Inter. Jour. of Engineering
Vol.4, No.2 (2010) 161-167

RHEOLOGICAL PROPERTIES OF TREATED OIL WELL CEMENT CONTAMINATED BY PSEUDO OIL BASED MUD

Isehunwa, O. Sunday and **Mumuni, O, Thomas**

Department of Petroleum Engineering /
Shell Petroleum Development Company Chair Office
University of Ibadan
Nigeria

ABSTRACT

Contamination of cement slurries during oilwell cementing distorts their designed properties and leads ultimately to poor cement jobs. To promote best practices and enhance cementing successes, it is always desirable to understand slurry response under different conditions such as contamination. Appropriate corrective measures can then be undertaken when necessary. This study carried out complete rheological experimental characterization of oil well cement slurries contaminated by pseudo oil based muds (POBM) and treated with additives. Results show that gel strength increases with POBM contamination for all types of cement slurries.

Introduction

Cementing quality is one of the parameters that affect the productivity of an oilwell. During cementing, the slurry of adequate physical and chemical properties are pumped through the casing and made to bond the casing to the formation. Good slurry with ideal properties must ensure favourable rheology to facilitate efficient placement, ensure no gel strength development to maintain hydrostatic balance and must have low shrinkage to minimize gas entry. Furthermore, there must be low fluid loss, low permeability and adequate strength and toughness to absorb stress changes. (Art and Demos, 1996). POBM contamination could significantly distort these properties.

It has been established that rheological properties of cement slurries affect the pumpability at minimum pressure, governs the flow regime during the displacement, and the affect the suspension of solids during the static conditions (Gandeman, et al, 2004). Additives are usually added to cement slurries to correct any observed defects and improve on desired properties and behaviors.

Pelinpenko and Frigaard (2004) have noted that ineffective mud removal affects the placement of cement during primary cementing. However, while the general adverse effects of mud contamination on cement slurries are commonly known, the behaviour of contaminated cement in the presence of additives have not been well investigated. Justnes et al (1995) studied the chemical shrinkage of oil well cement slurries and the mechanism of gas intrusion during the shrinkage. Rubiandin (2000) observed that appearance of mud cake will decrease the shear bond strength of cement. Gandelman et al (2004) studied the rheological parameters governing oilwell cement shiny stability. This study highlights the gel strength and other rheological properties of c and investigates the effects of POBM contamination levels on it.

Materials And Experimental Methods

Laboratory experiments were carried out uncontaminated and POBM-contaminated Lead, Plug and Tail cement slurries. Rheological properties of the cement slurries were determined using Fann VG viscometer. Get strength was determined at 10s and 10 minutes using standard procedures. The experiments were replicated to enhance reliability of results.

Results And Discussion

The formulation of the three different types of cement slurries are as presented in Tables 1, 2 and 3. The Shear stress and Shear rate values were estimated using equations (1) and (2) respectively:

$$\text{Shear Stress} = 0.01 \times \text{Dial Reading} \times \text{rpm} \times 1.066 \ (\text{lbf/ft}^2) \quad (1)$$

$$\text{Shear Rate} = \text{Fann rpm} \times 1.703 \ (\text{sec}^{-1}) \quad (2)$$

The slope of the plot of share stress versus shear rate gave the flow behaviour index, while the intercept gave the consistency index,

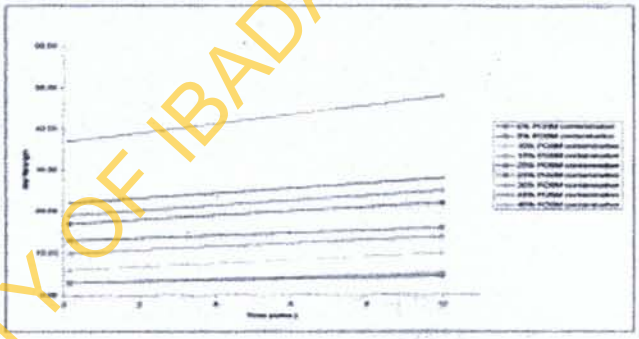

Figure 1 : Effect Of POBM Contaminaton On Lead Slurry Gel Strength

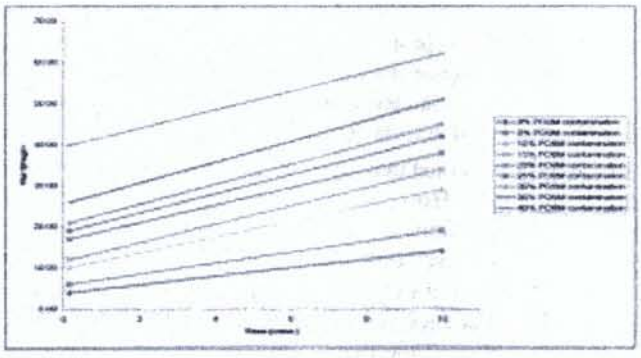

Figure 2 : Effect Of POBM Contaminaton On Plug Slurry Gel Strength

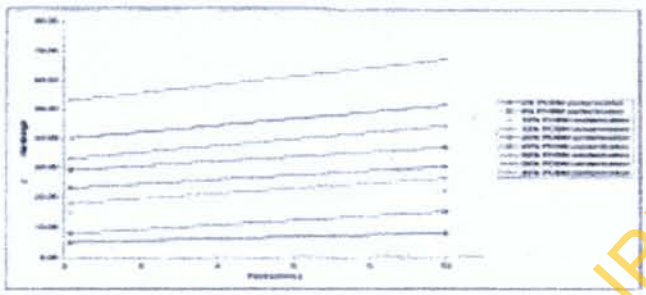

Figure 3 : Effect Of POBM Contaminaton On Tail Slurry Gel Strength

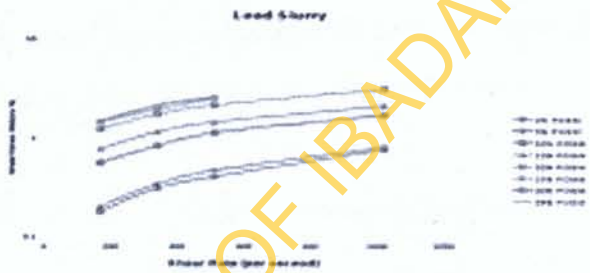

Figure 4 : Effect Of POBM Contaminaton On Lead Cement Slurry Shear Stress/Shear Rate

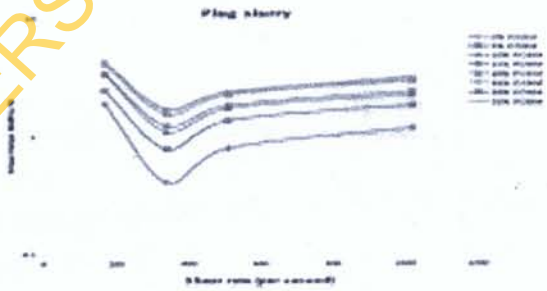

Figure 5 : Effect Of POBM Contaminaton On Plug Cement Slurry Shear Stress/Shear Rate

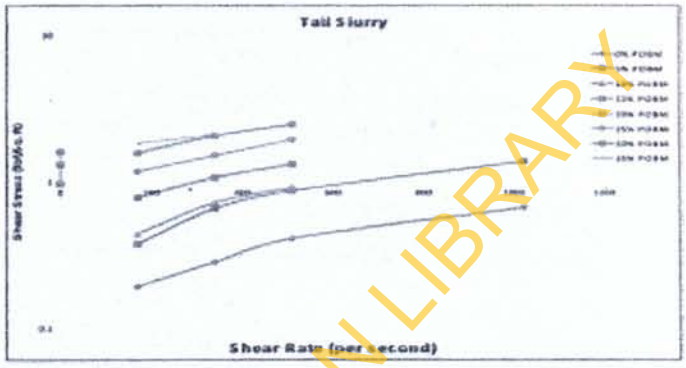

Figure 6 : Effect Of POBM Contaminaton On Tail Cement Slurry Shear Stress/Shear Rate

Figures 1-3 show the effect of POBM on gel strength, while Figures 4-6 show the effect of POBM on shear stress and shear rate.

Table 1 : Lead Cement Formulation

Material	Quantity (g)	Remarks
Fresh Water	379.12	
Cement	367.79	
Additives		
Sodium Silicate	13.71	Extender
2-Propenamide-N-(Hydroxymethyl) Polymer with 1,3 Butadiene and Ethylbenzene Monoethanolamine	49.46	Bonding Agent
Calcium Chloride	1.84	Accelerator
Sulphonated Organic Polymer	15.28	Dispersant
BJ 2001 Mixture	22.53	Cement Additive
FP-30L Silicon Emulsion	1.32	Antifoamer
Lignosulphonate	12.24	Retarder

Table 2 : Tail Cement Formulation

Material	Quantity (g)	Remarks
Fresh Water	345.11	
Cement	786.99	
Additives		
FP-2 I L Silicon Emulsion	1.17	Defoamer
Lignosulphonate	3.06	Retarder

Table 3 : Plug Cement Formulation

Material	Quantity (g)	Remarks
Fresh Water	320.38	
Cement	781.52	
Additives		
Sulphonated Organic Polymer	1623	Dispersant
BJ 2001 (Mixture)	14.36	Cement Additive
FP-21L (Silicon Emulsion)	2.33	Defoamer
Lignosulphonate	1.47	Retarder

Strong relationship between gel strength mud contamination volume and time was observed, with R^2 values of 0.962, 0.904 and 0.884 for the tail, plug and lead slurries respectively. Furthermore, mud contamination volume has a stronger with correlation with gel strength than time in all the slurries. In the tail slurry it has a correlation value of 0.948 compared with 0.252 for time. In the plug slurry, % mud contamination volume had a correlation with gel strength of 0.740 compared with time (0.597), while it had 0.919 compared with 0.199 for time, in the lead slurry. The decrease in relationship between gel strength and the variables in the plug slurry more then in the tail slurry is attributed to the presence of additive (2.7% dispersant BWOC slurry). In the lead cement, the lower relationship is attributed to the additive (1.82% BWOC slurry) as well as the high water-to-cement ratio of 50.75% Therefore, in the, presence of POBM contamination, the amount of additives and water-to-cement ratio play a big role in defining the relationship of gel strength with time. This has serious implications during oil well cementing operations. Excessive shutdown time will require an excessive amount of pressure to restart the movement of the slurry that has increased gel strength due to mud contamination. This high pressure may have adverse effects on the formation. Furthermore, these results show that high gel strength due to mud contamination may seem useful when sealing lost-circulation zones but could end up having a poor cement job because the contaminated slurry will not bond properly and the zone will not be properly plugged in the long run.

Conclusion

POBM contamination was found to affect the rheological properties of cement slurries treated with additives. The main conclusions were:

1. POBM contamination and time were significant predictors of rheological properties of cement slurries.
2. Slurries with no additives showed stronger relationship between gel strength, POBM contamination and time, while additives tend to decrease the correlation between POBM contamination and rheological properties but increases the more logical relationship of the properties with time.
3. POBM contamination of cement increased the gel strength. Although this seems helpful initially when sealing lost-circulation zones, the benefit is short-lived as the POBM contamination leads to poor cement bond in the long run.

Acknowledgement

This work was supported by the Shell Petroleum Development Company, Nigeria through the Shell Professorial Chair at the University of Ibadan. The use of facilities at the Production Chemistry laboratory of SPDC Port Harcourt is gratefully acknowledged.

REFERENCES

1. Justnes, H., Van Loo, D., Reyniers, B., Skalle, P., Sveen, J. and Sellevold, J. : "Chemical Shrinkage Of Oil Well Cement Slurries", Advances In Cement Research, Vol. 7, No. 26, (April, 1995), 85-90.
2. Gandelman, R., Miranda, C., Teixeira, K., Martins, A. L. and Waldmann, A. : "On The Rheological Parameters Governing Oilwell Cement Slurry Stability", Annual Trans. Of The Nordic Rheology Soc., Vol. 12, (2004).
3. Pelipenko S. and Frigaard, I. A. : "Mud Removal And Cement Placement During Primary Cementing Of An Oil Well: Part 2-Steady State Displacements", Journal Of Engineering Mathematics, 48: (2004),1-26.
4. Rubiandin, R. : "New Additive For Improving Shearbond Strength In High Temperature And Pressure Cement", IADC/SPE Paper 62750, Presented At The IADC/SPE Asia Pacific Drilling Technology Conference, Kuala Lumpur, Malaysia, (2000).
5. Art, B. and Demos, P. : "Getting To The Root Of Gas Migration," Oilfield Review, Vol. 8, No. 1, (1996) 36-49.

6. Dingsoyr, E., Pedersen, E. and Taugbol, K. : "Oil Based Drilling Fluids With Tailor-Made Rheological Properties: Results From A Multivariate Analysis", Annual Trans. Of The Nordic Rheology Soc., Vol. 12, (2004).

7. Nelson, F. B. and Cassabone, J. M. : "New Method For Better Control Of Cement Performance In High-Temperature Wells", SPE Paper 24556, (1992).

8. Lindsay, F., Tom, G., Mourhat, J., Greg, S., Mike, S., Peter, V. : "Seamless Fluids Programs: A Key To Better Well Construction", Oil Field Review, 8, No. 2, (1996), 42-56.

9. Parcevaux P. A. and Sault, P. H. : Cement Shrinkage And Elasticity: "A New Approach For A Good Zone Isolation", SPE Paper 13176, (1984).

0. Lockyear, C. F., Ryan, D. F., Gunningham, M. M. : "Cement Channeling: How To Predict And Prevent" SPE Drilling Engineering, (September 1990), 201-208.

1. Klausek, G. L. : "Research On Cement For Geothermal And Deep Oil-Well", SPE Paper 5490, (1976).

2. Nelson, F. B. : "Well Cementing", Schlumberger Educational Service, Houston, Texas, (1990).

13. N. N. : "Specification For Material And Testing For Well Cements", API Specification 10, First Edition, Washington DC, (1990).

14. N. N. : : "Standard Method Of Test For Fineness Of Portland Cement By Air Permeability Apparatus", ASTM–C, (1995), 204-255.