JATROPHA CURCAS L. OIL DERIVED BIODIESEL AS ESTER BASED DRILLING FLUID

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To my beloved mum and dad,

brother and sister

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ABSTRACT

Waste fluid from drilling operations especially from oil based mud (OBM) has always been a major concern on the environment. The increase in environmental legislation and stringent regulations has sparked the use of a more environmentally friendly fluid such as ester derived from vegetable oil as the base for drilling muds. This study was conducted by using Jatropha curcas L. oil derived biodiesel (JDB), Sarapar and a blending of 20% JDB 80% Sarapar as the base of the drilling mud. Experiments were conducted to study its physical fluid properties, rheological mud properties, rubber compatibility and marine toxicity. JDB shows good physical fluid properties except for kinematic viscosity. JDB also exhibit good rheological mud properties except for plastic viscosity. However, the issue can be solved by blending with low kinematic viscosity oil such as Sarapar to reduce JDB's viscosity property. For the rubber compatibility test, Nitrile Butadiene Rubber (NBR) was exposed to the drilling muds for 1 and 2 weeks consecutively. Swelling volume and tensile strength was tested before and after exposure. Overall however, JDB mud shows a huge effect on the NBR after the time period and at high temperature. As for the LC_{50} toxicity test, Guppy fish (Poecilia reticulate) was used as test organisms. The LC_{50} obtained for JDB was more than 100 000 ppm indicating JDB based mud is non-toxic. The overall result shows JDB is a promising alternative to be used as an environmentally friendly drilling mud with further enhancement on its properties.

ABSTRAK

Buangan daripada operasi penggerudian terutamanya dari lumpur berasaskan minyak (OBM) merupakan satu kebimbangan yang besar terhadap alam sekitar. Undang-undang serta peraturan yang semakin ketat telah mencetuskan penggunaan ester berasaskan minyak sayuran yang lebih mesra alam sebagai asas untuk lumpur penggerudian. Kajian ini menggunakan biodiesel dari Jatropha curcas L. (JDB), Sarapar dan campuran 20% JDB 80% Sarapar sebagai asas untuk lumpur. Eksperimen yang dijalankan adalah untuk mengguji sifat fizikal bendalir, sifat reologi lumpur, kesesuaian dengan getah dan tahap ketoksikan terhadap hidupan laut. JDB menunjukkan sifat fizikal bendalir yang baik kecuali kelikatan kinematik. JDB juga menunjukkan sifat reologi lumpur yang baik kecuali kelikatan plastik. Walaubagaimanapun, isu ini boleh diatasi dengan pencampuran minyak berkelikatan rendah seperti Sarapar. Bagi eksperimen kesesuaian dengan getah, NBR telah didedahkan kepada lumpur selama 1 dan 2 minggu. Isipadu penggembangan dan ketegangannya diuji sebelum dan selepas pendedahan. Keseluruhannya, JDB menunjukkan kesan yang besar terhadap NBR selepas seketika dan suhu yang tinggi. Bagi ujian toksik LC_{50}, Ikan Gapi (Poecilia reticulate) telah digunakan. LC_{50} untuk JDB adalah lebih daripada 100 000 ppm menunjukkan JDB adalah tidak toksik. Keputusan keseluruhan menunjukkan JDB adalah alternatif yang baik untuk digunakan sebagai lumpur mesra alam dengan memperbaiki sebahagian sifatnya.

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LIST OF ABBREVIATIONS

^{o}C	-	Celcius
cp	-	centipoise
cSt	-	centistokes
St	-	stoke
EBM	-	Ester based mud
FFA	-	Free fatty acid
HTHP	-	High temperature high pressure
IO	-	Internal olefins
JDB	-	Jatropha derived biodiesel
LAO	-	Linear alpha olefin
LC_{50}	-	50 percent lethal concentration
NABF	-	Non-aqueous based fluid
NBR	-	Nitrile Butadiene Rubber
OBM	-	Oil based mud
SBM	-	Synthetic based mud
PAO	-	Polyalphaolefin
WBF	-	Water based fluid
WBM	-	Water based mud

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CHAPTER 1

INTRODUCTION

1.1 Background

Over the decades, oil and gas exploration activities have evolved from onshore to offshore. With the depletion of reserves in existing fields and the high demand of energy, oil companies are now exploring for new reserves in the deepwater locations. Because of this, the drilling environment is also much harsher and challenging. Therefore, oil based muds (OBM) are more favourable to be used for its better rheological properties and performance in hostile conditions compared to the conventional water based muds (WBM) (Patel A. D., 1998).

Although OBMs are better for offshore drilling environment, the discharge and its drill cuttings are a source of pollution to the marine environment even when low toxicity mineral oils were used as base fluids. Constant improvement has to be done on the OBMs as people are more aware of the environment and more stringent regulations were applied by the environmental agencies (Davies J. M., 1984). Thus, synthetic based muds (SBMs) formulated by esters were given more attention as esters were better in terms of biodegradation and toxicity compared to low toxicity mineral oils and conventional diesels.

Although esters have advantage on biodegradability, their physical and chemical properties have resulted in limited application in invert emulsion muds (Amin R. A. M. *et al.*, 2010). This is because esters generally have higher kinematic viscosity. The high kinematic viscosity translate into higher drilling fluid rheological properties which will limit the ability of ester based fluids to tolerate high solids loading at high fluid density. However, these disadvantages of high viscosity can be overcome by selecting esters that high temperature stability and low viscosity. Also, generally esters are more aggressive towards elastomer components used in downhole drilling and equipment. For this research, ester based mud will be formulated from Jatropha curcas L. oil derived biodiesel (JDB). Several tests would also be conducted to study its applicability as a drilling mud since there are not many researches done for this vegetable oil.

1.2 Problem statement

In this report, Jatropha biodiesel oil was used as the base for ester drilling fluid. The rheological properties, effects on elastomer and toxicity level of the Jatropha derived biodiesel based drilling fluid were investigated to make sure it fulfils the drilling mud standards and environmental needs.

1.3 Scope and objectives

The experiments of this study were solely carried out in laboratory and no field test was conducted. The objectives of this study were to evaluate the physical and rheological properties of the ester based drilling fluid derived from Jatropha curcas L. oil. Besides, the other objectives were to determine the effects on elastomer and the toxicity of the mud. The scopes of this study were as follows:

i. Extraction of biodiesel from crude Jatropha curcas L. oil
ii. Mud formulations from three types of base fluids which are Jatropha curcas L. oil derived biodiesel (JDB), Sarapar (mineral) oil and 20% Jatropha curcas L. derived biodiesel (JDB) 80% Sarapar
iii. Rheological properties of the Jatropha curcas L. oil derived biodiesel (JDB)
iv. Tensile and volume test on Nitrile Butadiene Rubber (NBR)
v. Toxicity evaluation of the drilling fluid.

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