Shape-stabilized Phase Change Material Preparation for Thermal Energy Storage Application

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Abstract: This work was conducted to see the behavior of n-octadecane PCM towards different palm kernel shell activated carbon (PKSAC) prepared as shape-stabilized phase change material (SSPCM) for thermal energy storage (TES) application. The different PKSAC was identified from different amount of H_3PO_4 treatment given to palm kernel shell from 0, 5, 10, 20, 30 and 40% before activation. The impregnation of n-octadecane with the different PKSAC produced SSPCMs that expressed different physico-chemical characteristics. The BET surface area shows the obvious changes of value before and after impregnation which proves that the PKSAC is very suitable framework for the n-octadecane. The most obvious changes show in the graph is C20 by having the highest surface area compared to the others which is 1169 m^2g^{-1} and decreased to 2 m^2g^{-1}. The X-ray diffractometer, field emission scanning electron microscope and FESEM images prove that the n-octadecane was successfully impregnated into the pores of AC without chemical interaction between the AC and n-octadecane. The SSPCM nanocomposite shows that the PKSAC is thermally good framework material for n-octadecane observed by raman spectroscopy, TGA/ DTG thermal analysis, differential scanning calorimeter and leakage study.

Keywords: Activated carbon, palm kernel shell, phase change material, thermal energy storage, n-octadecane

INTRODUCTION

Thermal energy storage (TES) for buildings has recently received much attention. Many different techniques of TES preparation were developed over the past decades such as underground thermal energy storage, building thermal mass utilization, energy storage tanks and phase change materials (PCM) [1]. The energy storage system is common and available in many different types, but they are limited by cost, low density, low volume of storage and limited efficiency [2].

MATERIALS AND METHODS

The Palm kernel shell (PKS) was cleaned and crushed before it was treated with H_3PO_4. About20 g of the precursor was weighted and treated with 100 mL of freshly prepared various concentration of H_3PO_4 at different concentration percentages: 0, 5, 10, 20, 30 and 40% in a conical flask.In PCM impregnation, about 1.8 g of n-octadecane paraffin wax weighted before melted on its melting temperature before dissolved with 30 mL absolute ethanol. After that, the weighted 2 g sample of PKSAC was added into the dissolved n-octadecane and stirred at 600 rpm for 4 h. The main characterization is BET surface area analysis.

RESULTS AND DISCUSSION

Fig. 1. summarized the BET surface area value of the activated carbon after the impregnation. The value shows that all AC were successfully impregnated with the n-octadecane which defined that the PKSAC is a very suitable framework for the n-octadecane. The most obvious changes show in the graph is C20 by having the highest surface area compared to the others which is 1169 m^2g^{-1} and decreased to 2 m^2g^{-1}. It is clearly showing that the pores of C20 activated carbon able to hold the

highest amount of n-octadecane which is very good for the application in TES. The higher the amount of n-octadecane loaded, more thermal energy will be stored the better the SSPCM nano-composite.

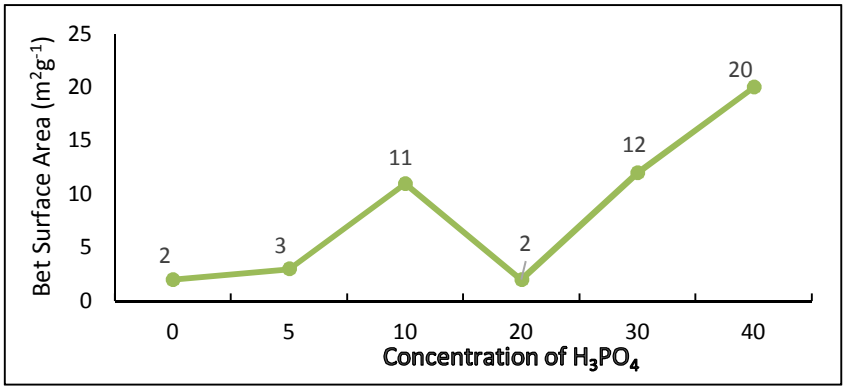

Fig. 1. Graph of BET surface area versus concentration of H_3PO_4 for SSPCM.

CONCLUSIONS

We believe that the n-octadecane was successfully impregnated into the pores of AC. The most obvious change of BET surface area value is C20 by having the highest value compared to the others which is 1169 m^2g^{-1} and decreased to 2 m^2g^{-1}. SSPCM-C20 has higher temperature range compared to other SSPCM shows that the C20 able to store and hold more n-octadecane compared to other AC. FESEM observation agreed the result in N_2 adsorption-desorption isotherms which proves that C20 is the best AC compared to the others by having well-developed porous structure, multiple pores, regular in shape and high inner surface area.

ACKNOWLEDGMENT: We would like to thank Universiti Putra Malaysia and the Ministry of Higher Education of Malaysia (UPM-MOHE) for funding this project under NANOMITE grant, vote no. 5526300 and 9443100.

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