The Tolerance of Lime mud to Effect of Salt From Lower Faris Formation Missan Oil Fields

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Abstract:

In our study we have used several concentration of sodium chloride salts (Nacl) to test a tolerance of lime – treated mud prepared in laboratory in order to predict the conditions and amount of salt that may be occurred when we pass through salt formation or salty – formation as we have in Missan oil fields. We tried to show the effect of salt concentrations and variation of amount of lime on rheological properties of lime treated mud. Many samples were prepared for this goal. The main result of this study was, we can't use this type of mud to drill the interval(lower Faris formation) because of its pressure abnormality, but as an inhibitive acting lime treated mud appeared good properties to drill like this lithology with normal pressure.

Keyword: Missan oil fields, lime – treated mud, sodium chloride salts, tolerance of contaminants, lower Faris formation.

Introduction:

Lime - treated muds were used widely throughout the 1940s', and 1950s'. They were considered to be an inhibitive fluid with a tolerance to such common contaminants such as salt, cement, and anhydrite [1].

The Rheological properties of lime - based muds remain stable even in a high – temperature environment, they can be made with any type of makeup water and easily maintained. The fluid loss by lime treated mud can be maintained at the desired value by additions of CMC also can be treated by other type of materials like IMCO – Loid or IMCORD – 11, and etc. [2]

The solids percent by volume should be maintained within the desired range; otherwise, additions of lime may cause an undue rise in viscosity and / or gel strengths. Additions of fresh bentonite to maintain proper colloidal distribution in the mud system in considered a good drilling practice.

Lime treated muds are considered in good condition when they possess zero initial and zero or near zero 10 minute gels . Viscosity is easily controlled at the desired range with water and / or chemical additions. Lime, treated muds will tolerate salt contamination up to 60.000 PPM. [3]

Calcium is added to a mud to convert sodium clays to calcium clays. This base exchange from a monovalent sodium bonding action to a di -valent calcium bonding cation with its strong bonding force in order to pull clay platelets closer together, As the clay platelets are dehydrated, the adsorbed water from the hydrated clay is emitted. This in effect reduces the size of particles and increases the volume of free water with a corresponding reduction in Viscosity [2 – 4].

Theoretically the higher the soluble calcium carried in the filtrate the more inhibitive. System soluble calcium varies from 120 PPM in a lime mud to 400 to 800 PPM in a calcium chloride mud, and as high as 1200 PPM in a gyp mud. The phenomenon allows more solids to be maintained in the mud system with minimum viscosity and gel strength [5].

Amount of calcium that can be adsorbed depends upon:-

1- Type of clay and its ability to adsorb calcium under any conditions.
2- The amount of soluble calcium presents to react with the clay.

The mount adsorbed will vary with the calcium in solution. The filtrate calcium decreases with increased amount of clay, provided the calcium is not replenished [6].

The magnitude of the viscosity increase, during conversion, depends upon total solids, bentonite content, and previous chemical treatment It is apparent that lower viscosity occurs with lower solids concentration. For this reason, solids should be reduced with water prior to and during the break over. For better and easier conversions, pits should be thoroughly cleaned before converting this eliminates the possibility of picking up and recirculation settled solids.

The soluble calcium in lime muds various between 80 to 200 PPM and is controlled by the P - alkalinity of the filtrate. By raising the PF , the solubility of the calcium is reduced , the higher the PF , the less PPM of calcium can go into solution . Caustic additions thereby limit the lime solubility and serve to give minimum viscosity and gel strengths. If the soluble calcium is not controlled properly high gel strengths may result. Excess lime in the mud must be maintained to replace the calcium absorbed by drilled shale. [4].

Lime - treated muds are considered in good condition when they shower near zero gel strengths, and daily lime additions can be made without gellation. If lime thickness the mud, increasing alkalinity may remedy the trouble. If sufficient lime is present, additional thinner and increased alkalinity will lower high gels.

When drilling with conventional high solid muds, mud properties have much influence on Penetration rates. Variations in viscosity and solids content have a comparatively small effect on Penetration rate.

When drilling in shale, drilling rates may be improved by the use of muds or mud additives that inhibit bit balling. For this purpose lime or calcium lignosalfonate mud helpful because they inhibit the softening of the shale. The compressive stress around hole may be reduced and the stability of the hole increased by increasing the density of the mud. Care must be taken not to raise the density so much that the hole fails in tension, with consequent loss of circulation. Swelling and dispersion of shale have long been inhibited by the use of muds containing lime or gypsum, and thinners-such as tannates or chromelignosulfonates -to offset the Flocculating effect of the calcium ion. Alternatively, chromelignosulfonate is used alone, but in considerably higher concentration. [7-9]

Experimental work:

Lime - treated muds are calcium - treated muds utilizing lime as the source of soluble calcium in the filtrate .As shown in table (1), their composition consists mainly of caustic soda, organic dispersants, lime and a fluid loss control agent, chemical environments vary greatly, with filtrate alkalinities (P -filtrate) between 1 and 15 cc, having lime contents from 1 to 15 lb/bbl.

Two types of lime muds were developed:

(1) Intermediate (Conventional lime). 2 - 5 cc P - Filtrate.

2 - 5 lb/bbl excess lime.

(2) High lime, high alkalinity. 5 - 10 cc P - Filtrate . 5 - 1 5 lb/bbl excess lime.

- The intermediate and high lime muds are more adoptable to areas where salt water flows , anhydrite contamination or fast drilling is encountered, [2]

Table (1): Apparatus and chemical materials that were used in laboratory works.

No.	APPARATUS	CHEMICALS
1	Mixer	Water
2	Mud balance	Bentonite
3	Fann, 35A, viscometer	Barite
4	Sensitive balance	Calcium oxide (CaO)
5	Marsh funnel	Sodium hydroxide (NaOH)
6	pH meter	High viscosity CMC
7	Volumetric cylinder	Sodium Chloride (NaCl)
8	Thermometer	Qubracho

Work conditions and procedures:-

1- Temperature was (25° C)surface conditions .

2-distilled water was used to standardize mud balance.

3. Water density was 8.33 lb/gal., 1 gr/cc , 1.0 sp.gr. 62.4 lb/ft^3

4. Viscometer Fann 35A; was standardized by dist. water (fresh) straight line was reported between shear stress: shear rate.

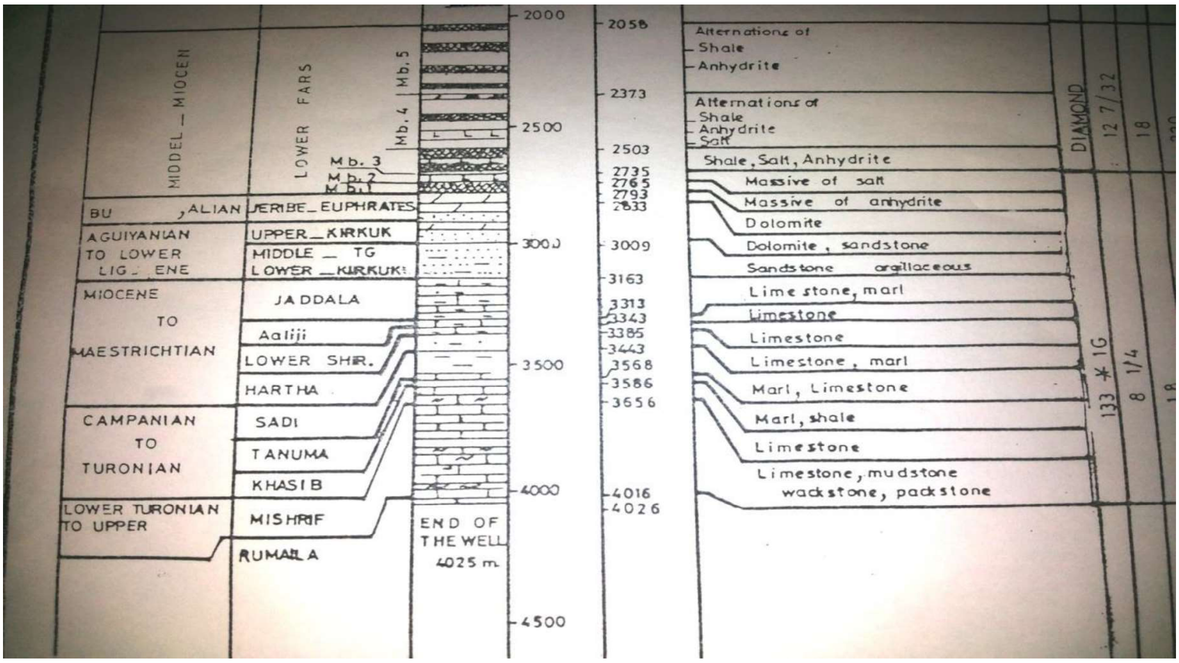
5. The sensitive balance was stabilized.

6. pH meter was checked by fresh water as pH 7.0 at the beginning of each usage.

Results and Discussion:

As shown in fig.1 below the studied area (lower Faris formation, depth:2058 – 2793 m ; its lithology is shale , anhydrite and salt) The drilling of such rock layers must use an inhibitive drilling muds to avoid contamination possibilities, so lime muds or any calcium treated muds consider as very useful if these layers have normal pressure. After reviewing the drilling program for the Missan fields appeared to us that these layers are of abnormal pressure. To drill these formations they use salt saturated drilling mud in order to get the density (2.2 - 2.25 gr/cc).

Fig.(1) lithology of lower Faris formation (Missan oil field).



Many type of Lime muds were prepared to have a density of 12 , 10 and 9 ppg respectively with different amount of lime as shown in table(2). All types were unsuccessful except the last one (9.0 ppg).

Table (2) Rheological properties of samples before the addition of different concentrations of salt.

No.	1	2	3
NaCl, %	0	0	0
Density, ppg	12	10	9
Cao,%	0.57	0.75	0.85
Bentonite ,%	6.9	7.4	7.3
Barite, %	33.5	14.4	4.1
CMC,%	0.57	0.75	0.85
NaOH,%	0.17	0.22	0.26
Cubracho ,%	0.9	1.1	1.3
Marsh Funnel, sec	74	48	37
Φ600/ Φ300	122/69	50/30	24/15
µp	53	20	9
yb	16	10	6
µapp	61	25	12
PH	11.5	11.8	11.8
(initial / 10min.) gel	6/8	4/5	1/2
Solid content, %	42.61	24.62	14.66

The above types of muds were prepared as follows steps.

A. First, water & bentonite is prepared, then the following materials were added, but at stated sequence: NaoH, Qubracho, and CaO .The ratio of these materials is stated in table (2).The Rheological properties of the drilling mud was reported. Then NaCl was added to the prepared liquid in a rate of 1%. Rheological properties were studied & reported in tables (3, 4).

NaCl is added at different values, 1% and more to the third lime drilling mud that was prepared at a density of 9.0 lb/gal. All the cases were successful & gave satisfactory results which were shown in table (3) & figures (2 ,3).

Table (3) composition and rheological properties of 9 ppg lime mud with different add. of (salt %).

No.	1	2	3	4	5	6
NaCl, %	0	1%	2%	3%	4%	5%
Density, ppg	9	9	9	9	9	-
Cao,%	0.85	0.85	0.85	0.85	0.85	-
Bentonite ,%	7.3	7.3	7.3	7.3	7.3	-
Barite, %	4.1	4.1	4.1	4.1	4.1	-
CMC,%	0.85	0.85	0.85	0.85	0.85	-
NaOH,%	0.26	0.26	0.26	0.26	0.26	-
Cubracho ,%	1.3	1.3	1.3	1.3	1.3	-
Φ600/ Φ300	24/15	23/14.5	38/29	66/46	60/46	-
µp	9	8.5	9	20	14	-
yb	6	6	20	26	32	-
µapp	12	11.5	19	33	30	-
PH	11.8	11.8	11.8	11.8	11.8	-
(Initial / 10min.) gel	1/2	8/38	18/73	9/30	7/17	-
Solid content, %	14.	15.66	16.66	17.66	18.66	-

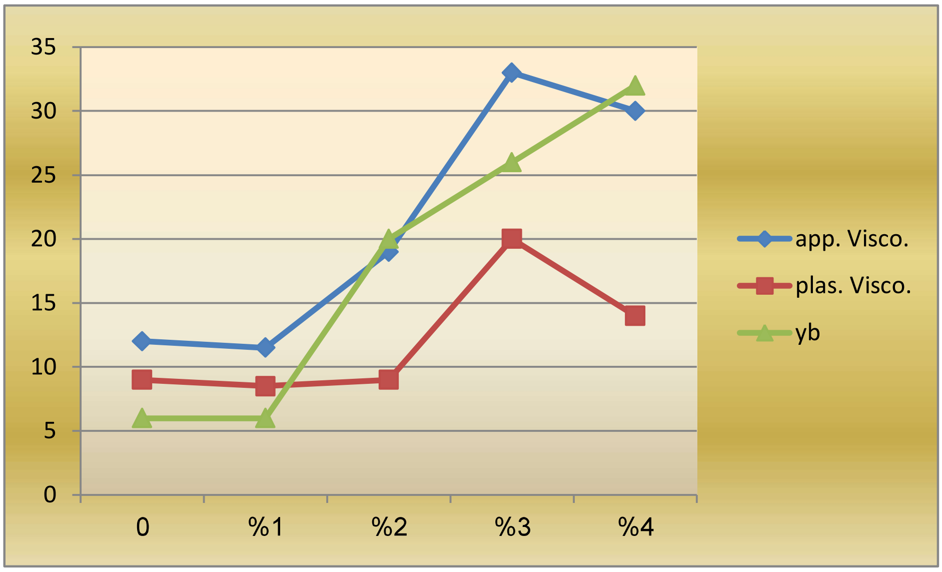


Fig. (2) effect of salt on rheological properties of (9 ppg , 0.85 % CaO) lime muds.

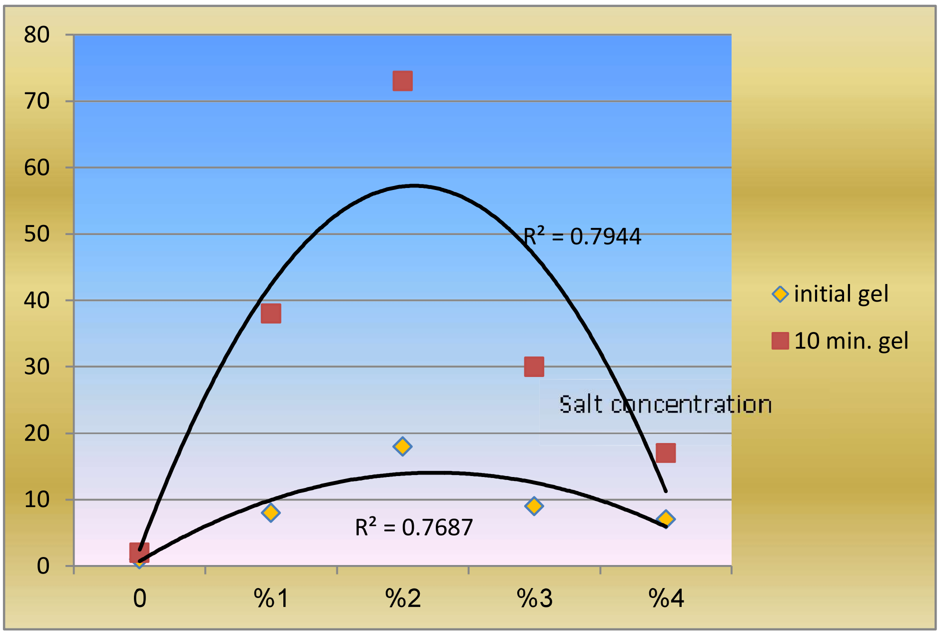


Fig. (3) effect of salt on gel strength of (9 ppg, 0.85 % CaO) lime muds.

These experiments lead us to conclude that a low density (9.0 lb/gal) mud with a high lime is the best mud which can overcome a high concentration (i.e., contamination) of NaCl.

The following experiments were done: prepared three samples of lime treated muds with different concentration of lime 6%, 7% and 8% respectively, and then we test the effect of salt on each type of mud, the rheological properties and gel strength properties tabulated in table 4. Also the results of this tests were shown in fig.(4,5,and 6). As shown in table 4 and figures (4,5 and 6) all these type of muds didn't tolerance amount of salt above 2% because when we added more than 2% of salt the test was failed.

Table (4) Effect of salt on rheological and gel strength properties of different types of lime mud.

No.	1	2	3	4	5	6	7	8	9
Density, ppg	9			9			9		
Cao,%	6%			7%			8%		
Bentonite ,%	7%			7%			7%		
NaCl, %	0%	1%	2%	0%	1%	2%	0%	1%	2%
Φ600/ Φ300	60/37	80/55	112/84	30/18	88/70	110/85	22/13	40/30	48/37
μp	23	25	28	12	18	25	9	10	11
yb	14	30	56	4	52	60	4	20	26
μapp	30	40	56	15	44	55	11	20	24
PH	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2
(Initial / 10 min.) gel	2/3	3/20	4/22	2/32	15/35	30/45	2/9	4/18	5/20
Solid content, %	19.57	20.57	21.57	20.4	21.4	22.4	21.84	22.84	23.84

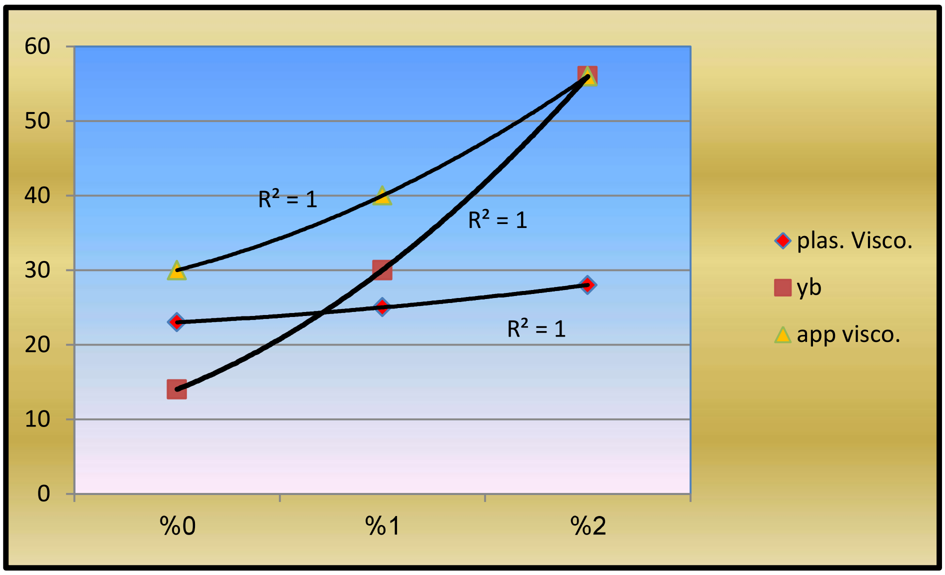


Fig. (4) Effect of salt concentration on rheological properties (9 ppg lime mud with7% Bentonite and 6% CaO).

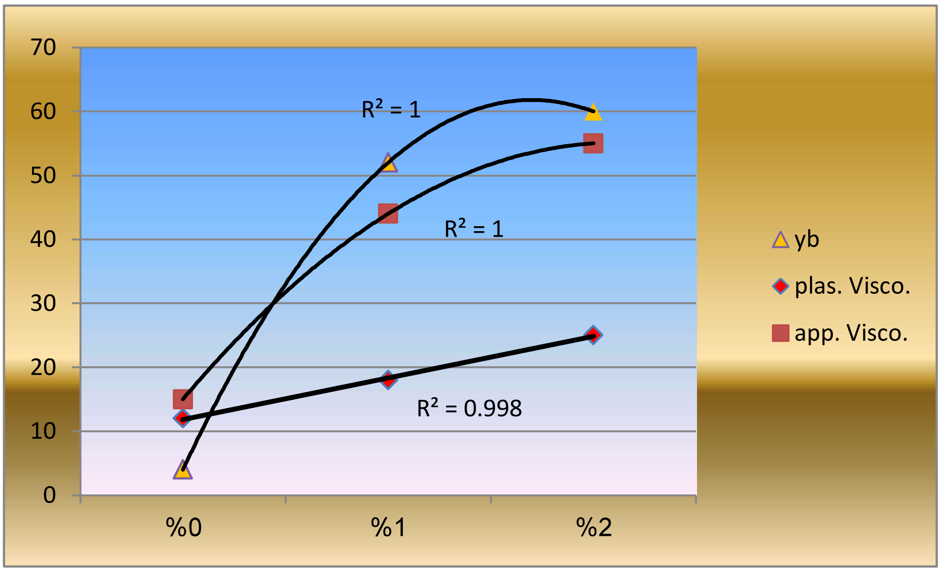


Fig. (5) Effect of salt concentration on rheological properties (9 ppg lime mud with7% Bentonite and 7% CaO).

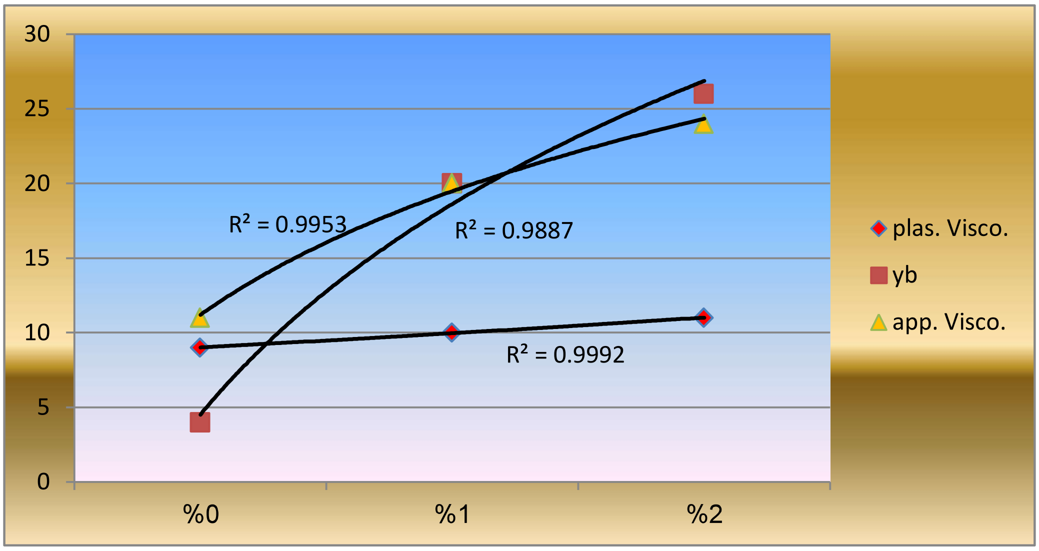


Fig. (6) Effect of salt concentration on rheological properties (9 ppg lime mud with7% Bentonite and 8% CaO).

After that the study of effect of the increasing in both salt and lime concentrations was done, the results were plotted as shown in figs. (7,8 and 9) we can clearly see that all rheological properties were increased with decreasing in lime concentration and in the other hand these properties were increased with increasing of salt concentrations for fixed amount of lime.

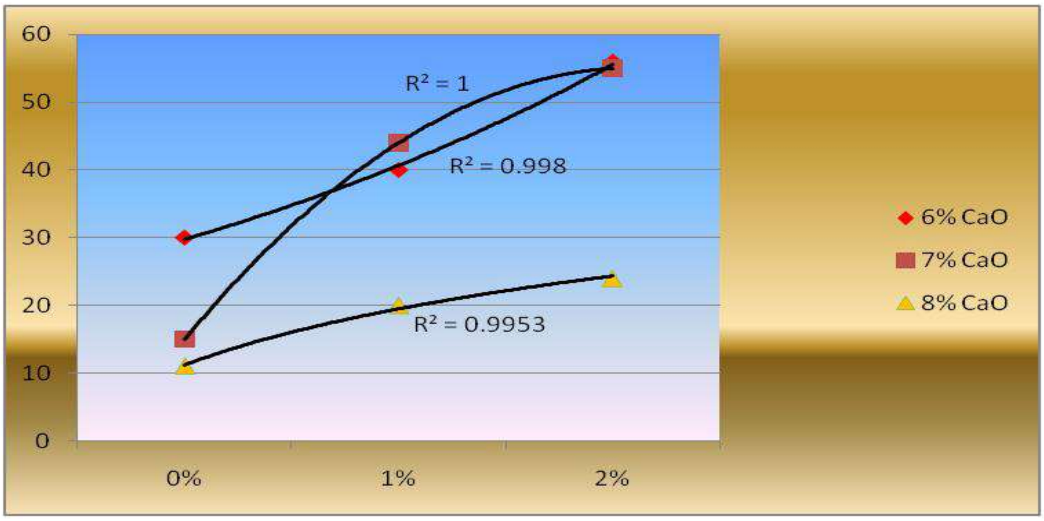


Fig.. (7) Effect of salt on apparent viscosity for different types of 9 ppg, lime muds.

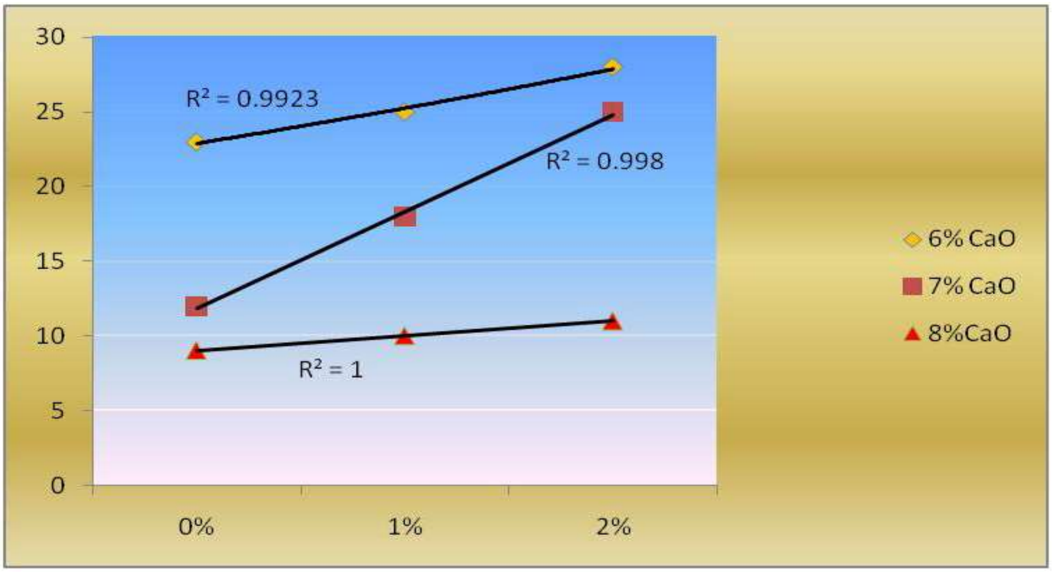


Fig.. (8) Effect of salt on plastic viscosity for different types of 9 ppg , lime muds.

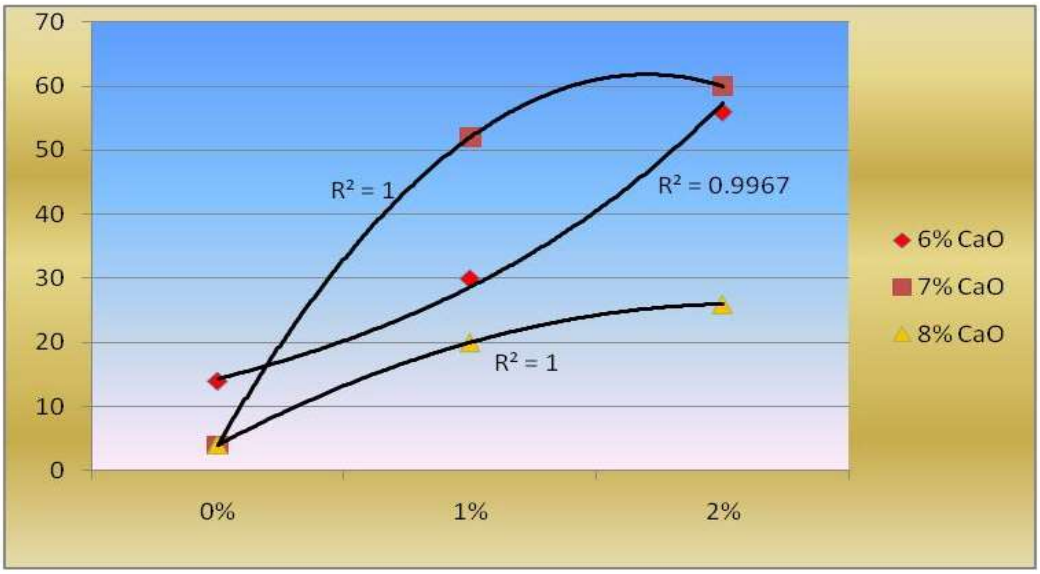


Fig. (9) Effect of salt on yield point for different types of 9 ppg , lime muds.

Also the effect of solid content (increase in density) on rheological properties of 9 ppg lime mud was studied as shown in figure (10), the results of this test showed that increasing in density leads to increasing in all rheological properties for a fixed type of lime mud.

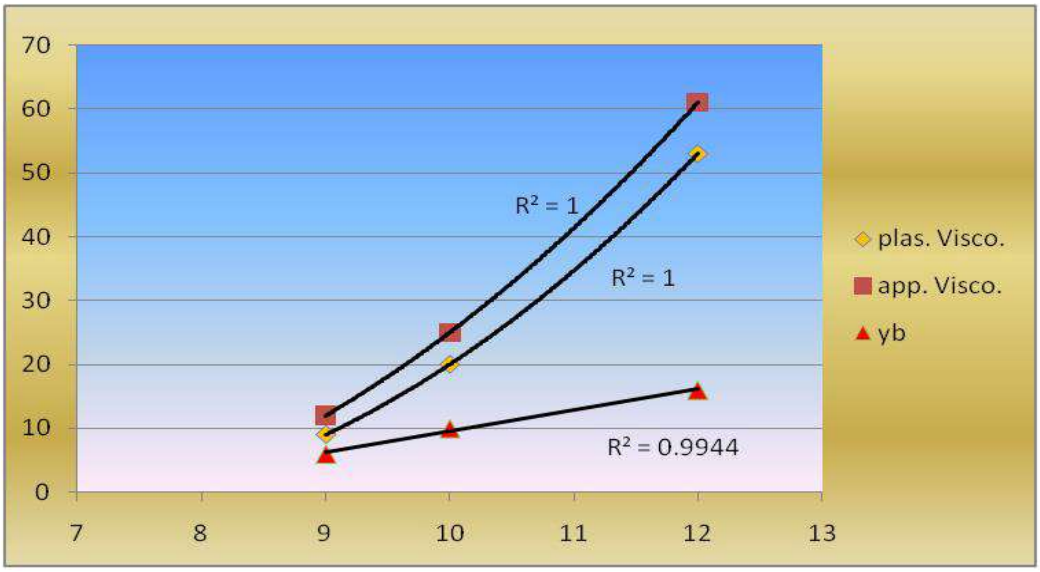


Fig.(10) Effect of solid content (increase in density) on rheological properties of 9 ppg lime mud.

CONCLUSION:

1-Studies of the contaminant NaCl , shows that muds with low lime is very sensitive to NaCl contamination , whether has low or high density

2-Bentonite concentration when changed had great effect on the tolerance of mud to NaCl contaminant, this is due to ion exchange phenomenon , where exchange between the positive ions of bentonite & negative ions of salt.

3-It is of importance that the additives should be at the proper sequence during the preparation of the mud . As well the period of hydration is very important (24 hours). Which have a crucial effect on the experimental results.

4- The results of this test showed that increasing in density leads to increasing in all rheological properties for a fixed type of lime mud.

5-All rheological properties were increased with decreasing in lime concentration and in the other hand these properties were increased with increasing of salt concentrations for fixed amount of lime.

6-These experiments lead us to conclude that a low density (9.0 lb/gal) mud with a high lime is the best mud which can overcome a high concentration (i.e., contamination) of NaCl.

7-Lime treated muds with different concentration of lime 6% , 7% and 8% respectively, all these type of muds didn't tolerance amount of salt above 2%.

8-The main result of this study was, we can't use this type of mud to drill the interval(lower Faris formation) because of it's pressure abnormality, but as an inhibitive acting, lime treated mud appeared good properties to drill like this lithology with normal pressure.

References:

1-Elson J. M. ; Mixon III, A. M. ; Broussard M. D. ; and La Huo, D. R. , “Application of a lime – based drilling fluid in a high temperature / high pressure environment”. SPE drilling engineering (March 1991).

2-IMCO Services, 1977; applied mud technology, 6th Ed.

3-Chilingarian G. V. and Varabutr P.; “Drilling and drilling fluids”, Elsevier Science publishing company, development in petroleum science, 11, (1981)

4-Faleh. H. M. “Contamination of drilling muds in southern Iraqi fields”, a thesis submitted to the college of engineering, university of Baghdad, (August 1998).

5-Darley H. C. H. and George R. Gray, “Composition and properties of drilling and completion fluids”, 5th Ed. Gulf publishing Co., Houston, London, Paris, Tokyo, (1988).

6- Power, D. and Zamora, M. (2003),“Drilling Fluid Yield Stress: Measurement Techniques for Improved Understanding of Critical Drilling Fluid Parameters”, AADE-03-NTCE-35, AADE Technical Conference, Houston, Apr. 1-3.

7- A.T. Bourgoyne Jr., M.E. Chenevert, K.K. Millheim, F.S. Young Jr. Applied Drilling Engineering, SPE Textbook Series, Vol. 2Society of Petroleum Engineers, Richardson, TX (1991).

8- Matthew T. Balhoff and et. al. "Rheological and yield stress measurements of non-Newtonian fluids using a Marsh Funnel", Journal of Petroleum Science and Engineering,june,2011 v.77 pp.393-402.

9- Ahmadi Tehrani, Behaviour of Suspensions and Emulsions in Drilling Fluids. mannual transactions of the nordic rheology society, vol. 15, (2007).