in big city such as Surabaya, generates increasing number of automobile service station and car washing. This cause the increasing amount of oily wastewater release from the automobile service station and car washing. Nowadays, automobile services station and car washing produced oily wastewater up to 4.000 L with concentration of 86-159 ppm [1]. Commonly, the oily wastewater was discharged directly without treatment and caused closed supplied oxygen in the land and pollute soil microorganism. According to the Minister of Environmental regulation number 5 of 2014 concerning waste water quality standards stating that the waste can be disposed of directly must have the oil and fat content of at most 10 ppm. Therefore, that problems need to be solved.

Membrane technology could be the most efficient method to treat oily wastewater compared to biological treatment constructed in wetlands and dissolved air flotation. Previous research reported that PVDF/TiO_2 hollow fiber membrane has been applied for oily wastewater treatment with permeate flux 43,21 L/m^2.h and rejection coefficient 98,28% [2]. It will be better if the permeate flux can be improved further. Polyethylene glycol is an additive membrane that has an impact on enhancing the permeate flux by creating larger membrane pores and keeping membrane resistance from external factor [3].

This research aims to improve the performance of PVDF/TiO_2 membrane by adding PEG and investigate the influence of oily wastewater concentration on the performance of the membrane.

MATERIAL AND METHODS

Material used for membrane matrix was PVDF (Kynar®740) pellets purchased from Arkema Inc., Philladelphia, USA. Solvent to dissolve the PVDF was N,N-dimetylacetamide (DMAc) from Merck. Polyethylene glycol (PEG-400) was purchased from Orec, Titanium dioxide (TiO_2) (Degusa P25) was purchased from Evonik. TiO_2 has BET surface area 50 m^2/g and average particle size ~21 nm with energy band gap 3,18 eV. The oily wastewater was synthesized from lubricant, Enduro Racing 4T SAE10W-40 Pertamina. Other materials used were glycerol and epoxy resin.

Fabrication of hollow fiber membrane begins with preparing dope solution by adding PVDF into DMAc solvent after being dried in the oven for 24 hours to remove pollutant. PEG and TiO_2 were added into the dope solution and mechanically stirred at 600 rpm until the solution completely dissolved form coagulant. The dope solution was then ultrasonicated to remove any bubbles. The hollow fiber membrane was fabricated using dry-jet wet spinning method, then immersed in coagulation bath, for 2 days to removal residual solvent. In third days, hollow fiber membrane was immersed in 10% glycerol for minimizing fiber shrinkage. Finally, hollow fiber membranes were dried at room temperature [4].

The hollow fiber membranes were potted into tube as a module, before placed in the photocatalytic membrane reactor as shown in Figure 1. The membrane was then tested to treat the synthetic oily wastewater.

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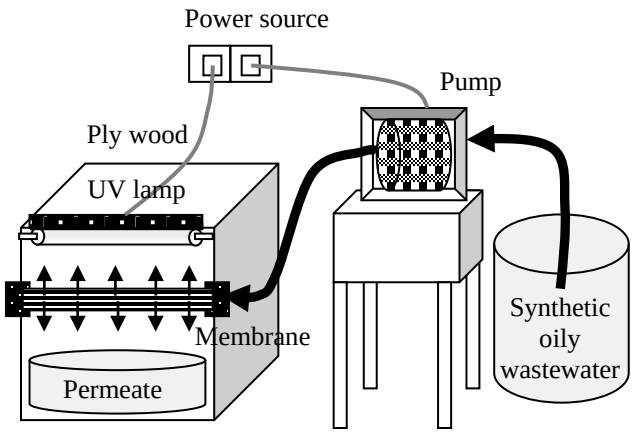

Figure 1. Photocatalytic Membrane Reactor.

RESULTS AND DISCUSSION

The PVDF/TiO_2/PEG hollow fiber membrane was successfully fabricated by dry-jet wet spinning method. Hollow fiber membranes were characterized and results shown in Table 1.

TABLE 1. THE CHARACTERISTICS OF PVDF/TiO_2/PEG HOLLOW FIBER MEMBRANE

Characteristics	Value
Porosity membrane	78,86 %
Contact angle goniometer	69,86°
Tensile mechanic strength	1,71 MPa
Pure water flux	67,37 L/m^2.h

The morphologies of PVDF/TiO_2/PEG hollow fiber membrane shown in Figure 2,

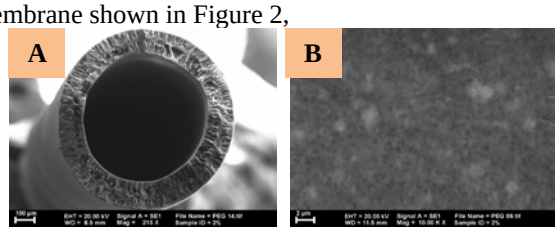

Figure 2. The Morphologies of PVDF/TiO_2/PEG hollow fiber membrane (A) cross section; (B) outer surface.

Performance of PVDF/TiO_2/PEG hollow fiber membrane for treating synthetic oily wastewater at 90 ppm, 125 ppm and 160 ppm was shown in Figure 3,

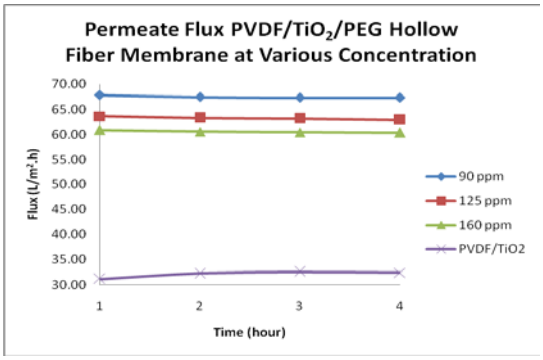

Figure 3. The effect of PEG additive on the performance of PVDF/TiO_2 and the effect of oily wastewater concentration on the flux.

CONCLUSION

PEG as an additive membrane has an impact on enhancing significantly the performance of PVDF/TiO_2 hollow fiber membrane such oily wastewater flux. Increasing the concentration of synthetic oily wastewater, decreasing the flux of oily wastewater.

REFERENCES

[1] Priyanti, P. A. R., "Pengolahan Air Limbah Pencucian Mobil dengan Reaktor Pemisah Minyak dan Karbon Aktif"

[2] Teow, et, al, "Preparation and characterization of PVDF/TiO_2 mixed matrix membrane via in situ colloidal precipitation method", *Journal of Desalination*, vol. 295, pp. 61 – 69, 2012.

[3] Saljoughi et al, "Effect of PEG additive and coagulation bath temperature on the morphology, permeability and thermal/chemical stability of asymmetric CA membranes," *Journal of Desalination*, vol. 262, pp. 72 – 78, 2010.

[4] Ong et al, "Preparation and characterization of PVDF-PVP-TiO_2 composite hollow fiber membranes for oily wastewater treatment using submerged membrane system," *Desalination and Water Treatment*, pp. 1 – 11, 2013.