SWS Treatment - PRJ

by Anwar Ma'ruf

Submission date: 08-Oct-2020 03:50PM (UTC+0700)
Submission ID: 1408913152
File name: 02_Poll_Res-4-_Microfiltration_sour_water.pdf (1.15M)
Word count: 1789
Character count: 9632

Article-4

Poll Res. 37 (4) : 31-34 (2018)

ISSN 0257–8050

MICROFILTRATION OF SOUR WASTEWATER USING NATURAL ZEOLITE CERAMIC MEMBRANE

[1]ANWAR MA'RUF, [2]MOHAMMAD AGUS SALIM, [3]WISNU PRATOPO YUWONO

[1,3]*Chemical Engineering Department, Universitas Muhammadiyah Purwokerto Jl. Raya Dukuh Waluh Kembaran, Purwokerto, Indonesia 53182*

[2]*Chemical Engineering Department, Universitas Muhammadiyah Purwokerto Jl. Raya Dukuh Waluh Kembaran, Purwokerto, Indonesia 53182*

(Recieved 11 June, 2018; accepted 30 July, 2018)

ABSTRACT

The Refinery process of fuel oil will produce sour wastewater with contains high of hydrogen sulfide (H_2S) and ammonia. Commonly, before being discharged into the effluent, the wastewater was treated in the sour water stripper (SWS) unit. The Refinery process of fuel oil will produce sour wastewater with contains high of hydrogen sulfide (H_2S) and ammonia. Commonly, before being discharged into the effluent, the wastewater was treated in the sour water stripper (SWS) unit. The purposes of this study are to determine the application of ceramic membrane from natural zeolite for microfiltration of sour wastewater and to study the fouling mechanism. The flat sheet ceramic membrane was used in this research with the cross-flow model. The result of the research shows that rejection coefficient of the membrane is 86.2% at the pressure of 4 bar. Cake formation fouling can be used to describe the fouling mechanism of the membrane. The value of the cake formation constant increases by 150% / bar.

KEY WORDS : Microfiltration, Ceramic membrane, Natural zeolite, Sour wastewater.

INTRODUCTION

The Refinery process of fuel oil will produce sour wastewater with contains high of hydrogen sulfide (H_2S) and ammonia. Commonly, before being discharged into the effluent, the wastewater was treated in the sour water stripper (SWS) unit. The utilization of SWS unit has disadvantages, especially in its steam dependence.

Several studies have been conducted to look for alternative processes in addition to SWS unit. Coelho *et al.* (2006) using advanced oxidation processes for sour water treatment. Minier-Matar *et al.* (2017) studied the utilization membrane technology for remove hydrogen sulfide from sour water. The membrane used was hydrophobic hollow fiber polypropylene membranes.

Ceramic membranes are potential materials to process sour water. Ceramic membranes show its capability to reduce the contaminants from water. Jana *et al.* (2010) developed the ceramic membrane from clay. The ceramic membrane obtained was successful to remove the chromate from aqueous solutions. Khemakhem *et al.* (2009) produced and applied the ceramic membrane development from clay to process the cuttlefish effluents. Rekik *et al.* (2017) also produced ceramic membrane from naturally occurring-kaolin clay for microfiltration of the cuttlefish wastewater.

The purposes of this study are to determine the application of ceramic membrane from natural zeolite for microfiltration of sour wastewater and to study the fouling mechanism.

MATERIALS AND METHODS

Materials

The ceramic membrane was obtained from Membrane and Polymer Research Center of Chemical Engineering Department of Universitas Muhammadiyah Purwokerto (Ma'ruf *et al.*, 2015).

***Corresponding author's email:** anwarump@yahoo.com

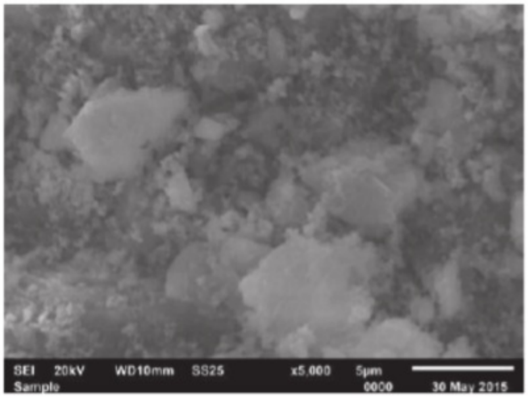


Fig. 1 Morphology of ceramic membrane

Sour wastewater was obtained from X Refinery of Indonesia.

Methods

The laboratory pilot used for the filtration experiments was equipped with a cross flow of flat sheet ceramic membrane. The volume of 1000 mL of sour water was inserted into beaker glass. Sour wastewater was pumped into the membrane holder. The permeate (filtrate) obtained was collected and measured the volume every 5 minutes. The turbidity of the permeate was measured by turbidimeter.

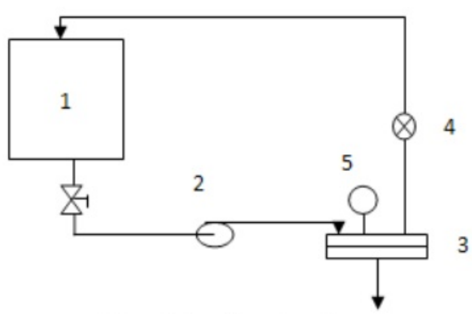


Fig. 2. Microfiltration pilot

Where (1) is sour wastewater feed; (2) is a pump; (3) is membrane holder; (4) is pressure control valve; and (5) is pressure indicator.

Data analysis

The flux of microfiltration process can be expressed by the equation (Miller *et al.,* 2014)

$$J = \frac{V}{A.t} \quad ..(1)$$

Where J is a flux of membrane, ml/cm^2. min; V is the volume of permeate obtained, mL; A if the surface area of the ceramic membrane, cm^2; and t is time, min.

Rejection of the membrane is defined as an equation:

$$R = \left(1 - \frac{C_p}{C_f}\right) x100\% \quad ..(2)$$

Where R is the rejection, %; Cp is a concentration of the permeate, NTU; and Cf is the concentration of the feed, NTU.

The fouling mechanism of sour water filtration can be assumed as cake formation fouling. The membrane resistance model used in this study is a model in which the cake resistance controls the permeate flux with the following equations (Aryanti *et al.*, 2016):

$$J^2 = \frac{Jo^2}{1+Jo^2 kc.t} \quad ..(3)$$

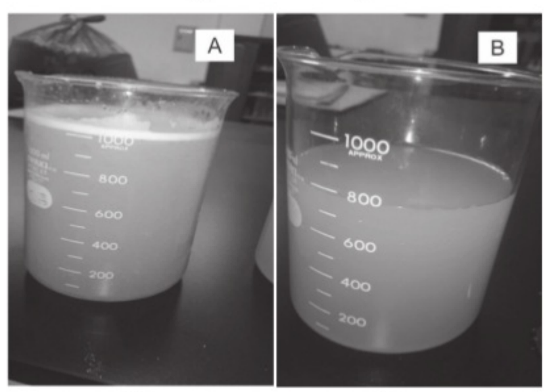
Equation (3) can be linearized to determine the cake formation constant with the following equation:

$$\frac{1}{J^2} = \frac{1}{J_0^2} + k_c.t \quad ..(4)$$

Where J is a flux of membrane, ml/cm^2.min; Jo is an initial flux of membrane, ml/cm^2.min; kc is cake formation constant cake formation constant, cm^2/ml; and t is time, min.

RESULTS AND DISCUSSION

Microfiltration of sour wastewater using ceramic membrane has successfully done. Physically can be seen from the color of sour wastewater after microfiltration process is more clear when compared with before being processed. Figure 3 shows the



(a) (b)

Fig. 3. Sour wastewater : (a) before microfiltration; (b) after microfiltration

color of sour wastewater before and after microfiltration process.

Flux and Rejection Analysis

Figure 4 shows the flux during microfiltration of sour wastewater using natural zeolite ceramic membrane. The flux of membrane depends on pressure operation. At the higher pressure, the flux will increase. Although at the constant pressure, the flux will decrease over time due to the fouling of the membrane. Fouling can be defined as the potential deposition and accumulation of constituents in the feed stream on the membrane.

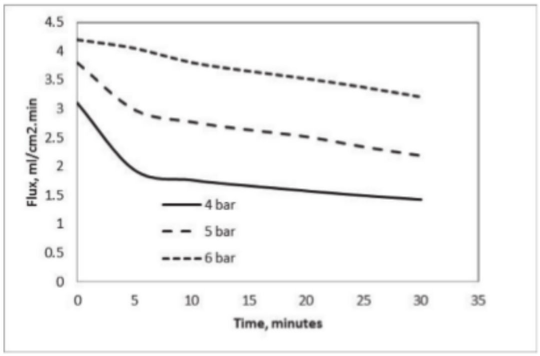


Fig. 4. Flux of sour wastewater microfiltration

In order to control the operation of a membrane process, there are two types of model operation, with respect to the flux and to the TMP (Trans Membrane Pressure) that can be used, i.e. constant TMP and constant flux. The operation model will be affected when the rejected materials and particles in the retentate tend to accumulate in the membrane. At a given TMP, the flux of water through the membrane will decrease and at a given flux, the TMP will increase, reducing the permeability (Figure 5) (Miller *et al*., 2014). This phenomenon is known as fouling, and it is the main limitation to membrane process operation.

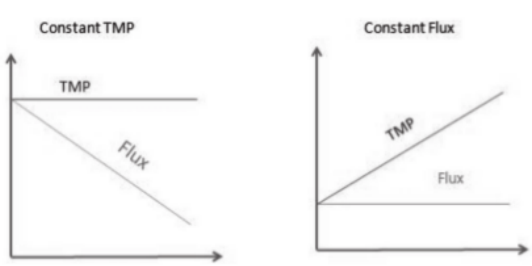


Fig. 5. Model operation of membrane processes

In this study, the model operation used is constant of TMP. At the time of 30 minutes, the flux will decrease of 53.83%, 43.42% and 23.65% at the pressure of 4 bar, 5 bar and 6 bar respectively. Rekik *et al.* (2017) reported on the microfiltration of the sea-product freezing factory using clay ceramic membrane, the flux reduction of 54% at 60 minutes.

Table 1 shows the rejection of sour wastewater. The maximum rejection will be obtained at the pressure of 4 bar with the value of rejection is 86.2%. This indicates that the ceramic membrane is quite effective for processing sour wastewater.

Table 1. Rejection of sour wastewater microfiltration

Pressure, bar	Rejection, %
4	86.2
5	78.88
6	69.04

Cake Formation Fouling Analysis

Fouling is a critical point of the membrane utilization. The presence of fouling on the membrane will cause a decrease in membrane performance. This will lead to higher operating costs. During microfiltration, slurry particles are carried by the liquid towards the filter membrane and then deposit on the membrane surface to form a filter cake or block in the pores of the membrane. Both cases result in the increase of filtration resistance and in the attenuation of the filtration rate. There are three steps of cake formation i.e. pore narrowing, pore-clogging and cake formation (Iorhemen *et al.*, 2016). Figure 6 shows the mechanism of cake formation.

Figure 6 shows that the value of cake formation constant depends on pressure operation. The value of cake formation constant will increase with

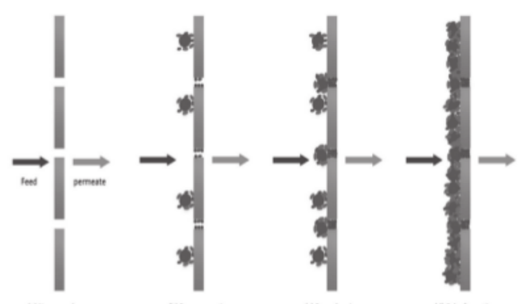


Fig. 6. Mechanism of membrane fouling (Iorhemen et al., 2016)

pressure addition. Rekik *et al.* (2017) reported on the process recovery of milk solids from dairy wastewater by ultrafiltration with polyvinylidene fluoride (PVDF) showed that the cake formation will increase with pressure addition. The value of the cake formation constant increases by 150% / bar.

Figure 7 shows the relationship between pressure operation with the value of cake formation constant. The equation can be expressed by the equation:

$$kc = 0.0037.(P) - 0.0139 \quad .. (5)$$

The R^2-value is 0.9545. It means that the equation is valid.

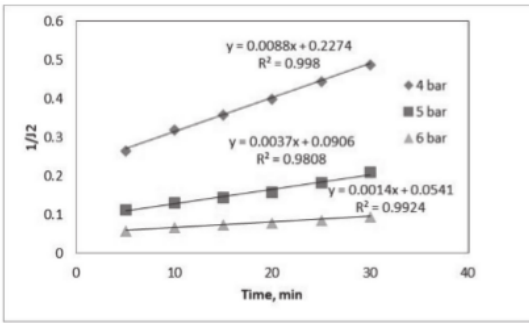


Fig. 7. Cake formation constant of sour wastewater microfiltration

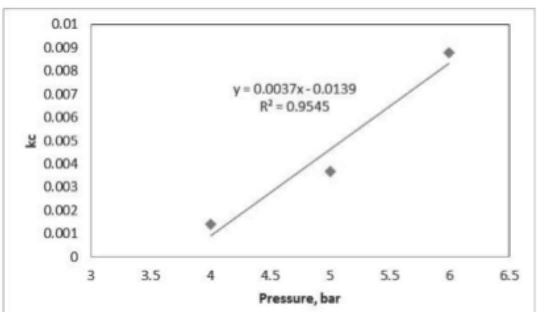


Fig. 8. Cake formation constant of sour wastewater microfiltration at various pressure

CONCLUSIONS

The ceramic membrane obtained from natural zeolite can be used for microfiltration of sour wastewater. Utilization of ceramic membrane can reduce the cost of SWS unit. The maximum rejection of 86% can be obtained at the pressure of 4 bar. The relationship between pressure operation with the value of cake formation constant can be expressed by the equation: kc = 0.0037.(P) - 0.0139.

ACKNOWLEDGMENTS

The authors acknowledge financial support from the Ministry of research, technology and higher education of Indonesia.

REFERENCES

Aryanti, N., Wardhani, D. H. and Supandi, S. 2016. Flux Profiles And Mathematical Modeling of Fouling Mechanism for Ultrafiltration of Konjac Glucomannan. *Chemistry & Chemical Engineering, Biotechnology, Food Industry.* 17 (2) : 125 - 137.

Briao, V.B. and Tavares, C.R.G. 2012. Pore Blocking Mechanism for The Recovery of Milk Solids from Dairy. *Brazilian J. Chem. Eng.* 29 (2): 393-407.

Coelho, A., Castro, A. V. and Dezotti, M. 2006. Treatment of petroleum refinery sour water by advanced oxidation processes. *J. Hazard. Mater.* 137 (1) : 178-184.

Iorhemen, O.T., Hamza, R. A. and Tay, J. H. 2016. Membrane Bioreactor (MBR) Technology for Wastewater Treatment and Reclamation/: *Membrane Fouling. Membranes (Basel).* 6 (33) : 13-16.

Jana, S., Purkait, M.K. and Mohanty, K. 2010. Applied Clay Science Preparation and characterization of low-cost ceramic microfiltration membranes for the removal of chromate from aqueous solutions. *Appl. Clay Sci.*, 47(3-4) : 317-324.

Khemakhem, S., Larbot, A. and Ben Amar, R. 2009. New ceramic microfiltration membranes from Tunisian natural materials/: *Application for the cuttlefish effluents treatment. Ceram. Int.* 35 : 55-61.

Ma'ruf, A., Budiana, B. and Mulyadi, A. H. 2015. Pembuatan dan Karakterisasi Membrane Keramik TiO2 untuk Ultrafiltrasi. *in Simposium Nasional Teknologi Terapan.* 3 : 1-5.

Miller, D. J., Kasemset, S., Paul, D. R. and Freeman, B. D. 2014. Comparison of membrane fouling at constant flux and constant transmembrane pressure conditions. *J. Memb. Sci.* 454 : 505-515.

Minier-Matar, J., Janson, A., Hussain, A. and Adham, S. 2017. Application of membrane contactors to remove hydrogen sulfide from sour water. *J. Memb. Sci.*, 541(July) : 378-385.

Rekik, S. B., Bouaziz, J. and Deratani, A. 2017. Study of Ceramic Membrane from Naturally Occurring-Kaolin Clays for Microfiltration Applications. *Period. Polytech. Chem. Eng.* 61 (3) : 206-2015.

SWS Treatment - PRJ

ORIGINALITY REPORT

18%	15%	9%	5%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	en.wikipedia.org Internet Source	7%
2	www.scielo.br Internet Source	4%
3	pp.bme.hu Internet Source	1%
4	docobook.com Internet Source	1%
5	Submitted to Universiti Malaysia Pahang Student Paper	1%
6	journals-jd.upm.edu.my Internet Source	1%
7	Jamilu Usman, Mohd Hafiz Dzarfan Othman, Ahmad Fauzi Ismail, Mukhlis A Rahman et al. " Impact of Organosilanes Modified Kaolin Ceramic Membrane on Efficiency of Oil Recovery from Produced Water ", Journal of Chemical Technology & Biotechnology, 2020 Publication	1%

8	Saida Bousbih, Emna Errais, Fadila Darragi, Joelle Duplay, Malika Trabelsi-Ayadi, Michael Olawale Daramola, Raja Ben Amar. "Treatment of textile wastewater using monolayered ultrafiltation ceramic membrane fabricated from natural kaolin clay", Environmental Technology, 2020 Publication	1%

Exclude quotes	On	Exclude matches	< 1%
Exclude bibliography	On		

SWS Treatment - PRJ

GRADEMARK REPORT

FINAL GRADE

/0

GENERAL COMMENTS

Instructor

PAGE 1

PAGE 2

PAGE 3

PAGE 4