Effect of addition sodium lignosulfonate additive in g class cement on thickening time and compressive strength

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Abstract. Cementing process was not good can be caused by the poor planning of cement slurry carried out in the laboratory. Poor cementing certainly cannot meet the expectations and goals of the cementing process. The purpose of this study was to select the right and optimal cement composition by testing sodium lignosulfonate retarder additives for thickening time and compressive strength. The methodology used in this study was laboratory testing using class G cement. The addition of sodium lignosulfonate additive in this class G cement was obtained the highest thickening time value at a concentration of 1.5% temperature 150 ° F for 24 hours test result.

1. Introduction
Cementing is the most important factor in drilling operations so that it can reduce the possibility of problems when drilling on the next route [1,2]. Failure in cementing is a huge loss, both material losses, time and costs [3,4]. The cause of failure in cementing can be caused by the imperfect mechanism of the cement slurry so that the annulus is not fully filled with cement slurry [5,6]. Other things can also be caused by the poor planning of cement slurry that is usually done in the laboratory. Poor cementing results certainly cannot meet the expectations and goals of cementing work [3].

To avoid all the possibilities of the above, various ways and efforts have been tried and developed to obtain optimal cementing results. In order for cement to have good characteristics, cement must have stable properties in various comparisons of cement and water, easily mixed and pumped, has good rheological properties, has adequate compressive strength, has long lasting strength, has a binding strength perfect both in the casing and in the formation, has a low permeability to avoid the occurrence of a relationship between the formation fluid with one another [7].

For this reason, so that cement can function properly and has the characteristics mentioned, the cement must be added with additives that are in accordance with the conditions in which the cement will be placed [6].

Sodium lignosulfonate is one of the retarders used to slow cement hardening so that it prolongs the pumping time of slurry so that it affects the cement compressive strength. Retarders are used in wells with depths of 6,000 - 25,000 ft.

2. Methods
This test is carried out based on the standards and requirements set by API and ASTM, and the conditioning is adjusted to the actual temperature at the time the drilling activity takes place. The
experiments conducted in the laboratory aimed to determine the effect of adding sodium lignosulfonate additives, based on the results obtained during the study [2,8]. The physical properties analyzed are compressive strength and thickening time with various temperatures.

The concentration of sodium lignosulfonate used is 0.5%; 0.7%; 0.9%; 1%; 1.3%; and 1.5% and will be measured at 80°F, 100°F, and 150°F.

Thickening Time experiments were measured using thickening time tester, penetrometer. The experiment was carried out to determine the time needed to reach the maximum consistency price of 100 BC (Bearden Unit of Consistency).

Figure 1 shows the workflow of the study starting with the prepare equipment and material, then making cement slurry [1,9-12], then adding sodium lignosulfonate in to cement slurry [5,13], then immersion cement slurry for 24 hours, then testing compressive strength and thickening time [14,15]. Obtained the composition of the cement with the strongest compressive strength and long thickening time [16,17].

![Figure 1. Flowchart of research work.](image)

3. Results and discussion

Table 1, 2 and 3 shows the results of Compressive Strength with additional Sodium Lignosulfonate at temperatures of 80 °F, 100 °F and 150 °F with 24 hours immersion time. In each experiment the volume of water used is the same. The greater the additive concentration, the more additives are included.

| Water (ml) | Cement (gr) | Properties | Additives | Compressive Strength |
|------------|-------------|------------|-----------|----------------------|
|            |             |            | %         | gram | psi    |
| 348.533    | 785.031     | 0.5        | 3.93      | 1229  |
| 348.533    | 779.541     | 0.7        | 5.49      | 1070  |
| 348.533    | 772.502     | 0.9        | 7.04      | 930    |
| 348.533    | 764.692     | 1          | 7.81      | 792    |
| 348.533    | 795.46      | 1.3        | 7.78      | 652    |
| 348.533    | 796.132     | 1.5        | 7.8       | 457    |
Table 2. Result of compressive strength at 100 °F.

| Water (ml) | Cement (gr) | Properties | Additives | Compressive Strength |
|------------|-------------|------------|-----------|----------------------|
| 348.533    | 785.031     |            | 0.5       | 3.93                 | 1540 |
| 348.533    | 779.541     |            | 0.7       | 5.49                 | 1408 |
| 348.533    | 772.502     |            | 0.9       | 7.04                 | 1268 |
| 348.533    | 764.692     |            | 1         | 7.81                 | 1155 |
| 348.533    | 795.46      |            | 1.3       | 7.78                 | 1031 |
| 348.533    | 796.132     |            | 1.5       | 7.8                  | 902  |

Table 3. Result of compressive strength at 150 °F.

| Water (ml) | Cement (gr) | Properties | Additives | Compressive Strength |
|------------|-------------|------------|-----------|----------------------|
| 348.533    | 785.031     |            | 0.5       | 3.93                 | 2893 |
| 348.533    | 779.541     |            | 0.7       | 5.49                 | 2679 |
| 348.533    | 772.502     |            | 0.9       | 7.04                 | 2456 |
| 348.533    | 764.692     |            | 1         | 7.81                 | 2233 |
| 348.533    | 795.46      |            | 1.3       | 7.78                 | 2013 |
| 348.533    | 796.132     |            | 1.5       | 7.8                  | 1793 |

Temperature plays a role in measurement compressive strength [18,19]. The higher the temperature, the greater the compressive strength [20,15]. This condition occurs at a temperature of 150 °F. In table 3 which is at a temperature of 150 ° the compressive value is highest compared to table 1 and table 2. But if the concentration of the additive is enlarged then the compressive strength value decreases. The value of compressive strength to be taken is adjusted to the longest thickening time to be used in deep wells [9,17,20].

Figure 2 shows addition to the sodium lignosulfonate additive the concentration given is 0.5; 0.7; 0.9; 1; 1.3 and 1.5. Obtained correlation of additive Sodium Lignosulfonate to Thickening Time.

Figure 2. Correlation of additive sodium lignosulfonate to thickening time.
In Figure 2 thickening time in three different temperature conditions shows a linear increase. Thickening time at temperature 150 °F is longer than when temperature 80 °F and 100 °F and also seen the higher the additive concentration added, the thickening time is longer. Thickening time plays a central role during slurry formulation because it is a measure of the time within which the cement is pumpable [9,21].

4. Conclusion
The addition of sodium lignosulfonate additive in this class G cement was obtained the highest thickening time value at a concentration of 1.5% temperature 150 °F. Additive Sodium Lignosulfonate is good for the work of cementing deep wells because it has a long thickening time and a high temperature. It can be seen that the decrease continues to occur due to the nature of this additive which prolongs the drying time. Based on the data that has been presented, temperature plays an important role in testing the thickening time of a cement sample.

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