UNIVERSITI PUTRA MALAYSIA

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PRODUCTION OF SYNTHETIC BASED DRILLING FLUID FROM PALM OIL

By

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Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Master of Science

PRODUCTION OF SYNTHETIC BASED DRILIING FLUID FROM PALM OIL

By

NOR SAIFUL HAFIZ ABDUL HABIB

April 2013

Chairman : Prof RobiahYunus, PhD

Faculty : Engineering

The use of ester as a base fluid in synthetic base fluids (SBF) has become a trend in drilling operations due to many advantages compared to the conventional drilling fluids. The production of ester for SBF from vegetable oils is found to be the most successful invention in terms of environmentally friendliness and drilling costs since the vegetable oil is biodegradable and shows competitive performance as drilling fluids. The synthesis of ester as biodegradable base oil was conducted via transesterification reaction of palm oil methyl ester (POME) with 2-ethylhexanol (2EH). High oleic POME was used in the reaction. The selection of 2-ethylhexanol as the raw material is to produce the low viscosity but branched ester. The catalyst used in the reaction was sodium methoxide. Sodium methoxide which is a base catalyst proved to have better performance in terms of productivity and reactivity compared to many acid catalysts. The reaction was carried out at different temperatures (70°C to 140°C) and the vacuum pressure was fixed at 1.5 mbar.

The reactant molar ratio of POME to 2EH was 1:1.5, 1:2 and 1:2.2. Since the reaction with 2-ethylhexanol only involves a single reaction, this transesterification reaction is considered as a single step reversible reaction; hence, the reaction was completed in a very short time. 98% palm based EHE were successfully synthesized in less than 30 minutes at 1.5 mbar pressure, 70°C, and 1:2 molar ratio of POME to 2EH. The analysis of the product (EHE) was performed using gas chromatography which was operated at an initial temperature of 80°C, held for 3 minutes then increased at 6°C/min to 340°C and held for another 8 minutes. The injector and detector temperature were set at 320°C and 340°C, respectively. This procedure provided a complete separation of the reaction products, palm based methyl ester and monoesters.

The reversible rate constant of the reaction is negligible, thus the equilibrium constant of the reaction is the rate constant. The rate constant of the reaction (*k*) obtained from the kinetics study was in the range of 0.44 s^{-1} to 0.66 s^{-1}. The activation energy of the reaction was 15.6 $kJ.mol^{-1}$.The preliminary investigations on the lubrication properties of drilling mud formulated with palm based EHE indicated that the base oil has a great potential to substitute the synthetic ester base oil for drilling fluid. Its high kinematic viscosity provides better lubrication to the drilling fluid compared to other ester-based oils. The pour point and the flash point are superior for the drilling fluid formulation. The plastic viscosity, High Pressure High Temperature filtrate loss and emulsion stability of the drilling fluid had given acceptable values, while gel strength and yield point could be improved by blending it with proper additives.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai keperluan untuk ijazah Master Sains

PENGHASILAN LUMPUR PENGGERUDIAN SINTETIK DARIPADA MINYAK KELAPA SAWIT

Oleh

NOR SAIFUL HAFIZ ABDUL HABIB

April 2013

Pengerusi : Prof RobiahYunus, PhD

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Penggunaan ester sebagai bendalir asas dalam bendalir asas sintetik (SBF) telah menjadi satu trend dalam operasi-operasi penggerudian oleh kerana banyak kelebihan berbanding dengan bendalir penggerudian konvensional. Penghasilan ester untuk SBF daripada minyak-minyak sayuran merupakan penemuan terbaik dari segi mesra alam dan kos-kos penggerudian kerana minyak sayuran mempunyai kemampuan untuk terbiodegradasikan dan menunjukkan prestasi kompetitif sebagai bendalir penggerudian. Sintesis ester sebagai minyak asas terbiodegradasikan telah dijalankan melalui tindak balas transesterifikasi oleh minyak kelapa sawit metil ester (POME) dan 2-etilheksanol (2EH). Minyak kelapa sawit metil ester tinggi oleik digunakan didalam tindakbalas ini. 2-etilheksanol digunakan didalam tindak balas ini adalah untuk mendapatkan ester yang berkelikatan rendah dan bercabang. Pemangkin yang telah digunakan dalam tindak balas ini ialah natrium metoksida. Natrium metoksida yang merupakan pemangkin bes terbukti menunjukkan prestasi

yang lebih baik berbanding banyak pemangkin asid dari segi penghasilan produk dan kereaktifan. Tindak balas tersebut telah dilakukan pada suhu-suhu yang berbeza (70°C hingga 140°C) dan tekanan ditetapkan pada 1.5 mbar. Oleh kerana transesterifikasi melibatkan satu tindak balas sahaja, tindak balas ini dipertimbangkan sebagai langkah tindak balas berbalik yang tunggal. Oleh sebab itu, tindak balas tersebut telah lengkap dalam tempoh yang sangat pendek. Sebanyak 98% ester-ester etilheksil berasaskan kelapa sawit telah berjaya disintesiskan dalam tempoh kurang daripada 30 minit di bawah tekanan 1.5 mbar, suhu 70ºC, dan nisbah molar POME kepada 2EH 1:2. Analisis produk (etilheksil ester) telah dilakukan menggunakan gas kromatografi yang telah beroperasi pada suhu permulaan 80°C, ditangguhkan selama 3 minit,kemudian dinaikkan sebanyak at at 6°C/min hingga 340°C dan ditangguhkan lagi selama 8 minit. Suhu bagi alat suntikan dan pengesan telah disetkan pada 320°C dan 340°C, secara urutannya. Langkah ini adalah untuk pemisahan lengkap bagi semua produk tindak balas, iaitu di dalam kes ini, minyak kelapa sawit metil ester dan beberapa monoester.

Pemalar kadar tindak balas berbalik bagi tindak balas ini diabaikan, maka pemalar keseimbangan tindak balas adalah pemalar kadar tindak balas. Pemalar kadar tindak balas (*k*) yang telah didapati daripada kajian kinetik adalah dalam lingkungan 0.44 hingga 0.66. Tenaga pengaktifan tindak balas tersebut adalah sebanyak 15.6 $kJ.mol^{-1}$. Penyelidikan awal pada sifat-sifat pelincir pada lumpur gerudi yang telah diformulasikan dengan ester 2EH berasaskan kelapa sawit telah menunjukkan bahawa minyak asas tersebut mempunyai pontensi besar untuk menggantikan minyak asas sintetik ester yang sedia ada untuk bendalir penggerudian. Kelikatan

kinematiknya memberikan pelinciran lebih baik kepada bendalir penggerudian berbanding dengan minyak-minyak asas ester yang lain. Takat-takat tuang dan kilat minyak tersebut adalah lebih tinggi mutunya bagi formulasi bendalir penggerudian. Keputusan nilai-nilai kelikatan plastik, kerugian turasan HPHT dan kestabilan emulsi bagi bendalir adalah dapat diterima. Kekuatan gel dan titik alah boleh diperbaiki lagi melalui proses pengadunan dengan bahan campuran yang sesuai.

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I certify that a Thesis Examination Committee has met on 5th of April 2013 to conduct the final examination of Nor Saiful Hafiz bin Abdul Habib on his thesis entitled "Production of Synthetic based Drilling Fluid from Palm Oil" in accordance with the Universities and University College Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 March 1998. The committee recommends that the student be awarded the Master of Science.

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This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfilment of the requirement for the degree of Master of Science. The members of the Supervisory Committee are as follows:

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DECLARATION

I declare that the thesis is my original work except for quotations and citations which have been duly acknowledged. I also declare that is has not been previously, and is not concurrently, submitted for any other degree at Universiti Putra Malaysia or at any other institution.

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NOR SAIFUL HAFIZ ABDUL HABIB

Date:

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