A REVIEW OF VEGETABLE OILS TECHNICAL PROPERTIES AS ENVIROMENTAL FRIENDLY MUD

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ABSTRACT

For decades, diesel has been used as oil based drilling fluid since it was proven in performance and worldwide availability. Yearly, world demand for oil and gas consumption will continue to grow and sufficient supply is an important key to sustain constant and improve economic development. As exploration of new well and drilling operation take place, there are the need for cost reduction without compromising the performance of drilling fluid and environmental effect. Unfortunately diesel has been found to be toxic and harmful to environment, due to the present of cyclic aromatic compound. This study will provide better understanding on the choices available for drilling operation particularly related to environmental friendly drilling fluid. This study focused on the processed vegetable oil; palm oil, corn oil, canola oil and soybean oil as potential substitute component for environmental friendly oil based drilling fluid. The physical and chemical properties on the processed vegetable oil were identified followed by determining the acceptable rheology properties of drilling fluid. Several field cases were selected based on similarity and comparison approaches in using environmental friendly oil based drilling mud. The cost related to produce mud was compared with conventional diesel and mineral oil mud. This study concludes that the use of vegetable oil as drilling mud is plausible, but not recommended.

ABSTRAK

Sekian lama, diesel telah di gunakan sebagai minyak pelincir di dalam proses carigali minyak di dasar laut berikutan keberkesanan keupayaan minyak diesel sebagai pelincir dan juga mudah didapati di pasaran. Setiap tahun permintaan terhadap keperluan minyak dan gas meningkat di peringkat dunia, maka bekalan terhadap permintaan ini harus di penuhi bagi memastikan pembangunan ekonomi yang berterusan. Oleh itu, pengerudian minyak harus di lakukan dengan mengambil kira kos yang rendah tanpa menjejaskan prestasi bendalir lumpur pengerudian dan juga kesan kepada alam sekitar. Project ini akan memberikan penjelasan tentang pilihan yang ada bagi memenuhi keperluan operasi pengerudian yang berasaskan projek mesra alam. Akan tetapi, diesel telah dikenal pasti mempunyai kumpulan aromatic yang berbahaya kepada alam. Thesis ini akan memberi fokus kepada minyak sayuran; minyak kepala sawit, minyak kanola, minyak kacang soya dan minyak jagung sebagai bahan penganti tambahan di dalam bendalir lumpur berasaskan minyak. Sifat fizikal dan kimia minyak sayuran akan dipelajari diikuti dengan sifat rheology minyak sayuran terproses. Kemudian, beberapa kes lapangan akan di ambil kira untuk membuat persamaan dan perbandingan terhadapa bendalir lumpur berasaskan minyak ini. Selepas itu, kos penghasilan minyak pelincir berasaskan sayuran akan di ambil kira dan di bandingkan dengan minyak diesel di pasaran. Sebegai penutup, thesis menyimpulkan bahawa penggunaan minyak sayuran sebagai bahan di dalam bendalir lumpur berasaskan minyak boleh digunakan tetapi tidak digalakkan.

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LIST OF ABBREVIATIONS

API	-	American Petroleum Institute
BMD	-	Bursa Malaysia Berhad
CBOT	-	Chicago Board of Trade
$CaOH_2$	-	Calcium Hydroxide
IO	-	Internal Olefins
KCI	-	Potassium Chloride
LAO	-	Linear Alpha Olefins
NaOH	-	Sodium Hydroxide
OBM	-	Oil Based Mud
PCO	-	Palm Crude Oil
PAO	-	Poly alpha Olefins
PV	-	Plastic Viscosity
PFAME	-	Palm Fatty Acid Methyl Ester
PHPA	-	Partially Hydrolyse Polyacrylamide (PHPA)
ROP	-	Rape of Penetration
SCO	-	Soybean Crude Oil
SSP	-	Suspended Particulate Phase
SBM	-	Synthetic Based Mud
TVD	-	True Vertical Depth
WBM	-	Water Based Mud
YP	-	Yield Point

CHAPTER 1

INTRODUCTION

1.1 Introduction

Drilling oil and gas wells requires special drilling fluid, which are usually called mud. In the year of 1900, a new era in rotary drilling begin where drilling fluid is used in rotary drilling. The American Petroleum Institute (API) give definition for drilling fluid as circulation fluid use in rotary drilling, carry various drilling function.

The circulation of drilling fluid begin at the tanks, where drilling fluid is pumped into down drill pipe, through nozzle in drill bit. It then flowing out to the surface, passing annular space between drill pipe and borehole together with the rock cuttings.

Cuttings discharged to the floor of ocean, in the event their toxicity test is permitted to do so. Thus, drilling fluid must be in biodegradable type which is met with the standard set by environmental regulator for example Environmental Protection Agency (EPA).

Gas or water or oil, is the main type of drilling mud available in the market. Initially, Oil Base Mud (OBM) is refer to diesel oil fractions where it comes from derived petroleum product which contain aromatic compound. The release of aromatic content is banned by government authority since it could give harmful effect to the marine life and its ecosystem.

Initially diesel oil is used because it provide stability in term of performance at high temperature and pressure, minimum maintenance is needed while drilling and its performance is extended in directional drilling operation.

The discharged of cuttings using OBM is banned early 1990. This situation create a mass attention to oil and gas operator, where the cost of drilling would increase drastically. Drilled cutting shall be packed and transported to the shore, where it would undergoing special treatment before it could be dispose of safely.

Since then, Synthetic Base Mud (SBM) were introduced in the industry, prepared synthetically from derived base fluids. It was developed in compliance with regulation standard where safe discharged to the ocean floor without affected marine life is compulsory. The synthetic fluid used are Linear Alpha Olefins (LAO), Isomerized Olefins (IO), Polyalphaolefins (PAO) and esters. In this paper work, ester derived from various vegetable oils are the main focus of discussion.

For most drilling, Water Base Mud (WBM) is primarily used where mud were prepare by using dispersing finely clays in water. The presence of clay is important factor since it provides better suspending power to assist the removal of cutting. Apart from that, it control mud pressure while drilling.

But water is sensitive to the formation where it can interact during drilling, leading to bit bailing in the event problem occurred, such as stuck pipe condition.

Drilling cost by using OBM is always high compare to drilling cost for WBM. It was estimated that, drilling cost for OBM is three to five times higher compare to WBM. However, by years, SBM is become a preference choice in exploration oil well drilling. SBM was claimed to be better in performance, increase rate of penetration so that saving in drilling time compare to conventional drilling fluid type and reduce drilling cost.

SBM derived ester employed vegetable oil as raw material, produce from transesterification reaction with alcohol in the presence of catalyst. It was tested to be biodegradable in both anaerobic and aerobic condition and produce low level of toxicity in compliance with standard set by EPA. It is believe that ester is a promising drilling mud that can replace conventional drilling fluid like diesel and mineral oil.

In order to perform drilling operation smoothly, drilling mud must possess certain criteria. It must be able to perform the basis function as below:

- It must perform the ability to clean the hole during drilling
- It must provide suspension capability by providing adequate barite suspension
- It must form stability in reactive formation
- It must be able to control formation pressure

In year of 1990, ester is being used as drilling fluid, the first ever trial occurred in oil and gas industry. This trial took place in Norwegian water, where it was claimed that as successful in term of economic and technical capability.

Since then, it was reported that, nearly 400 wells is drilled by using ester, C12 – C14 component in drilling operation. Even though, chemical properties and drilling performance of each them is different, these chemical are far less toxic than diesel where they can be dumped safely without polluting the environment.

To measure the ability of drilling mud to perform successful drilling operation, rheological behavior is an important criteria to be evaluated. In short, rheological behaviors would summarized the ability of drilling fluid in carrying their function at best. For example, yield point (YP), plastic viscosity (PV) and gel strength (GS) is one of rheological properties which shall be taken into consideration.

Yield point is defined as the measurement of electrical attractive forces under flowing condition in drilling fluid. Plastic viscosity is measure the ability of drilling fluid to attain and suspend drilled cuttings. It can also measure hole cleaning ability under dynamic condition.

In general, rheological properties of drilling fluid is important to take into measure since it's determine the overall success of drilling operation. Rheological properties must be flexible and adjustable to fit the functions of drilling operation. Apart from rheological properties, physico-chemical properties play major contribution in order to determine the effectiveness of ester base drilling fluid.

1.2 Statement of the Problem

In the event WBM is failed to meet drilling application, OBM will particularly selected to perform drilling. OBM is particular used to tackle these problem:

- OBM will used to tackle shale swelling problem
- OBM will be used in water sensitive shale
- OBM will be used in high temperature and high pressure well
- OBM will be used high risk exposure to the well problem such as acid gas and differential pressure sticking

Drilling mud is selected based on dual-factors cost and performance. Within last centuries, biodegradable drilling mud amassed great attention by oil and gas companies in their different drilling activities.

All these situation arise because of tight environment regulations set up in various countries whereby the usage of diesel oil based mud which highly environmentally-unfriendly. Environmental consideration has becomes one of the most important key in order to choose the fluid that will bring less harm to the environment and at the same time can perform very well during drilling operation.

Diesel is composed of aromatic compound, including naphthalene and alkylbenzenes which are toxic to environments. In 2007, the US EPA issued effluents limitations guidelines. EPA is taken an initiative during that time to limit waste discharge into the ocean floor. Other than that, EPA set several additional limitation:

- Free oil discharged shall not be detected by static sheen test
- Limitation on suspended particular phase, where 30,000 ppm for 96 hour LC_{50}
- The usage of cadmium and mercury barite in muds shall be limit
- Mud and cutting discharge is banned if contained diesel oil
- A ban on discharge of drilling fluids and drill cuttings within three miles of shore

In Indonesia, guideline for discharge drilling waste is set by Ministry of Mining and Energy. The government of Indonesia set that, drilling waste from OBM and SBM must pass 96 h $LC_{50} \leq 30000$ ppm Suspended Particulate Phase (SPP). LC_{50} is a standard test to ensure the concentration on substance in drilling waste will prove to 50% of a test population of marine organism in 96 h.

Apart from containing toxic material in the presence or aromatic compound, OBM has major drawback as per below:

- OBM has very poor biodegradability in aerobic condition and even slow in anaerobic condition
- Disturb marine ecosystem where severe effect to the seafloor sediments and food chain
- OBM has poor gas kick detection since gas is soluble in oil.
- OBM caused rig to be dirty during drilling operation
- OBM caused rubber part to be deteriorated by oil base

As a conclusion to this problems, ester based drilling fluids are gradually getting more acceptance due to their readily biodegradable, in both condition and environment aerobic and anaerobic environments. Several studies have been done on potential use vegetable oil based drilling fluid. For example palm crude oil (Yassin and Kamis, 1991), corn, cottonseed, canola, peanut, olive and soybean oil (Amanullah, 2005). The increasing demand for biodegradable based fluid in Saudi Arabia market is showed in figure below

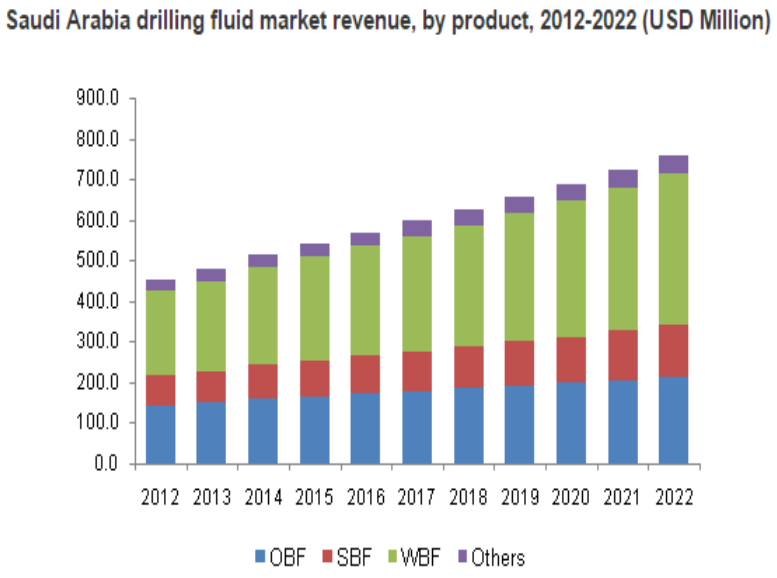

Figure 1.1: The increasing demand for biodegradable based fluid in Saudi Arabia market (source: www.grandviewresearch.com)

Therefore, in this project the author is aimed to give the readers an insight and brief understanding the important to utilize vegetable derived oil to replace conventional diesel as drilling mud. The challenge involve in this study is:

- To show technical performance for ester base mud via rheological and physico-chemical properties
- To show compliance in regulation set by EPA
- To show cost effectiveness for ester based mud

1.3 Objectives of the Study

The objectives of this project can be summarized as below:

1) To study technical performance in term of rheological & physico-chemical properties of biodegradable drilling fluid and compare their suitability with conventional oil and water based drilling fluids.

2) To study the performance guarantee and effectiveness of vegetable oils as substitute as base mud.

3) To study vegetable oil base mud market & economic analysis in tern of cost benefit analysis

1.4 Scope of the Study

The study covers the following aspects:

1) Selection and application of new formulate environmental friendly vegetable oil base drilling fluid which is comparable to conventional diesel based mud drilling fluid.

2) Important to maintain rheological properties in drilling fluid system

3) To give brief overview on vegetable oil base drilling fluid production cost and their market situation

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