A New Alternative Thinner in the Drilling Fluid System

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Abstract

The most important constituent of drilling operation success is keeping the drilling fluid rheological properties within a certain limit to maintain continuing their functions in a good manner. To achieve that, the drilling mud system needs continuous and direct supervision such as measuring its rheological properties and treating any deviation in their values. Viscosity is the most important property in hydraulic program success due to its direct relation with bottom hole cleaning during drilling, thus related with the drilling rate, so this property should be kept basically to ensure bottom hole cleaning and high drilling rate at the same time.

Some chemicals such as thinner should be added to the mud system to keep both viscosity and other properties within certain standards and required limits; these materials have a high cost, increasing both the metric cost and the final cost of such well.

The aim of this research is to test the physical and chemical properties for a local material, as a thinner, which tends to decrease the rheological properties of drilling mud .Thirty nine samples of different types of drilling mud are tested with both the native and foreign imported materials.

The results for both additive materials are compared and concluded that the local thinner has the same trend with the imported material to a certain limit.

Introduction

Basically, the drilling operations depend on two factors, time and cost. The drilling engineers work hard to reduce the drilling cost by using economic drilling program.

The drilling program includes all the ways that lead to decrease both the time and cost effectively through increasing the drilling rate which depends mainly on the drilling mud properties, weight on bit, and the rotary speed.

In Iraq, the chemicals which are added to the drilling fluids lead to increase the drilling cost due to their high price and continuous requirement to control the rheological properties.

Our objective is finding out an alternative thinner instead of conventional thinner to reduce the rheological properties and thus, decreasing the cost of well drilling. The researcher follows both the theoretical way depending on the trusted references in drilling fluids and experimental way through laboratory testing for three types of drilling fluids(fresh water, salt water and lime mud) using two types of thinner, the first one is ferrochrome lignosulphonate and the second one is a local thinner. The chemical analysis for both types of thinner are studied

Functions of drilling mud

Drilling mud is the most important factor for the success of drilling operation. The target which represents the oil reservoir could not be reached without using standard and conventional drilling mud properties. The functions of the drilling mud are:-

1-Controlling the formation pressure which may have different fluids.

2-Cleaning the well through lifting the cuttings to the surface.

3-Consolidating the wall of the hole through forming a thin mud cake.

4-Cooling and lubricating the bit.

5-Facilitating cementing and completion operations.

6-Controlling corrosion in acceptable limit.

7-Transmitting hydraulic energy to the tools and bit. [6]

8-Providing geological information. [1]

Drilling fluid characteristics

1-Suitable pressure requirement to circulate drilling mud with recommended quantity and velocity.

2-Mininmum effects on the production zone.

3- Doesn't corrode or cause excessive wear of drilling equipment.

4-Doesn't reduce penetration rate. [6]

Drilling fluid ingredients

1-The liquid phase which include both types of water (fresh and brine) and crude oil.

2-Solid phase:-subdivided into:

A- Interactive solids: they can interact with the other drilling fluid ingredients such as clay and salts. They can be controlled by adding chemicals to the drilling fluid.

B-Inert solids: such as Barite which is used to increase mud weight.

3- Chemicals: they can be used to maintain drilling fluid properties within suitable limit. [6]

The rheological properties of the drilling fluids

They are related with the flowing of the drilling fluid in the mud system. They include the following:-

1- VISCOSITY: It can be defined as a fluid resistance to flow. It is measured by Marsh funnel or rotational viscometer. The measuring unit is centipoise.

The viscosity is created depending on two components:

A-Plastic viscosity: it results from mechanical friction force which happens among

The solids in the drilling fluid, solids and surrounding liquid phase and the liquid phase surfaces. [6]

The plastic viscosity depends on the concentration, shapes, and the volume of the solids. Mathematically, the plastic viscosity can be calculated by following formula:-

$\mu p=\theta 600-\theta 300$ where:

μp =plastic viscosity (C.P),$\theta 600$= Dial reading at 600 RPM ($Ib\backslash 100\ ft^2$), $\theta 300$= Dial reading at 300 RPM ($Ib\backslash 100\ ft^2$)

B-Yield point: The amount of electrochemical attracting forces between the particles during the flow due to the negative and positive charges on or near the particle surfaces. [6]

The yield point depends on the characteristics of particles surfaces, concentration and presence of ions in drilling fluids. It can be calculated by the following formula:

$Yp=\theta 300-\mu p$ where:Yp=yield point ($Ib\backslash 100\ ft^2$),$\theta 300$= Dial reading at 300 RPM ($Ib\backslash 100\ ft^2$),μp =plastic viscosity (C.P).

There are other types of viscosity:-

1-Apparent viscosity: It results from the combined effect for both plastic viscosity and yield point, it can be calculated by the following formula:-

$\mu a=\theta 600\backslash 2$

where:-μa=Apparent viscosity (C.P),$\theta 600$= Dial reading at 600 RPM ($Ib\backslash 100\ ft^2$).

2-Effective viscosity: - It is defined as equivalent viscosity, it takes into consideration hole diameter, drill string diameter in addition to plastic viscosity and yield point. It can be calculated by the following formula [3]:-

$\mu e=\mu p+(6.65\ Yp\ (dH-dP)\backslash v)$ where:-

μe=effective viscosity (C.P),μp=plastic viscosity (C.P),

Yp=Yield point ($Ib\backslash 100\ ft^2$),dH=Hole diameter (inch),dP=Drill string diameter(inch)

2-Gel strength: - The measure of attractive forces between particles in the static state. It also represents the shear stress necessary to start the fluid flowing.

The units of gel strength are (Ib\100 ft^2) and measured by rotational viscometer at 3 RPM. [6]

3-Alkalinity: - It is defined as the negative logarithm of positive hydrogen ion concentration.

PH=log (H^+) where:-

PH=Alkalinity

(H^+)=Hydrogen ion.

It can be measured by digital PH meter, or special test papers. [6]

4-FILTRATION:-Percolation of drilling fluid filtrate into the permeable zone due to the pressure difference that results in settling part of solid phase on the wall, thus a film of mud cake can be formed. The filtration is measured by API filter press and the measurement unit is cm^3\30 min. [6]

Types of drilling fluids [6]

There are several types of drilling fluids classified depending on the main liquid phase:-

1-Water base mud

In this type, water represents the liquid phase and it is subdivided into:-

A-Fresh water mud

B-Salt water mud

2-Inhibitive mud

This type of mud has a little effect on the penetrated sections through resisting solids hydrates; also this type resists clay hydration and keeps the well stable.

There are two types of inhibitive mud:-

A-Calcium treated mud

a- Lime base mud

b- Gypsum mud

B-Ferro chrome Lignosulphonate treated mud

3-Emulsion mud

It includes both oil and water liquids and it can be subdivided into:-

A-Oil in water emulsion mud

B-Water in oil emulsion mud

4-Oil Base mud

The base liquid in this type of mud is oil. It contains about (5-7%) of water that includes dissolved calcium in emulsion state.

5-Modern drilling mud

Known as low solids mud, such as polymers which are characterized by high cost because of their synthetic contents.

Chemicals used in the drilling fluid system

It is important to maintain the rheological properties of any drilling fluid at a certain limit. To achieve that, chemicals are used to increase or decrease these properties according to hole condition. They are known as thinners and subdivided into the following:-

1-Non organic thinners

One of the most conventional compounds of this type is phosphates which are used with water base mud in normal temperature gradients to control the rheological properties of the drilling fluids.

There are four types of phosphates:-

A-Sodium acid pyrophosphate ($Na_2H_2P_2O_4$)

B-Sodium hexameta phosphate ($NaPO_3$)

C- Sodium tetra phosphate ($Na_6PO_4O_{13}$)

D-Tetra sodium pyrophosphate ($Na_4P_2O_7$) [4]

2-Organic thinners

It can be subdivided into:-

A-Li gnosulphonate:-A complex compound extracted from special plants, it is prepared synthetically by lignin compounds interaction with acid sulfite, calcium acid sulfite or sodium acid sulfite.

These compounds are used as thinners and known as ferro chrome lignosulphonate.

B-Lignin compounds

They are natural compounds whose internal compositions are unknown. They can be classified as acids. These compounds are produced by plants degradation as dark brown powder. [4]

C-Tannin compounds

The word tannin is a collective term for a group of complex astringent substances made of carbon, hydrogen , oxygen ,and in some cases containing small amounts of nitrogen and phosphorous.

Tannins are broadly classified chemically as hydrolysable tannins consisting esters of one or more polyphenolic acids such as Gallic acid.

Tannins occur in many plants and are extracted from bark, wood, and fruit.

Sources include the barks of wattle, mangrove and eucalyptus, the woods of quebracho and chestnut. [5]

The local thinner, chemical and physical tests

The local thinner is characterized by its low cost, cheap and attainable. It is found in roots, stems ,and fruits such as gall oak ,quebracho ,sumac ,mimosa ,these plants are widely spread in different countries over the world especially in south Africa , Argentina ,and Iraq .The local thinner contains about 25-28% of organic material known as tannins and some compounds such as punicalin (Grananatine D) and punicalagin (Grananatine C).The tannin decreases the rheological properties(plastic viscosity, yield point and gel strength) of the drilling fluid due to presence of Gallic acid which result from tannin analysis in the water as shown later.

Tannin is an organic complex compound and dark color plants. It dissolves in water, alcohol and glycerin. This compound is produced by biochemical process of the plants. The internal composition contains carbon, oxygen, and sometimes impurities like nitrogen and phosphors. [3]

The chemical structure of tannin is complex but it is such various benzene acid hydrates, it a mixture of five molecules of digallic acid with one molecule of glucose. In degradation in water, the digallic acid transforms to Gallic acid which tends to decrease the rheological properties of the drilling fluids as shown below: - [5]

$$_{14}H_{10}O_9+C_6H_{12}O_6\ 5C \longrightarrow 5H_2O+5(C_{14}\ H_9O_9)C_6H_7O$$

The tannin is also used in the taw and manufactured leather.

Chemical tests

1-Detection of tannin ratio

It was conducted in analysis laboratory in Baghdad Oil Training Institute; it has been found that the tannin ratio is 28% by the following process:

1 gm of native thinner is dissolved in 40 ml of boiled water, 0.1gm of cupric acetate is added and the mixture is re boiled and then filtrated with filter paper. The paper is dried with 0.1 gm of nitric acid. The precipitation is burned and the weight of Cuo (Copper oxide) is taken. The tannin ratio is calculated by the following formula: [2]

Cuo*1.45=tannin%

0.194*1.45=28%.

The following tests were done at the laboratories of Petroleum Research and Developing Centre (PRDC) (See Appendix B).

2-Detection of both cooper and iron ratio in the local thinner by ultra violet tests. It has been found that the Cu=0.095 and Fe=0.06.

3-Detection of real density

It has been found that the real density is 1.318 gm\cc.

4-Fourier transform infrared test.

It has been found that the local thinner contains hydroxyl, Easter, and benzene groups in addition to aromatic compounds.

Physical tests

In order to detect the effect of local thinner on the rheological properties of the mud, three types of drilling fluid are tested with local and foreign thinners.

The tests results are compared and discussed, the foreign thinner used in these tests is (FCl) which is widely used in Iraqi fields.

Results and discussions

1-For fresh water mud

Numbers of samples of this type of mud are prepared. They contain 22.5 gm of Bentonite with 350 ml distilled water, the mixtures are left 24 hours for hydration, the FCl thinner is added with weights (0.5, 1, 1.5, 2, 2.5, 3) gm respectively, then the samples are mixed for 20 minutes before the tests process are run at room temperature. The tested properties are apparent viscosity, plastic viscosity, yield point, filtration, and the alkalinity of the filtrate. The same procedures are repeated again with the local thinner; their results are compared and discussed.

Figures (1, 2) (tables 1 & 2 in Appendix A) show the effect of both FCl and local thinners on the rheological behavior for this type of mud.

A- FCl thinner

It is noticed the apparent viscosity, yield point, and gel strength decreased clearly, while the plastic viscosity values were almost constant (9-10) centipoise(C.P).

The filtration rate values decreased gradually by increasing weight of added thinner, the alkalinity of filtrate ranged (8.5-9.8).

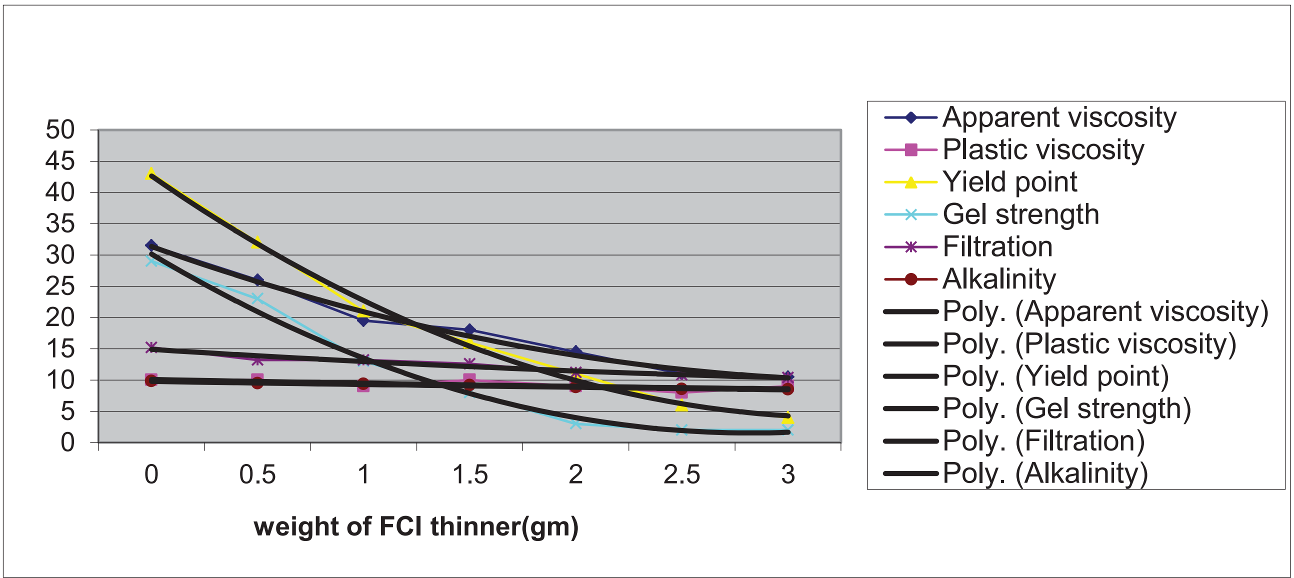

Fig.(1) Effect of FCl thinner on the rheological behavior of fresh water mud.

B- Local thinner

It is noticed that apparent viscosity, yield point, and gel strength decreased clearly to the weight of 1 gm of the added thinner, and then the values were almost 30, 31 C.P for apparent viscosity and 40-43 (lb\100 ft ^{2}) for yield point. At weight more than 1 gm of the added thinner both plastic viscosity and gel strength values remain constant.

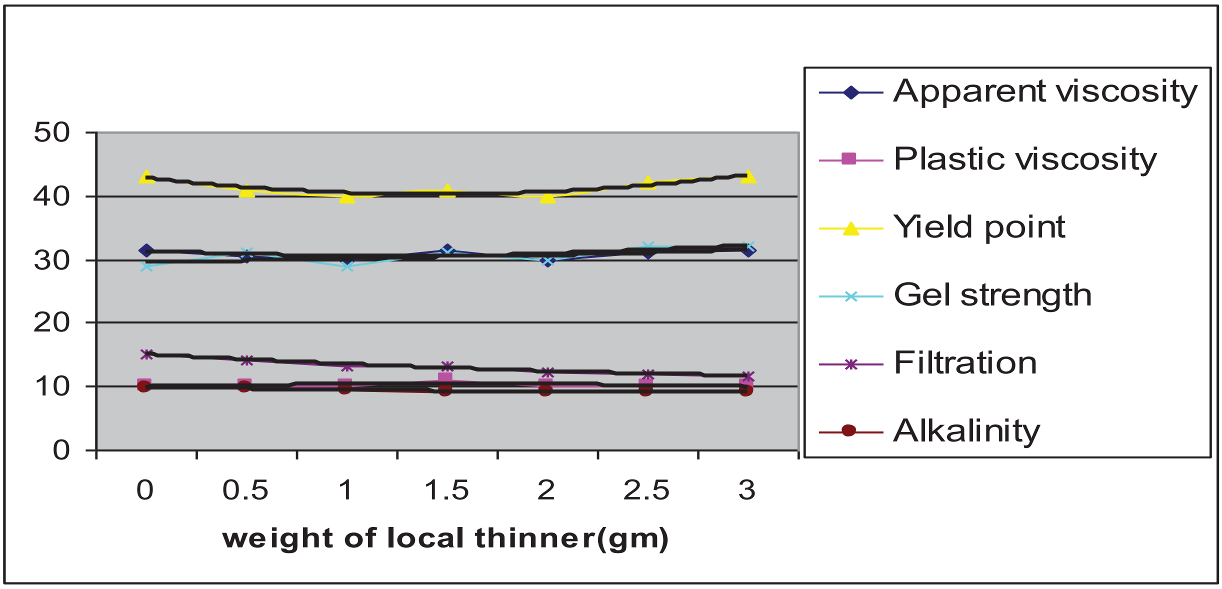

Fig.(2) Effect of local thinner on the rheological behavior of fresh water mud.

The filtration rate values decreased gradually to 11.6 cm^3\30 Min. With increased weight of added thinner, the alkalinity of filtrate ranged (9-9.8).

2-For salt water mud

Number of samples of this type of mud are prepared. They contain 22.5 gm of Bentonite with 350 ml tap water with 4% Nacl dissolved in water. The mixtures are left 24 hours for hydration, the FCl thinner is added with weights (0.5, 1, 1.5, 2, 2.5, 3) gm respectively, then the samples are mixed for 20 minutes before the tests process are run at room temperature. The tested properties are apparent viscosity, plastic viscosity, yield point, filtration, and the alkalinity of the filtrate. The same procedures are repeated again with the local thinner; their results are compared and discussed.

Figs (3 and 4)(tables 3 and 4 in Appendix A) show the effect of both FCl and local thinners on the rheological behavior for this type of mud.

A- FCl thinner

It is noticed that both apparent viscosity, yield point decreased clearly to the weight 1 gm of the added thinner ,after that, the apparent viscosity ranged (9-21)C.P while the yield point values ranged (32-34) (lb\100 ft ^{2}).

The plastic viscosity values remain nearly (4-6) C.P and the filtration rate values ranged (47.8-54) Cm^3\30 Min. The alkalinity values rated (8.9-7.73).

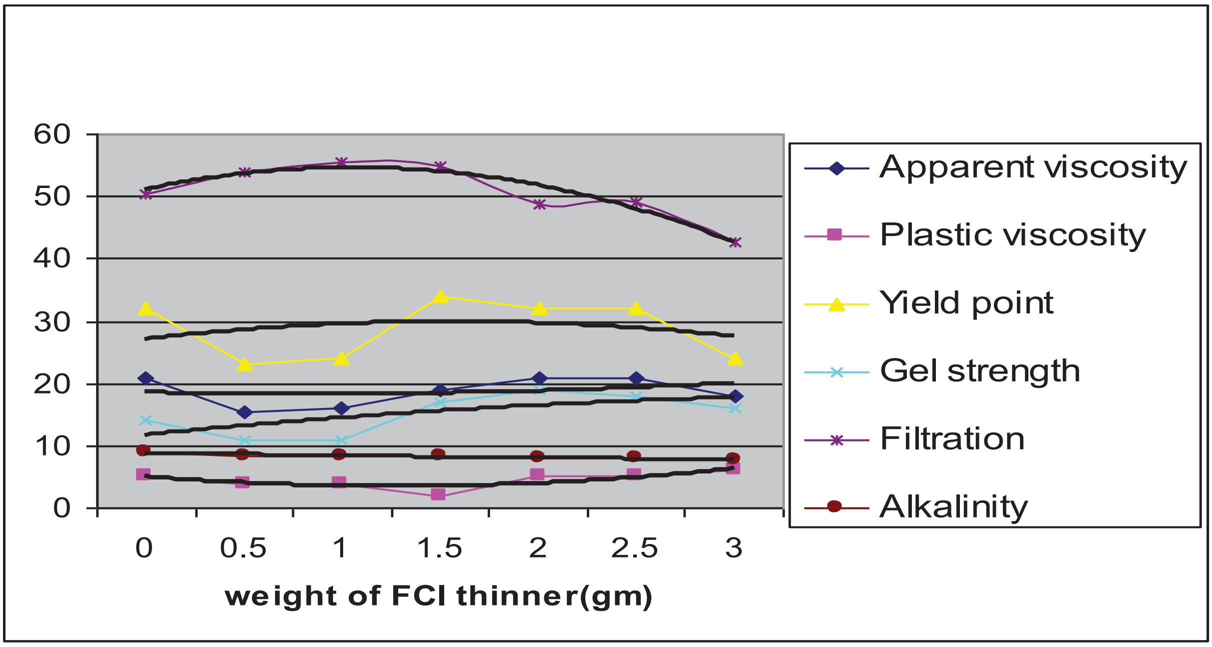

Fig.(3) Effect of FCl thinner on the rheological behavior of salt water mud.

B- Local thinner

It is noticed that both apparent viscosity, yield point decreased clearly to weight 1.5 gm of the added thinner, and then these properties remain almost constant (17 C.P for apparent viscosity and (24-26) lb\100 ft ^{2} for yield point). The plastic viscosity ranged (3-5) C.P while the gel strength ranged (12-14) lb\100 ft ^{2}.

The filtration rate values decreased gradually to 45.4 cm^3\30 Min. The alkalinity of filtrate decreased to stabilize at 8.24.

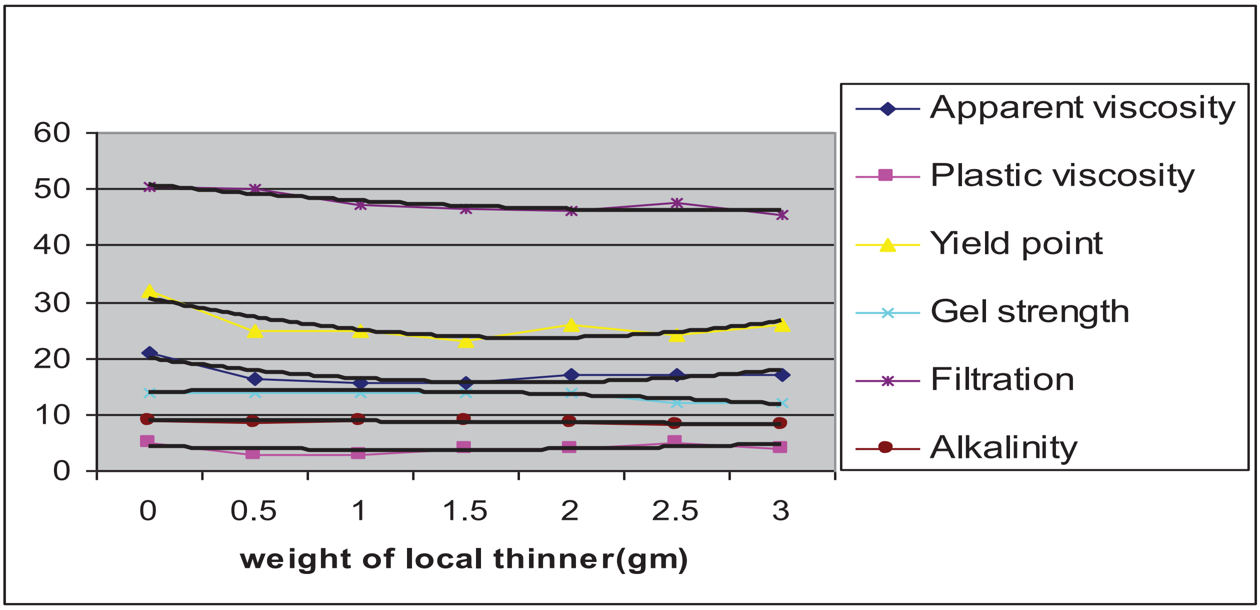

Fig.(4) Effect of local thinner on the rheological behavior of salt water mud.

3-For lime mud

Number of samples of this type of mud are prepared. They contain 22.5 gm of Bentonite with 350 ml tap water, and 5 gm of lime (Cao), the mixtures are left 24 hours for hydration, the FCl thinner is added with weights (0.5, 1, 1.5, 2, 2.5, 3) gm respectively, then the samples are mixed for 20 minutes before the tests process are run at the room temperature., the tested properties are apparent viscosity, plastic viscosity, yield point, filtration, and the alkalinity of the filtrate. The same procedures are repeated again with the local thinner; their results are compared and discussed.

Figures (5 & 6) (tables 5 and 6 in Appendix A) show the effect of both FCl and local thinners on the rheological behavior for this type of mud.

A- FCl thinner

It is noticed that the apparent viscosity, yield point ,and gel strength decreased clearly to the weight 2.5 gm of the added thinner ,after that, the apparent viscosity 44.5 C.P , yield point 71 (lb\100 ft^2) while the gel strength was 34(lb\100 ft^2).

The plastic viscosity values ranged (5-9) C.P* and the filtration rate values decreased gradually to 80 Cm^3\30 Min, and remain constant at weight 2 gm and more. The alkalinity values maintained around 13.

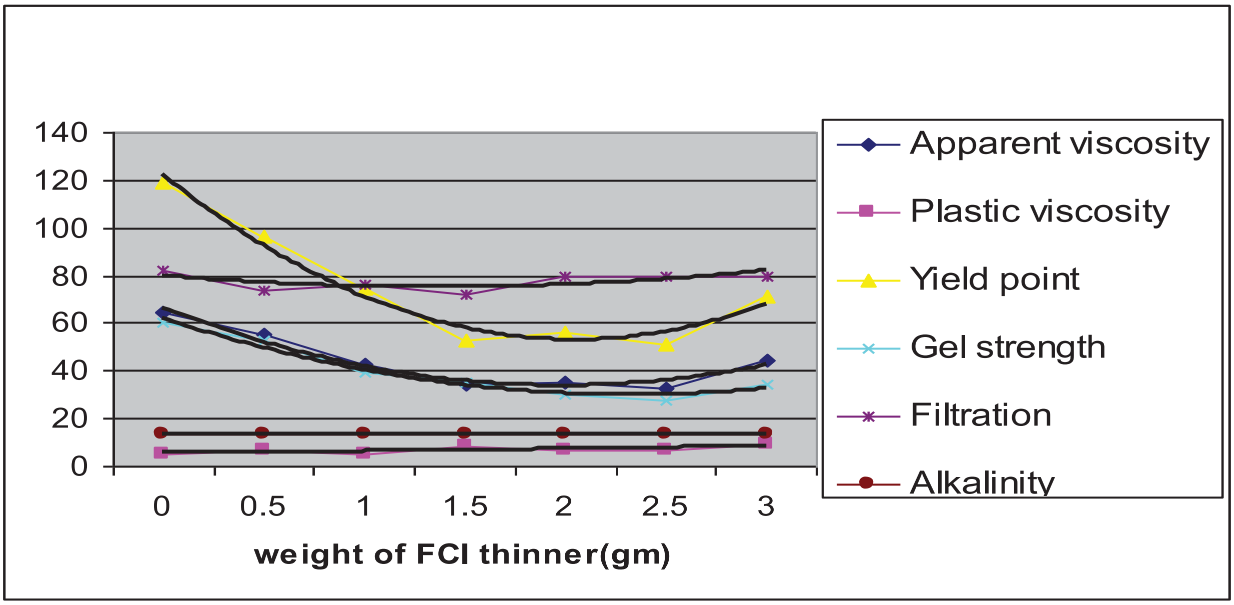

Fig.(5) Effect of FCl thinner on the rheological behavior of lime mud.

B- Local thinner

It is noticed that apparent viscosity, yield point and gel strength decreased clearly to weight 1 gm of the added thinner before they stabilized. The same behavior is concluded with the plastic viscosity before they stabilized between (3-5) C.P while filtration rate values at 1 gm are increased gradually to 100 cm^3\30 Min., before they decreased to be 90 cm^3\30 Min. at the 3 gm., the alkalinity of filtrate is nearly around 13.0.

* The increments in plastic viscosity, yield point and gel strength values are attributed to the flocculation phenomenon.

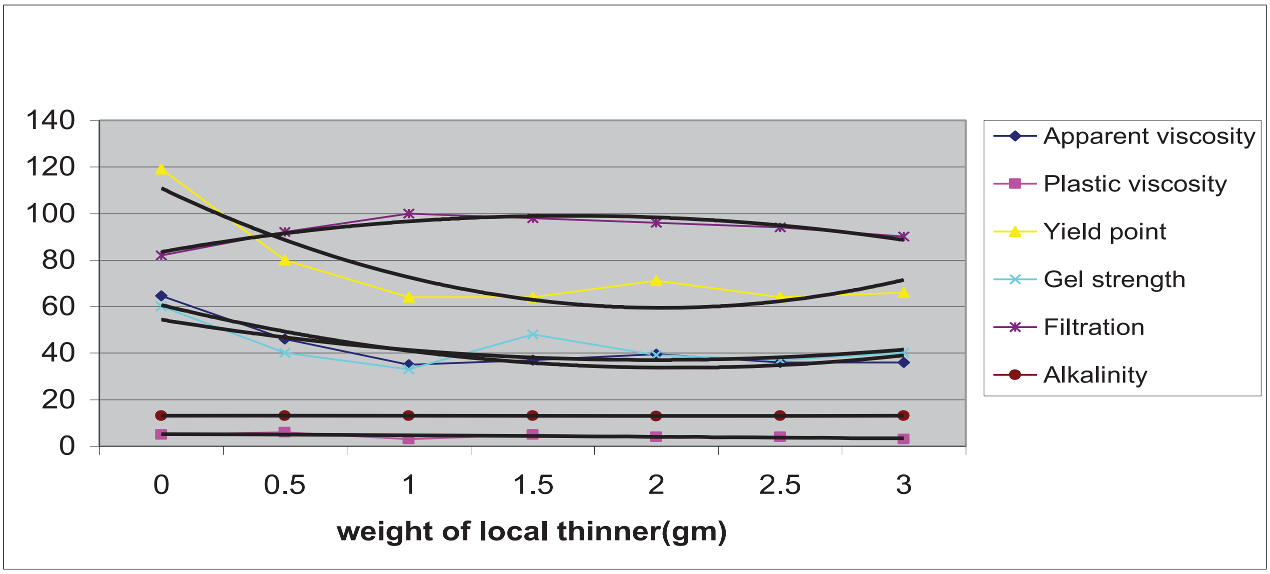

Fig.(6) Effect of local thinner on the rheological behavior of lime mud.

Conclusions

Depending on the results obtained in this study we can conclude the following:-

1-For fresh water mud

There is an identical behavior between the FCl and local thinners to the weight 1gm of the local added thinner before their properties are stabilized. In this type of mud the FCl thinner is better than the local to certain limit.

2- For salt mud

There is an identical behavior between the FCl and local thinners to some degree; the local thinner works properly until to 1.5 gm of the added thinner, while the FCl works to 1 gm only. In this type of mud the local thinner is better than the FCl to certain limit.

3-For lime mud

There is an identical behavior between the FCl and local thinners to 1gm of the local added thinner before their properties are stabilized. In this type of mud the FCl thinner is better than the local to certain limit.

Appendix –A-
(Tables of results)

Table (1)
Effect of FCl thinner on the rheological behavior for fresh water mud

Distilled water, ml	350	350	350	350	350	350	350
Bentonite,gm	22.5	22.5	22.5	22.5	22.5	22.5	22.5
Aged temperature,F^0	**Room temperature**						
Aged time,hrs	24	24	24	24	24	24	24
gm,thinner	0	0.5	1	1.5	2	2.5	3
Mixing time,min	20	20	20	20	20	20	20
R600	63	52	39	36	29	22	21
R300	53	42	30	26	20	14	13
R200	48	37	27	23	16	11	9
R100	42	35	22	17	12	8	6
R6	33	25	14	10	3	3	2
R3	32	25	14	9	3	2	1
10 sec.gel lb/100 ft^2	29	23	15	8	3	2	2
Apparent viscosity,cp	31.5	26	19.5	18	14.5	11	10.5
Plastic viscosity,cp	10	10	9	10	9	8	9
Yield point lb/100 ft^2	43	32	21	16	11	6	4
API filtrate loss(30 min),ml	15.2	13.2	13.2	12.6	11.2	10.8	10.4
PH of filtrate	9.8	9.44	9.35	9.13	8.85	8.53	8.5

Table (2)
Effect of local thinner on the rheological behavior for fresh water mud

Distilled water, ml	350	350	350	350	350	350	350
Bentonite,gm	22.5	22.5	22.5	22.5	22.5	22.5	22.5
Aged temperature,F^0	**Room temperature**						
Aged time,hrs	24	24	24	24	24	24	24
gm,thinner	0	0.5	1	1.5	2	2.5	3
Mixing time,min	20	20	20	20	20	20	20
R600	63	61	60	63	60	62	63
R300	53	51	50	52	50	52	53
R200	48	47	47	49	48	49	49
R100	42	41	41	42	43	43	44
R6	33	33	32	33	32	34	34
R3	32	32	30	32	31	33	33
10 sec.gel lb/100 ft^2	29	31	31	31	31	32	32
Apparent viscosity ,cp	31.5	30.5	30	31.5	30	31	31.5
Plastic viscosity,cp	10	10	10	11	10	10	10
Yield point lb/100 ft^2	43	41	40	41	40	42	43
API filtrate loss(30 min),ml	15.2	14	13.2	13.2	12.4	12	11.6
PH of filtrate	9.8	9.6	9.5	9.16	9.14	9.04	9

Table (3)
Effect of FCl thinner on the rheological behavior for salt water mud

Sea water, ml (4% Nacl)	350	350	350	350	350	350	350
Bentonite,gm	22.5	22.5	22.5	22.5	22.5	22.5	22.5
Aged temperature,F^0	Room temperature						
Aged time,hrs	24	24	24	24	24	24	24
gm,thinner	0	0.5	1	1.5	2	2.5	3
Mixing time,min	20	20	20	20	20	20	20
R600	42	31	32	38	42	42	36
R300	37	27	28	36	37	37	30
R200	36	25	27	35	35	35	28
R100	33	23	25	33	34	34	26
R6	25	19	20	27	27	27	20
R3	20	17	18	22	25	24	19
10 sec.gel lb/100 ft^2	14	11	11	17	19	18	16
Apparent viscosity,cp	21	15.5	16	19	21	21	18
Plastic viscosity,cp	5	4	4	2	5	5	6
Yield point lb/100 ft^2	32	23	24	34	32	32	24
API filtrate loss(30 min),ml	50.4	54	55.6	54.8	48.8	49.2	42.8
PH of filtrate	8.9	8.34	8.34	8.27	7.9	7.87	7.73

Table (4)
Effect of local thinner on the rheological behavior for salt water mud

Sea water, ml (4% Nacl)	350	350	350	350	350	350	350
Bentonite,gm	22.5	22.5	22.5	22.5	22.5	22.5	22.5
Aged temperature,F^0	Room temperature						
Aged time,hrs	24	24	24	24	24	24	24
gm,thinner	0	0.5	1	1.5	2	2.5	3
Mixing time,min	20	20	20	20	20	20	20
R600	42	33	31	31	34	34	34
R300	37	28	28	27	30	29	30
R200	36	27	27	26	28	27	28
R100	33	26	24	24	25	25	26
R6	25	20	19	19	19	19	20
R3	20	18	17	18	18	17	18
10 sec.gel lb/100 ft^2	14	14	14	14	14	12	12
Apparent viscosity,cp	21	16.5	15.5	15.5	17	17	17
Plastic viscosity,cp	5	3	3	4	4	5	4
Yield point lb/100 ft^2	32	25	25	23	26	24	26
API filtrate loss(30 min),ml	50.4	50	47.2	46.4	46	47.6	45.4
PH of filtrate	8.9	8.6	8.75	8.8	8.47	8.14	8.24

Table (5)

Effect of FCl thinner on the rheological behavior for lime mud

Tap water, ml	350	350	350	350	350	350	350
Bentonite,gm	22.5	22.5	22.5	22.5	22.5	22.5	22.5
Aged temperature,C^0	Room temperature						
Aged time,hrs	24	24	24	24	24	24	24
gm,thinner	0	0.5	1	1.5	2	2.5	3
Lime(Cao)gm	5	5	5	5	5	5	5
Mixing time,min	20	20	20	20	20	20	20
R600	129	110	85	69	70	65	89
R300	124	103	80	61	63	58	80
R200	119	99	70	58	61	55	76
R100	111	93	65	54	58	51	70
R6	69	63	59	42	45	40	44
R3	62	54	40	37	36	32	43
10 sec.gel lb/100 ft^2	60	53	39	35	30	28	34
10 min.gel lb/100 ft^2	67	63	40	42	34	30	39
Apparent viscosity,cp	64.5	55	42.5	34.5	35	32.5	44.5
Plastic viscosity,cp	5	7	5	8	7	7	9
Yield point lb/100 ft^2	119	96	75	53	56	51	71
API filtrate loss(30 min),ml	82	74	76	72	80	80	80
PH of filtrate	13.12	13.3	13.2	13.1	13.3	13.3	13.00

Table (6)

Effect of local thinner on the rheological behavior for lime mud

Tap water, ml	350	350	350	350	350	350	350
Bentonite,gm	22.5	22.5	22.5	22.5	22.5	22.5	22.5
Aged temperature,C^0	Room temperature						
Aged time,hrs	24	24	24	24	24	24	24
gm,thinner	0	0.5	1	1.5	2	2.5	3
Lime(Cao)gm	5	5	5	5	5	5	5
Mixing time,min	20	20	20	20	20	20	20
R600	129	92	70	74	79	72	72
R300	124	86	67	69	75	68	69
R200	119	83	66	67	71	67	67
R100	111	79	64	65	67	66	65
R6	69	56	48	55	54	52	52
R3	62	46	39	49	45	44	44
10 sec.gel lb/100 ft^2	60	40	33	48	39	37	40
Apparent viscosity,cp	64.5	46	35	37	39.5	36	36
Plastic viscosity,cp	5	6	3	5	4	4	3
Yield point lb/100 ft^2	119	80	64	64	71	64	66
API filtrate loss(30 min),ml	82	92	100	98	96	94	90
PH of filtrate	13.12	12.97	12.98	13.0	12.88	12.96	12.96

Appendix-B-
(Laboratory tests for local thinner)

1- Detection of real density

Republic Of Iraq
Ministry Of Oil
Petroleum R & D Center

جمهورية العراق
وزارة النفط
مركز البحث والتطوير النفطي

BM TRADA ISO 14001:2004
BM TRADA ISO 9001:2008

العدد: 52 / 3 / 002
التاريخ: 18 / 11 / 2013

الجهة المستفيدة : قسم بحوث الاستخراج
تاريخ استلام النموذج: 17 / 11 / 2013

No.	Test	Results Sample Code Cortex	القيمة اللاتاكدية Cortex	طريقة الفحص	Price ID/test
1	Surface Area (m^2/gm)			ASTM D1993	25,000
2	Pore volume (cm^3/gm)			ASTM D1993	25,000
3	Grain Crushing Strength (N/mm)			ASTM D-4179	45,000
4	Platinum Content (wt %)			By Atomic Absorption	60,000
5	Compacted Bulk density (gm/cm^3)			ASTM B-527 D-4164 & D-4781	15,000
6	Real density (gm/cm^3)	1.3181	± 0.0025	Gas Pycnometry	20,000
7	Porosity (%)			....	15,000
8	Loss on ignition at 900 ^{O}C 1 Hr (wt %)			UOP 412-87, UOP 295-98, ASTM D7348	15,000
9	Adsorption Capacity (%)			*******	35,000
10	Chlorine Content (wt %)			Quantitative Method	15,000
11	Carbon & Coke Content (wt %)			Quantitative Method	25,000
12	Gas Relative Humidity (ppm)			....	10,000
13	Gas Dew Point (^{O}C)			....	10,000
14	Surface Area ** (m^2/gm)			ASTM D5604, ASTM 3663, ASTM D6556, ASTM D1993	45,000
15	Pore volume ** (cm^3/gm)			ASTM B922, ASTM D4365	45,000
16	Pore Size ** (^{O}A)			ASTM D4641	45,000
17	Active Metallic Surface Area ** (m^2/gm)			ASTM D3908	75,000
18	Metal Dispersion ** (wt %)			ASTM D3908	75,000
19	Particle Size by Sieving Analyzer (µm)			....	20,000
	Total Cost				

** يتم الفحص في جهاز الأمتزاز الفيزياوي و الكيمياوي.

Maher B. Antwan
Manager of Refining & Gas Researches Department

Sattar J. Hussein
Section Manager

Marwa N. Abbas
Tester Names:

2- Detection of both cooper and iron ratio in the local thinner by ultra violet test.

Republic Of Iraq
Ministry Of Oil
Petroleum R & D Center

جمهورية العراق
وزارة النفط
مركز البحث والتطوير
النفطي

ISO 14001:2004 — ISO 9001:2008

العدد: 113 /1/ 004
التاريخ: 2013/11/18

الجهة المستفيدة: قسم بحوث الاستخراج
تاريخ استلام النموذج: 2013/11/10
مذكرة رقم ب ت 694 /3/ 005 في 2013/11/10 (مادة عضوية)

NO	Test%	Results				القيمة اللاتاكدية	Method test	Price ID/test
		Sample NO						
		المتبقي						
1	Cu	0.095					UOP 314	35000
2	Ni	Nil					ASTM D1886-77	35000
3	Fe	0.06					ASTM D5392-93	25000
4	FTIR	Chart					ASTM D3921	25000
5								

Kareem Thamer
Chemist incharge

Soaad M.N.Hameed
Dep. Manager

Analyzed by

1-Najwa Saleem
2-Lamya Jaleel
3- Zeena Ibrahim

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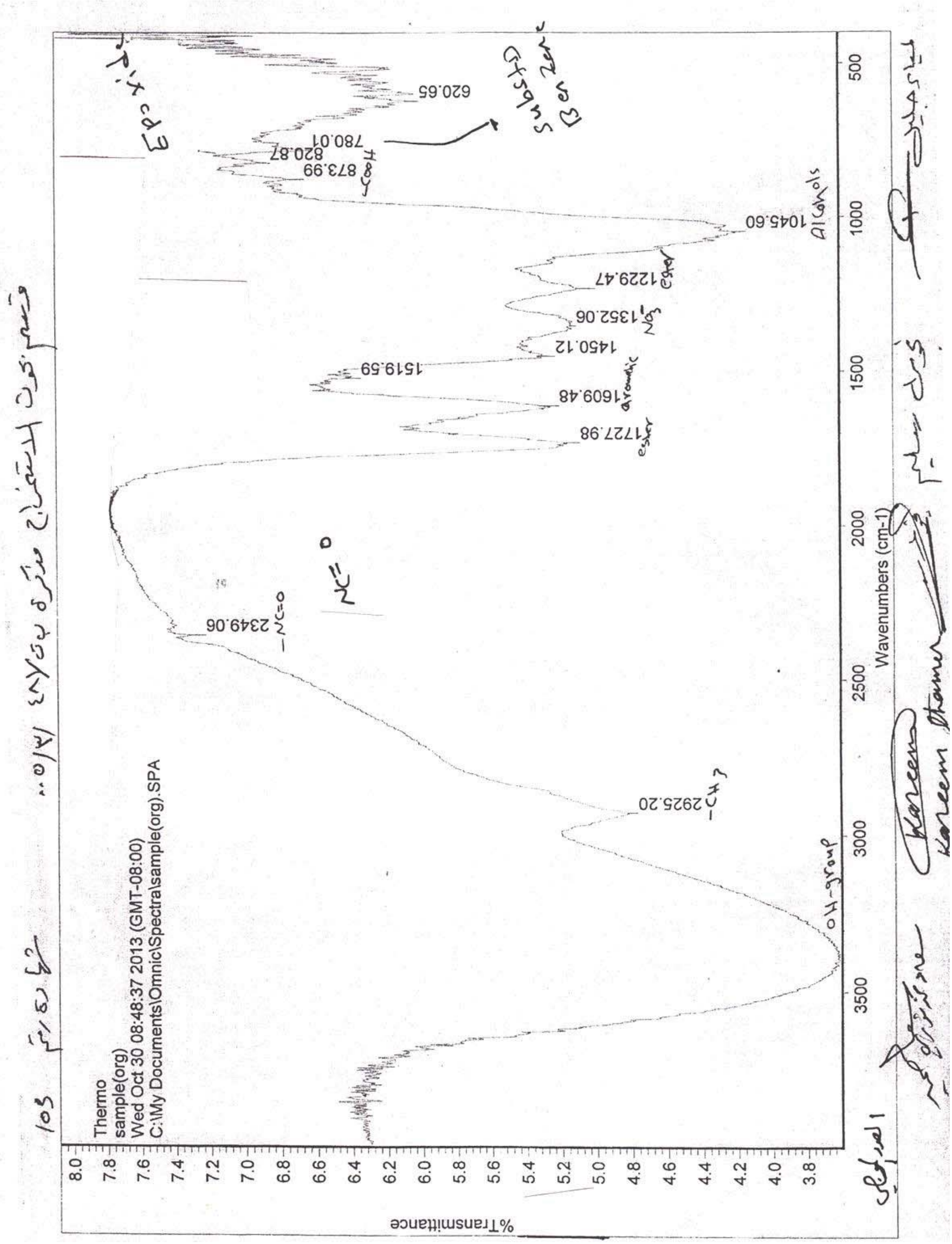
الهاتف : 07901356910 / 07901356921
البريد الالكتروني : prdc2004@yahoo.com

3-Fourier transform infrared test



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