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Adsorptive Performance of GSC and Coconut Shell based Activated Carbon

Lydia Dundun Francis, Rosnah Abdullah Zainal and Irna Bakri
Faculty of Chemical Engineering, Universiti Teknologi MARA (UiTM) Sarawak Branch,
Kota Samarahan, Sarawak, Malaysia, lydiafrancis@uitm.edu.my

Abstract: This study aims to observe the adsorptive performance mixture of Graphene Sand Composite (GSC) and Coconut Shell-based Activated Carbon (CSAC) at different activation temperature. Experimental results showed the optimum condition for activation temperature was 400°C with the absorbance value of 1.65A. The chemical activated carbon yield was investigated and the maximum yield percentage of the activated carbon prepared in this study was 33% at 400°C.

Key words: Activated carbon, coconut shell, graphene sand composite, optimum, condition, temperature

INTRODUCTION

Adsorption process is one of the effective method for removal of dyes because of low operation cost, simple, better pollutant removal, easy to treat dye solution at high concentration and easily remove sludge (Mathivanan and Saranathan, 2015). Activated carbon is used to increase adsorptive performance for colour removal. It has the potential to adsorb a large amount of difference types of dye. However, some of carbon are expensive, non-selective and ineffective against disperse and vat dyes (Gusmao *et al*., 2012). These lead many researchers to find another way to replace expensive activated carbon with low cost adsorbent. A low cost adsorbent which is natural raw materials such as sugarcane bagasse, orange peel, sawdust, rice husk and coconut shell have been studied to adsorb the synthetic dyes (Gusmao *et al*., 2012). Another lower cost adsorbent is Graphene Sand Composite (GSC) which is made from low cost materials such as sugar and river sand. Graphene is one of the fascinating carbon which is known as the one-atom thick sheets of carbon (Gupta *et al*., 2012). It has the best potential surface area and can be produced at low cost, making it the most affordable adsorption medium in diverse applications.

MATERIALS AND METHODS

Preparation of Graphene Sand Composite (GSC): The sugar was dissolved in water while it was stirring, sand was put into the solvent. The temperature was maintained at 95°C for 1 h with constant stirring until the sugar coated sand obtained. The sugar-coated sand was then placed in a crucible and heated in a furnace with the following temperature from room temperature to 100°C in 30 min, from 100-200°C in 30 min, held at 200°C for 1 h, increase dramatically to 750°C in 1 h and held for 3 h at 750°C to ensure complete graphitization of sugar. The material was cooled to room temperature. The black colour sample after heated in furnace was called graphene sand composite. Activation process was conducted after GSC was obtained. As for activation, GSC was treated with concentrated sulphuric acid and kept undisturbed at room temperature for 30 min. The mixture was then filtered and dried at 120°C using oven for 24 h and the active GSC was labelled GSC_{750}.

Preparation of Coconut Shell-based Activated Carbon (CSAC): The coconut shell was collected from Khubah Ria Complex. The coconut shell was pounded into smaller pieces approximate 5 mm in size. It was soaked into sodium hydroxide, NaOH solution (activation solution) for 24 h. The impregnation ratio between coconut shell and activating agent was maintained at 1:1. The sample was dried in an oven at 120°C to remove water. The carbonization was carried out at three different activation temperatures 400, 500 and 600°C for a period of 1 h 30 min by using a furnace and labelled as $CSAC_{400}$, $CSAC_{500}$ and $CSAC_{600}$. When the activated carbon was cooled, it was temporarily stored in desiccators and then continuously washed using 0.1 M Hydrochloric acid (HCl) in order to remove the activating agents until the filtrate was obtained. The activated carbon was washed several times using distilled water in order to remove the HCl. The product is dried in an oven overnight to remove the water. The mass of dried coconut shell-based activated carbon is measured by using analytical digital balance.

Corresponding Author: Lydia Dundun Francis, Faculty of Chemical Engineering,
Universiti Teknologi MARA (UiTM) Sarawak Branch, Kota Samarahan, Sarawak, Malaysia
lydiafrancis@uitm.edu.my

Yield percentage of CSAC: The yield percentage of Coconut Shell-based Activated Carbon (CSAC) is calculated using formula as follow:

$$\text{Yield percentage} = \left(\frac{B}{A}\right)\times 100$$

Where:
A = Weight of sample before carbonization
B = Dried weight after wash

Experimental scheme: The mixture of GSC, $CSAC_{400}$ and methylene blue dye solution was poured into conical flask and placed on the magnetic stirrer. After 5 h of continuous stirring process, the mixture was then filtered to remove the activated carbon from methylene blue solution. The liquid sample was analysed by using UV-Vis. The experiment was replicated with $CSAC_{500}$ and $CSAC_{600}$..

RESULTS AND DISCUSSION

Yield percentage: The yield percentage result of chemical activation temperatures at 400°C, 500°C and 600°C given in Table 1 are 33%, 28.6% and 25.6%, respectively. The increase in temperature decreases the CSAC yield percentage. Similar study also found that carbon yield was decreased with an increasing in the activation temperature (Ahmida *et al.*, 2015). This is due to more volatile component being lost at higher temperature. Another study (Aragaw *et al.*, 2016) indicates that the lower yield obtained at a higher temperature is caused by a much larger release of volatile matters. The higher the percentage in yield contributes to better adsorption of activated carbon. This further implies in a literature (Kumar and Jena, 2016) that activating agent act as dehydrating agents that prevent the formation of tar as well as volatile substances during the process which can improve the yield of porous carbon and to lower the activation temperature and activation time compared with the physical activation method.

Figure 1 shows that the absorbance value of adsorption of MB are 1.65A (400°C), 5.89A (500°C) and 6.01A (600°C). The coconut shell based activated carbon is a non-graphite form of carbon which contains internal porosity with high surface area adsorption capacity and degree of surface reactivity (Samdin *et al.*, 2015). Low temperature produce very strong binding forces between the dye molecule and adsorbent surface (Sharma and Kaur, 2011) that can increase adsorptive performance. Higher temperature may cause more pore expansion that leads to leaching of MB molecules adsorbed on the MB (Khattri and Singh, 2011). The heat from activation

Table 1: Yield percentage at different activation temperature

Activation temperature (°C)	A(g)	B(g)	Yield (%)
400	50	16.5	33.0
500	50	14.3	28.6
600	50	12.8	25.6

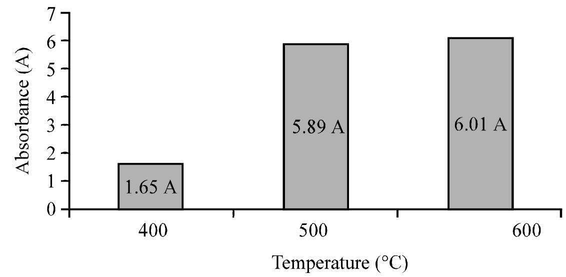

Fig. 1: Absorbance value at different activation temperature

temperature causes the pores breaks bigger. The addition of NaOH as treatment for coconut shell enhance its ability to adsorb various substances such as gases, liquid or adsorbates on the surface of its pores.

CONCLUSION

GSC with CSAC activation temperature at 400°C is the best adsorptive performance with low absorbance value of 1.65A. This proves that the low activation temperature produced the best absorptive performance with the lowest absorbance value. The yield percentage of CSAC increases when the activation temperature decreases which helps get better adsorption of activated carbon and less energy consumption.

REFERENCES

Ahmida, K., M. Darmoon, F. Al-Tohami, M. Erhayem and M. Zidan, 2015. Effect of physical and chemical preparation characteristics of activated Carbon from agriculture solid waste and their potential application. Proceedings of the International Conference on Chemical, Civil and Environmental Engineering (CCEE-2015), June 5-6, 2015, Istanbul, Turkey, pp: 83-87.

Aragaw, T.A., 2016. Proximate analysis of cane bagasse and synthesizing activated Carbon: Emphasis on material balance. J. Environ. Treat. Tech., 4: 102-110.

Gupta, S.S., T.S. Sreeprasad, S.M. Maliyekkal, S.K. Das and T. Pradeep, 2012. Graphene from sugar and its application in water purification. ACS. Appl. Mater. Interfaces, 4: 4156-4163.

Gusmao, K.A.G., L.V.A. Gurgel, T.M.S. Melo and L.F. Gil, 2012. Application of succinylated sugarcane bagasse as adsorbent to remove methylene blue and gentian violet from aqueous solutions: Kinetic and equilibrium studies. Dyes Pigments, 92: 967-974.

Khattri, S.D. and M.K. Singh, 2011. Use of Sagaun sawdust as an adsorbent for the removal of crystal violet dye from simulated wastewater. Environ. Prog. Sustainable Energy, 31: 435-442.

Kumar, A. and H.M. Jena, 2016. Preparation and characterization of high surface area activated Carbon from Fox nut (Euryale ferox) shell by chemical activation with H3PO4. Results Phys., 6: 651-658.

Mathivanan, M. and E.S. Saranathan, 2015. Sugarcane bagasse-a low cost adsorbent for removal of methylene blue dye from aqueous solution. J. Chem. Pharm. Res., 7: 817-822.

Samdin, S.M., L.H. Peng and M. Marzuki, 2015. Investigation of coconut shells activated Carbon as the cost effective absorbent in drinking water filter. J. Technol., 77: 13-17.

Sharma, P. and H. Kaur, 2011. Sugarcane bagasse for the removal of erythrosin B and methylene blue from aqueous waste. Appl. Water Sci., 1: 135-145.