# Study about Utilization of Used Oil by Ceramic Membrane to Separate The Metal Elements

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**ABSTRACT**

High quantity of vehicle use have been triggered to increase the use of oil and caused the increase of used oil in environment. Used oil might contained the metallic elements such as aluminum (Al), iron (Fe), copper (Cu) and zinc (Zn). In this study, ceramic membrane was used to separate the metal elements to utilize the used oil. The objective of this research were to investigate the metal separation process from used oil and to analyze the effect of metal separation by using ceramic membrane. The materials that used as membrane component were zeolite, iron powder and clay. Flux analysis showed that ceramic membrane which contain 30% zeolit, 5% iron powder and 65% clay at flowrate 3L/min were resulted in Al 0.12 ppm, 0.12 ppm Fe, Cu 0.003 ppm and Zn 0.07 ppm .
Keywords: ceramic membranes, oil, metallic, flash point.

## I. INTRODUCTION

High quantity of vehicle use have been triggered to increase the use of oil and caused the increase of used oil in environment. The engine oil was liquid oil that has been used as cleaner, cover, and lubricant for vehicle machine. The perform of this oil would be decreased after use periodically[1]. The characteristis of oil would change in colour and composition[2]. The used oil contained waste namely acid, corosion, and heavy metal[3]. Used oil might contained the metal elements such as aluminum (Al), iron (Fe), chopper (Cu) and zinc (Zn). This waste would became the environmental and health issue for environment. The metal elements in used oil were unwated elements that should be removed.

Nowadays, membrane technology has been used to separate particle with different size of molecule. Membrane, a tiny media that has semipermiable pore size would passed the small particle and trapped big particle in pore[4].
One of membrane technology that often used was ceramic membrane. Ceramic membrane was used to separate component that has different molecule size. This microporous membran with asimetric poresize has been applied for microfiltration and ultarafication with random distribution and highly voided molecule [5].

In this study, the metals were separated from used oil by using ceramic membrane. The used oil that has been already separated from their metals element were expected to be used again as oil for vehicles, asphalt additive, and fuel. The purposes of this study were to investigate the metal separation process from used oil and to analyze what kind of metal elements that could be separated by using ceramic membrane.

## II. METHODOLOGY

### Materials and Equipments

The used oil was obtained from Honda service station at Musi Raya Timur Street. The equipments that used in this study were ceramic membrane with zeolite, steel and clay composition, the housing of ceramic membrane, housing filter, oil pump, flowmeter, PVC pipe, analytical balance, plastic container, and plastic pipe.

### Methodology

The procedure for this experiment were divided into four stages; the preparation of used oil, the equipments instalation, the filtration process using ceramic membrane, and filtrate analysis. Pretreatment process was obtained by heating the used oil at $40^0$C before use. Before primary treatment, the used oil was passed through zeoilte and silica part for trapped unwated waste that has big molecule size.

This study was used three different ceramic membrane; zeolite ceramic membrane 20%, 30%, and ceramic mambrane thatcontain 30% zeolite with steel powder 5% for primary treatment.

Filtrate was taken in every 30 minute in filtration process, with different flowrate treatments. The used oil was passed through filter and at 180 minutes, the used oil was collected in bottle sample for further analysis.

## II.RESULT AND DISCUSSION

Ceramic membrane that used in this study were ceramics membrane with composition zeolit 20% - clay 80%; zeolit 30% - clay 70% and zeolit 20% - steel powder 5% - clay 65%.
The correlation between flux and time of those membrane could be seen in Figure 1-3. The graphic showed that the membrane was decreased metals component in used oil.

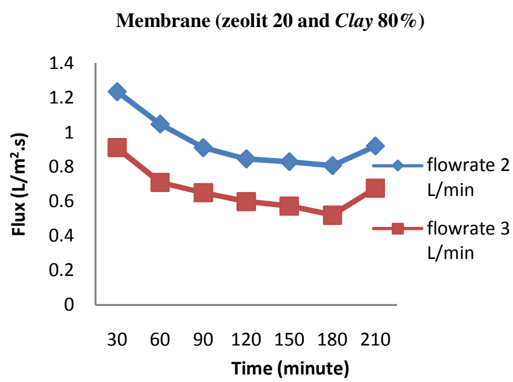


**Figure 1. the corelation between flux and time (zeolite 20% and clay 80%)**

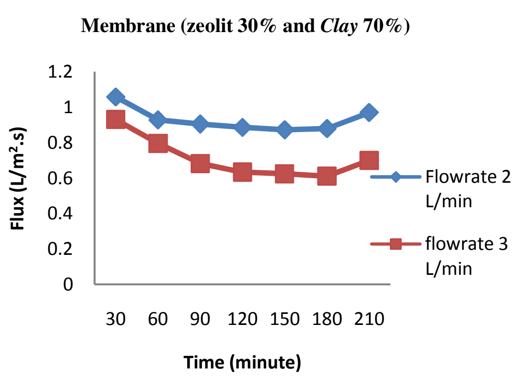


**Figure 2. the corelation between flux and time (zeolite 30% and clay 70%)**

Figure 1-3 showed that the flux value of membrane with flowrate 2L/min was higher than the flux value of membrane with flowrate 3L/min. It means that the membrane process was affected by flowrate.

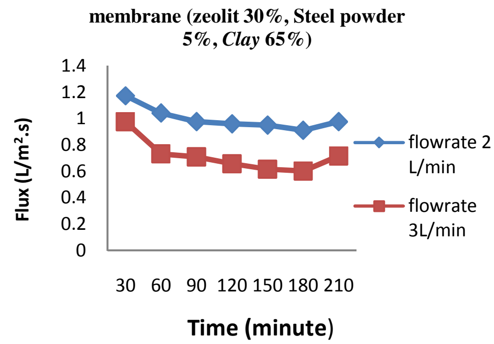


**Figure 3. the corelation between flux and time (zeolite 30%, steel powder 5% and clay 65%)**

The decrease of flux value was affected by operation time. The longer operation time, the lower the flux value. Flux was high at 210 minutes due to at that time backwash occured. *Backwash* was done for wash the liquid waste that trapped in ceramic membrane during operation. The waste that formed tiny film thruogh membrane made the membrane perform decreased.

### Coeficient of rejection

Coeficient of rejection was calculated the value of membrane to remove the metals element in used oil. The coeficient rejection of Aluminium (Al) could be shown in Figure 4. The higher value of coeficient showed the higher membrane perform to separate the metals from used oil. Figure 4 showed that the maximum value of coeficient rejection for flowrate 2l/min was 47,5% (t= 180 minute) and 50 % for flowrate 3l/min (t= 180 minute)

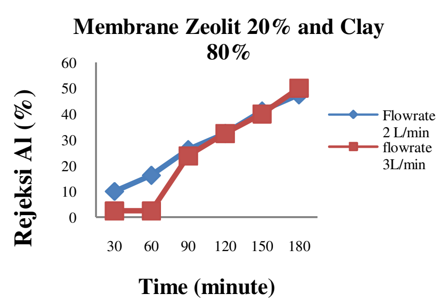


**Figure 4. The correlation between time and coeficient of rejection of Aluminium (Membrane: Zeolit 20% and Clay 80%)**

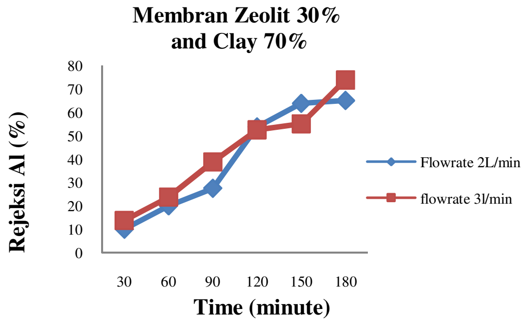


**Figure 5. The correlation between time and coeficient of rejection of Aluminium (Membrane:Zeolit 30% and Clay 70%)**

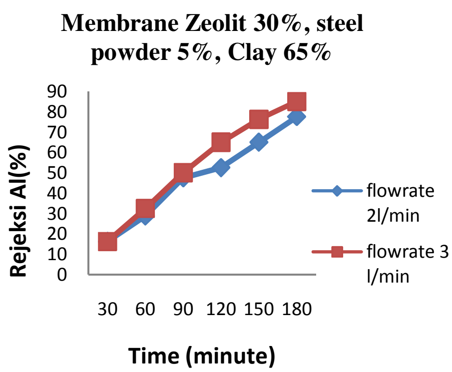


**Figure 6. The correlation between time and coeficient of rejection of Aluminium (Membrane Zeolit 30%, steel powder 5% and Clay 80%)**

Figure 5 showed that the coeficient of rejection was affected by the membrane perform to separate the metals element. The highest coeficient value for flowrate 2L/min was 65% and for flowrate 3L/min was 73,75%.
The highest coeficient of rejection for membrane in Figure 6 was 77,5% at florate 2l/min and 85% for *flowrate* 3L/min the coeficient rejection value in figure 6 was the highest among other membrane. It means that membrane with composition of Zeolit 30%, steel powder 5% and Clay 80% was the best for separate Aluminum element in used oil among others.

**The decrease of Aluminium value removal during operation time**

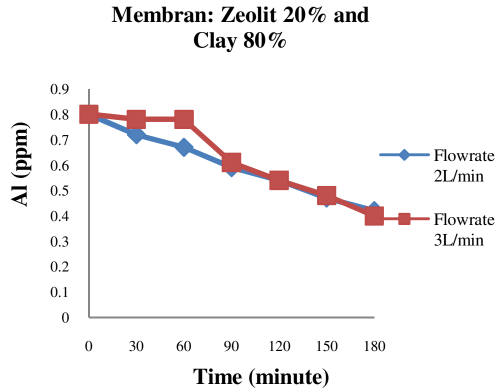


**Figure 7. The decrease of Aluminium value in used oil during operation time (membrane: zeolite 20% and clay 80%)**

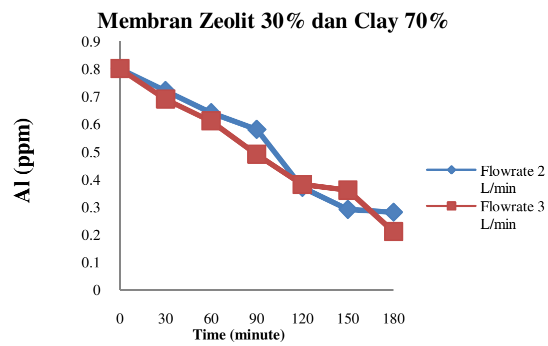


**Figure 8. The decrease of Aluminium value in used oil during operation time (membrane: zeolit 30% and *clay* 70%)**

It could be seen in Figure 7 that Aluminium value before treatment was 0,8 ppm. After treatment, the aluminium value in used oil was decreased. At flowrate 2L/min (30 minutes), the aluminium value was 0,72 ppm. In minute-180, aluminium value was 0,42 ppm. *Flowrate* 3 L/min showed that the aluminium value was also decreased from 0,8 to 0,4 ppm.

Figure 8 showed that at *flowrate* 2L/min the aluminium value was 0,72 to 0,28 ppm. At *Flowrate* 3 L/min the value was 0,69 to 0,21 ppm. The aluminium value in Figure 9 was 0,67 to 0,18 ppm (at flowrate 2L/min) and was was 0,67 to 0,12 ppm (At *Flowrate* 3 L/min). The longer operation time, the lower the aluminium content in used oil.

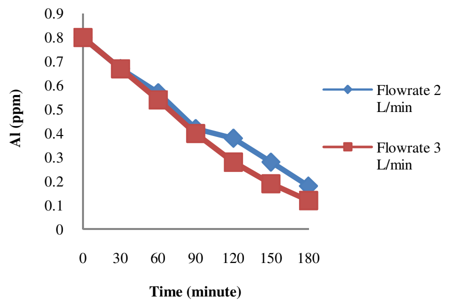


**Figure 9. The decrease of Aluminium value in used oil during operation time (membrane: zeolit 30%, steel powdre 5% and *clay* 65%.**

**The Correlation between flash point and operation time**

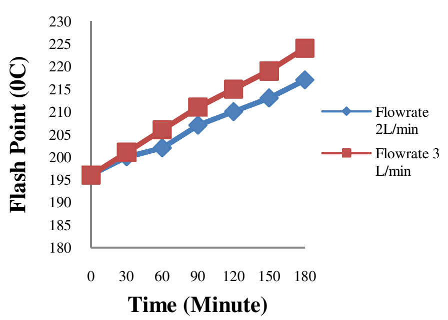


**Figure 10. The Correlation between falash point and operation time (membrane: Zeolit 20% and clay 80%)**

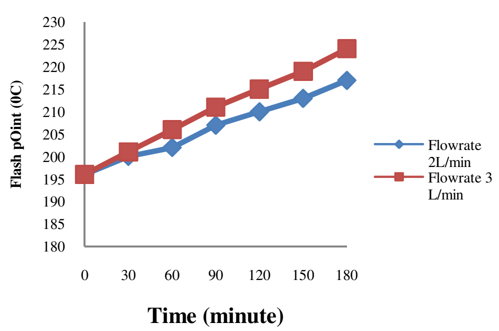


**Figure 11. The Correlation between falash point and operation time (membrane: zeolit 30% and clay 70%)**

Figure 10 showed that flash point of used oil before treatment was 196$^0$C. Treatment with flowrate 2L/min, flash point was 199$^0$C to 207$^0$C. It showed that flash point was increased during operation time. Treatment with *flowrate* 3L/min, the flash point value was ranged between 200$^0$C to 211$^0$C. It could be seen in Figure 11 at *flowrate* 2L/min, the flash point were ranged between 200$^0$C to 217$^0$C, and at *flowrate* 3L/min was
201$^0$C to 224$^0$C.

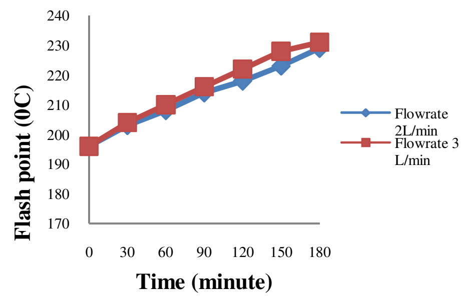


**Figure 12. The Correlation between falash point and operation time (membrane: zeolit 30%, steel powder 5% and clay 65%)**

Figure 12 showed that the flash point at *flowrate* 2L/min were ranged between 203$^0$C to 229$^0$C, and ranged between 204$^0$C to 231$^0$C at flowrate 3L/min.

## V. CONCLUSION

It can be conluded from the study that the membrane process was affected by flowrate. The flux value of membrane with flowrate 2L/min was higher than the flux value of membrane with flowrate 3L/min. The decrease of flux value was affected by operation time. The longer operation time, the lower the flux value. The higher value of coeficient of rejection showed that the higher membrane perform to separate the metals from used oil. Membrane with composition of Zeolit 30%, steel powder 5% and Clay 80% was the best for separate Aluminum element in used oil among others. The longer operation time, the lower the aluminium content in used oil. It showed that flash point was increased during operation time. The decrease of metals element content in used oil would increase the flash point value. The highest flash point value was 231$^0$C (ceramic membrane with composition of zeolit 30%, steel powder 5% and *clay* 65% at *flowrate* 3L/min).

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