CONTAMINATION OF DRILLING MUDS IN SOUTHERN IRAQI FIELDS

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ABSTRACT

The main aim of this research is to study the effect of contaminants on the behavior of water-based muds using different contaminant concentrations to know the rheological properties of muds under evaluated temperatures.

Five types of water-based muds (Spud mud, FCLS mud, Gypsum mud, Salt-Saturated mud, and Polymer/KCl mud) including five types of contaminants (Green cement, Plug cement, Gypsum Anhydrate, and Salt). 25 samples were tested under a temperature of S.C. to 300°F and 100 psi as a differential pressure to avoid the vaporization of samples.

Most samples were prepared showed a normal trend of rheological properties with test temperatures and concentration used. No thermal flocculation was observed for all drilling fluids except gypsum and FCLS muds. Therefore, both plastic viscosity and yield point decreases gradually as temperature increases.

INTRODUCTION

Mud properties are adversely affected by many conditions encountered during a course of drilling a well.

Contamination is a term used to describe the effects of these adverse conditions, such as drilling through salt domes (NaCl), anhydrite, or gypsum, and drilling-out a cement plug.[2,4,5,6]

Salt contamination is a result of addition of various salts to the drilling fluid during of certain formations, completion, or workover. The commonly encountered soluble salts may be divided into two groups, i.e., monovalent and divalent.

The most common monovalent salts encountered are sodium chloride (NaCl) and, to a lesser extent, potassium chloride (KCl). The most common divalent salts that cause contamination are calcium sulfate ($CaSO_4$), calcium hydroxide *in cement* ($Ca(OH)_2$), and calcium chloride ($CaCl_2$).[7,9]

Divalent salts are introduced into drilling-mud system during the process of drilling through different formations. Calcium sulfate, which exists in nature as gypsum ($CaSO_4.2H_2O$) or anhydrite ($CaSO_4$), is found as thick sections, as stringers, in make-up water, embedded in sand stones, silt stones, and shales, and sometimes as cap-rocks of salt domes. [12,14,15]

Many phases of drilling operations require the use of cement, which is mainly composed of calcium hydroxide. Calcium hydroxide is introduced into the drilling fluid as a result of such operations as squeeze cementing, drilling-out a cement plug, and running casing. The contamination effects of cement are similar to those resulting from contamination which a mono-valent salt. [11,3,8]

EXPERIMENTAL WORK

Twenty-five samples of five types of water-base mud were prepared with different concentrations of contaminants to be tested under different temperatures using the Fann viscometer model 50C. The temperature which used in these tests were, room temperature, 100, 150, 200, 250, and 300°F.

The basic compositions of the muds, which are considered the base, are given below:

1. For fresh water bentonite mud, the basic compositions which used are: 500 cc tab water + 30 ppb bentonite, weighted with barite to 8.72 ppg.
2. For lignosulphonate mud, the basic compositions which used are: 500 cc tab water + 35 ppb bentonite + 2 ppb QBroxine + 0.2 ppb NaOH + 2.1 ppb CMC, weighed with barite to 9.24 ppg.
3. For gypsum mud, the basic compositions which used are: 500 cc tab water + 35 ppb bentonite + 6 ppb gypsum + 0.7 ppb NaOH + 3 ppb QBroxine + 1 ppb CMC, weighted with barite to 9.55 ppg.

4. For polymer mud, the basic compositions which used are: 500 cc tab water + 2 ppb XC + 4 ppb bentonite + 0.1 ppb KOH + 2 ppb CMC, weighted with barite to 8.73 ppg.
5. For salt saturated mud, the basic compositions which used are: 500 cc tab water + 8 ppb bentonite + 120 ppb NaCl + 14 ppb zeogel + 2 ppb QBroxine + 0.5 ppb NaOH + 4 ppb CMC + 0.5 ppb XC, weighted with Barite to 9.82 ppg.

RESULTS AND DISCUSSION

Fig. (1) shows the effect of the concen-tration of green cement on the plastic viscosity, yield point, and apparent viscosity of the polymer/KCl mud. The effect of the green cement is clearly indicated that as green-cement concentration increases, all the rheological properties increase at certain temperature. This is due to the bridging flocculation caused by the present of bentonite in the base mud, and the cation (K, Ca) affect the swelling of clay particles. Also, increase the friction forces between particles due to the increase of solids percentages resulting in an increase in plastic viscosity.

The effect of temperature on the rheological properties of different green cement concen-trations is shown in fig. (2). The rheological properties decrease a temperature increases. Increasing temperature cause a decrease in viscosity of the continuous phase of polymer muds.

Fig. (3) is clear indication of the effect of gypsum on the salt –saturated mud rheology. It showed that, as the concentration of gypsum increases there is an increase in the rheological values as a result of electrolyte flocculation.

In fig. (4), it can be seen clearly that all rheological properties decrease as temperature increases. Viscosity of the continuous phase decreases as a result of increasing temperature, which result in the reduction of plastic viscosity values through decreasing the friction forces between particles in the sample. Also increasing temperature causes decreasing in the attraction forces between particles causing a reduction in interaction between the materials, which result in the reduction of yield point.

As interesting series of experiments are illustrated in Fig. (5). It showed that the additional os different concentrations of NaCl on the gypsum mud caused an increase in all rheological properties, viscosity increases as a result of base exchange (Na for any Ca cation present).

Fig. (6) showed that, gypsum mud behavior is similar to another types of water-base mud, in which all rheological properties decrease as a result of increasing in temperature due to the same reasons, which are discussed above.

At certain temperature, the effect of plug-cement on the, as FCLS mud rheology is clearly indicated that, as contaminant concentrations increases both the apparent viscosity and yield point increase, while the plastic viscosity slightly increases. This is due to the salts dissociation in water into two groups of cations and anions. As shown in Fig. (7).

Fig. (8) shows the effect of temperature on FCLS mud, temperature greater that 200°F lead to high gelation because of electrolyte presence in mud which causes an increase in solidification at high temperature.

Fig. (9) shows that, spud mud appears to be highly affected by contamination, because the base mud is prepared without any pretreatment materials. The increasing in anhydrite concentration cause an increase in all rheological properties, due to the electrolyte effect. These electrolytes cause an increase in attractive forces between planner faces of clay platelets.

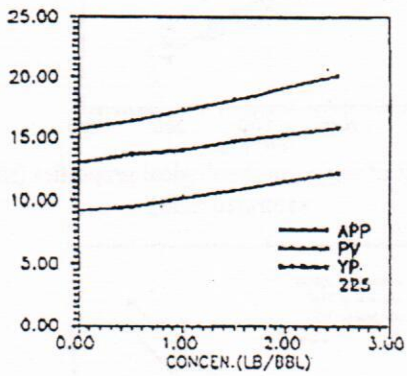

Fig. (1) Effect of green-cement rheological properties (polymer/KCl)

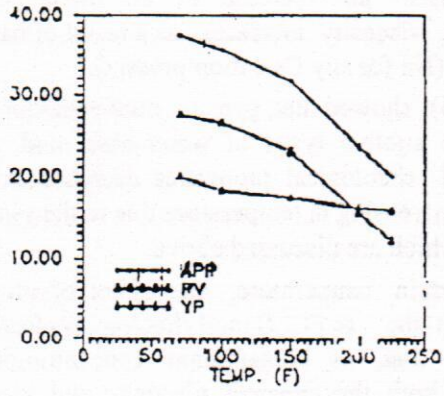

Fig. (2) Effect of temp. on rheological properties (polymer/KCl)

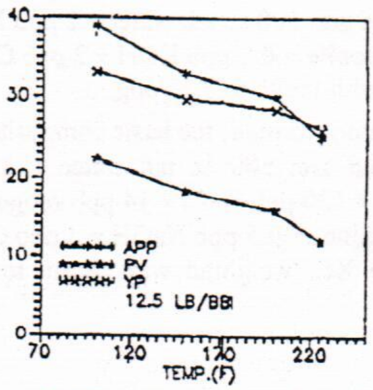

Fig. (6) Effect of mud on rheological properties (gypsum mud)

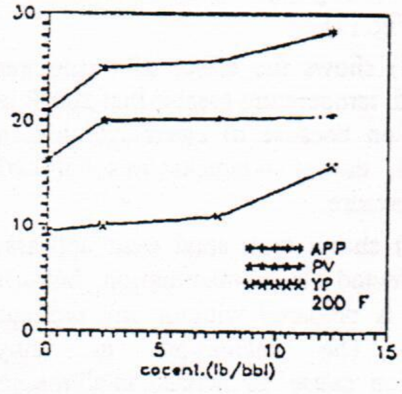

Fig. (3) Effect of gypsum on rheological properties (salt-saturated mud)

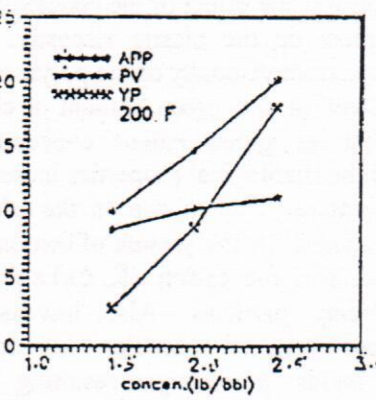

Fig. (7) Effect of plug-cement on rheological properties (FCLS mud)

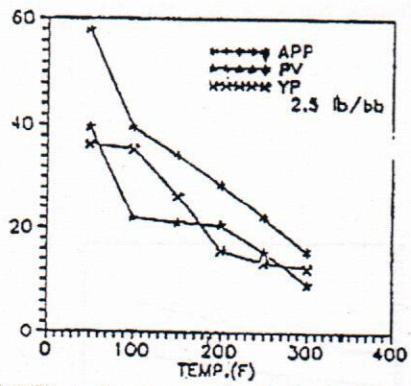

Fig. (4) Effect of temp. on rheological properties (salt-saturated mud)

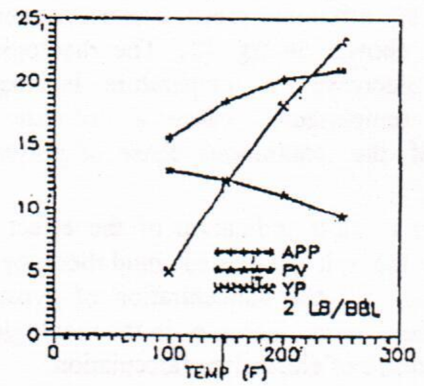

Fig. (8) Effect of temp. on rheological properties (FCLS mud)

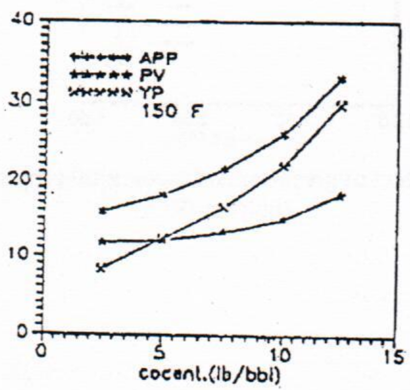

Fig. (5) Effect of NaCl on rheological properties (gypsum mud)

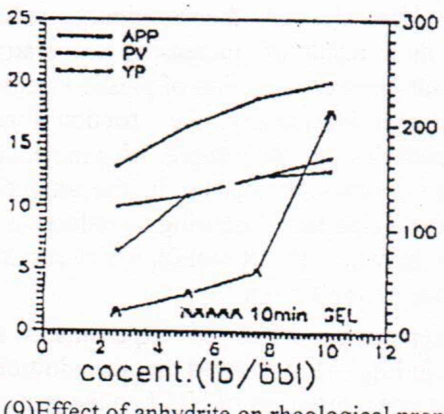

Fig. (9)Effect of anhydrite on rheological properties (spud mud)

CONCLUSIONS

The following conclusions were drawn from this work:

1. Spud mud is highly affected by the contaminants compared with other types of water-based mud.
2. Cement contamination of FCLS mud has high effect on gel strength more than the rest of the other rheological properties.
3. The thermal stability of gypsum mud decrease in the present in the presence of contaminants.
4. The addition of 0.5 lb/bbl XC-Polymer improves the rheological properties of salt-saturated mud.
5. In spite of the presence of other contaminants, the polymer/KCl mud hos more thermal stability than other types of water-based mud.
6. Salt saturated and polymer/KCl mud showed more contamination tolerance than other tested types of mud at elevated temperatures.

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