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LOSS CIRCULATION CURE WHILE DRILLING AND CEMENTIN

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Abstract

Cementing operations are conducted on oil and gas wells for many purposes such as, zone isolation, casing support and water shut off. Cement strength dependent on the quality of the cement, cement pumping procedure, and casing leak of water channeling behind casing. This research is conducted on the laboratory work by measuring cement slurry physical properties, and bend cement properties using mixture of different cement slurries with different cement densities.

The results of this study indicate that, the best way to cure the loss circulation is to use the cement slurry with 14 ppg density. Meanwhile the temperature has a great effect on decreasing the properties of the cement slurry, and also cement additives have a good control on cement slurry yield point and plastic viscosity. Indication from laboratory work is the thixotropic slurry has a huge difference in shear stress comparing with the extend slurry. This is an excellent indicator that thixotropic system will cure the losses much better than any other systems.

Key words: cement slurry; loss circulation; yield point; strength.

1. Introduction

Well cementing is the process of placing cement slurry in the annulus space between the well casing and the geological formations surrounding the well bore to provide zonal isolation in oil, gas, and water wells [1], in order excluding fluids to move from one zone to another in the well. Incomplete zonal isolation may cause oil spills and the well never run at its potential full production[2]. The appropriate cement slurry design for well cementing is a function of various parameters, including the well bore geometry, casing hardware, formation integrity, drilling mud characteristics, presence of spacers and washers, and mixing conditions.

Over the last few decades, several types of new chemical admixtures such as super plasticizers, retarders, viscosity modifying admixtures, etc. have been introduced to optimize the flow properties of cement-based products. Early age and hardened properties of cement based systems are highly depended on the type and dosage of chemical admixtures used. The proper selection of chemical admixtures is mainly based on a trial and error procedure using tests such as the Marsh cone flow, mini slump test, and other rheological tests. The performance of chemical admixtures is strongly influenced by the chemical and physical properties of the cement. Most of the commercial chemical admixtures have been used with ordinary portland cement for general purpose use. Therefore, the technical data sheets provided by the manufacturers are not generally applicable for oil well cementing. In order to contend with bottom hole conditions (wide range of pressure and temperature), a special class of cements called OWCs, specified by the American Petroleum Institute (API)[3] are usually used in the slurry composition. The interactions of OWC with different types of admixtures and the associated cement-admixture compatibility at high temperature are still largely unexplored.

In the wake of a potential energy crisis, the threat of global warming, and increasing cement consumption of a rapidly growing world population, the uses of supplementary cementations materials (SCMs) are being encouraged considering their significant environmental and economic benefit and their potential as a sustainable solution.

The main objective of this paper is to investigate the effect of different cement additives on the properties of cement slurry as well as on the cement bending properties (ultra sonic compressive strength), in order to find the best way to cure the loss circulation by choosing best cement slurry and additives .

2. Material and methods

The Chandler Engineering 4265 ultrasonic cement analyzer (UCA,) was used in the test. Specifications: Maximum curing temperature 400^{o}F (204^{o}C), Maximum curing pressure 20,000psi (138MPa), heater power 2,000 watts.

System 1:

Temp(F°)	T.T(hr)	U.C.A(psi)
100	5:14	590
170	5:22	457

Setting time of 100^{o}F for cement density of 12.5 ppg indicates that the consistency of cement slurry stays constant until a setting time of 4:00 hrs. while settling time of 170^{o}F for cement density of 12.5 ppg indicates that the consistency stays constant until a settling time of 4:30 hrs. Cement consistency higher at lower temperature result in high resistance of cement to flow.

System 2:

Temp(F°)	T.T(hr)	U.C.A(psi)
100	4:15	1000
170	5:30	1700

Setting time of 100^{o}F for cement density of 14 ppg indicates that the consistency of cement slurry stays constant until a setting time of 3:00 hrs. while settling time of 170^{o}F for cement density of 14 ppg indicates that the consistency stays constant until a settling time of 5:00 hrs. Cement consistency higher at lower temperature result in high resistance of cement to flow. Cement consistency higher for lower temperature which result in high resistance of cement to flow.

System 3:

Temp(F°)	T.T(hr)	U.C.A(psi)
100	4:31	2000
170	4:45	2535

Setting time of 100^{o}F for cement density of 15.8 ppg indicates that the consistency of cement slurry stays constant until a setting time of 6:00 hrs. while settling time of 170^{o}F for cement density of 15.8 ppg indicates that the consistency stays constant until a settling time of 1:00 hr. Cement consistency higher at lower temperature result in high resistance of cement to flow.

System 2 with thixotropic gives acceptable value of CS that can be drilled after cure the losses and this is very important when drilling continued.

Comparing with the system 1 very low CS and it can cause stuck pipe while running into the hole with drilling bit. While System 3 has very high CS which is not really needed in loss circulation system, higher CS will need more time to be drilled and this caused non productive time.

2. Results and discussion

Cement slurries rheologies are highly effective with bottom hole temperature [4-5]. Plastic viscosity (PV) and temperature at different densities may effect highly in reduction, and it can be controlled with chemicals used in system 2 (thixotropic system) which has special product for loss circulation issues Figure 1.

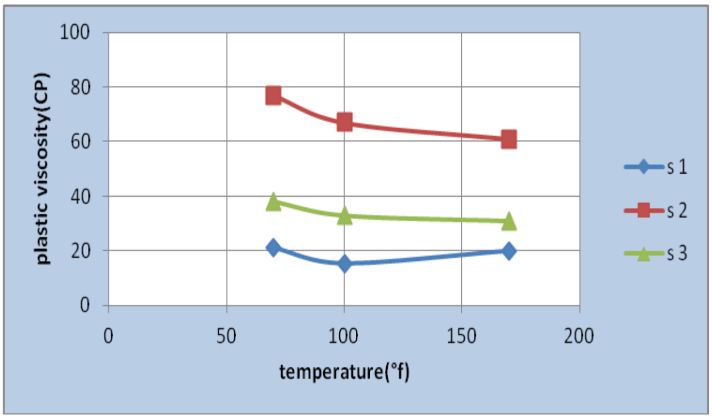

Figure 1 Temperature vs plastic viscosity

Gel strength is the key to cure the losses and it was clear from lab work, that thixotropic is producing high gel strength value. Figure 2 shows, that plastic viscosity with thixotropic reacts much higher than neat cement, meanwhile the possibility to cure the losses by thixotropic system with higher value of PV and gel strength, more effective than neat cement, which strength is very low.

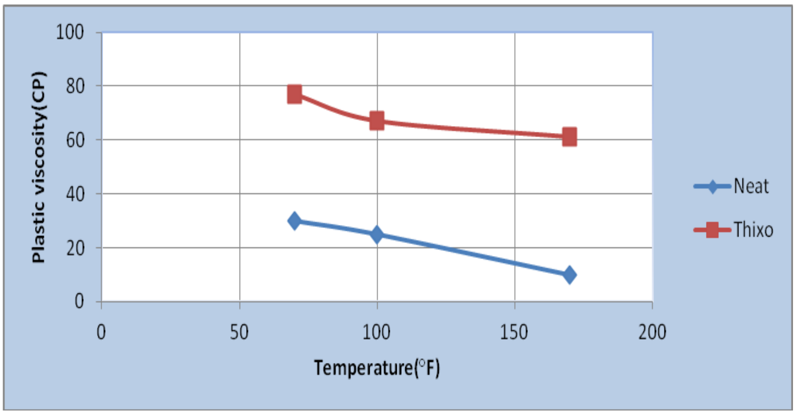

Figure 2 Plastic viscosity comparison vs temperature for system 2

Three systems and their behavior toward to the heating where compared. Figure (3a), shows that systems 1 and 3 behavior are normal with heating, but system 2 behaved normal at the begging then the YP increased again with the temperature. YP is important to insure the slurry stability and pump ability at the same time, two tests have been done at lab to insure that loss circulation control system of purposed solutions with neat cement indicates low YP may cause unstable slurry, while thixotropic slurry indicates good mud removal and higher rheology which's required in losses cures figure (3b).

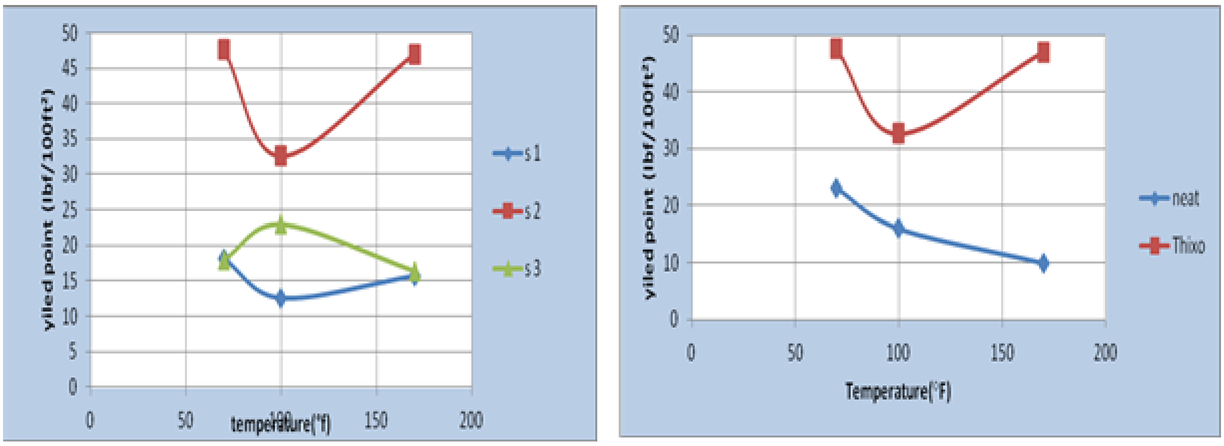

Fig.3 (a) YP vs temperature (b) YP comparison for System 2

Figure 4, shows, that thixotropic slurry has higher shear stress comparing with the other systems, where higher shear stress (SS) achieved by adding the special product to insure the cement high rheology & gel strength, while system 1 is very sensitive to the temperature increase.

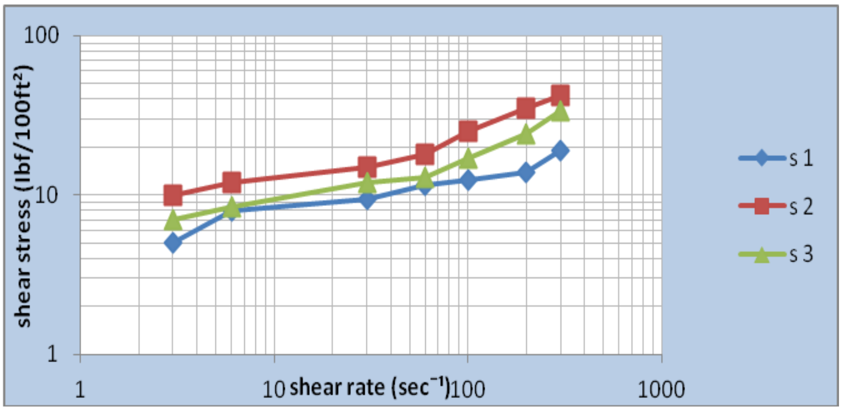

Figure (4) Three systems behaivers vs. shear stress

Figure 5 illustrates system 2 behavoir under different temperatures by adjusting the concentrations, as well as the whole properties. It is clear that thixotropic slurries has a key in cure losses as it keeps constant even while heating.

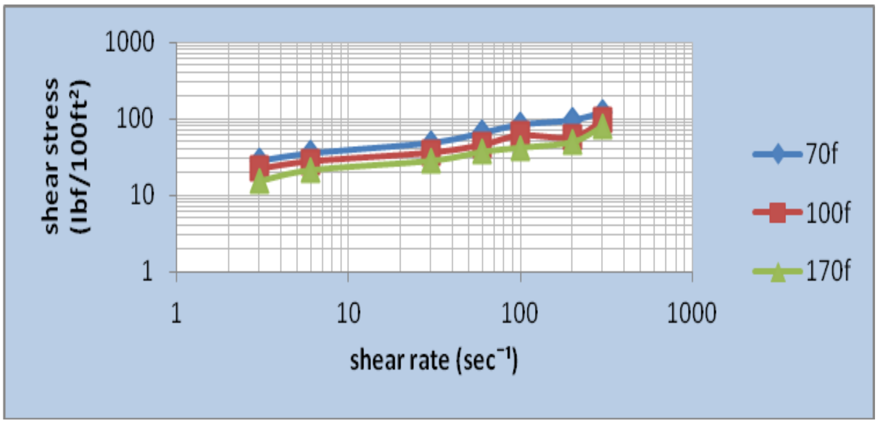

Figure 5 Different temperatures vs. share stress

Figure 6 shows the tests behavior of the cement slurries at the same density and different compositions (thixotropic and extended slurry with bentonite) at surface temperature@ 14 ppg.

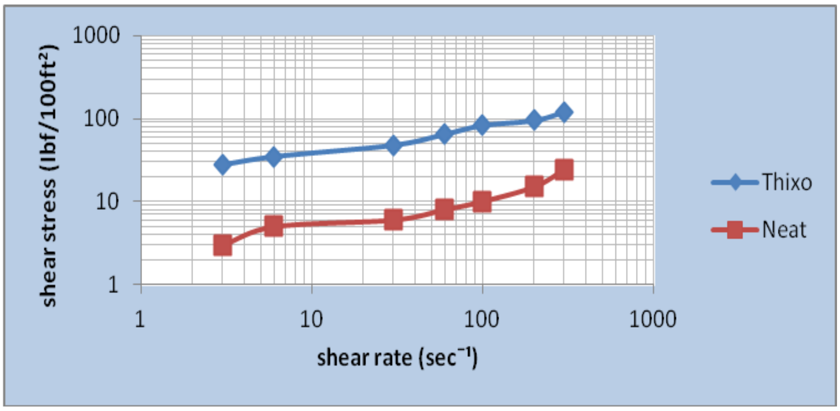

Figure 6 Share stress @ 14 ppg with different compositions

Cement slurries systems tested with different chemicals concentrations are shown in table 1.

Some solutions from executive study to cure losses are:
1) Test and optimize different cement slurries
2) Include fibers in the cement slurries
3) Study the bills

Table 1 Cement slurries systems that tested and optimized with different chemicals concentrations:

Systems	Definition	Density (ppg)	Products
System 1	Slurry compositions	12.5	Antifoam Bentonite
System 2	Slurry compositions	14.00	Antifoam Thixotropic
System 3	Slurry compositions	15.80	Antifoam

3. Conclusions

It is concluded that the cement slurry properties start to change at lower (few) time for high temperatures mixture. Cement slurry consistency of 70F is reached at higher settling time for lower cement slurry temperature of 100F compared with the cement slurry with higher temperature of 170F. The consistency as the settling time for cement slurry at 12.5 ppg higher for lower temperature which result in high resistance of cement to flow, but with experiments after adding the antifoam and extender,(increases the time and decreases cement slurry (CS)). While cement slurry at 14 ppg consistency is higher for lower temperature which result in high resistance of cement to flow, but in experiments after adding antifoam and thixotrop and retarder increase in time and increase CS.

Thixotropic slurry shows huge different in shear stress comparing with the extend slurry that has very low shear stress, this is an excellent indicator that thixotropic system will cure the losses much better than any other systems.

System 2 with thixotropic gives acceptable value of CS that can be drilled after curing losses and this is very important while drilling continues. Comparing with the system 1 which not proper set, and can cause the stuck pipe when run in hole with the drilling bit. While System 3 has very high CS which is not really needed in loss circulation system.

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