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XC Polymers in Drilling Mud

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ABSTRACT

Due to the progress of science, especially drilling mud technology and a high amount of costs that are spent on them, controlling the fluidity properties of drilling muds and optimizing them is essential. Properties of conventional muds in deep wells under high temperature and high pressure are changed and mud couldn't implement its main duty of carrying drilled materials. For correcting these properties different ways are utilized. One of these methods is using polymers in drilling muds. In this research, the effect of an XC polymer on rheological and physical properties of mud was investigated.

Keywords: drilling fluid, formation damage, XC polymer, optimizing drilling mud

1. INTRODUCTION

Recognizing filter cake properties for the right choice of drilling fluids, which decreases bore difficulties like formation damage is very essential. Correctly knowing the properties of filter cake provides the effective management of the hydrocarbon producing process.

This research aims to practically investigate the effect of different concentrations of XC polymer on filter cake properties, materials destroyed due to filtering, and formation damage for choosing optimum concentration of XC polymer. High-pressure high-temperature (HPHT) filter, which was compressed by a ceramic plate was used for flow direction in this study. Seven samples of water-based drillings were used. These filter cake chemical compounds were investigated by scanning electron microscope (SEM) descriptor.

The results show that the optimum concentration of XC polymer in this study was 1.0 Lb/bbl (1 g/350 ml). Also, it was observed that 1.0 g XC polymer per 350ml of the drilling fluid is suitable for the proper application of the optimum material deformation. If more than 2.0 g of XC polymer is added, the fluid loses its properties and becomes almost motionless. Therefore, 1.0 g concentration of XC polymer causes less diffusion reduction of ceramic plate. At these concentrations, less reduction in ceramic plate diffusion and sound filter cake properties were observed. Besides, it's an identifier for fewer formation damages at this concentration of XC polymer. This research intends to collect keywords and required concepts based on the series for a more tangible understanding of the subject. These will be examined in the following sections.

2. DRILLING FLUID

The drilling fluid can be defined as any fluid that rotates into the well during the drilling operation and after passing through the drill string and drill bit through the annular space, it returns to the surface. In (**Table 1**) the path of the drilling mud can be seen.

Mud pumps are the starting point of the mud circulation, and the necessary power and force of these pumps are provided by the motors. In electric derricks, internal combustion engines produce direct electrical current using the energy of fuels such as diesel fuel. After passing through the … unit this current becomes alternating current and is available to the pump. It provides the necessary force for pumping operations. The type of drilling mud pumps is of positive displacement pumps. These pumps are capable of producing up to 5000 pam of pressure. Choosing the right size piston and liner, and correct size drill bit nozzle plays an essential role in optimizing the hydraulic system of drilling fluid, supply pressure, and discharge flow rate from the pam and improves the efficiency of the drilling operation.

3. FORMATION DAMAGE

Formation damage is a general term related to the permeability disturbance in oil containing formations, which can occur in hydrocarbon reservoirs during different stages of oil and gas extraction. In recent decades the use of hydrocarbon fuels as a suitable fuel, with the ability to provide sufficient energy, has been vastly increased in the oil, gas, and petrochemical industries. To achieve the optimal production of hydrocarbons, it is necessary to reduce the formation damage. The focus of this book is to provide sufficient knowledge to know relevant processes by laboratory analysis and site tests, development of mathematical theories and expressions to describe the mechanisms and basic processes plus mathematical modeling and bringing numerical solutions to develop simulators and computer executions, predicting and simulating succession, and dependencies of different types of formation damage process that can be faced in hydrocarbon reservoirs. Optimization is done for preventing or reducing the formation damage probability of the reservoir and eventually, for developing methods and strategies to control and repair the formation damage.

4. MUD

Mud refers to a combination of water and clay, which is used in drilling systems for carrying the drilled materials to the earth's crust. Besides the removal of the ground chips, drilling mud is used for other applications at the bottom of wells, including cooling and lubricating drill bit. The reason for using drilling mud instead of water is due to the high extent of specific weight in drilled stone chunks. Although mud (due to its high speed) brings drilled chunks to the upside, the viscosity of the mud should be such that it can easily and swiftly remove the gravels from the well.

The mud pulls the gravels out of the well and directs them out into a special filter that looks like a sieve. There, the mud itself can pass through the filter, but the gravels remain on the filter, and the mud is collected in a reservoir and then again pumps back into the drilling string. Thus, the constant flow of mud from the rotating bowl continues into the drilling string and bit head and from there to the space between the drilling string and the well and up to the reservoir filter.

Drilling mud causes the drilling mud column to push against the wall of the well and prevent it from falling. Moreover, it plasters the body of the well and works as a barrier of holes. Also, when the drill reaches the gas or oil layer in large actions (oil and gas drillings) the mud column prevents gas or oil from penetrating the pores of the layer (which may also have high pressure) and finding a way to the upside the well. Therefore, the concentration and weight of drilling mud should be more than the weight of water, and also it must be as much that it can neutralize the pressure of the porous layer.

5. XC-POLYMER

Polymers are used in the exploration of oil resources, along with drilling fluids. For this purpose, XC polymers which are high-molecular-weight polysaccharides are used to create viscosity in water-based mud (ordinary and saline water). These materials are controlled and prepared by bacterial growth in a fermentation environment (without using colloidal materials, such as bentonite) plays an important role in creating fluid properties such as viscosity, inversion point, and jelly structure in saline waters. These materials are not applicable at temperatures above 250 °F. To prevent them from dissolving, anti-fermentation agents like paraformaldehyde is used.

6. DISCUSSION AND CONCLUSION OF FILTER CAKE THICKNESS

The thickness of the filter cake on the ceramic was measured after completing the HPHT filtration test (T = 212° *F&P*=200*psi*). The results of thicknesses in drilling fluid filter cake are presented in (**Table 1**). According to Table 1, there are variations in the thickness of the drilling fluid filter cake due to the difference in the concentration of XC polymer. Thickness was measured in the range of 0.102 to 0.186 in. According to (**Fig. 1**), it was observed that increasing XC polymer reduces the thickness of the drilling fluid filter cake.

Drilling fluid with an XC polymer concentration of 3.0 g, has a little thickness. At this concentration, the drilling mud loses its properties and becomes almost motionless and very thin. The shape of the filter cake thickness shows the drilling fluid sample obtained from the filtration loss test. The filter cake is measured using a laser and criterion index components [13].

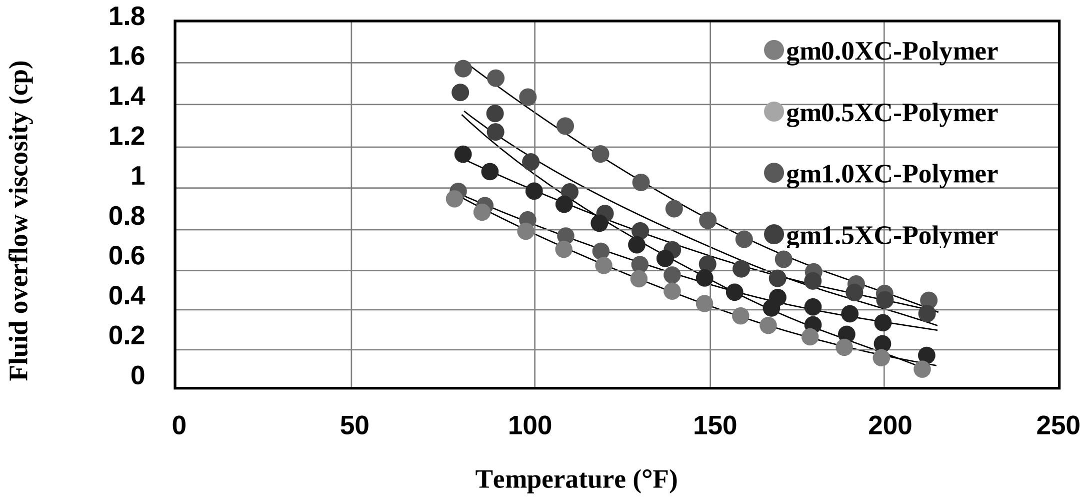

Fig. 1. Overflow viscosity variation by temperature

Table 1. Filter cake thickness h_c (different concentrations of XC polymer)

Fluid source	**Ceramic plate thickness (mm)**	**Ceramic plate thickness + mud layer (mm)**	**Cake filter thickness (mm)**	**Cake filter thickness (1.32 in)**
Sample 1	6.35	11.075	4.725	3.75
Sample 2	6.35	10.150	3.800	3.05
Sample 3	6.35	9.480	3.130	2.49
Sample 4	6.35	9.470	3.120	2.48
Sample 5	6.35	9.450	3.100	2.46
Sample 6	6.35	9.380	3.03	2.41
Sample 7	6.35	8.950	2.60	2.06

Fig. 2. SEM analysis of filter cake, sample 1(0.0 g of XC polymer)

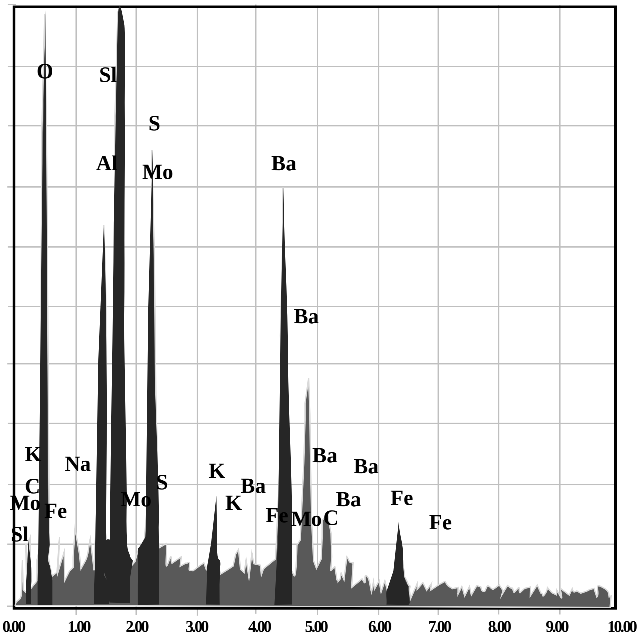

Fig. 3. SEM analysis of filter cake, sample 5 (2.0 g of XC polymer)

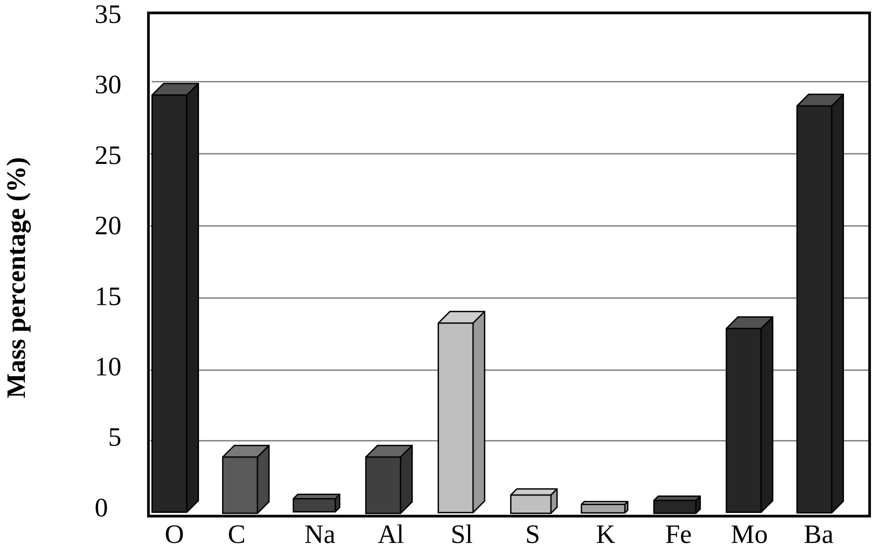

Fig. 4. Filter cake chemical composition using SEM, sample 5 (2.0 g of XC polymer)

7. Determining the amount of porosity

Filter cake porosity: the porosity of drilling fluid filter cake was measured. (**Table 2**) illustrates the porosity of the drilling fluid filter cake with different concentrations of xanthan gum (0.0, 0.5, 1.0, 1.5, 2.0, 2.5, and 3.0 g). Convert et al. [15] introduced a method for measuring filter cake porosity. The results show that the porosity extent of drilling fluid filter cake is between 0.813-0.866. A slight decrease in the porosity of the filter cake with an increase in the concentration of XC polymer was observed as well.

8. Steps of measuring the porosity extent of the filter cake

The following steps were performed for measuring the filter cake porosity:

1) The dry and wet weight of ceramic plate was measured using a balance having a high-sensitivity resolution of balance i.e. 0.01 G.
2) After completing the fluid loss test, the filter cake was removed directly from the cell.
3) The wet weight of the ceramic plate mixture and filter cake (100% was considered by a saturated filter) was measured.
4) The wet ceramic plate weight was deduced to obtain the total weight of the filter cake.
5) The layer was dried at 200 °F for 24 hours to lose all its water.
6) The weight of the ceramic plate combination and the dried filter cake was measured.
7) The dry filter cake weight was deduced to obtain the total dry weight of the filter cake.

Table 2. Filter cake porosity φc (different concentrations of XC polymer)

Fluid source	**Dry ceramic plate weight g**	**Wet ceramic plate weight g**	**CD and MCG wet weight**	**MCG Total wet weight**	**CD and MCG dry weight**	**MCG Total Dry weight**	**Average density of grain ρ_G P_gg/cc**	**Porosity φ_c**
Sample 1	40.369	47.133	63.300	16.167	45.614	5.245	2.09	0.866
Sample 2	39.537	46.387	59.200	12.903	43.281	3.744	2.50	0.859
Sample 3	38.516	45.156	57.190	12.034	41.999	3.483	2.37	0.853
Sample 4	39.01	45.822	57.570	11.748	42.594	3.584	2.12	0.828
Sample 5	39.876	46.508	56.634	10.126	43.027	3.151	2.14	0.826
Sample 6	39.306	46.050	55.945	9.895	42.362	3.056	2.01	0.818
Sample 7	40.694	47.215	56.452	9.237	43.456	2.762	1.85	0.813

Table 3. Change in the ceramic plate porosity

fluid source	**Dry sample weight W^0_d**	**Saturation sample weight W^0_s**	**Porosity volume (V_p)**	**Final porosity (%)**
Sample 1	40.474	46.990	6.516	32
Sample 2	39.688	46.398	6.7100	33
Sample 3	38.662	45.536	6.874	34
Sample 4	39.146	45.710	6.564	32.64
Sample 5	39.994	46.655	6.661	33
Sample 6	39.726	46.358	6.632	32.97
Sample 7	40.889	47.542	6.653	33

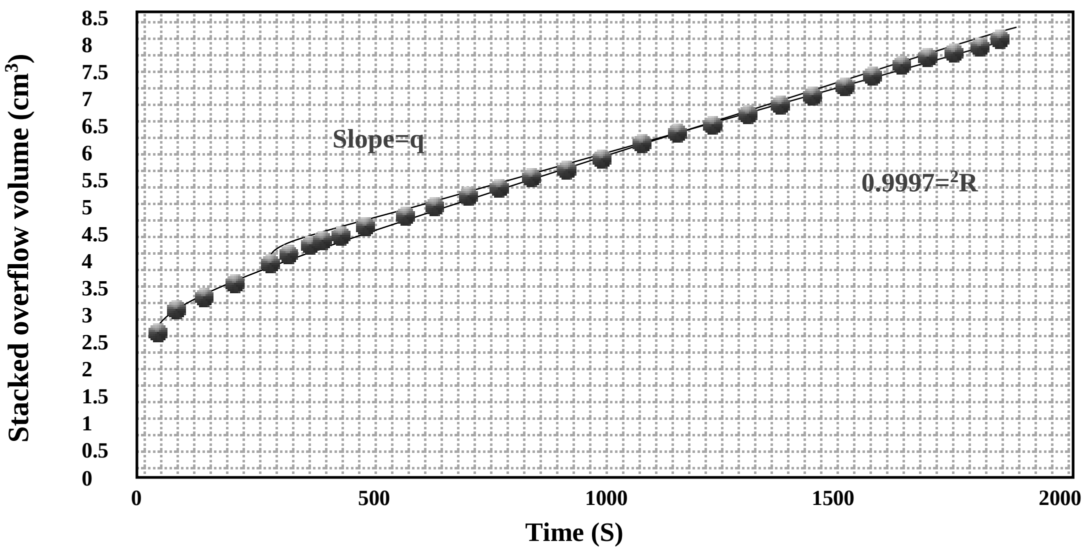

Fig. 5. Filter cake diffusion using Li et al. [16] method (0.0 g XC polymer)

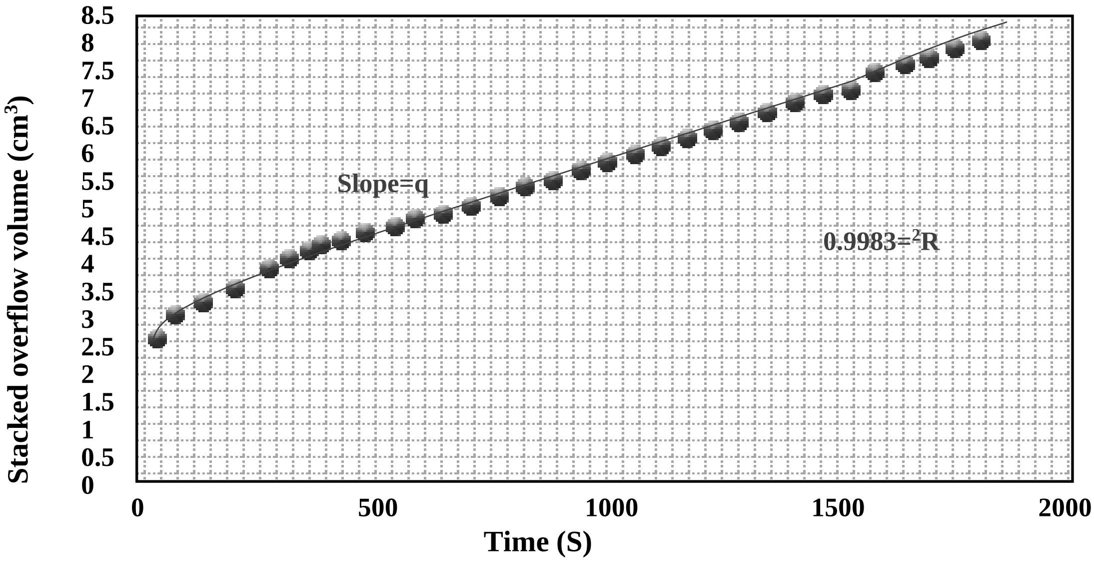

Fig. 6. Filter cake diffusion using Li et al. [16] method (0.5 g of XC polymer)

In this dissertation, seven samples of water-based drilling fluid with the same composition and different concentrations of XC polymer enhancers were prepared and analyzed to choose the optimum concentration of XC polymer and measuring filter cake indexes. According to the results, one can conclude:

1) Increasing the XC polymer extent enhances the deformation characteristics of the drilling fluid.
2) SEM analysis provides a proper way to study the structure and morphology of filter cake. Further, it allows us to know the average value of the filter cake chemical structures.

3) The thickness of the drilling fluid cake decreases with increasing XC polymer.
4) Enhancing the concentration of XC polymer slightly decreases the amount of porosity and permeability.
5)

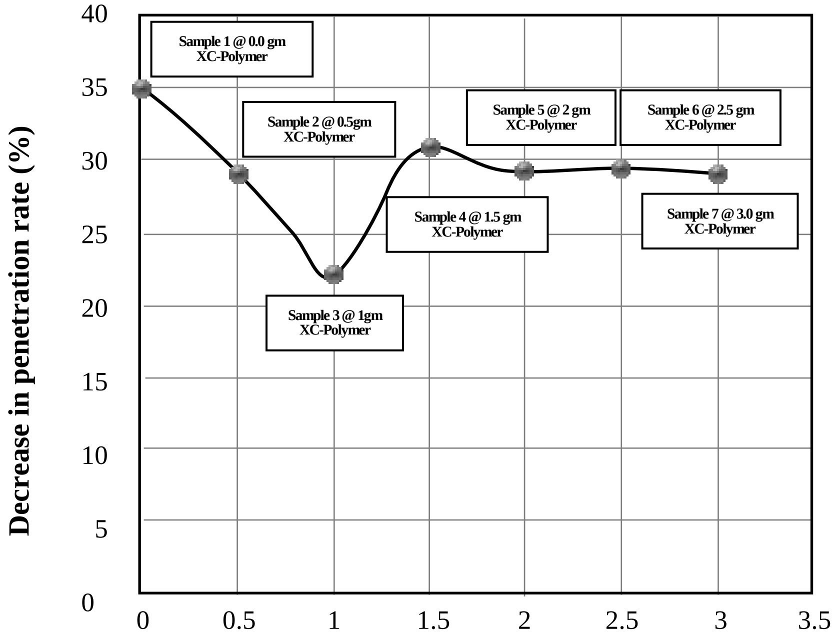

Fig. 7. Effect of XC polymer concentration on the reduction of permeability.

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