

**SYNTHESIS AND EVALUATION OF NOVEL ESTERAMIDE
AS SYNTHETIC BASED DRILLING FLUIDS**

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ABSTRACT

Novel hexylamid-mono and di-linoleniate esters were prepared by the reaction of linolenic acid and hexylamide (derived from the reaction of Hexanoic acid and diethanol amine). The chemical structure for the new prepared hexylamid-mono and di-linoleniate esters were elucidated using elementary analysis, (FTIR), ¹H NMR and chemical ionization mass spectra (CI/MS) and spectroscopic techniques. The results of the spectroscopic analysis indicate that they were prepared through the right method and they have high purity. The new prepared esters have high Biodegradability and a lower toxicity (environmentally friendly) so they were evaluated as a synthetic -based mud (ester-based mud) for oil-well drilling fluids. The evaluation includes study of the rheological properties, filtration and thermal properties of the ester based-muds formulated with the new prepared esters compared to the reference commercial synthetic-based mud. Biodegradation of the new synthetic esters were also studied.

Key words:- Drilling Fluids – Synthetic Ester Based Mud, Rheological Properties, Biodegradation

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INTRODUCTION

Drilling in extreme conditions is under considerable time and cost pressures and new technologies are constantly being developed. Today's drilling fluids have to satisfy higher and higher technical criteria and uphold safety standards and environmental protection [Colloids & surfaces (2010)]. Drilling fluids are used in large quantities by the oil and gas industry to optimize on-and-off-shore drilling operations, when wells such as (oil, gas and geothermal wells) are drilled using rotary well-drilling equipments. The flow of drilling mud performs a number of functions, the most important of which are transport the cutting to the surface, balance subsurface, cool, lubricate and support part of the weight drill bit and the drill pipe, cement or seal the walls of the drill hole, hold the drilling cutting on suspension when drilling is stopped and form hydrostatic head and thus served to control the flow of high pressure gas, oil or water. Over the long history of on -land and off-shore drilling two based type of drilling fluids have been used, water-based drilling fluids (WBDs) and non-aqueous -based drilling fluids (NABDs) or oil-based drilling fluids (OBDs). Although principally due to the lower cost aqueous or water -based mud are most commonly used drilling fluids, the use of more costly oil-based mud are usually more stable than water -based mud,(when drilling deep well at high temperatures) [HALL, J., (1999)].

Oil-based mud are being more advantageous to use when drilling into subterranean formations which contain water swellable clays (which can be damaged by water contact). Because of their comparatively lower cost and good availability, crude oil petroleum and diesel oil have been used in the formation of oil-based mud [Svon Tapavicza (2002)]. All such petroleum -based oil used for drilling mud contain relatively large concentration of aromatics and at least substantial concentration 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 mud (SBMs) that combine the desirable operating qualities of oil -based mud with the lower toxicity and environmental impact qualities of water -based mud and also it can improve drilling efficiency without polluting. Synthetic-based fluids are drilling fluids where the base fluid consists of non-water soluble organic compounds and where neither the base fluid nor the additives are of petroleum orgies so they are environmentally friendly, high biodegradability and have a lower toxicity. Synthetic base fluids are classified into four general categories synthetic hydrocarbon, ether, esters and acetals. Ester-base drilling fluids have recognized for providing the best environmental performance of any synthetic based fluids and also they are fully biodegradable base fluid. Rheological properties, thermal stability and filtration of the synthetic based mud are the most frequently used methods for selecting the best synthetic ester-based mud [Samira et al., (2009) - Environmental protection agency (EPA), (1999)].

EXPERIMENTAL AND TECHNIQUES

Preparation methods

Preparation of Hexylamide

Hexanoic acid (1 mol) was added to diethanolamine (1 mol) in a three necked flask equipped with a Dean-Stark apparatus in presence of (0.02 mole) of sulphuric acid added as a catalyst and xylene added as a solvent, temperature was raised slowly up to 50C°, nitrogen gas was passed in with continuous stirring. The reaction mixture was heated with continuous stirring until the theoretical amount of water was collected; the product was purified by washing with (5%) sodium bicarbonate solution followed by petroleum ether (b.p 40-60 C°). The product obtained was diethanamide- N hexyl or hexylamide (A) was yellow oily product obtained after collected 18 gm of water. [Shapiro, S.H., (1968) - Manawwer Alam, S.M. et al., (2004) - Manawwer Alam, S.M. et al., (2008)]. Infra-red spectrum of the product was carried out by (Faurier transform infrared (FTIR) spectrophotometer ATI Mattsonm Genesis series TM).

Esterification of Diethanamide N-Hexyl (Hexylamide)

1 mole of the prepared fatty amide (Hexylamide) (A) was added to linolenic acid (1 mole) or (2 mole) in three necked flask in presence of (0.005 mole) of solid p-toluene sulfonic acid as a catalyst and xylene as a solvent, The reaction mixture was heated with continuous stirring until the theoretical amount of water was collected in Dean-Stark tube. The products were purified by washing with(5%) sodium bicarbonate solution then dissolved in petroleum ether(b.p 40-60 C°).The organic layer was separated and the solvent was distilled off [Lietz et al., (1999) – Pouilloux et al., (1999) – Sekula et al., (2000)]. The products obtained were:

1. Diethanamide N-hexyl monolinoleate (T₁) pale brown oily product was obtained after collecting the theoretical amount of water (18 gm) from the reaction.
2. Diethanamide N-hexyl dilinoleate (T₂) brown oily product was obtained after collecting the theoretical amount of water (36 gm).

Infra-red spectra of products were carried out by (Faurier transform infrared (FTIR) spectrophotometer ATI Mattsonm infinity series TM), Elemental analyses were determined on a Perkin-Elmer 240C micro-analyzer ;Molecular weight determinations were conducted by (Mass spectrophotometer Hp- Model, Ms 5988) and H¹NMR spectra was measured on a Varian Gemini (300 MHz) instrument for each products (T₁, T₂).

Tests of Synthetic – Based Mud

Work for synthetic- based invert emulsion mud (ester- based mud) was performed by using the new prepared esters (T₁, T₂) compared to the imported known fatty acid ester(reference sample R) with 100% synthetic ester (all oil system) . All samples were prepared according to American Petroleum Institute (API 1998) .All additives for ester based mud and the imported fatty acid ester R were obtained from Baroid Company.

Mud Formulation

DRIL N system (100%) synthetic ester (all oil system)

Ester oil 500 ml+ polar activator (0.2 ml, 0.025 ppb) + 8.5 ml primary emulsifier + 6 gm lime + 8 gm filtration control agent + 6 gm viscosifier + 0.95 ml rheological modifier + calcium carbonate as weighting material. For all mud formulations, all chemical additives were added slowly using stirring and mixed well in the mixer. So we have (2) mud formulations and a reference sample mud.

M_R : Mud formulation with the imported ester mud (R).

M_{T1}: Mud formulation with the new prepared ester (T₁) Diethanamide N-hexyl monolinoleate.

M_{T2}: Mud formulation with the new prepared ester (T₂) Diethanamide N- hexyl dilinoleate.

Rheological Properties

Rheological properties of the synthetic-based muds were measured by using chandler engineering laboratory model (API) viscometer chan 35 Model (3500). Apparent viscosity (AV), plastic viscosity (PV) and yield point (YP) were determined by making a relation between share rate and share stress, where shear stress was taken from the dial reading which is in degree of circle and shear rate (sec⁻¹)= rpm x 1.067 .

Unit of: PV in centipoises (CP), AV in centipoises (CP) and YP in lb/100 ft².

Determination of Gel Strength and Thixtropy of a Mud

The gel strength of the mud is a measure of the minimum shearing stress necessary to produce slip-wise movement of fluid. Two readings are generally taken (1) After the mud has been rested for 10 sec in the cup (G₁₀ sec) (2) After the mud in the cup has been rested for 10 min rested (G₁₀ min). Thixtropy of the mud is the difference between the low reading after 10 sec and 10 min.

Effect of Temperature on the Rheological Properties

Viscosity of the mud is a function of temperature more than pressure. It is necessary to measure viscosity at elevated Bottom Hole Temperature. This is done by using the viscosity-cup heater which is thermostat-controlled unit for heating the mud sample directly on a viscometer.

High Pressure- High Temperature Filter Press

The test method for filter loss is performed by using standard HP- HT filter loss model (107c). The test was run at (350°F and 500psi) and the volume of filtrate recorded from the graduated cylinder at the end of cylinder 2, 5, 10, 15 and 30 minutes. The relation between time and volume of filtrate was plotted to calculate the corrected filter loss.

Thermal Stability Test

The thermal stability of the synthetic ester- base mud was done to check the ratio of deterioration in filtration and rheological properties of synthetic ester- base mud under high temperature, high hydrostatic pressure and continuous circulation the following test was carried out. Prepare synthetic ester- base mud formulation for each of new prepared ester (T_1 , T_2) and reference mud (R) with ratio 100% ester base mud. The samples were placed in a rolling oven operating at 350°F for 16 hours. The samples were removed and cooled for 20 minutes in a cold water bath. Samples were then blended in a high speed blender for few minutes; PV, AV, YP, G_{10sec} and G_{10min} and filter loss were determined. The rheological properties before and after thermal stability test were compared [Lahalih et al., (1989)].

Biodegradability of emulsion samples by using different organisms

In 100 mL batch flasks containing 20 mL basal salts medium with initial pH 7. The emulsion samples [prepared esters (T_1 , T_2)] were prepared according to [Piddington, CS., et al., 1995]. Incubation period was seven days at 30°C in a shaking incubator (150 rpm). Growth was monitored by total viable count (TCFU) technique on tryptone glucose yeast extract medium (TGY) prepared according to [Benson, H.J., 1994] after seven days.

RESULTS AND DISCUSSION

Hexylamide (Diethanamide N-hexyl) (A) was prepared through elimination of water molecule and produce amide linkage, Diethanamide N-hexyl monolinoleate (T_1) and Diethanamide N-hexyl dilinoleate (T_2) were prepared through elimination of water and produce ester linkage [Maclafferty et al., (1980) -Boerhoom et al., (1983) – Foti et al., (1983) – Self et al., (1983)] The chemical structures of the prepared compounds A, T_1 and T_2 show on Fig (1).

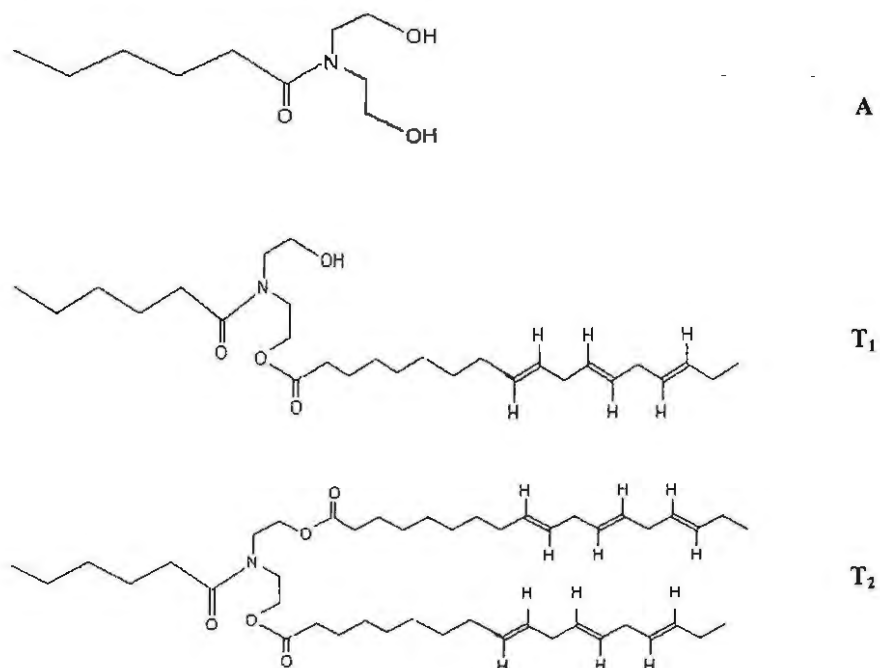


Fig (1) : The chemical structures of the prepared compounds

Structure Conformation of Hexylamide (diethanamide-N hexyl)

The chemical structures of the prepared compounds (A), was confirmed by IR spectra and elementary analysis.

Infrared Spectroscopy (IR)

IR spectra gives indication for presence of amide linkage (CO-N), IR Spectroscopy of compound (A) is illustrated in Table (1).

Table (1): (IR) Spectroscopy of hexylamide (A).

Designation Name	IR Spectroscopy Band
A	Two vibration stretching bands at 1620.15 cm^{-1} and 1558.93 cm^{-1} indicate the presence of CO-N (amide linkage), two adjacent bands at $1455.59\text{--}1470.99\text{ cm}^{-1}$ and at 3318.66 cm^{-1} of free OH hexanoamide.

Elemental analysis

The elementary analysis of the prepared compound (A) shows good coincident between the calculated and found values of C, H, O and N (%), Table (3).

Structure Conformation of Esterification of Diethanamide N-Hexyl (Hexylamide)

The preparation process based on the elimination of water and produce ester linkage [MacLafferty et al., (1980) -Boerhoom et al., (1983) – Foti et al., (1983) – Self et al., (1983)]. Structure elucidations of these esters (T_1 , T_2) were made accessible to IR spectra, elementary analysis, mass spectrometric analysis and $^1\text{H-NMR}$ spectra as the follow.

Infrared Spectroscopy (IR)

Infrared Spectroscopy (IR) spectra of (T_1 , T_2) gives indication the presence of ester linkage (C = O) which are shown in Table (2).

Table (2): (IR) Spectroscopy of (T_1 , T_2) esters.

Designation Name	IR Spectroscopy Band
T_1	$\nu\text{ C}=\text{C}$ band at 1626 cm^{-1} due to oleic acid, $\nu\text{C}=\text{O}$ of ester at 1736 cm^{-1} and νOH at 3408 cm^{-1} of free OH hexanoamide-mono linoleniat. .
T_2	$\nu\text{C}=\text{C}$ band at 1626 cm^{-1} due to oleic acid, $\nu\text{C}=\text{O}$ of ester at 1736 cm^{-1} but the absence of νOH band in case of hexanoamide-di linoleniat.

Elemental analysis

The elementary analyses of each (T_1 - T_2) results indict that the elements within $\pm 0.3\%$ of the calculated values as show in Table (3).

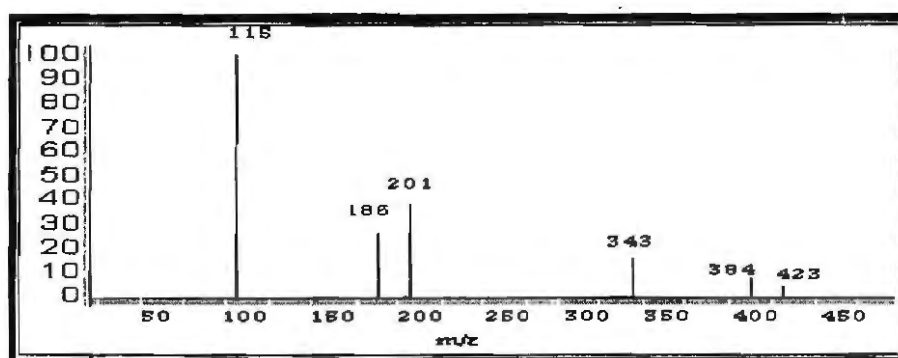
Table (3): The elemental analysis of the major components and their yield percentage.

compounds	hexanoamido-mono linoleniat ester	hexanoamido-di linoleniat ester
designation	T ₁	T ₂
molecular weight	472.8	730.3
	(463.73)*	(724.16)*
C%	71.76	75.91
	(72.46)*	(76.23)*
H%	10.25	10.45
	(10.35)*	(10.49)*
O%	13.66	10.95
	(13.80)*	(11.05)*
N%	2.99	1.93
	(3.02)*	(1.94)*
C Number	28	46
H Number	48	76
O Number	4	5
N Number	1	1

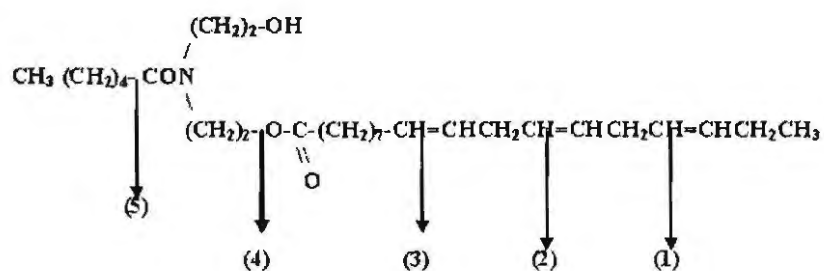
Where ()* are the calculated values.

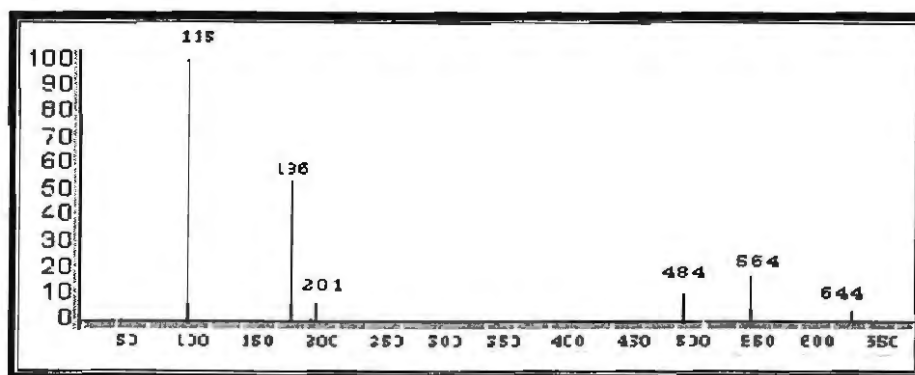
Chemical ionization/ mass spectra

(CI/MS) the chromatogram and mass spectrum of (T₁, T₂) were shown in Fig (2) Scheme (1) and Fig (3) Scheme (2) respectively.

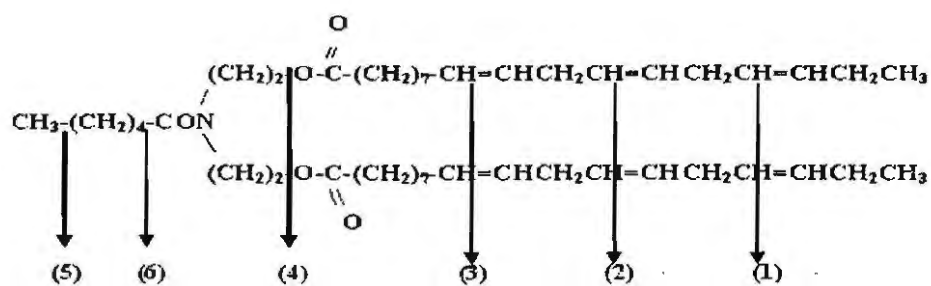
Fig (2): CI/MS spectrum of ester (T₁)

Scheme (1)

1-[CH-CH₂CH₃]2-[CH-CH₂-CH=CH-CH₂CH₃]3-[CH CH₂CH=CH-CH₂-CH=CH-CH₂CH₃]4-[O-CO-(CH₂)₇-CH=CH CH₂CH=CH-CH₂-CH=CH-CH₂CH₃]5- Finger print [CON(CH₂)₂-(CH₂)₂-OH]

Fig (3): CI/MS spectrum of ester (T₂)

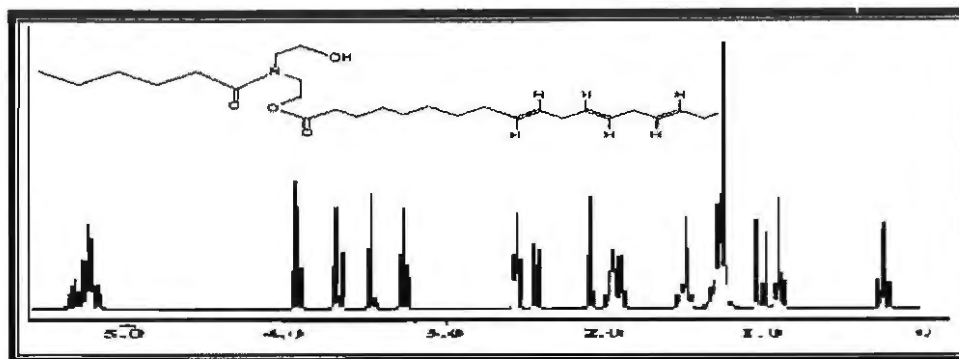
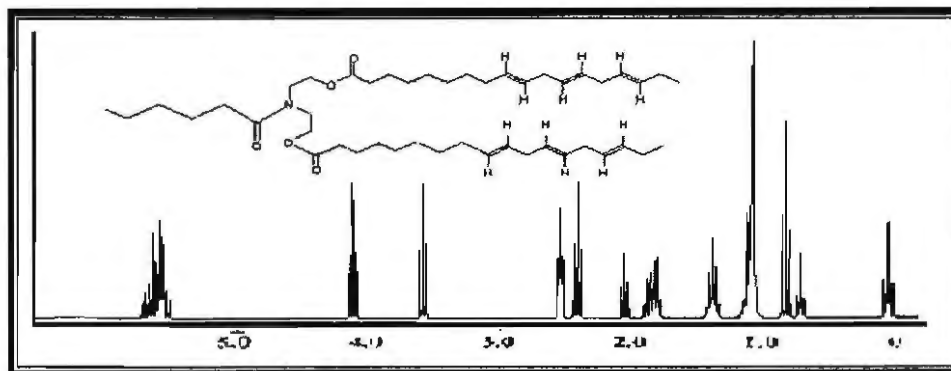
Scheme (2)



- 1- $2x [\text{CH}-\text{CH}_2\text{CH}_3]$
- 2- $2x [\text{CH}-\text{CH}_2-\text{CH}=\text{CH}-\text{CH}_2\text{CH}_3]$
- 3- $2x [\text{CH}-\text{CH}_2-\text{CH}=\text{CH}-\text{CH}_2-\text{CH}=\text{CH}-\text{CH}_2\text{CH}_3]$
- 4- $2x [\text{O}-\text{CO}-(\text{CH}_2)_7-\text{CH}=\text{CH}-\text{CH}_2-\text{CH}=\text{CH}-\text{CH}_2-\text{CH}=\text{CH}-\text{CH}_2\text{CH}_3]$
- 5- $2x [\text{O}-\text{CO}-(\text{CH}_2)_7-\text{CH}=\text{CH}-\text{CH}_2-\text{CH}=\text{CH}-\text{CH}_2-\text{CH}=\text{CH}-\text{CH}_2\text{CH}_3] + [\text{CH}_3(\text{CH}_2)_4]$
- 6- Finger print $[\text{CON}(\text{CH}_2)_2-(\text{CH}_2)_2]$

H¹NMR spectra

H¹NMR spectra (ppm, CDCl₃) of (T₁, T₂) esters were shown in Fig (4-5) and Table(4-5).

Fig (4): H^1 -NMR spectra (ppm, $CDCl_3$) of T_1 esterFig (5): H^1 -NMR spectra (ppm, $CDCl_3$) of T_2 esterTable (4): H^1 NMR spectra (ppm, $CDCl_3$) of (T_1 , T_2) esters.

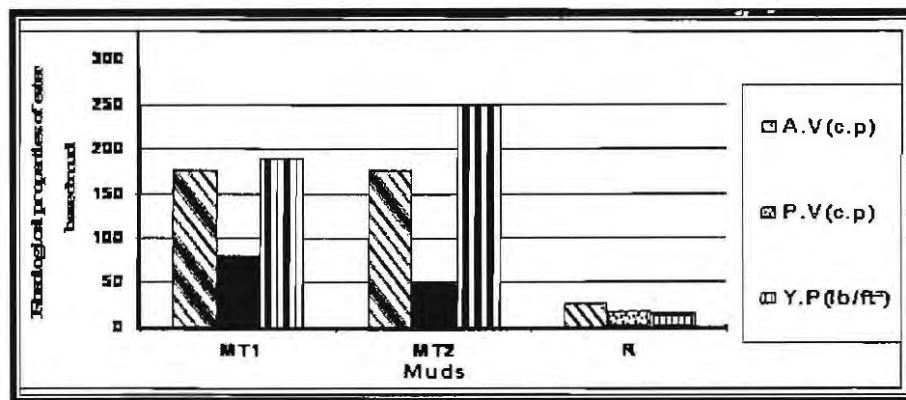
Designation name	H^1 -NMR spectra (ppm, $CDCl_3$)
T_1	[0.96 (terminal CH_3 saturated fatty chain)], [1.06 (terminal CH_3 unsaturated fatty chain)] [3.39 , 3.59 (CH_2 attached to amide nitrogen)], [2.0 (O-H)], [3.79 (CH_2 attached to -OH) , [5.40 - 5.49 (- $CH=CH$ - protons attached to alternative double bond of unsaturated fatty acid)], [1.29,1.57,1.96 (CH_2 fatty chain)], and 4.08 (CH_2 attached to $C=O$ ester)] Fig (4).
T_2	[0.96 (terminal CH_3 of saturated fatty chain)], [1.06 (terminal CH_3 unsaturated fatty chain)] [3.59, (CH_2 attached to amide nitrogen)], [5.40-5.49 (- $CH=CH$ - protons attached to alternative double bond of unsaturated fatty acid)], [1.29, 1.57, 1.96 (CH_2 fatty chain)], and 4.08 (CH_2 attached to $C=O$ ester)] Fig (5).

Evaluation of the prepared esters

The new prepared esters (T_1 , T_2) were evaluated as a synthetic based mud (ester-based mud) for oil – well drilling fluids. The mud formulation of synthetic-based mud were (ester) (All oil system) (100%) synthetic ester this formulation was considered as the control sample (reference) for the evaluation measurements of the new ester– based mud. All synthetic–based mud were prepared according to American Pétroleum Institute (API 1998), and this muds were evaluated as a synthetic based mud, for oil–well drilling fluids. In this research the evaluation incorporates the following

Rheological properties

The rheological properties of ester–based muds composed of esters mud (M_{T1}, M_{T2}) were measured compared to the field ester–based mud formulated by the imported ester mud as a reference sample (M_R). Rheological results at 77 F° were illustrated in Fig (6). For both of (M_{T1}, M_{T2}), the apparent viscosity (AV) were (175 cp) which is more than the apparent viscosity of the reference mud sample (26 cp). The plastic viscosity (PV) changing from (50 to 80 cp) for the new based mud compared to reference mud sample M_R which is equal to (18.5 cp), and the yield point (YP) ranges from (190 to 250 lb/100ft²) for the new esters – mud where the yield point of the reference mud sample (M_R) is equal to 17 lb/100ft². From the above results, it had been shown that the rheological properties of the new ester–based muds (M_{T1}, M_{T2}) exhibit rheological properties value better than the reference (M_R) that formulated with the imported fatty ester.

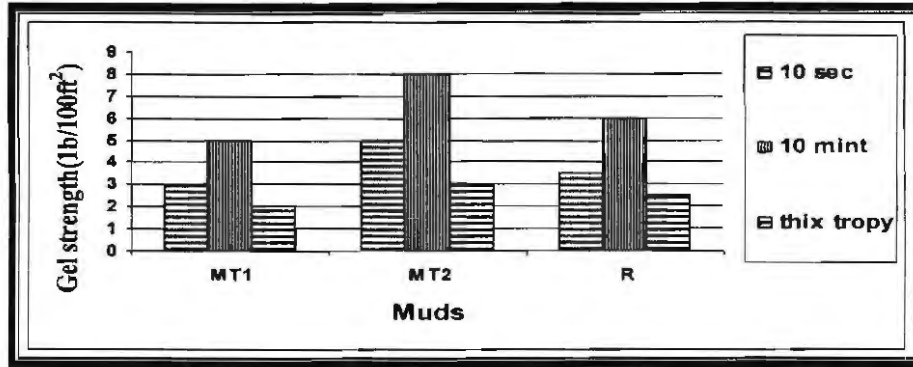


Fig(6):Rheological properties of synthetic Esters-Based mud formulated with a new prepared esters (M_{T1}, M_{T2}), compared to refers sample (M_R)

Gel Strength

The gel strength of ester–based muds formulated by the prepared esters (M_{T1}, M_{T2}) were plotted in Fig (7) compared to reference mud sample (M_R). The Figure shows that the gel strength of esters – based mud (M_{T1}, M_{T2}) composed of new prepared (T_1, T_2)

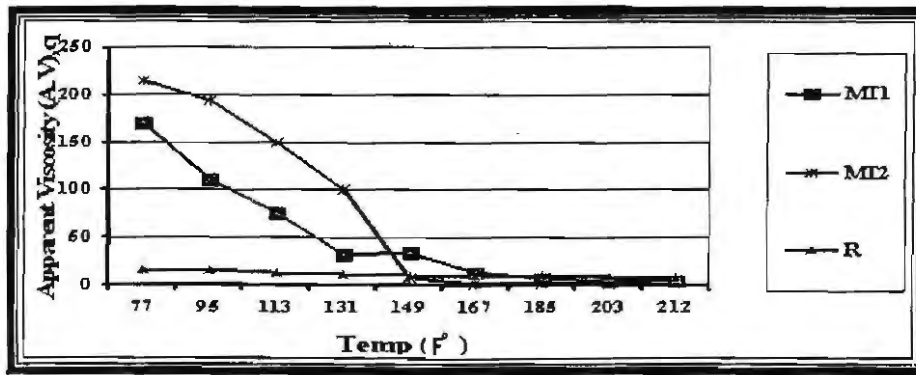
esters. Their values change from (3 to 5 lb/100ft²) after (10 sec), where the gel strength of the reference mud sample (M_R) was (3.51b/100ft²). The gel strength after (10 mint) varies from (6 to 8 lb/100ft² for the prepared esters mud and was (6 lb/100ft²) for reference mud sample (M_R). The thixotropy of the prepared esters mud changes from (2 to 3 lb/100ft²) and the reference mud sample was (2.5 lb/100ft²). The results of gel strength of new prepared ester – muds change within acceptable range compared to the American Petroleum Institute (API 1998).



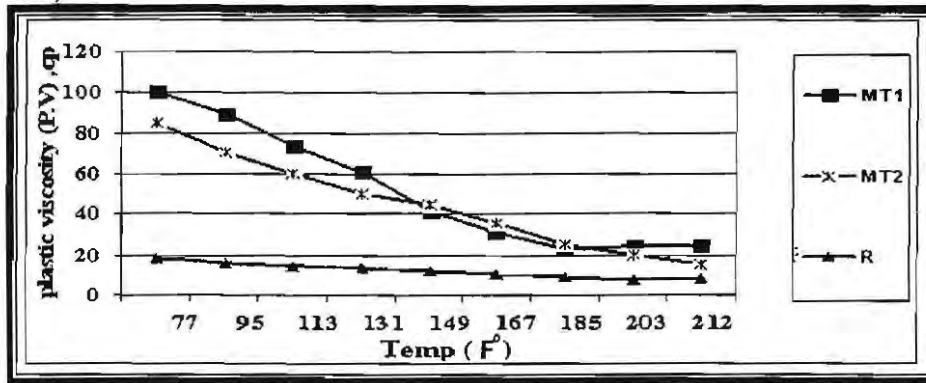
Fig(7): Gel Strength of synthetic Esters-Based mud formulated with a new prepared esters (M_{T1} , M_{T2}), compared to refers sample (M_R)

Effect of temperature on the rheological properties of esters - based muds (M_{T1} , M_{T2}) and the reference mud sample (M_R).

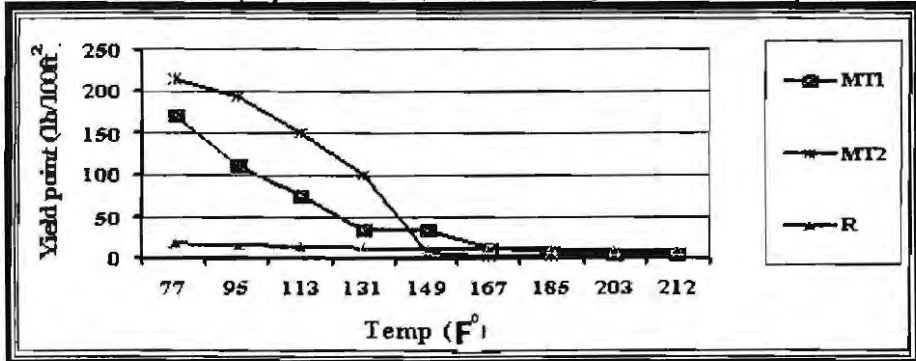
Rheological properties vary under variable temperatures for (ester – based mud) formulated by the prepared esters (M_{T1} , M_{T2}), Fig (8-10) shows the results of apparent viscosity(AV) , plastic viscosity (PV) and yield point (YP) for the ester – based muds compared to reference (M_R), with temperature rises from 77 F° to 212 F°. Fig (8) show results of apparent viscosity, plastic viscosity and yield point for the new ester – based mud (M_{T1} , M_{T2}) compared to reference R, with temperature rises up to 212 F°. The apparent viscosity (AV) was 175 cp and decreases to (17-25) cp for the new ester- based muds respectively whereas the apparent viscosity of the reference (M_R) decreases from (26 cp to 10 cp).In Fig (9) the plastic viscosity (P.V) was (85 cp and 100 cp) respectively for the new ester –based mud(M_{T1} , M_{T2}) decreases to (15 cp and 24 cp) respectively when the temperature increases from 77 to 212 F° the reference ester mud sample (M_R) Show reducing plastic viscosity from 18.5 cp to 8 cp. In Fig (10) the yield point (YP) of the new ester–based muds under varying temperature up to 212 F° were (170 lb/100ft² to 2151b/100ft²)the decreases was (6-4 lb/100ft²) when the temperature increases from 77 F° to 212 F°. Testing results for rheological properties under variable temperatures indicate that the new ester–based mud (M_{T1} , M_{T2}) were more stable under high temperature than the imported ester – based mud when utilized in field synthetic–based mud.



Fig(8): Apparent viscosity(AV) Temperature relationship of synthetic Esters-Based mud formulated with a new prepared esters (MT1, MT2), compared to refers sample (MR)



Fig(9): Plastic viscosity(PV) Temperature relationship of synthetic Esters-Based mud formulated with a new prepared esters (MT1, MT2), compared to refers sample (MR)



Fig(10): Yield point (Y.P) Temperature relationship of synthetic Esters-Based mud formulated with a new prepared esters (MT1, MT2), compared to refers sample (MR)

Effect of temperature on gel strength of esters - based muds (M_{T1} , M_{T2}) and the reference mud sample (M_R).

The gel strength of the ester-based mud (M_{T1} , M_{T2}) composed of a new prepared esters changes with increasing temperature Fig (11) shows the effect of temperature on gel strength, after 10 sec. ranging between 3.2-3 lb/100ft² and when temperature increases from 77 F° to 212 F° the gel strength ranging between (1-2 lb/100ft²) while the reference ester based mud decreases from 5 to 2 lb/100ft². While in Fig (12) the gel strength after 10 min. for the new ester - based muds ranging from (5.5 to 3 lb/100ft²) when temperature increases from 77 F° to 212 F° where the reference sample (M_R) decreases from (8 to 3 lb/100ft²). So the muds are stable and they can keep their rheological properties for a period of time during the drilling operation.

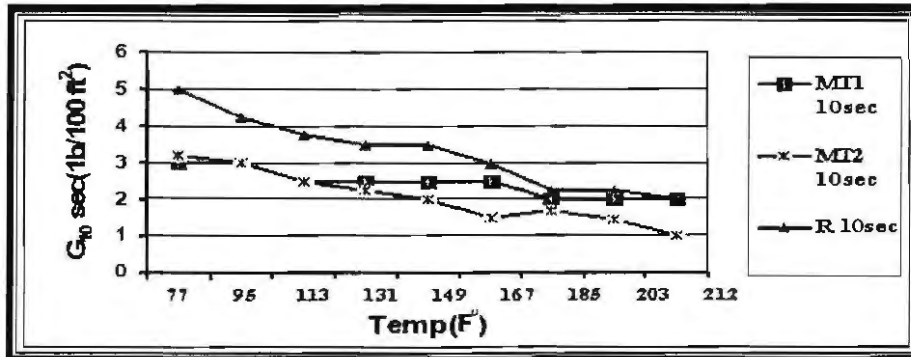


Fig (11): G_{10} sec Temperature relationship of synthetic Esters-Based mud formulated with a new prepared esters (M_{T1} , M_{T2}), compared to refers sample (M_R)

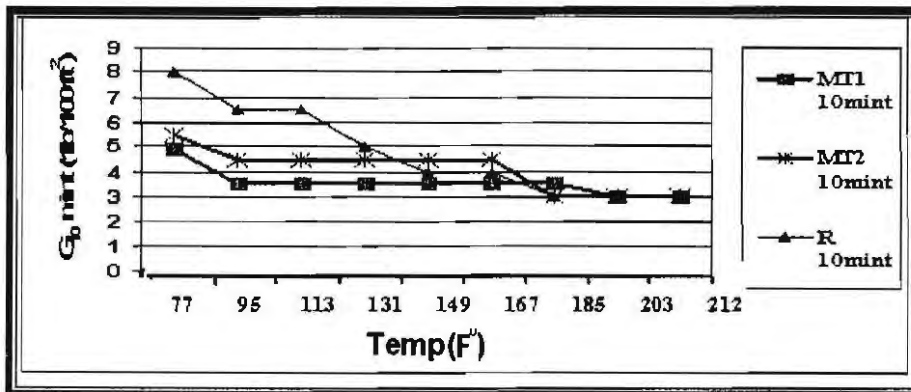


Fig (12): G_{10} min Temperature relationship of synthetic Esters-Based mud formulated with a new prepared esters (M_{T1} , M_{T2}), compared to refers sample (M_R)

Filtration

Table (4) shows that the (HP – HT filter loss) at (350 F° – 500 psi) for the new ester – based muds formulated with the new prepared esters (M_{T1}, M_{T2}) compared to the reference ester – based mud (M_R) (100%) ester mud. The results were 9 ml for ester – based mud (M_{T1}) which was comparable with filter loss of the reference sample (M_R), while (M_{T2}) ester – based mud was 7.5 ml. The decrease of filter loss of the (M_{T2}) ester – based mud indicate their stability.

Table (4): Filter loss (ml) for the new ester – based muds (M_{T1}, M_{T2}) and reference ester mud (M_R).

Mud formulation	Filter loss
Reference mud (R)	9
M_{T1}	9
M_{T2}	7.5

Thermal stability

One of the major problems of drilling fluids is their instability to shear and thermal aging. In drilling operations, drilling fluids encounter geological formations with different temperature. The combination of thermal and shear stresses accelerates the degradation of the drilling fluids and results in significant reduction in its effectiveness. Table (5) illustrates the relative stabilities of ester-based mud formulated with the new prepared esters (M_{T1}, M_{T2}) compared to the reference ester-base mud (M_R) after aging for 16 hours at 350 F°, high hydrostatic pressure and continuous circulation.

Table (5) the relative stabilities of ester – based muds (M_{T1}, M_{T2}) compared to the reference sample ester base (M_R) at 350 F°, high hydrostatic pressure and continuous circulation.

Mud	Hours of aging at 350°F	Av (CP)	PV (CP)	YP lb/100ft ²	Gel strength lb/100ft ²		Filter loss (ml)
					G_{10sec}	G_{10min}	
M_R	0	80	60	38	18	24	7
	16	66	50	32	15	21	9
M_{T1}	0	175	80	25	13	15	7
	16	140	73	17	11	12	5
M_{T2}	0	175	50	17	15	18	5
	16	150	45	11	10	15	7.5

Biodegradation of the prepared esters

Results show in Fig (13) and Fig (14) indicated the ability of the studied microbial strains to grow on the emulsions samples as a sole source of carbon and energy, indicating the emulsion of prepared esters (T_1, T_2) biodegradability compared to the

reference sample ester base (R) where CFU/ml is total count of the growth colliens of these organism in one mill liters (ml) [STEBER, J., et at., (1995)].

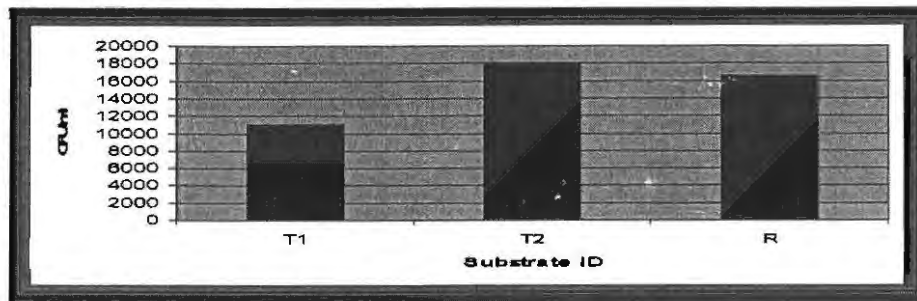


Fig (13): Growth of Bacillus sphaericus HN1 on tested compounds

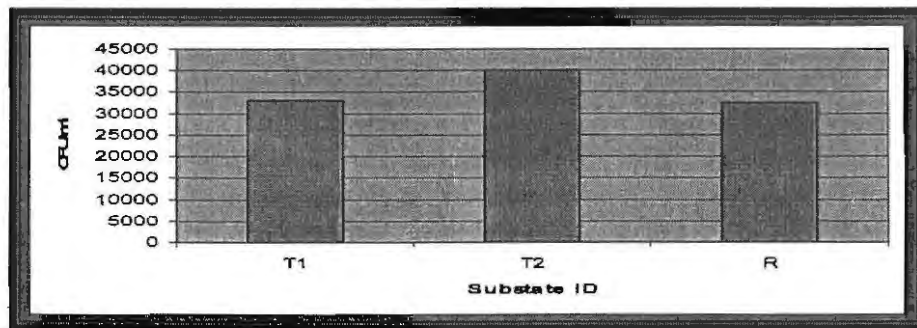


Fig (14): Growth of Corynebacterium variabilis Sh42 on tested compounds

CONCLUSION

In this study experimental work and evaluation of the new prepared esters T_1 - T_2 showed good results when utilized in the formulation of ester – based mud. Experimental work for all new prepared esters were conducted in the Same time compared to field ester based mud (reference sample) with the international standards and specifications. From the data of evaluation of the new prepared ester utilized in the ester-based mud we can conclude the following

- 1- Rheological properties of the most new prepared ester based mud performed a superior results compared to the imported ester – based mud (M_R).
- 2- The effect of temperature on the rheological properties of new ester – based muds (M_{T1}, M_{T2}) formulated with the new esters T_1 - T_2 show slight decrease by increasing temperature compared to field ester–base mud (M_R), also they are stable at high temperature and pressure with continuous circulation (thermal stability) .
- 3- Gel strength of ester – based muds formulated with the new prepared esters (T_1 - T_2) showed gradual decrease by increasing temperature as the field ester – based mud (M_R).
- 4- Filtration properties of ester – based muds formulated with the new prepared esters (T_1 - T_2) showed low filter loss compared to the field ester – based mud (M_R).
- 5- The new prepared esters (T_1 - T_2) were biodegradable compared to the field ester (R).

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الملخص العربي

تحضير وتقييم الإسترات الأمينيه لإستخدامها فى حفر أبار البترول

فى هذه الدراسة تم:

أ- تحضير إسترات جديدة ناتجة من تفاعل ثنائى الإثانول هكساميد (الناتج من تفاعل حمض الهكسانوك مع ثنائى الإثانول أمين) و حمض اللينولينيك وهى:

١. أحادي اللينوليت هكساميد (الناتج من تفاعل عدد جرام جزئى واحد من حمض اللينولينيك مع عدد جرام جزئى واحد ثنائى الإثانول هكساميد) .

٢. ثنائى اللينوليت هكساميد (الناتج من تفاعل عدد إثنين جرام جزئى من حمض اللينولينيك مع عدد جرام جزئى واحد ثنائى الإثانول هكساميد) .

وقد تم اثبات التراكيب الكيميائية للإسترات الجديدة بواسطة تحليل العناصر و التحليلات الطيفية المختلفة (طيف الأشعة تحت الحمراء وتحليل طيف الكتلة وأطياف التآين الكيميائي). وقد تبين من التحلل البيولوجي للإسترات المحضرة (١) و(٢) قدرة هذه المركبات على التحلل بواسطة الكائنات الدقيقة وقلة سميتها فاعتبرت مركبات صديقة للبيئة.

ب- تقييم الإسترات المحضرة لإستخدامها كسائل حفر بديل عن مثيلتها المستوردة و ذلك من خلال القياسات التالية :

١. قياس خواص سريان الطفلة و قد وجد أن طفلة الإستر المحضرة لها قيم لزوجة أعلى من نظيرتها المستوردة و قد امتدت الدراسة لدراسة تأثير درجة الحرارة على خواص السريان.

٢. قياس الفقد الترشيحي لطفلة الإستر .

٣. دراسة قدرة طفلة الإستر على التحلل .