SAGO WASTE STARCH AS FLUID LOSS CONTROL AGENT IN WATER BASED MUD

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I would like to dedicate this work to my parents,

for their support and love.

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ABSTRACT

Water Based Mud (WBM) is a common type of drilling mud that widely used in drilling operation. Wide acceptance of WBM for drilling is hugely due to the reasons of existence of stringent environmental policies, and high hydrocarbon exploration cost. However, disadvantages such as poor filtration characteristic, poor suspension behavior and stuck pipe problems had limited the usage of WBM. Fluid loss into formation is a problematic situation whereby invasion of water will leads to formation damage and wellbore instability which can jeopardize the formation evaluation job. While poor suspension behavior will affects the cutting transport efficiency. Besides that, stuck pipe problem which happens due to growing of mud cake in permeable formation layer will also give arise to the increase of possibility of losing the bottomhole assembly in hydrocarbon exploration. Starch is a type of biopolymer that can function as fluid loss control agent and viscosifier in drilling mud. Sago waste starch (SWS) which is inexpensive and environmental friendly has the potential to be used as an additive in drilling mud. Therefore the objective of this study is to investigate the possibility of using sago waste starch from sago palm (Metroxylon Sagu) in drilling mud. Results shows that performance of SWS is inferior compared to commercialized Hydro Starch (HS). Development of gel strength is high for SWS. From the experimental finding, higher SWS concentration is needed to obtain similar plastic viscosity obtained by HS. In terms of filtration control performance, SWS is inferior to HS. All starches performances deteriorate after aging process. Mud cake thickness of SWS is generally thicker than HS.

ABSTRAK

Lumpur asas air adalah jenis lumpur penggerudian yang digunakan secara meluas dalam operasi penggerudian. Penerimaan meluas bagi lumpur asas air untuk operasi penggerudian adalah disebabkan oleh punca-punca polisi persekitaran yang ketat serta kos penerokaan hidrokarbon yang tinggi. Walau bagaimanapun, kelemahan-kelemahan seperti ciri penapisan yang kurang memuaskan, tingkahlaku ampaian yang rendah dan masalah pelekatan paip menghadkan pengunaan lumpur asas air. Kehilangan bendalir ke dalam formasi adalah satu keadaan dimana turasan lumpur akan menyebabkan kemusnahan formasi dan ketidakstabilan lubang telaga sehingga menjejaskan kerja penilaian formasi. Manakala tingkahlaku ampaian yang rendah akan menjejaskan kecekapan pengangkutan serpihan. Selain itu, masalah pelekatan paip akan meningkatkan kemungkinan hilang peralatan dalam lubang semasa penerokaan hidrokarbon. Kanji adalah satu jenis biopolimer yang boleh berfungsi sebagai agen kawalan kehilangan bendalir dan agen kelikatan. Sisa kanji sagu yang murah and mesra alam mempunyai potensi yang besar untuk digunakan sebagai bahan tambahan dalam lumpur penggerudian. Oleh itu, objektif kajian ini adalah menyiasat kemungkinan menggunakan sisa kanji sagu daripada pokok sagu (Metroxylon Sagu) dalam lumpur penggerudian. Hasil kajian menunjukkan prestasi sisa kanji sagu adalah lebih rendah berbanding dengan komersial Hydro Starch. Kekuatan gel untuk sisa kanji sagu adalah lebih tinggi. Berdasarkan kajian eksperimen, kepekatan sisa kanji sagu yang lebih tinggi diperlukan untuk menghasilkan kelikatan plastik yang sama dengan kelikatan komersial Hydro Starch. Prestasi pengawalan turasan untuk sisa kanji sagu adalah lebih rendah berbanding dengan komersial Hydro Starch. Kedua-dua kanji merosot selepas proses penuaan. Secara umumnya, kek lumpur yang dihasilkan oleh sisa kanji sagu adalah lebih tebal daripada Hydro Starch.

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LIST OF ABBREVIATIONS

API	-	American Petroleum Institute
AV	-	Apparent Viscosity
GS	-	Gel Strength
HPHT	-	High Pressure High Temperature
HS	-	Hydro Starch
LPLT	-	Low Pressure Low Temperature
OBM	-	Oil Based Mud
PV	-	Plastic Viscosity
RPM	-	Rotational Per Minute
SWS	-	Sago Waste Starch
WBM	-	Water Based Mud
YP	-	Yield Point

LIST OF SYMBOLS

μ	-	Micro
μ_a	-	Apparent Viscosity
μ_p	-	Plastic Viscosity
Y_p	-	Yield Point
$\emptyset_{300}$	-	Viscosity Reading at 300 RPM
$\emptyset_{600}$	-	Viscosity Reading at 600 RPM
%	-	Percentage
cP	-	Centipoise
$\dot{\gamma}$	-	Shear Rate
τ	-	Shear Stress
k	-	Ratio of Shear Stress over Shear Rate
n	-	Power Exponent

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CHAPTER 1

INTRODUCTION

1.1 Background

Drilling fluid also known as drilling mud used in the hydrocarbon exploration and production operation could made up of several drilling additives, cuttings, formation water and crude oil. The design of drilling mud in early days is simple and only contained basic clay and water which has no impact to the environment (Amanullah and Yu, 2005). As time goes by, rapid evolvement of hydrocarbon exploration and production activities pushing the oil companies to drill deeper wells brings intensive development of drilling muds. There are two main type of drilling muds which receives intense development: water based mud (WBM) and oil based mud (OBM).

Drilling mud which consists of various chemical compositions will show different fluid performance in all kinds of situation, ranging from different temperature and pressure to different formation characteristics. Thus, specific type of drilling mud will shows advantages and disadvantages when using in a specific condition. The typical restrains which posted on the water based mud development are the safety of drilling mud, fluid loss issue, and suspension behavior.

As many countries are getting more serious on creating a green sustainable environment for future generations, numerous environmental policies have been rolled out to preserve the nature ecology and environment. Rules and regulations were set up to closely monitor the drilling muds disposal activities. As a result of stringent laws and regulations on drilling muds waste treatment plan, major oil and gas companies are forced to seek for an environmental friendly drilling mud product. For example, the prohibition of using non-biodegradable OBM in offshore drilling operations had forced major oil and gas companies operated in Europe countries to utilize the WBM instead of OBM.

Due to the nature of water based mud, the present of continuous phase of salt water or fresh water inside the mud will invade into the formation during the drilling operation. The pressurized drilling mud which used to suppress the formation fluids from entering into the wellbore will create fluid loss. This phenomenon is caused by the existence of differential pressure between the pore pressure and borehole pressure. Formation which has considerable percentage of shale will tends to absorbed water, causing potential shale sloughing problem. This will indirectly invite numerous drilling and formation evaluation problem. In the most pessimistic condition, drilling operation cannot continue and well has to be abandoned just to drill a new well. Such a condition is the situation whereby operator would like to avoid so that development cost will not erodes the company profits.

Suspension behavior is an important characteristic for drilling muds. The suspension behavior depends on mud viscosity. In drilling operation, mud viscosity plays an important role in a drilling mud. A drilling mud should have a good hole cleaning capability and a good cutting transport capability to enable circulation of debris or cuttings from bottomhole to the surface. Since WBM is less viscous due to the present of abundant water content, adding desired amount of additives or chemicals such as viscosifier to the WBM can significantly increase the viscosity. Such an increase in WBM viscosity will able to enhance the hole cleaning capability and cutting transport capability.

When hydrocarbon exploration extended into deeper formation which is more than 5000ft, the exploration team might expect the presence of a high pressure and high temperature (HPHT) well condition. Such a HPHT bottomhole condition which is more hostile than a low pressure and low temperature (LPLT) well environment may face alarming fluid loss occurrence. Such an occurrence is hugely caused by the weakening of drilling mud molecular bonding structure which triggers the decrease of drilling mud viscosity. Thus, the understanding of the drilling mud additives performance in hostile environment is important before it is used in actual drilling operation.

Challenges which stated clearly above have driven oil and gas operators to seek for an alternative solution: to increase the level of participation on finding a cost effective additive. This cost effective additive should be environmental friendly in nature and able to blend into the WBM so that the WBM can fulfills the minimum drilling muds disposal requirement and meet the technical specification challenges. As a result, a compromise between cost and performance of a WBM can be achieved.

In this study, sago waste starch (SWS) from sago palm (Metroxylon Sagu) was used as fluid loss control agent in WBM. The SWS supplied by Biotechnology Diversified Industries Sdn Bhd is a type of biopolymer nature starch extracted from the sago residue which is not similar to the premium consumable starch available in market. As SWS is an inexpensive and environmentally friendly product from native sago palm tree, such a distinctive product has the potential to use as fluid loss control agent in WBM.

1.2 Problem Statement

Starch is a type of biopolymer which has been used for many years in drilling operation. Previous research had showed that starch powder has the ability to enhance the drilling mud viscosity and act as a fluid loss control agent in WBM by sealing the micro fractures (Yeow, 2013).Yet, the utilization of SWS as a fluid loss additive in WBM is not fully well known. Thus, this project aims to study the performance of SWS in WBM. To evaluate the SWS performance in WBM, commercialized Hydro Starch (HS) was used as comparison.

1.3 Objectives

The experiments of this study were solely carried out in laboratory and no field test was conducted. There are three main objectives in this project. The objectives are listed as follows:

i. To study the rheological properties of SWS and HS in WBM by varying the starch concentration.
ii. To study the fluid loss properties of SWS and HS in WBM by varying the starch concentration.
iii. To compare the performance of SWS with the HS in WBM.

1.4 Scope of Study

The scopes of the study were listed as follows:

i. To employ SWS and HS as the main additive in WBM.
ii. To prepare the WBM samples of different starch in different concentration.
iii. To carry out plastic viscosity, apparent viscosity, yield point and gel strength test for 16 hours aged WBM samples and non-aging WBM samples at room temperature of 74°F.
iv. To carry out API LPLT filtration properties test in 30 minutes for non-aging WBM samples by setting pressure at 100psi.
v. To carry out HPHT filtration properties test in 30 minutes for 16 hours aged WBM samples and non-aging WBM samples by setting pressure at 500psi. For 16 hours aged WBM samples, the setting temperature is at 200°F, 225°F, and 250°F. As for non-aging WBM samples, the setting temperature is at 250°F.

1.5 Rationale and Significance of Study

This study is possible to unleash the potential of non-food grade SWS into value-added industrial product, especially in drilling muds engineering. In Sarawak, especially in Sibu and Mukah Division, approximately 50-110 Ton of sago hampas are produced daily (Awg-Adeni *et al.*, 2010). This significant quantity of sago hampas can produce extensive quantity of SWS.

As the use of sago starch in the production of food, polymer, pharmaceutical and textile industry will lead to a high demand of sago starch therefore it is expected more sago 'hampas' available in the market. Thus, the utilization of the non-food grade SWS will able to reduce the quantity of solid residue discharge which can directly contributes to environmental pollution.

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