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Preventing the Loss, Improving the Properties of the Circulating Material to Seal Fractures and a Depleted Section of the Well

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Abstract: The loss of circulation is an extremely unhealthy phenomenon for drilling, as the liquid solution leaving in the reservoir often leaves the entire drilled breed in the borehole and, in most cases, all the large particles in the solution itself. The settling masses are compacted and can create around the drill tool dense shell and also cause so-called clamp tool-a phenomenon when to remove the drill pipe poses great difficulties. The methods devise in the current research for loss of circulation or eliminated are a reduction of mud density until its hydrostatic pressure becomes equal to the reservoir and Pumping Mudpack with a high concentration of clogging additives in the absorption zone. In addition, the clogging materials to combat the loss of circulation can be used as additives in circulating drilling mud in the drilling of sediment prone to absorption. For the control of absorption, it is possible to use saw dust, flaky and granulated materials or a mixture of all three [1-6]. The flaky materials include cellophane, mica, the husk of sunflower seeds cotton, nut shells. The granulated materials include grinding rubber or asbestos, asphalt. This method differs from other methods in that in order to prevent the loss of the drilling solution to the composition of the chemical compound can be improved by increasing the agent's viscosity in cracks or pores clogging. A series of experiments was conducted to determine the optimal viscosity of the agent, consisting of urea formaldehyde with ammonium sulfate and bentonite. Ammonium sulfate is added to urea formaldehyde in the ratio of 1/5. In a series of experiments, the ratio of chemicals was increased properly. Measurement of solution viscosity was performed by rheometer up to 500MPa. Since there are errors in Rheometer after 500MPA, the measurement of viscosity began by hand with the help of 200ml of the test tube, weights and steel ball. The obtained results satisfied the requirement for the loss of the chemical of drilling mud. Thus, on the basis of the experiments, it was found that to prevent the loss of the drilling solution to improve the composition of the chemical compound by increasing the viscosity of the agent. This will save the amount of mud and expensive additives save time for drilling and prevent clogging of potentially productive drilling areas.

Keywords: Urea Formaldehyde, Sand Pack, Lost Circulation Material, Depleted Zones, Fracture Sealing

1. Introduction

As conventional reservoirs have been depleted, the oil industry starts seeking deeper environments that are more challenging. These environments are associated with loss of circulation (LC) which costs the industry nearly a billion dollars a year [7]. The loss mechanisms differ for each candidate formation. On one hand, drilling fluid losses into natural fractures, cavernous, vugular, and high permeability formation are triggered as soon as the drilling fluid pressure exceeds the pore pressure. On the other hand, losses into induced fractures are initiated when the drilling fluid pressure exceeds the fracture pressure [6-8]. Designing a cost-effective drilling fluid is, without a doubt, of primal importance. Investment in drilling fluids can sometimes be very significant, especially when partial or complete fluid losses are encountered while drilling. Drilling through cavernous and highly fractured, naturally and sometimes induced, formations could be challenging if the lost circulation material is not properly designed. Lost circulation materials can be classified as fibers, flakes, granular material, or a mixture of all three. [9-14] The materials are needed to stop fluid losses in order to drill ahead. These materials, which come in different forms and have different chemistries, should provide the proper seal to problematic thief zones. The materials ought to block openings within the matrix itself and provide bridging capability between the different fluid flow channels that could exist outside the matrix in open cracks and caverns. [5, 8, 15] Most of the lost circulation materials tested by the local oil company and the industry have limited capability of blocking pore-throat openings (in the case of clastics) and open cracks and fractures (in the case of carbonates). A lost circulation material that is placed in the wellbore should be timed to react, block fractures, and bridge to provide a perfect seal. The seal could be temporary or even permanent. Permanent seals are often pumped to block thief zones in non-producing formations. The temporary seals are placed in hydrocarbon-bearing zones that have been encountered while drilling. In the oil industry, most of the conventional LCMs have been tested with different degrees of success. Lost circulation materials in the form of fibers, flakes, granular material and a mixture of all three have proved to be effective in some instances. The tendency, however, has moved towards using polymeric materials.

LC is defined as losing some drilling mud into the formation, thief zone, and classified based on the LC severity, barrels per hour, as 1) seepage (<10bbl/hr), 2) partial (10-50 bbl/hr), 3) severe (>90bbl/hr), 4) total losses (no returns). However, this classification does not explain the mechanisms at which losses occur; resulting in appropriate treatments. [3, 9, 16-22] By identifying the loss severity, proper remedial action takes place to mitigate or stop the losses. Seepage and partial losses are often cured using conventional lost circulation materials; however, when it comes to severe or total losses, special treatments are used.

Table 1. *Lost cicualtion.*

Seepage Losses	Partial Losses	Severe Losses	Total Losses
<10bbl/hr	>50bbl/hr	>90bbl/hr	No returns
Porous and permeable sand, gravel, shell beds	Small open fractures	A large section of unconsolidated sands or fractures	Cavernous/large fractures

In addition, the rate of loss in a producing zone is of greater concern than the small loss in a non-productive zone because formation damage can reduce overall productivity and recovery.

2. Methodology

There are two methods of LCM experiment:

Experimental chemical reagents, including ammonium sulfate, urea formaldehyde, and bentonite, have been shown to be highly effective.

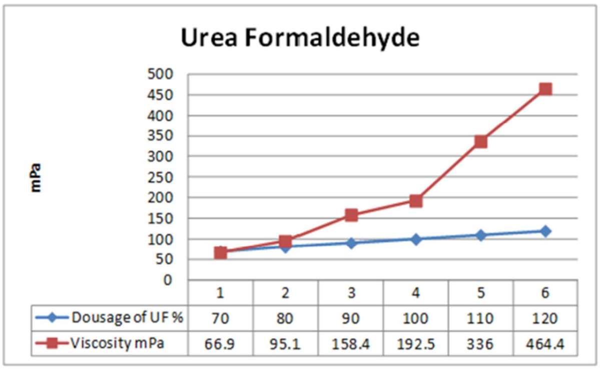

Figure 1. *Amount of Urea formaldehyde in water.*

LCM's performance evaluation is a crucial step that involves different factors that contributes to the overall sealing efficiency. The sealing efficiency of LCM's is defined here as the maximum pressure at which the formed seal breaks and fluid starts to flow again through the slotted area. Two specifically developed apparatuses were used to optimize the combination of LCMs combination and investigate their ability to sealing wide fractures at different pressures. In this experiment used, effective LCM formulations with proper concentration and sandpack, to seal pores and depleted zones. The formulation consists of urea formaldehyde resin, ammonium sulfate, and bentonite according to the previously published literature [16]. Other testing equipment has been developed to evaluate the sealing efficiency of LCM treatments in sealing permeable/impermeable depleted/fractured formations. [6, 14, 20-22] Both sand pack and total LCM concentration were found to have a significant effect on the sealing efficiency. It was also concluded that the fluid loss volume is not a good parameter to measure the sealing efficiency of LCM treatments. The permeability is determined from the Darcy law as per defined in published literature [11]. The sand pack is used to perform the action the procedure is described below.

Table 2. *Urea formaldehyde.*

Number of experiments	1	2	3	4	5	6
Urea Formaldehyde in %	70	80	90	100	110	120
Viscosity MPa	66,9	95,1	158,4	192,5	336	464,4

Step 1 The pure weight of the sand pack was measured after sand preparation starting from washing and drying in the oven for 20 hours.

Step 2 The dried sand is fixed in the tube and other parts of the device are tightened and water is injected for 3-4 hours. The water flow at the rate of 2ml/min. At the end of the appliance, the container is put for water draining, and 200ml of water should be removed at the time of LCM saturating. In the second phase it is fixed again for LCM with a flow rate of 2ml/min injection. After 200 ml of water is removed, the LCM will be completely covered and the water will be turned on for 2 times. When the water was started 2 times, we were sure that the water did not flow from the other side of the unit. The pressure of the pump was 15MPa. Then the expected result was achieved.

The experience of the device is equipped with 4-part pressure gauges i.e. P_1, P_2, P_3, and P_4. These gauges are mounted on the pipe as an array. The pressure difference shows how the experiment progresses and how much the chemical fluid is spreading and how much the pores are covered. When the fluid was injected into the pipe, the input pressure was 18.6MPa. P_1 showed 2.09MPa. The flow rate of 2ml/min. P_2 0.04 P_3 was 0.03MPa and P_4 was 0.01MPa. An hour and thirty minutes after P_1=3.10; P_2=2.05; P_3=0.93 and P_4=0.63. The results after 50 minutes are P_1=3.9; P_2=2.05; P_3=1.04 and P_4=0.98MPa. Final results: After 40 minutes, P_1=6.60; P_2=3.06; P_3=1.86; and P_4=0.95MPa. The input pressure on this device was 29.8MPa.

3. Result

The study was conducted, as per the test procedure and methodology discussed earlier, to qualitatively determine the effect of the selected LCM. The results are presented below in Table 1.

Table 3. *Sand Pack apparatus data.*

№	$P_{entrance}$	Time	P_1	P_2	P_3	P_4	Temperature	Flow rate
1	18,6	15:00	2,09	0,04	0,03	0,01	106*C	2ml
2	18,7	16:30	3,1	2,05	0,93	0,63	108*C	2ml
3	19,01	17:20	3,9	2,35	1,04	0,98	110*C	2ml
4	19,8	19:00	6,6	3,06	1,86	0,95	115*C	2ml

In table 1, $P_{initial}$ represents the initial volume at which the first seal was developed while P_{max} represent the highest sealing pressure recorded. To evaluate LCM, each individual test for sand pack prepared several times. From table 2 to table 5 shows the data about rheometr the mixture of Urea Formaldehyde and ammonium sulfate.

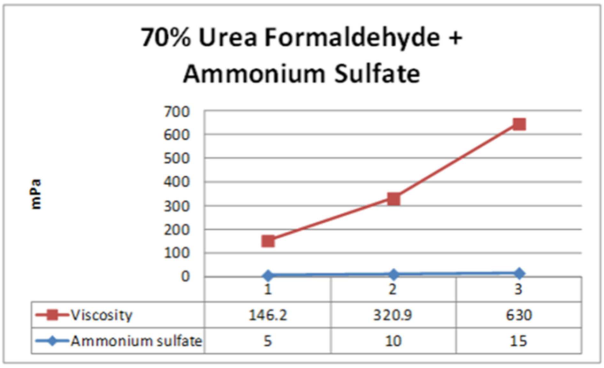

Figure 2. *70% Urea formaldehyde and ammonium sulfate (5%-15%).*

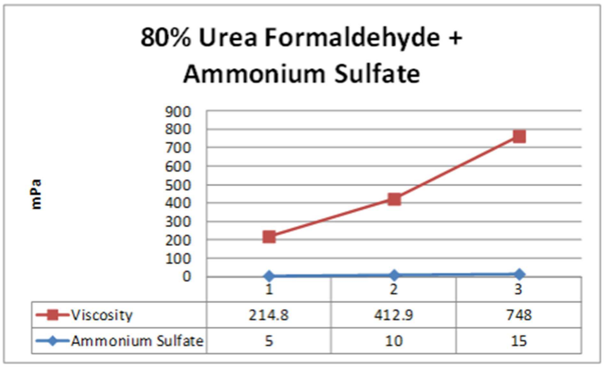

Figure 3. *80% Urea formaldehyde and ammonium sulfate (5%-15%).*

Table 4. *70% Urea Formaldehyde.*

Number of experiments	1	2	3
Ammonium sulfate	6	10	15
Viscosity MPa	146,2	320,9	630

Table 5. *80% Urea Formaldehyde.*

Number of experiments	1	2	3
Ammonium sulfate	5	10	15
Viscosity MPa	214,8	412,9	748

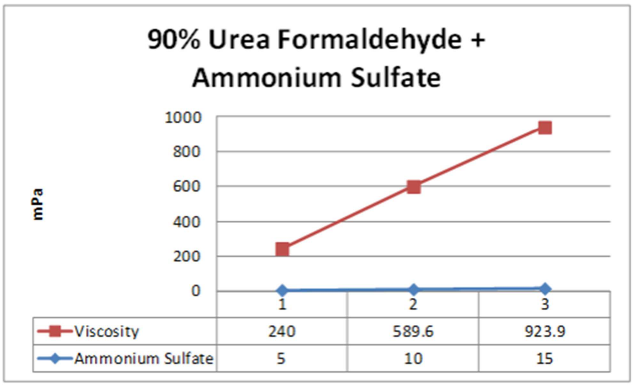

Figure 4. *90% Urea formaldehyde and ammonium sulfate (5%-15%).*

Table 6. *90% Urea Formaldehyde.*

Number of experiments	1	2	3
Ammonium sulfate	5	10	15
Viscosity MPa	240	589,6	923,9

4. Sand Pack Apparatus Results Summary

Sandpack experiment

Open the water chamber to check for water, keeps the channel the same turn on the model and flow rate when temperature reaches begin recording the pressure with time and this process will take about 7 to 8 hr and then after finishing it chemical flooding process begins.

Chemical flooding

Follow the same procedure of water flooding.

How to calculate the chemical and time needed for the experiment.

The volume of LCM saturation=300PV.

Injection rate 2ml/min.

The half volume of LCM saturation will be divided by the flow rate example 150/2=75min.

Water weight M5-M4-M1 (From this formula).

Water volume (V)=Mw/ρ=(the volume of water here will refer as porosity).

And finally second water flooding with a similar procedure for the first water flooding.

5. Discussion

A total of 30 tests to evaluate the integrity of the seal formed under elevated pressures were conducted using the Sand Pack. The results are summarized in Table 3. The fluid loss values from the screening tests were included within the table to show how they are comparable with the fluid loss per cycle values. Random tests were repeated to ensure the repeatability of the results. Some fluid loss per cycle values were significantly higher than the LPA values and this is due to the porous seal resulting from high concentration of larger particles.

6. Conclusion

Implementing a thorough plan is essential to mitigating lost circulation with non-aqueous fluids. Preventing lost circulation in non-aqueous fluids can be easier than restoring circulation. RGC has proven to be one of the more effective lost circulation mitigation materials in both the field and laboratory. “One-sack” engineered combinations of sized LCM can simplify lost-circulation treatment. Sizing lost-circulation treatments by volume of material is a more realistic approach than using weight, particularly when incorporating materials with a relatively low specific gravity. Chemical systems that form pliable or flexible ultra-high viscosity treatments may be necessary to treat the most severe lost circulation events.

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