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Effects of Temperature on Fluid Loss Additive Used in Cement Slurries for Cementation

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Abstract: ***Studies have shown that the rheology of cement slurries used in oil well cementing operations is a function of temperature, additive type, cement grade, pressure, and concentration of the additives. The cementing operation can directly affect the drilling operations. This study aims to analyze the effect of fluid loss additives on different temperatures and slurry thickening time. Three experiments were conducted by changing the surface temperature of the slurry and the impact of Fluid Loss on thickening time was observed. The first result shows that when the temperature is kept at the standard conditions the thickening time of the slurry was the same as it was designed. The second result of the analysis revealed that when the temperature is increased by 10 degrees Celsius the thickening time of the slurry is increased by more than 3 hours as the fluid loss additive is highly affected by the high temperature and the fluid loss will release the water sooner than the standard design. The third experiment results showed when the slurry temperature was dropped to 18 degrees Celsius the thickening time of the slurry was increased by more than 12 hours due to the effect of temperature on the slurry as the slurry is unable to release the water from the slurry due to fluid loss additive. This study concludes that temperature fluctuations can significantly influence cementing operations and if those are overlooked, may lead to complications in the well. This helps in petroleum testing and fluid mechanics in the oil and gas industry.***

Keywords: PV and YP, Fluid Loss, Temperature, Slurry.

I. INTRODUCTION

Cementing operations play an important role in oil wells. Cementation is the process of cementing a well after drilling a section or complete drilling of the well is done [1][2]. Cementing involves mixing dry cement, cement additives, and water to make a cement slurry and pumping it down through the casing to the critical point in the annulus around the casing or in the open hole below the casing string. Cement slurry is generally designed considering pressure, temperature, fracture gradient, and formation properties. Proper design of the slurry is important as the thickening time of the cement varies as the quantity of the additive changes, where the amount of the cement additives and their concentration play an important factor in the thickening time of the cement slurry [3]. Thickening time refers to the pumpable period of the cement slurry, during which it must be pumped without exceeding the safety factor timing.

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If this period is surpassed, the cement may begin to set, leading to complications in the cementing operations. Sound knowledge of the rheology of cement slurries are required for the following reasons;

i. Appraisal of cement slurry mix ability and pumping pressure required to displace mud inthe annulus of the Casing 2 SPE-203628-MS.
ii. To estimate the effect of the borehole temperature profile for the placement of slurry.
iii. To estimate the pressure-depth relationship during and after cement slurry placement.
iv. Predicting the flow distribution and profile of cement slurry.

This study investigates the properties of cement slurries at various temperatures while maintaining constant additive concentrations. The insights gained from this analysis will assist Cementing Engineers in comprehending how additive concentration influences cement rheology under different temperature conditions.

II. THEORY AND LITERATURE REVIEW

Cement slurry is designed to be pumped considering downhole or bottom hole conditions like pressure, temperature, and fracture gradient of a well. In India, particularly in Gujarat, the fields generally do not exhibit extremely high temperatures, and at certain depths, they demonstrate nearly isothermal conditions. However, temperature variations can occur within the same field, leading to changes in the properties of the additives [1][4][6][7][8][9][10]. If those changes are not accounted for, they can negatively impact the cementing operations.

These conditions are important to consider while designing the cement slurry. Cementing is done for the following reasons:

i. To maintain the stability of the wellbore.
ii. To restrict the movement of fluid between formations.
iii. To establish zonal isolation.

Cementing is performed when the cement slurry is deployed into the well via pump, displacing the drilling fluid which is still located within the well, and replacing it with cement. The cement slurry flows to the bottom of the wellbore through the casing, which will eventually be the pipe through which the hydrocarbons flow to the surface. From there it fills in the space between the casing and the actual wellbore called annulus space, and hardens [4]. This creates a seal so that outside foreignmaterials cannot enter the well flow that disturbs the properties of oil flowing to the surface, and permanently position the casing in place [5].

Additives are added to the cement slurry to extend the thickening time of the cement slurry and make sure that the cement slurry is still pumpable during the operation. Thickening time is the time, in which cement slurry will form a gel-like structure and will start to set. These additives could include a deformer, retarder, extender, fluid loss, gas block, spacer blend, anti-setting, etc. In this study, wehave used a fluid loss additive kept its concentration at the same varied temperature, and monitored its effect on the thickening time of the cement slurry.

III. METHODOLOGY

Three (3) different cement slurries were prepared for this study. The first case was assumed to bethe base case, with all temperatures recorded under surface conditions. The remaining two (2) cases were designed to evaluate the effect of temperature on the fluid loss additive by varying the temperature of the slurry.

The components of the Cement slurries used for this study consist of:

i. Retarder
ii. Drill water
iii. Cement
iv. Deformer
v. Gas block
vi. Dispersant
vii. Fluid loss control

Apparatus used in the laboratory experiment includes: Sieve, weighing scale, mixing blender, Fann viscometer, atmospheric consistometer, and measuring cylinder

[Fig.1: Mixer Blender Used to Mix Cement Slurry]

[Fig.2: Viscometer Used for Rheology]

[Fig.3: Atmospheric Consistometer Used to Condition Slurry]

The following procedures were followed during the experiment:

i. The cement and additive were sieved and weighed using a sieve and weighing scale respectively, whereas the volume of water was measured using the measuring cylinder.
ii. Cement slurry was formed by mixing cement, water, and additives using the blender.
iii. The slurry was conditioned following the procedure set out in API RP 10B-2 to ensure that the atmospheric consistometer was at 194°F before commencing conditioning.
iv. The slurry was conditioned for 30 minutes ± 30 seconds at the test temperature, in this case 194°F.
v. The slurry is then kept outside to the surface to observe the thickening time and hardening time of the slurry.
vi. The thickening time of the slurry is observed and noted.

IV. PRESENTATION OF DATA AND RESULTS

A. Design of Experiment

A Total of 3 experiments was done using, one design considered as base slurry and the other two withincrease and decrease of the temperature as shown in the table:

S/N	Temperature in Fahrenheit	PV	YP
1	122	40	11
2	140	28	7
3	64.4	52	21

Design: 0.02gps Deformer+ 0.90% Fluid Loss+ 0.7% Dispersant+ 4% BondingAgent+ 0.10% Retarder

B. Result

Density: 15.8 lbs/gal
Manufacturer: Shree Digvijay Cement

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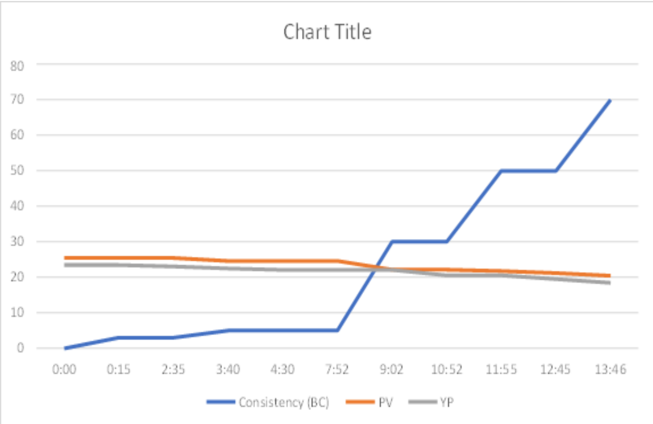
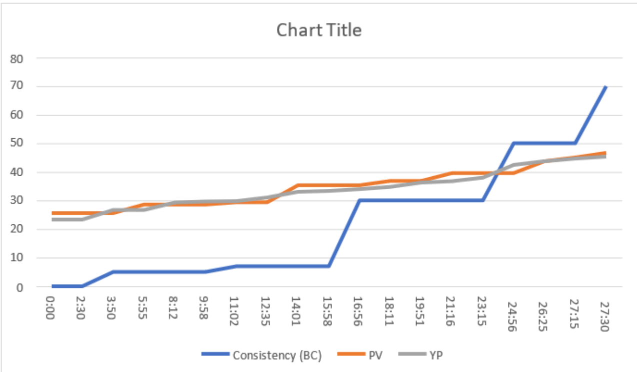
[Observation 1: Temperature 122F]

In the graph above we can see that consistency of 70 BC was reached as per the slurry design in17 hours.



[Observation 2: Temperature 140F]

The graph above shows that consistency of 70 BC is reached at 13 hours and 46 minutes which is more than 3 hours from the original slurry design.



[Observation 3: Temperature 64.4F]

In the graph above we can see the effect of temperature on fluid loss additive when the temperature is kept at 64.4 degrees Fahrenheit there is a vast difference in the slurry thickening and setting time. The results show an increase of more than 10 hours in the setting time.

V. CONCLUSION

- When the temperature was kept at 122 degrees the slurry was set at 17 hours with no changein PV and YP as per the design of the base slurry.
- When the temperature was 140 degrees the setting time of the slurry was reduced by morethan 3 hours.
- When the temperature was kept at 64.4 degrees the setting time of the slurry was increased by more than 10 hours.

From this study, we can conclude that the effect of temperature is inversely proportional to the fluid loss additive. This is due to the changes in temperatures on the fluid loss additive. If the temperature is raised the setting time can be decreased, but if the temperature decreases the setting time will be increased.

DECLARATION STATEMENT

I must verify the accuracy of the following information as the article's author.

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Aman. Subhash. Deshmukh, M.Tech student (Petroleum Engineering) at MIT-World Peace University with a strong interest in oil and gas cementing. My research focuses on the effect of temperature on fluid loss additives to understand changes in the thickening time of cement slurry. I am currently working as a lab engineer at Weafri Well Services Pvt. Ltd., with 2 years of experience in the field, applying my academic knowledge to real-world cementing operations.

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