Possibility Studies Of Using Local Cement In Oil And Gas Wells Cementing Operation In Malaysia - Part III

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ABSTRACT

Besides the chemical and normal physical properties evaluation, neat cement must also show its compatibility towards additives when they are mixed with the additives and tested at reservoir condition. Retarder and fluid loss additive were mixed with the pfa and G cements at different percentage by cement weight and their physical properties were studied by closely followed the API Specification 10 and were tested at simulated reservoir conditions. Results proved that locally produced blended cement is compatible for cementing job as compared to G cement.

INTRODUCTION

In cementing an oil/gas well, the cement is placed from several hundred to several thousand feet below the surface of the earth and there are many factors over which the well cementer has no control i.e. temperature and pressure.[1] The cement is pumped through the casing and then back up through the small annular space between the walls of the hole and the casing. Therefore, the slurry mixed must remain as a fluid and pumpable until it is in its final resting place regardless of the temperatures and pressures to which it is subjected or to the time required.

At the setting depth, the cement slurry should set hard quickly and develop sufficient strength to withstand the tensile and compressive streses in the well and should also form a permanent and enduring bond between the formation and the casing.[2] The set cement has to seal off the undesirable water and to protect the casing from external corrosion and provides the strength and the reinforcement to the casing.

In order to achieved these requirements, additives were used with the cement to produce a satisfactory slurry performance for a given well condition.

The purpose of this paper is to present the laboratory data on the comparison studies done on blended and G cement when they were mixed with different percentage of additives.

LABORATORY WORK

Locally produced and imported class G cements were mixed with retarder and fluid loss additive and their physical properties which includes the free water, thickening time, fluid loss and compressive strength were tested by closely followed the API Specification 10.[3]

THICKENING TIME TEST

In the thickening time test, prepared slurry is immediately poured into the consistometer container and while the slurry being stirred, the temperature and pressure is increased according to schedule no. 5, Specification Test For Classes G and H. Stiring is then continued until the slurry reaches a consistency of 100 Bc.[3]

FLUID LOSS TEST

Prepared slurry is immediately placed in the preheating atmospheric pressure consistometer and stirred for 20 minutes. The slurry is then poured into the preheated high pressure filter press and maintained at the final temperature of the schedule for the duration of the test.

FREE WATER TEST

Slurry is prepared according to section 5, and immediately place in the atmospheric pressure consistometer and stirred for 20 minutes. The slurry is then remixed for an additional 35 seconds and followed by pouring it into a 250 ml graduated cylinder. The mouth of the cylinder is sealed and then is place on a vibration free surface and allowed to stand undisturbed for 2 hours. The volume of water removed from the top of the slurry is recorded as the amount of free water content.

The prepared slurry is immediately poured in the prepared molds in a layer equal to 1/2 of the mold depth and puddled for 25 times per specimen with puddling rod. After puddling the layer, the remaining slurry is stirred to eliminate segregation and the molds are filled to overflowing and puddle as before. The prepared molds are then placed in the high pressure and high temperature curing chamber and cured according to schedule 5g, Well Simulation Test Schedules for Curing Compressive Strength Specimens for a period of 8 hours, 24 hours, 3 days and 7 days and the removed and crushed with the compressive strength machine.[3]

RESULTS AND DISCUSSIONS

THICKENING TIME ANALYSIS

Table1 shows the results of the thickening time for both cements when mixed with different percentage of retarder and fluid loss additive and tested at 8000 feet and 52 degree celcius. It can be seen that there is an increased in pumping time as the amount of additive is added to the cement and class G cement proved to has better pumping time in all tests run as compared to pfa cement. In this situation the pozzolanic reactivity has caused the pfa cement to set a little faster but this cement is still can be used because of its compatibility with additives. Although the pumping time for pfa is less but the time clocked is reliable and can be considered suitable for well cementing job if five hours or less operating time is required. The difference in time setting of these cements can be seen in Figure 2 and 3.

FLUID LOSS ANALYSIS

Results of fluid loss when cement were mixed with different percentage of additives are shown in Table 2. The amount of fluid loss starts to decrease as the amount of mixing additive is increased and the trend is the same for both types of cement. However, the pfa cement gives better results in the amount of water loss to the formation. Besides the additives played their role in preventing fluid loss, the finely fly ash played its part in occupying micro pores and the pozzolanic reactivity provided by the ash has help in reducing the permeability of the cement and thus reduced the amount of water, as can be clearly seen in Figure 1.

FREE WATER ANALYSIS

The results of free water test betweeñ pfa and class G cement when added with different percentage of both additives are shown in Table 3. Generally, with the mixing proportion of additives, pfa cement proves to have less free water produced compared to the class G cement until when the mixing of fluid loss additive comes to 1.5 % and 2 %, whereby there is no free water for both cement. At these level, both cement were not set. The fly ash content in pfa cement delayed the reaction of cement with water by filling the pores between the cement grains and thus traps some of the water and further more some of the water is consume by the fly ash to disintegrade and react with calcium hydroxide and produced cementitious material and make the cement to set with less free water.

COMPRESSIVE STRENGTH ANALYSIS

Results of compressive strength cured at different period for each type of cement plus retarder and fluid loss additive are shown in Table 4 . With retarder, both types of cement does not set at 8 hours curing period and data were only obtained after 24 hours of curing period. However, with fluid loss additive only class G cement does not set at 8 hours curing period. In all tests run, the pfa cement gives a better strength development results as compared to class G cement. Besides the delaying effect of cement to set cause by the additives, the slow pozzolanic activities which took place between the calcium hydroxide that is the product of cement hydration has helped in developing the extra gel of tricalcium silicate hydrate which ocuppied the pores and contribute to the strength development of the cement. The profile of these development is shown in Figure 4 and 5.

CONCLUSION

Pfa cement proved to be better than class G cement in terms of fluid loss, free water and compressive strength but not in the thickening time aspect. The results also proved that pfa cement is compatible to be used with the existing oilwell cement additives. In general, pfa cement is suitable for a cementing job if five hours or less working time is required.

REFERENCE

1. R. Floyd Farris, A Practical Evaluation of Cement Fof Oil wells, Drillng and Production Tecnology, Volume 18, pg283-292.

2. John Bensted, Cement With a Specific Application - Oilwell Cements, World Cement March 1987, pg 72-79.

3 . API Specification 10, July 1, 1990. Specification For Material and Testing For Well Cemnets. American Petroleum Institute, 1220 L Street, Northwest, Washington DC, USA.

Table 1

Thickening time of cement sample according to schedule no. 5 API Specification 10.

SAMPLE	THICKENING TIME					
	40 BC (MINIT)		70 BC (MINIT)		100 BC (MINIT)	
	G	PFA	G	PFA	G	PFA
G/M + 1.0 %R	430	275	NS	293	NS	308
G/M + 0.7 %R	362	181	371	196	384	220
G/M + 0.5 %R	272	162	287	183	297	204
G/M + 0.2 %R	143	96	161	127	170	152
G/M + 2.0 %FL	243	174	260	183	275	198
G/M + 1.5 %FL	215	160	230	177	248	194
G/M + 1.0 %FL	162	154	173	168	196	180
G/M + 0.5 %FL	112	89	142	114	169	144

Table 2

Fluid loss of sample tested with 1000 psi differential pressure at 52 deg. C with different percentages of additives.

SAMPLE	G CEMENT (ml)/30 min.	PFA CEMENT (ml)/30 min.
G/M 0.2%R + 2%HL	76	72
G/M 0.5%R + 2%HL	81	76
G/M 0.7%R + 2%HL	89	81
G/M 1.0%R + 2%HL	98	87
G/M 0.2%R + 1.5%HL	164	120
G/M 0.5%R + 1.5%HL	172	136
G/M 0.7%R + 1.5%HL	181	157
G/M 1.0%R + 1.5%HL	200	171
G/M 0.2%R + 1% HL	344	312
G/M0.5% R + 1% HL	352	325
G/M 0.7%R + 1% HL	367	338
G/M 1.0%R + 1% HL	282	356
G/M 0.2%R + 0.5%HL	636	610
G/M 0.5%R + 0.5%HL	642	619
G/M 0.7%R + 0.5%HL	668	631
G/M 1.0%R + 0.5%HL	686	648

Table 3

Free water of samples when mixed with different percentage of additives.

Sample	G CEMENT (ml)	Pfa CEMENT (ml)
G/M 0.2%R + 0.5%FL	1.3	1
G/M 0.5%R + 0.5%FL	0.85	0.8
G/M 0.7%R + 0.5%FL	0.7	0.6
G/M 1.0%R + 0.5%FL	0.35	0.2
G/M 0.2%R + 1.0%FL	0.25	0.2
G/M 0.5%R + 1.0%FL	0	0
G/M 0.7%R + 1.0%FL	0	0
G/M 1.0%R + 1.0%FL	0	0
G/M 0.2%R + 1.5%FL	0	0
G/M 0.5%R + 1.5%FL	0	0
G/M 0.7%R + 1.5%FL	0	0
G/M 1.0%R + 1.5%FL	0	0
G/M 0.2%R + 2.0%FL	0	0
G/M 0.5%R + 2.0%FL	0	0
G/M 0.7%R + 2.0%FL	0	0
G/M 1.0%R + 2.0%FL	0	0

Table 4

Compressive strength of samples when mixed with different percentage of additives and tested at simulated reservoir condition.

SAMPLE	COMPRESSIVE STRENGTH G / PFA 8 HOURS (psi)	G/PFA 1 DAY (psi)	G/PFA 3 DAYS (psi)	G/PFA 7 DAYS (psi)
G/M + 0.2 %R	1750/1820	2500/2650	3100/3300	3200/3450
G/M + 0.5 %R	1550/1660	2320/2510	2950/3190	3150/3310
G/M + 0.7 %R	1010/1250	1850/2150	2450/2920	2980/3120
G/M + 1.0 %R	NS	980/1170	1260/1490	1410/1700
G/M + 0.5 %FL	1800/1920	2610/2800	3450/3780	3340/3610
G/M + 1.0 %FL	1720/1810	2500/2650	3290/3450	3160/3300
G/M + 1.5 %FL	1540/1660	2210/2360	3120/3280	3010/3180
G/M + 2.0 %FL	1310/1410	2020/2180	3050/3190	2910/3090

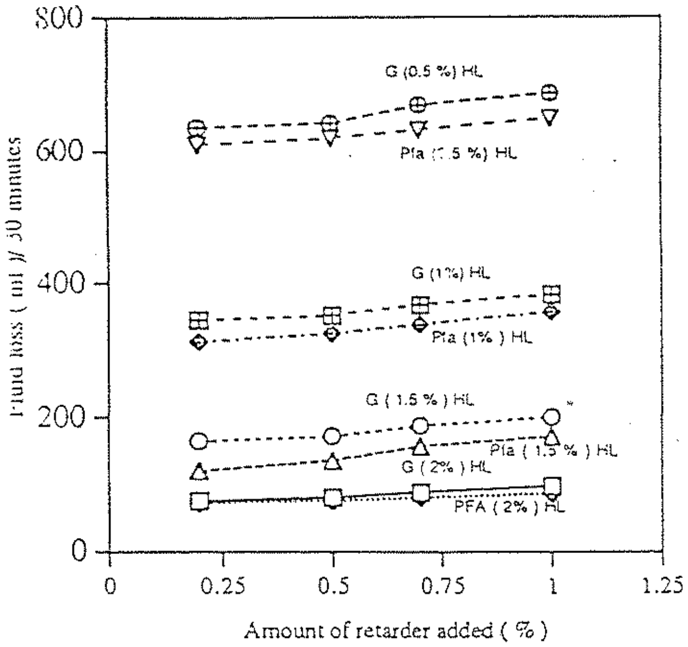

Figure 1. Fluid loss profile tested with 1000 psi differenctial pressure at 52 deg. C with different percentage of additive

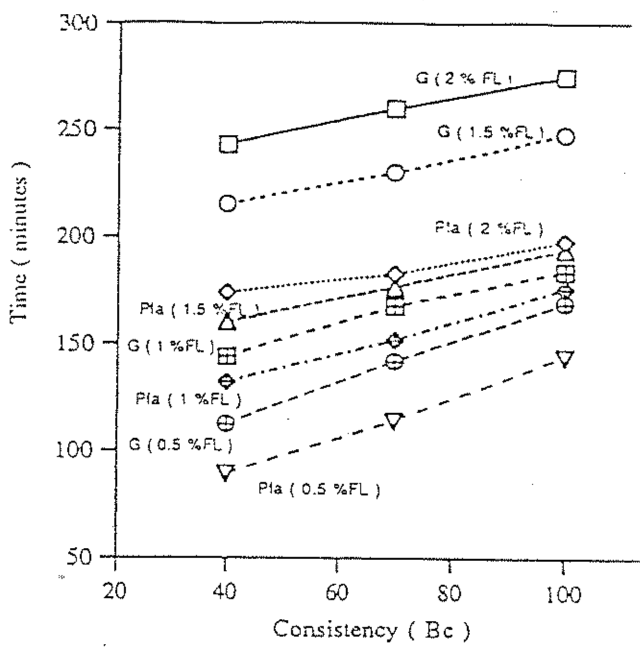

Figure 3- Thickening time profile when cement added with different percentage of fluid loss additive.

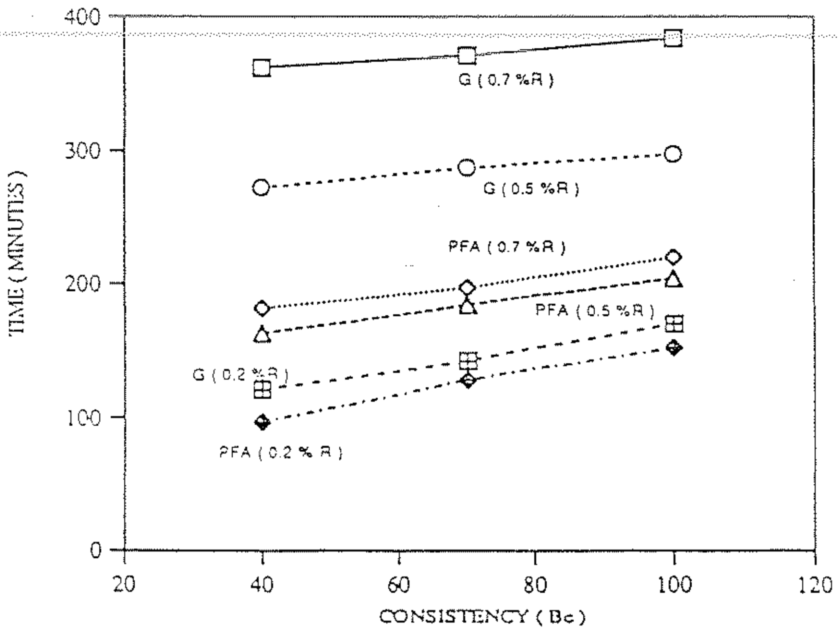

Figure 2 . Thickening time profile when cement is added with differenet percentage of retarder

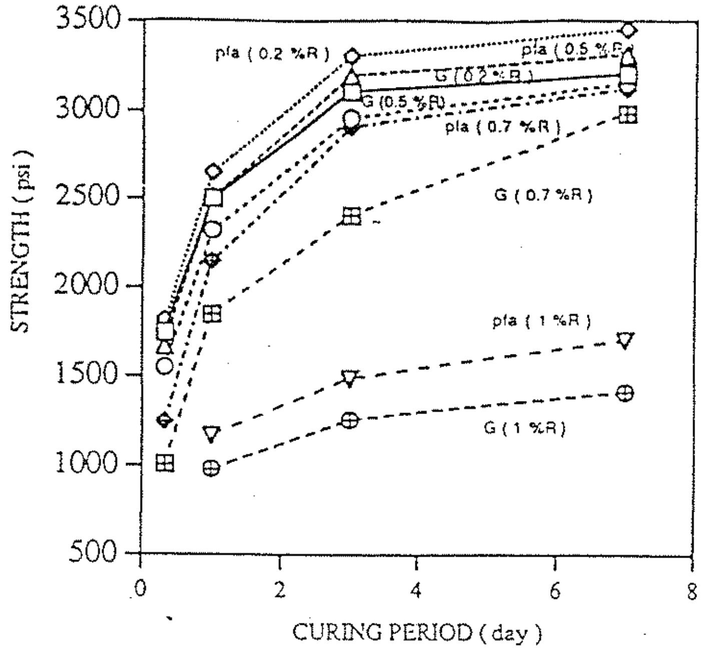

Figure 4. Strength profile of of sample when added with different percentage of retarder at simulated reservoir condition.

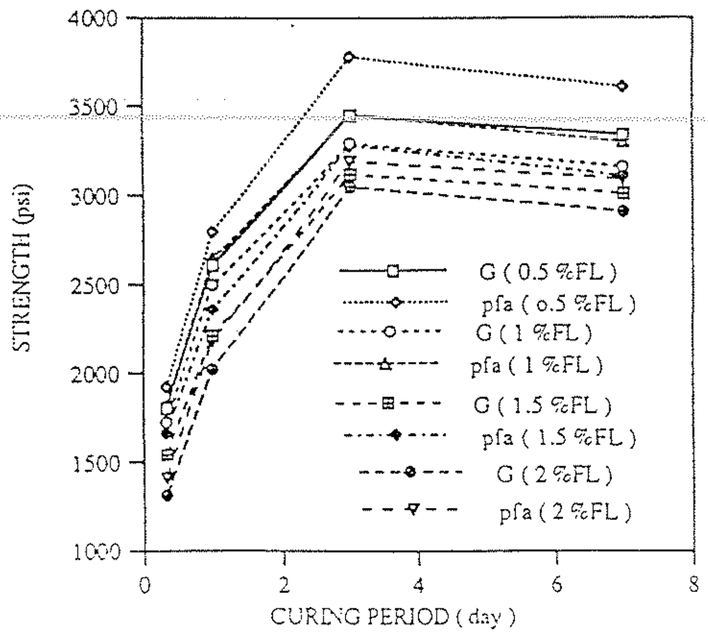

Figure 5. Strength profile of sample when added with different percentage of fluid loss additive and tested at simulated reservoir conditionre