UNIVERSITI TEKNOLOGI MARA

PREPARATION AND OPTIMISATION OF PALM KERNEL SHELL ACTIVATED CARBON FOR METHANE ADSORPTION

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Thesis submitted in fulfilment
of the requirements for the degree of
Master of Science

Faculty of Chemical Engineering

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CONFIRMATION BY PANEL OF EXAMINERS

I certify that a Panel of Examiners has met on 18th November 2015 to conduct the final examination of Mohd Saufi bin Md Zaini on his Master of Science (Chemical Engineering) thesis entitled "Preparation and Optimisation of Palm Kernel Shell Activated Carbon for Methane Adsorption" in accordance with Universiti Teknologi MARA Act 1976 (Akta 173). The Panel of Examiners recommends that the student be awarded the relevant degree. The panel of Examiners was as follows:

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AUTHOR'S DECLARATION

I declare that the work in this thesis was carried out in accordance with the regulations of University Teknologi MARA. It is original and is the results of my own work, unless otherwise indicated or acknowledged as referenced work. This thesis has not been submitted to any other academic institution or non-academic institution for any degree or qualification.

I, hereby, acknowledge that I have been supplied with the Academic Rules and Regulations for Post Graduate, Universiti Teknologi MARA, regulating the conduct of my study and research.

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ABSTRACT

The storage of natural gas by adsorption has high potential to replace the compressed natural gas storage in mobile application. The adsorbed natural gas storage technology (ANG), the gas is stored through adsorption in porous material (e.g. activated carbon) at low pressure. However, its capacity and performance depend on the type of porous material, the method used for the preparation of adsorbent and the preparation conditions. This study focuses on the development of activated carbon from palm kernel shell activated carbon for methane storage. The preparation of activated carbon was divided into two phases according to its objectives. The first phase of preparation of activated carbon was conducted to study the effects of activation agents by CO_2, steam and their sequential combinations on the pore development of activated carbon. The results show that the combination of CO_2 and steam, regardless of their sequences, results in a higher carbon burn-off than the single activating agent. The combination of activation in the sequence of CO_2-steam, however, gives the highest value of carbon burn-off and produces activated carbon with the highest total pore volume and BET surface area. Steam activation favours the creation of new microporous structures, while CO_2 activation tends to widen the existing pores leading to the formation of mesoporous structures. The second phase of the study employs the Taguchi orthogonal array to optimise the preparation of activated carbon for methane storage. The statistical results show that the optimised conditions are the impregnation ratio of 0.55, activation temperature of 900 °C and activation time of 150 min. The impregnation ratio has the most influenced effect on methane adsorption based on the highest difference in delta of the S/N ratio analysis. The result of experiment using optimum conditions falls within the predicted value of the developed model and therefore justifying the significance of the model. Higher storage capacity is obtained for activated carbon prepared at optimum conditions which has higher BET surface area and total pore volume. The highest methane uptake in this study was 145.89 V/V at 10 bars which is very close to the desired storage capacity for application of ANG. The equilibrium data of the adsorption characteristic in this study fitted favourably to the Freundlich isotherm.

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