QUALITATIVE ANALYSIS OF POLYMERS IN DRILLING FLUIDS

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ABSTRACT
The effects of some specified polymers namely Poly-anionic cellulose regular (Pac-R), Poly-anionic cellulose
linear (Pac-L), Enhanced Xanthan biopolymer (XC-Polymer) and bacterially stabilized potato starch (DN-91) on
the properties of water base drilling fluid has been investigated. Field data were collected, critically, analyzed
and pilot tests carried out on the samples at room temperature and pressure.
XC-Polymer and Pac-R greatly improved the viscosity of the samples thus enhance their yield point values. A
closer observation showed that XC-Polymer had a greater effect on the low-end rheology as well as gels. Pac-L
and DN-91 Polymeric showed to be primary filtration agents. However they are less effective when applied alone
than when combined with viscosifiers such as Bentonite and XC-Polymer or Pac-R.
The results show that there is a marked improvement on the rheological (fluid flow) characteristics over those of
conventional drilling fluids not composed of polymers.

INTRODUCTION
Researchers have worked extensively on the effect of drilling mud in the drilling industries
Larson [1] in his work on polymer mud to understand their behaviour under high pressure temperature
conditions observed that the pressure effects were negligible compared to that of the temperature effects.
During the measurement, it was noted that viscosity decreased as temperature increases and that the
decrease in the viscosity was more significant from 20 to 60°C than from 60 to 90°C. Polymer mud have been
found excellent in consolidating the walls of well bore. Baker Hughes [2] used cloud point glycols, aluminum complexes and
sealing polymers to greatly improve the osmotic effectiveness of water based drilling fluids. The new formulation known as
PERFORMAX is high performance water based drilling fluid specially designed to emulate the drilling performances of oil based mud.
The application was justified on the bases of borehole stability, penetration rate, fluid loss, filter cake quality and temperature
system for WestSok Field and found that oil base mud is best for this formulation. The study used a combination of drilling fluid design, laboratory test
and productivity analysis in this selection. Ujima et al [4] worked on the use of starch with new sulfonated polymer improved drilling mud and observed that
drilling fluid require fluid loss polymers that tolerate up to 140,000 ppm Ca/Mg and temperature stability that
exceed 177°C. He also showed that problems experienced with Carboxymethyl Cellulose and polyanionic cellulose can be reduced with the introduction of starch new polymer combination.
This method shows excellent filtration control, hardness, tolerance and temperature stability for this system.

During the course of drilling, the reaction between clay and mud additives becomes a major concern.
Bell [5] demonstrated the interaction between clay surfaces and polymer constituent of the mud. It was observed that the interaction was developed on
electrostatic attraction than on hydrogen bonding. In the molecular model, the use of polycrystalline and similar polymers were made to resolve two
fundamental waterbased drilling fluid concerns such as clay stabilization and reduction of cuttings erosion.
Quantitative analysis of drilling fluid products includes sampling and determination of density, operation by monitoring the quality of products added to the drilling fluid such as barite and polymer.
The analysis helps to improve management of factors that determine the drilling rate such as weight
on the bit, rotary speed and torque.
The drilling fluids as a drilling parameter have a host of operational features and accordingly fulfill some
very important functions.
Drilling performance records have made a considerable head way due to technical progress in the physiochemical nature of drilling fluids.
Drilling muds are commonly classified according to their base fluid: water-base mud and oil-base mud.
These muds are composed of several products which

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all add up to the enhancement of the drilling fluids for specified well types and formation types and zones. Basically, the functions and characteristics of drilling fluids include:

- Transporting cutting to the surface.
- Suspending the cutting when circulation is stopped.
- Cooling the bit and reducing drill string friction.
- Consolidating the walls of the hole.
- Preventing inflows of formation fluids into the well.
- Acting as a drilling parameter.
- Providing geological information.

However, the use of Polymer-based drilling mud have been studied extensively, and their functions in the drilling operation would be effectively discussed in this work.

**Materials and Experimental**

The materials for the formulation of the various waterbase mud systems used in this study and all the apparatus for the respective experiments were obtained from Baroid Nigeria Limited (BNL), a subsidiary of the Halliburton Energy Services (HES), Port Harcourt, South East, Nigeria.

The apparatus used include, weighing balance, Fann VG Rheometer, A/S apparatus, Bench mixer, laboratory barrels, measuring cylinders, stopwatch, filter papers, meter rule, spatulas and polystyrene containers for measuring out additives.

**Materials**

The materials used in the present work are shown in Table 1.

<table>
<thead>
<tr>
<th>Materials (formulations)</th>
<th>Identification Mark</th>
<th>Source</th>
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</thead>
<tbody>
<tr>
<td>1. Water + Bentonite</td>
<td>A</td>
<td>BN.</td>
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<tr>
<td>2. Water + Pol. - R</td>
<td>B</td>
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<td>3. Water + Pol. - L</td>
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<tr>
<td>4. Water + XG - Polymer</td>
<td>D</td>
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<tr>
<td>5. Water + D. N. 91</td>
<td>A</td>
<td>BN.</td>
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<tr>
<td>6. Water + Bentonite + Pol. - R</td>
<td>B</td>
<td>BN.</td>
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<tr>
<td>7. Water + Bentonite + Pol. - L</td>
<td>C</td>
<td>BN.</td>
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<tr>
<td>8. Water + Bentonite + XG - Polymer</td>
<td>D</td>
<td>BN.</td>
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<tr>
<td>9. Water + Bentonite + D. N. 91</td>
<td>A</td>
<td>BN.</td>
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<tr>
<td>10. Water + Bentonite + Pol. - R + Pol. - L</td>
<td>B</td>
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<tr>
<td>11. Water + Bentonite + Pol. - R + Pol. - L + XG - Polymer</td>
<td>C</td>
<td>BN.</td>
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<tr>
<td>12. Water + Bentonite + Pol. - R + Pol. - L + XG - Polymer + D. N. 91</td>
<td>D</td>
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</table>

For each sample of the water-base mud prepared for this study, the above stated mud formulations were used.

**Experimental**

350ml of water was accurately measured out using a measuring cylinder into the burette; this was agitated for a while on the bench mixer before the bentonite was gradually added in very little proportions to the water while stirring. This was done to prevent a situation known as "fish eye" from occurring. Bentonite takes some time to yield in water due to the fact that it is a gelling agent and therefore it is allowed to stir continuously for 20 minutes before the next constituent was added. A time interval of 5 minutes was allowed between additions of the various polymers.

The sample (barrel) was brought down from the mixer after 5 minutes of addition of the last material ready for the subsequent experiments. For the formulation without bentonite, a time interval of 5 minutes was allowed between water and the first polymer to be added and the subsequent constituents. The samples were then placed in the Fann VG Rheometer. The Rheometer is then set to run at the various speeds as indicated in Table 2. The gel point was determined by stirring the sample at high speed for 10 seconds and allowed a rest time of 10 minutes. The gel strength knob was turned slowly but steadily until the maximum deflection was obtained. This gives the gel point. The yield point was also read from the Rheometer for the various samples. All the tests were carried out at room temperature and for those requiring pressure, 100 psi was applied.

**Results and Discussions**

The results of the rheological tests showing the viscosities of the various water-base mud samples carried out on a Fann VG Rheometer are shown in Figures 1-12.

From the results obtained from the different samples, B has the highest viscosity value. This was closely followed by samples D, C, D, A, D, C, in that order. It was also observed that the sample A, which contains only Bentonite and water only performed better than sample A consisting of water and D. N. 91 (B.S.P. Starch), this could be explained by the fact that bentonite is a better Viscosifier than D. N. 91. However we can see from the graphs that a better choice of drilling mud could be got from a mixture of both bentonite and other polymers. These polymers helped in improving the yield point value, gel value and the fluid loss properties. These are evident in Table 2.
Table 2: Experimental Results

<table>
<thead>
<tr>
<th>Sample</th>
<th>Yield Point (lbs/100ft²)</th>
<th>Gel (10sec)</th>
<th>Gel (10min)</th>
<th>Fluid Loss (ml)</th>
<th>Particle Conc. Value</th>
<th>Speed (rpm)</th>
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</table>

- **A**: 21, 10, 17, 24.5, 5, 31, 26, 18, 13, 11, 6
- **B**: 8, 2, 1.5, 2, No control, 7, 22, 15, 12, 8, 2, 1
- **C**: 0, 1.5, 2, No control, 5, 10, 5, 4, 3, 1, 0.5
- **D**: 4, 1, 1, No control, 3, 10, 7, 6, 3, 2, 1
- **A'**: 0, 1, 1, No control, 2, 4, 2, 1, 1, 0, 0
- **B'**: 56, 23, 34, 2.4, 25, 106, 81, 68, 53, 31, 28
- **C'**: 8, 3, 10, 11.6, 13, 34, 21, 17, 11, 3, 2
- **D'**: 70, 24, 35, 15.6, 15, 100, 85, 80, 70, 50, 42
- **A''**: 40, 14, 20, 11.4, 13, 66, 53, 46, 38, 25, 20
- **B''**: 73, 44, 129, 5.8, 42, 157, 115, 95, 73, 37, 35
- **C''**: 56, 17, 57, 9.4, 32, 120, 88, 74, 57, 20, 16
- **D''**: 63, 22, 64, 7.8, 41, 145, 104, 87, 64, 23, 19
REFERENCES


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   C 2007 Baker Hughes Incorporated. All right reserved.

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In the discussion above, it could be seen that the importance of polymers as a drilling 
fluid additive not be over emphasized. Therefore in order to formulate any successful 
fluid, polymers must not be used alone because it has poor behavior of control ability 
and larger quantities are required to achieve a substantial improvement in viscosity as 
compared to polymers. Conclusion

From the data obtained, it can be seen that XC-polymer and Pac-R as viscosifiers greatly 
improved the viscosity (as shown in test results B’ and D’). Their use in any formulation 
enhances the yield point values there-by improving the hole cleaning capabilities and 
and cutting carrying efficiency of mud, which forms the main objective of all drilling 
operations.

Closer observation showed that XC-polymer had a better effect on the low end rheology i.e. 6 and 3rpm 
well as the Gels (ability to suspend cuttings under static conditions). It was also observed that the Pac-R 
and its side being a viscosifier also contributed to rotation control.

c-L and DN-91 showed to be primarily filtration control agents as can be seen from test result C” and 
Also it was observed that these filtration control 
ents (Pac-L and DN 90) appeared to be less 
active when applied alone as can be observed from 
result C and A’ than when combined with a 
viscosifier such as bentonite and XC-polymer or Pac-R 
evidently seen from test result C” and D’. Though 
bentonite is not a polymer, but its presence is 
necessary in any drilling fluid because it posses a 
visible property which enables it to yield in matter 
by increasing the viscosity. This is clearly seen 
in result, B, C, D and A’ where bentonite was 
ent. However, it is important to note that 
bentonite cannot be used alone because it has poor 
rotation control ability and larger quantities are 
required to achieve a substantial improvement in 
viscosity as compared to polymers.