Journal of Engineering and Applied Sciences 12 (14): 3740-3742, 2017
ISSN: 1816-949X

The Effect of Adsorption Contact Time and pH of Natural Rubber Latex Waste and Water Hyacinth Based Adsorbent on Grease Removal from Water

Pandapotan Turnip, Hamidah Harahap, Sukardi, Nuim Hayat, Rosdanelli Hasibuan and Taslim
Department of Chemical Engineering, University of Sumatera Utara, Jalan Almamater,
20155 Kampus Usu Medan, North Sumatera, Indonesia

Abstract: Natural rubber latex waste filled with water hyacinth was used as adsorbent as a part of the waste alternative utilization. This study was aimed to determine the maximum contact time and pH of the adsorbent on the adsorption process of grease in water. It was carried out by contacting the adsorbent with the mixture of grease and water for 5-25 min with the addition of different pH solution. It was found that the adsorption capacity of the adsorbent was improved with the increasing contact time while the increase of pH solution showed no significant effect on the adsorption capacity.

Key words: Adsorption, grease, latex, water hyacinth, pH solution

INTRODUCTION

Natural Rubber (NR) latex has been widely used in many daily product such as gloves, seals, hoses, cushions, tyres and various electirical instrument. These products have played an important role in daily life. However, manufacture of these product may also produce overcured NR-Latex compound. The use of overcured latex compound will produce bad quality products so it is usually dispose as waste. The direct waste disposal will result in environmental pollution. Therefore, it is necessary to utilize the NR-latex waste to minimalize the pollution (Zhou *et al*., 2015).

It is reported that the NR-latex waste can be used as adsorbent which enable removal process of oil spill on the soil and water (Hanafi and Azahari, 2005). So, the utilization of NR-latex waste as adsorbent can be applied to reduce water pollution due to excessive grease content. According to the data of North Sumatera Environmental Agency in 2012 the grease and oil content in Lake Toba has excceed the quality standard. It is reported that the grease and oil content at 22 location in Lake Toba area has reached 1.2-1.6 mg/L while the quality standard of the agency has the value of 1 mg/L. Besides, the lush growth of water hyacinth which is caused by agricultural waste has also polluted the Lake Toba (Nasution *et al*., 2016).

Both water hyacinth and grease pollution will damage the enviromental quality of Lake Toba. Therefore, the water hyacinth-filled NR-latex waste will be utilized as adsorbent to reduce the grease content of the water. The effect of the content time and pH of the adsorbent will be studied.

MATERIALS AND METHODS

Preparation of water hyacinth filled NR-Latex waste as adsorbent: Water hyacinth was washed with distilled water and was cut to the size of 1-2 cm^2. Then, it was boiled for an hour and followed by drying process in the oven until constant weight has been achieved. The dried water hyacinth was milled and sieve until 100 mesh water hyacinth powder obtained. The obtained water hyacinth powder was mixed with NR-Latex wasteat composition of 0:100; 10:100 and 20:100 (w/w) and was stirred until homogenuous mixture obtained. Each of the composition variation will be labeled as Adsorbent A-C. The adsorbent was dried in the oven at 130°C for 15 min. The dried adsorbent was further reduced to the diameter size of 40 mesh and was stored in desiccator.

Iodine number analysis: As much as 2 g of adsorbent was put into erlenmeyer and was added with 10 mL HCl solution 5%, followed by stirring and heating. Then, it was cooled at room temperature. The mixture was added with 100 mL of iodine solution 0.1 N and was homogenized as well as filtered. The filtrate as much as 50 mL was titrated using Sodium Thiosulphate 0.1 N until pale yellow solution obtained. Then, amilum indicator solution 1% was added and the titration was continued until clear filtrate obtained. The amount of $Na_2S_2O_3$ 0.1 N used was noted. The iodine number can be calculated by using Eq. 1 (SNI, 1995):

$$I = \frac{[(A) - (DF)(B)(S)]}{M} (\text{mg/g activated carbon}) \quad (1)$$

Corresponding Author: Pandapotan Turnip, Department of Chemical Engineering, University of Sumatera Utara, Jalan Almamater, 20155 Kampus Usu Medan, North Sumatera, Indonesia

Where:

I = Iodine number (mg Iodine/g activated carbon)
A = Iodine normality×12693
B = Sodium Thiosulphate normality×126.93
S = Volume of sodium thiosulphate
M = Mass of activated carbon

$$DF = \frac{mL\ Iodine + mL\ HCl}{mL\ Filtrate} \quad (2)$$

Determination of maximum contact time: As much as 10 g of grease was put in a beaker glass filled with 100 mL of water. The mixture was added with 2 g of adsorbent, followed by stirring at 170 rpm using magnetic stirrer. The stirring process was stopped at 5, 10, 15, 20 and 25 min. The adsorbent then was filtered and weighed. The grease content of the filtrate was analyzed to determine the adsorbent's adsorption capacity. The maximum contact time was obtained.

Analysis of pH effect on adsorption capacity of water hyacinth filled NR-Latex waste: Solution with initial pH of 5-9 was prepared in beaker glass. As much as 20 g of grease was put in a different beaker glass filled with 1000 mL of water. The mixture was mixed with 2 g of adsorbent and was poured in the solution with different initial pH, followed by stirring process at 170 rpm for 10 min. The final mixture was centrifuged with velocity of 3000 rad/min. The filtrate was analyzed using gravimetric method.

RESULTS AND DISCUSSION

Figure 1 shows the iodine number analysis data of the adsorbent with different water hyacinth composition. It can be seen that the iodine number for Adsorbent A-C each give value of 130.9918, 132.1087 and 136.5767 mg I_2/g adsorbent. The higher iodine number indicates that the adsorbent has greater adsorption capacity. The adsorbent with high iodine adsorption ability indicates the larger surface area of the adsorbent and has larger micro structure and mesopore (Nunes and Guerreiro, 2011). The improvement of iodine number from Adsorbent A-C shows that water hyacinth addition will enhance adsorption capacity of the adsorbent.

Figure 2 shows the effect of adsorbate contact time on the grease adsorption capacity of the adsorbent. It can be seen that the grease adsorption capacity increase as the contact time increases. However, the longer the contact time, the slower the increment of the adsorption capacity. The effect of contact time on the adsorption capacityof the adsorbent usually follow 2 step kinetic behaviour. In the first step, the adsorption process occurs

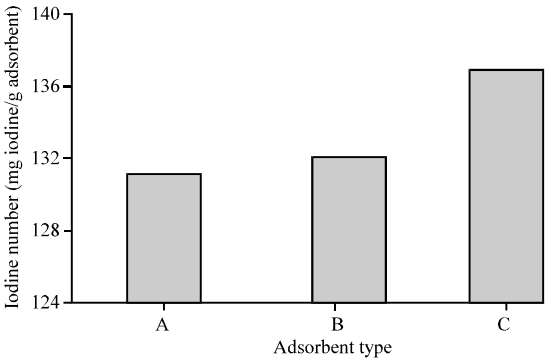

Fig. 1: Iodine number of various adsorbent type

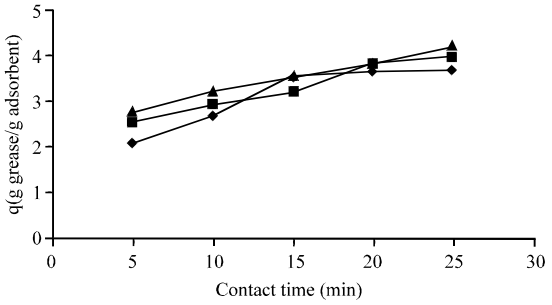

Fig. 2: The effect of adsorbate contact time on the grease adsorption capacity

quickly as the contact time increases. It is due to the large free bond sites which is available in the adsorbent. Yet, the longer contact time will result in the slower increment of adsorption capacity due to the lesser available bond sites. Besides, the spacious surface sites has been difficult to adsorb the grease because of the repulsive force among adsorbate molecules in the solid and liquid phase (Song *et al*., 2014; Ucar *et al*., 2015; Khosravihaftkhany *et al*., 2013; Roy *et al*., 2013).

It can also be shown at Fig. 2 that the grease adsorption capacity improve with the addition of water hyacinth as filler in NR-latex waste. It was due to the oleophilic properties if cellulose which enhance the grease adsorption. The improvement of grease adsorption capacity start to be slower at 5 min and the maximum grease adsorption capacity is achieved at 25 min by the value of 3.65 g grease/g adsorbent for Adsorbent A; 3.95 g grease/g adsorbent for Adsorbent B and 4.15 g grease/g adsorbent for Adsorbent C.

The effect of pH on the grease adsorption capacity of the adsorbent can be shown in Fig. 3. It can be observed that pH has no significant effect on the adsorption capacity of the adsorbent. The grease adsorption capacity for the water hyacinth-unfilled adsorbent from pH 5-9 show no changes with value of 2 g grease/g adsorbent.

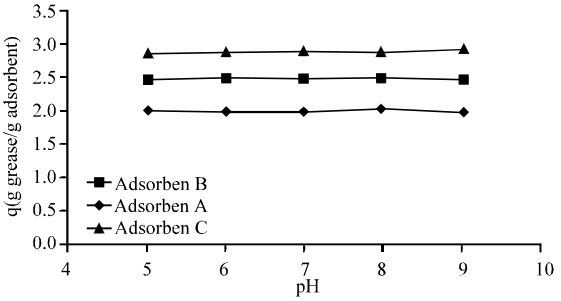

Fig. 3: The effect of pH solution on the grease adsorption capacity

Both 10 and 20% water hyacinth-filled adsorbent each gives the same grease adsorption capacity by the value of 2.5 and 2.9 g grease/g adsorbent from pH 5-9.

Adsorption ability of the adsorbent can be affected by pH solution due to the relation with protonation or deprotonation of active-side surface of the adsorbent. The pH value will influence the surface charge of the adsorbent and ionization degree of the adsorbable substance (Gadd and White, 1989). If the adsorption is only influenced by electrostatic interaction, the maximum adsorption capacity should approximately at pH 6-8. However, adsorption can also be caused by another mechanism such as hydrogen bond and hydrophobic-hydrophobic interaction (Al-Degs *et al*., 2008). The hardly constant value of grease adsorption capacity indicates that the main adsorption mechanism did not depend on the electrostatic interaction but may depend on another mechanism such as hydrogen bond or hydrophobic-hydrophobic interaction.

CONCLUSION

It is observed that the utilization of water hyacinth as filler in NR-latex waste adsorbent could enhance the adsorption capacity. The best properties of the water hyacinth-filled NR-latex waste adsorbent were obtained at 20% addition of water hyacinth with maximum contact time at 25 min. The pH solution showed no significant effect in the adsorption capacity. The use of water hyacinth-filled NR-latex adsorbent can be an alternative to reduce grease polution in the water.

REFERENCES

Al-Degs, Y.S., M.I. El-Barghouthi, A.H. El-Sheikh and G.M. Walker, 2008. Effect of solution pH, ionic strength and temperature on adsorption behavior of reactive dyes on activated carbon. Dyes Pigments, 77: 16-23.

Gadd, G.M. and C. White, 1989. Removal of thorium from simulated acid process streams by fungal biomass. Biotechnol. Bioeng., 33: 592-597.

Hanafi, I. and B. Azahari, 2005. Oil Zob: A Novel and Reactive Oil Adsorbent from Various Rubber Wastes. Universitas Sains Malaysia, George, Malaysia,.

Khosravihaftkhany, S., N. Morad, T.T. Teng, A.Z. Abdullah and I. Norli, 2013. Biosorption of Pb (II) and Fe (III) from aqueous solutions using oil palm biomasses as adsorbents. Water Air Soil Pollut., Vol. 224, 10.1007/s11270-013-1455-y

Nasution, M.I.T., S.M.S. Awal and D.M. Permana, 2016. The methods of preventing water hyacinth as aquatic pollution in Lake Toba caused by agricultural waste. Intl. J. Environ. Sci. Dev., 7: 630-633.

Nunes, C.A. and M.C. Guerreiro, 2011. Estimation of surface area and pore volume of activated carbons by methylene blue and iodine numbers. Quimica Nova, 34: 472-476.

Roy, P., N.K. Mondal, S. Bhattacharya, B. Das and K. Das, 2013. Removal of Arsenic (III) and Arsenic (V) on chemically modified low-cost adsorbent: Batch and column operations. Appl. Water Sci., 3: 293-309.

SNI., 1995. Technical active charcoal. Indonesia National Standard, Indonesia.

Song, S.T., N. Saman, K. Johari and H. Mat, 2014. Surface chemistry modifications of rice husk toward enhancement of Hg (II) adsorption from aqueous solution. Clean Technol. Environ. Policy, 16: 1747-1755.

Ucar, S., M. Erdem, T. Tay and S. Karagoz, 2015. Removal of lead (II) and Nickel (II) ions from aqueous solution using activated Carbon prepared from rapeseed oil cake by Na2CO3 activation. Clean Technol. Environ. Policy, 17: 747-756.

Zhou, Y., M. Fan, L. Chen and J. Zhuang, 2015. Lignocellulosic fibre mediated rubber composites: An overview. Compos. Part B. Eng., 76: 180-191.