UNIVERSITI TEKNOLOGI MARA

A STUDY ON LIQUEFACTION OF PRETREATED MUKAH BALINGIAN LOW RANK MALAYSIAN COAL

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Thesis submitted in fulfilment of the requirements
for the degree of
Doctor of Philosophy

Faculty of Applied Sciences

May 2007

ABSTRACT

Direct liquefaction on untreated Mukah Balingian (MB) coal was successfully carried out at temperatures and pressures of 360 – 450 °C and 4 – 13 MPa, respectively, using tetralin as hydrogen-donor solvent. The coal conversion, oil+gas, asphaltene and preasphaltene obtained at maximum conditions of 450 °C, 4 MPa, 30 min reaction time, 1:10 coal-to-solvent ratio and with stirring, were 90%, 80%, 7% and 2%, respectively. It was observed that heat plays an important role in comparison to pressure in contributing to high coal conversion and oil+gas yield, and these results are well correlated with the high content of reactive macerals. In this study, three types of pretreatments were applied on MB coal, i.e. solvent swelling, *in-situ* solvent soaking and heating (SSH) and microwave irradiation. In the solvent swelling pretreatment, higher swelling ratio, coal reactivity and volatile yield (Ei) were obtained when swelled in mixed solvents followed, in decreasing order, by single solvents and untreated coal. The Ei decreased from untreated coal followed by single and mixed solvents. The synergistic effect of mixed solvent swelling was attributed to good interactions between the solvent and coal reactive sites, which promoted the breaking of H-bonds in coal and eventually weakened the coal-coal macrostructure. Oil+gas yield obtained from liquefaction on the mixed solvent-swelled samples showed further enhancement at temperatures from 360 – 450 °C and reached a maximum value at 420 °C. In the SSH pretreatment, the DTG results of the pyrolysed SSH-treated coals showed the presence of highly volatile matter released at 150 – 200 °C, which was attributed to the tetralin incorporated within the coal macrostructure. The coal conversion and oil+gas yield obtained from the liquefaction of SSH-pretreated coals under various pretreatment conditions at 420 °C showed an increased of up to 7 and 12%, respectively, and was comparable to that of untreated sample at 450 °C, although the higher molecular weight preasphaltene also showed an increase. The increase in coal conversion and oil+gas yield might due to the ability of the solvent to penetrate deeply into the coal macropores to cap the radicals instantaneously, and promote the volatile matter released at lower liquefaction temperatures. Scanning Electron Microscope showed the formation of cracks and fissures of the coal surface. The liquefaction results on the SSH-pretreated demineralised coals showed a comparable amount of coal conversion with slightly lower oil+gas yield being obtained in comparison with the untreated and SSH-pretreated coals. With the addition of 4 wt% of impregnated-Fe_2O_3, coal conversion and oil+gas yield was maximised and comparable to that of the untreated coal at 450 °C. Finally, in the microwave irradiation pretreatment, the higher coal conversion and oil+gas yield obtained of up to 3 – 7% and 9 – 22%, respectively, are due to the formation of cracks and fissures in coal microstructure that enhanced the coal-to-solvent interaction, and the weakened C-C bonds, respectively. Inherent moisture in coal was found to be the determining factor in increasing coal conversion and oil+gas yield by absorbing the microwave energy. Of all the applied pretreatments, microwave irradiation was found to be the most practical (i.e. one-step pretreatment), rapid (i.e. one min residence time) and effective process (i.e. maximum conversion and oil+gas yield), in comparison to the solvent swelling and *in-situ* SSH pretreatments. As a conclusion, these new and effective pretreatments on coal could be a promising approach in enhancing coal conversion and oil+gas yield under less severe liquefaction conditions.

ACKNOWLEDGEMENTS

In The Name of Allah, The Most Merciful and The Most Gracious. Alhamdulillah, praise to Allah Subhanahuwata'ala for giving me the opportunity and strength to explore the research and successfully completed this thesis.

First of all, I wish to convey my deep and sincere appreciation, and special thanks to my main supervisor, Associate Professor Dr. Hj. Khudzir Hj. Ismail and co-supervisors, Professor Ir. Dr. Hj. Mohd Omar Abd. Kadir and Professor Dr. Abd. Rahman Mohamed, both from Universiti Sains Malaysia for their supervision and invaluable guidance during my study. May Allah bless all of you.

With this opportunity, I would like to express my acknowledgement to Universiti Teknologi MARA (UiTM) and Bahagian Latihan dan Pembangunan Staf, UiTM for awarding me scholarship to pursue this research study. I would also like to thank the Ministry of Science, Technology and Innovation, Malaysia for the research grant (IRPA: 02-02-01-0017-EA0017); Bahagian Pembangunan, UiTM and Institute of Research, Development and Commercialisation, UiTM for funding and UiTM Perlis Campus Director for supporting the research work.

I would also like to acknowledge Professor Colin E. Snape, University of Nottingham, United Kingdom; Professor Michael Cloke, University of Nottingham, Malaysia Campus; Professor Wan Hasiah Abdullah, Universiti Malaya, Kuala Lumpur; Professor Kouichi Miura, University of Kyoto, Japan and Associate Professor Dr Khairun Azizi Azizli, Universiti Sains Malaysia, for their ideas, supportive discussion and collaboration work.

To Fossil Fuels and Biomass Research Group members, Azil Bahari Alias, Rafedah Rakal, Mohd Fauzi Abdullah, Wan Izhan Nawawi Wan Ismail, Zubri Zakaria, Nur Nasulhah Kasim, Ridzuan Mat, Zaidi Ab. Ghani and Nor Hafizah Che Ismail; their help, ideas and support throughout the study will always be remembered.

To those who are direct or indirectly involved in this research work: Mr. Munif, UiTM Research Assistant; Mr. Vladimir, MSc student from Universiti Malaya, Kuala Lumpur; Mr. Baharuddin Salleh, UiTM Perlis Instrumental Laboratory Assistant; Mr. Chng Ban Pai, Syarikat Ban Edar Sdn. Bhd., Perlis; Mr. Bobby Ho, Hisco Company Sdn. Bhd.; Mr. Kamal Hadany, Engineering consultant, Kuala Lumpur; Mr. Md. Din Husin, Syarikat DI Saintifik, Petaling Jaya; Mr. Foong and Mr. Tan, TA Instrument Sdn. Bhd., Kuala Lumpur, their cooperation is highly appreciated.

Finally, it is hope that the ideas, outcomes and findings from the research work will be benefited and contributes to knowledge.

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