PREPARATION AND EVALUATION OF SOME SYNTHETIC ESTERS FOR OIL-WELL DRILLING FLUIDS

Thesis for Ph. D. Degree in Chemistry

Presented By

Mohamed Ibrahim Mohamed Abdel Salam

(*M. Sc. Degree Chemistry, Ain Shams University, 2003)*

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Thesis Advisors

Prof. Dr.: M. R. M. Aqal

Prof. of Organic Chemistry, Faculty of Science, Ain Shams University

Prof. Dr.: H. M. F. Madkour

Prof. of Organic Chemistry, Faculty of Science, Ain Shams University

Assoc. Prof. Dr.: A. A. Hafiz (Late)

Prof. of Applied Organic Chemistry, Petrochemical Dept., Egyptian Petroleum Research Institute (EPRI)

Dr.: M. M. Dardir

Assoc. Prof. of Applied Organic Chemistry, Production Dept., Egyptian Petroleum Research Institute (EPRI)

2013

ACKNOWLEDGEMENT

I would like to express my sincere gratitude and indebtedness to ***Prof. Dr.: M. R. M. Aqal & Prof. Dr.: H. M. F. Madkour****, Professors of organic chemistry, Faculty of Science, Ain Shams University and* ***Dr.: M. M. Dardir,*** *Assoc. Prof. of Applied Organic Chemistry, Production* ***dept., EPRI,*** *they were always kind enough to suggest the lines of research and for their valuable advice, encouragement and continuous helps during this work. I would like to thank them for offering me the opportunity to carry out this interesting research work under his kind supervision, for his valuable criticism and their efforts made this humble work a success*

Also, I give all my thanks and regards to ***the late Prof. Dr.: A. A. Hafiz, Prof. of Applied Organic Chemistry, Petrochemical dept., EPRI,*** *she was not only active enough during the progress of the work but also was loyally cooperative, so I pray to* ***God*** *to be merciful toward her and to make the paradise is the latest abode.*

Finally*, my great and deep gratitude for my family, friends, my colleagues (family) in Halliburton and for all people who help me to finish this work.*

MOHAMED

AIM OF THE WORK

Efficient drilling technology is essential to meet the needs of the oil industry. Both the challenges of new oil province especially in offshore waters, and the demands for efficient environmental protection have driven the development of new technology. Drilling mud is a key factor influencing drilling technology used in modem drilling operations. New oil industry developments involve directional and horizontal drilling as well as drilling in frontier area at greater and greater depth, such capabilities and conditions careful attention to the selection and engineering of efficient mud system.

Also, spent drilling fluids and drill cuttings are among the most significant waste strains from exploration and development activities in the oil and gas industry. They pose a serious and costly disposal problem for offshore operators who must barge spent mud and cutting to the shore (land) for disposal if they don't meet the enviromental protection agency discharge

limitation or permit requirements due to disadvantage of both water-base mud and oil-base mud (traditional drilling mud). The petroleum sector in Egypt is importing large amount of chemicals annually to be utilized in the preparation of synthetic mud and additives for oil-well drilling fluids.

Our objective of this study is important. Due to the above mentioned reason, esters which have a biodegradable property prevent many from the environmental problems caused by the drilling fluids. In this thesis experimental work is conducted on the different prepared ester mud from standard and local materials, which might substitute the imported ester mud .The new prepared esters were evaluated as ester based synthetic mud for oil - well drilling fluids, according to API and OCMA specification, compared to the imported synthetic mud, to verify the advantages and disadvantages of the local mud.

SUMMERY

The drilling fluids or muds are generally used in drilling wells when drill by rotary method. The use of oil-based drilling fluids are usually more stable than water -base drilling fluids , more effective for lubricating drill bits and drill pipe , and are typically more stable than water - base drilling muds at the high temperatures especially when drilling deep wells . Because of these, and other advantages, oil-base drilling muds are directed used in many important well drilling operations.

The formulation of oil-based drilling fluid is manly from diesel and kerosene. Such petroleum – based oil are typically contain relatively large concentrations of aromatics and at least substantial concentrations of n- olefins, both of which may be harmful or toxic to animal and plant life. The drilling industry has developed several types of synthetic – based muds (SBMs) that combine the desirable operating qualities of oil-base muds with the lower toxicity and environmental impact qualities of water –

based muds and also can improve drilling efficiency without polluting. The petroleum sector in Egypt imports large amount of chemicals annually for utilization as synthetic mud and additives for oil- well drilling fluids.

So the principal objective of the present study is to provide a new type of synthetic based mud drilling mud that combined the desirable operating qualities of oil based muds with the lower –toxicity and Enviromental impacts qualities of water-based muds and also can improve drilling efficiency without polluting.

Preparation is based on reaction of a fatty acid as starting materials namely, Oleic acid and/or Linoleic acid (one mole) and (two moles) and Ethylene glycol and or Polyethylene Glycol 600 to produce mono and di-esters **E1-E6** as follows:

Mono- esters (Ethylene Glycol: Fatty Acid) 1:1

Ethylene Glycol mono-Oleate **E1**

Ethylene Glycol mono-Linoleate **E3**

Di- esters (Ethylene Glycol: Fatty Acid) 1:2

Ethylene Glycol di-Oleate **E2**

Ethylene Glycol di-Linoleate **E4**

Mono- esters (Polyethylene Glycol : Fatty Acid) 1:1

Polyethylene Glycol mono-Oleate **E5**

Polyethylene Glycol mono-Linoleate **E6**

The structures of the new fatty acid esters were elucidated by the elemental analysis, spectroscopic analysis (FTIR), Gas chromatograph / Mass spectroscopy (GC/MS) and H^1 NMR spectra.

Biodegradability of Esters

This study aimed to investigate the ability of some microbial strains to utilize different emulsion samples as sole source for carbon and energy. The mono and di-esters and control sample were tested to know the matter that has the ability of degradation.

Evaluation of new prepared fatty esters as synthetic based drilling fluids (ester-based mud), all of them compared to the control mud sample, MR (imported ester mud).

The evaluation includes the study of the following parameters for each type

1- Rheological properties of the mud
   i. Viscosity (Apparent, plastic and Yield point)
   ii. Effect of Temperature on the viscosity properties
   iii. Effect of temperature on Gel strength
   iv. Effect of temperature on Thixotropy

It has been found that some of the new prepared ester based muds have higher apparent, plastic viscosity and yield point than the using control mud sample, MR (imported ester mud). The effect of temperature on the rheological of the mud formulation containing the prepared esters have good value compatible with the control mud sample, MR (imported ester mud).

2- Filtration properties

The new prepared esters based muds have filter loss very similar to the control mud sample MR.

3- Electrical stability measurements

Electrical stability measurements showed similarity of the filtration properties. The ES values for the new mud samples were very comparable to the standard mud.

Contents

LIST OF ABREVIATIONS AND SYMBOLS

I. Abbreviations

API	American Petroleum Institute
AV	Apparent Viscosity
B.p.	Boiling point
Cpd.	Compound
DEA	Diethanolamide
ELGs	Effluent Limitations Guidelines
EMOBF	Enhanced Mineral Oil Based Fluids
EPA	Environmental Protection Agency
Exp. M.Wt	Experimental molecular weight
FAA	Fatty Acid Amides
GBF	Gas- Base Drilling Fluid
IO	Internal Olefin
LAO	Linear Alpha Olefin
LC_{50}	Leptocheirus Toxicity Test
LPs	Linear Paraffin
M.P.	Melting point
MEA	Monoethanolamide
MIPA	Monoisopropanolamide
Mol. Formula	Molecular formula
NADF	Nonaqueous-Based Drilling Fluid
OBF	Oil- Base Drilling Fluid
OCMA	Oil Companies Materials Association
P.p.	Pour point
PAH	Polycyclic Aromatic Hydrocarbons

PAOs	Poly Alpha Olefins
PTSA	p-Toluene Sulfonic Acid
PV	Plastic Viscosity
Ref. Index	Refractive Index
SBF	Synthetic- Base Drilling Fluid
SBM	Synthetic - Base Mud
TCFU	Total Viable Count Technique
TGY	Tryptone Glucose Yeast
U.K	United Kingdom
US	United States Vis.
Oil	Viscous Oil
WBF	Water-Based Fluid
Y.P	Yield Point
Y.T	True Yield Point

II. Symbols

τ	Shear Stress
Υ	Shear Rate
μ	Viscosity
P	Poise
Pa	Pascal
cP	Centipoise
μe	Effective Viscosity
$\tau 0$	Yield Stress
n	Flow Behavior Index
Φ	Torque Readings from Instrument Dial at 600 and 300 rpm