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Effect of Nanocellulose as an additive in cement

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Abstract – *After drilling of oil wells, cementing is done to ensure proper positioning of casing and zonal isolation. Various properties of cement are needed in accordance of the geological conditions, economic factors, etc. one of the main property is the compressive strength of the cement. So we made an effort to improve the compressive strength of the cement by using a new, cheap and abundant nano material i.e nano cellulose.*

Key Words: Nano materials, Nano, nano cellulose, cellulose, cementing,

1.INTRODUCTION

Cement is used to hold casing in place and to prevent fluid migration between subsurface formations. Cementing operations can be divided into two broad categories: primary cementing and remedial cementing.

1.1 Primary cementing:

The objective of primary cementing is to provide zonal isolation. Cementing is the process of mixing a slurry of cement, cement additives and water and pumping it down through casing to critical points in the annulus around the casing or in the open hole below the casing string. The two principal functions of the cementing process are:

- To restrict fluid movement between the formations
- To bond and support the casing

1.2 Remedial cementing

Remedial cementing is usually done to correct problems associated with the primary cement job. The most successful and economical approach to remedial cementing is to avoid it by thoroughly planning, designing, and executing all drilling, primary cementing, and completion operations. The need for remedial cementing to restore a well's operation indicates that primary operational planning and execution were ineffective, resulting in costly repair operations. Remedial cementing operations consist of two broad categories:

- Squeeze cementing
- Plug cementing

2. NANO CELLULOSE

Cellulose is the most abundant bio material available in nature. It's a polymer with cellobios unit as the smallest repeating unit. Degree of polymerization may go to 1000 in case of wood cellulose. The structure of Nano cellulose are stronger than steel and the strength to weight ratio of nano cellulose is 8 times compared to steel. NCS(Nano cellulose in suspension with 7% concentration) helps to increase the compressive strength of the cement with changing the density of the cement slurry, due to its specific weight of 1.06 and high water content, water can be replaced by NCS to a small extent. NCS being viscous in nature, cannot be used more than 5% (i.e. 0.35% nanocellulose and 4.65% water) BWOC.

NCS is prepared by acid hydrolysis of cellulose(in this case from cotton)

2.1 Properties of NCS:

1. Width = 5-20 nm, length in micrometers
2. Long fibre like structures
3. Viscous
4. Acid hydrolysis gives short fibres (100 to 1000 nm in length)
5. Fibres are entangled at microscopic level
6. Tensile strength is 7.5 to 7.7 GPa
7. Strain upto 12%
8. Strength/weight ratio is 8 times that of steel
9. Impermeable to gas

3. EXPERIMENTS CONDUCTED:

3.1 **Rheology using viscometer**

Rheology refers to the deformation and flow behavior of all forms of matter. Certain rheologic measurements made on fluids, such as viscosity, gel strength, etc. help determine how this fluid will flow under a variety of different conditions. This information is important in the design of circulating systems required to accomplish certain desired objectives in drilling operations.

Viscosity: Viscosity is defined as the resistance of a fluid to flow and is measured as the ratio of the shearing stress to the rate of shearing strain.

Yield Point: This is the measure of the electro-chemical or attractive forces in the mud under flow (dynamic) conditions. These forces depend on (1) surface properties of the mud solids, (2) volume concentrations of the solids and (3) electrical environment of the solids.

3.1.1.Test Equipment:-

The Fann Viscometer is a coaxial cylindrical rotational viscometer, used to determine single or multi-point viscosities. It has fixed speeds of 3 , 6, 100, 200, 300 and 600 RPM that are switch selectable with the RPM knob

3.1.2.Test Procedure:-

1. Place a recently agitated sample in the cup, tilt back the upper housing of the rheometer, locate the cup under the sleeve (the pins on the bottom of the cup fit into the holes in the base plate), and lower the upper housing to its normal position.
2. Turn the knurled knob between the rear support posts to raise or lower the rotor sleeve until it is immersed in the sample to the scribed line.
3. Stir the sample for about 5 seconds at 600 RPM, then select the RPM desired for the best.
4. Wait for the dial reading to stabilize (the time depends on the sample's characteristics).
5. Record the dial reading and RPM.

3.1.3.Rheological Calculations:-

For rheology calculations we have direct formula, but with time the calibration changes and other factors effect the actually viscocity of the slurry. So taking all these in consideration, rheological value are find out by using halliburtons Ifact software. This requires the value of 3, 6, 100, 200, 300 and 600 rpm readings.

3.2 Hydraulic compressive strength testing

Compressive strength is one of the main properties of cement which helps to avoid the collision of the casing in well. We have used the hydraulic compressin machine to test the compressive strength of the cement.

3.2.1 Procedure:

1. Slurry is prepared in blender with all necessary additives
2. This slurry is poured in a cube mould of 2" by 2"
3. It is allowed to cure at 170^0F for 24 hrs
4. After 24 hrs, the cube is removed and kept in water for 30 minutes
5. This cube is placed in crushing machine and pressure is applied till the cube breaks
6. And the total force required to break the cube the noted
7. The compressive strength is given by;
   Comp. strength = force applied/4

4.SPECIMEN PREPARATION

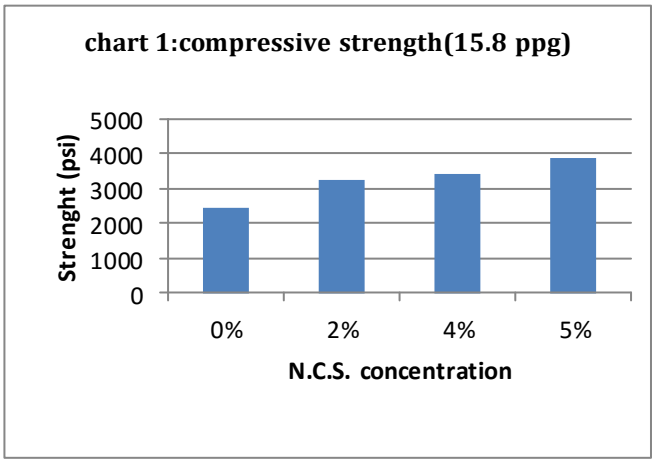
15.8 ppg samples:

N.C,S. content	0%	2%	4%	5%
MATERIALS:				
1.CClass G Cement	100%	100%	100%	100%
2..N.C.S.	0%	2%	4%	5%
3.Friction reducer	0.3%	0.3%	0.3%	0.3%
4.Water	44.45 %	42.69 %	40.94 %	40.05 %

5.RESULTS

5.1.2.Compressive strength(psi)

We can see from chart the increase in compressive strength of cement, with the increase in the nano cellulose content. At 5% NCS(i.e. 0.35% nanocellulose BWOC), the compressive strength is approximately 1.5 times that of neat cement. So here 50% increase in compressive strength is seen.



5.1.2.Thickening time

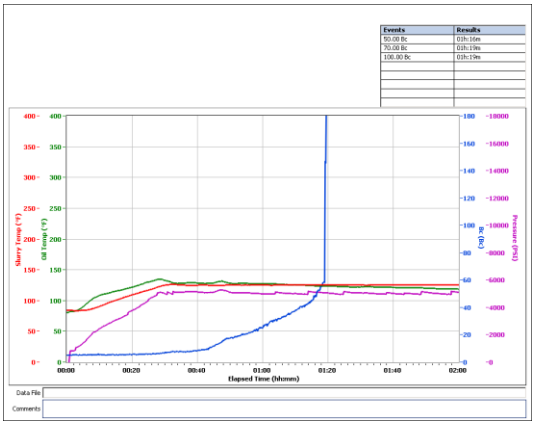


Figure 1 : 4% NCS

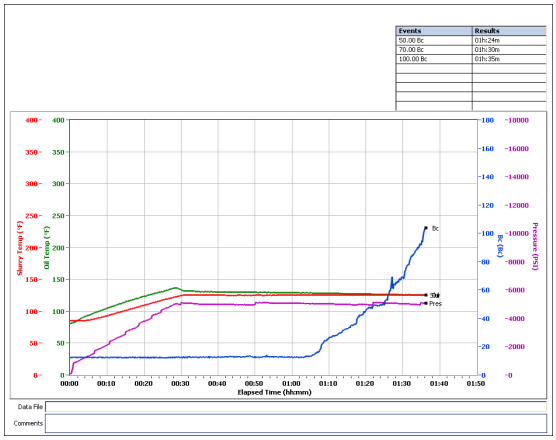


Figure 2 : 0% NCS

For neat cement, thickening started at 1 hr 24 min(figure 2), where as for cement with NCS 4% thickening time is 1hr 16 min(figure 1). So from these two charts we can see that the thickening time is not changed much. So we can say that, nanocellulose has no effect on the thickening time

6. CONCLUSION:

From the results of the specimens we can say that the compressive strength goes on increasing in linear pattern from 2450 psi (for 0% NCS, i.e. neat cement) to 3875 psi (for 5% NCs, i.e. 0.35 % BWOC of nanocellulose). Which is 1.5 times that of the neat cement. So nano cellulose is an effective additive for conditions wgere high compressive strength is required. Also, nanocellulose are easily available thus making it the cheapest nano material available.

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