Preliminary Studies Of The Possibility Of Using Local Cement In Oil And Gas Wells Cementing Operation In Malaysia

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ABSTRACT

Calcareous and argillaceous materials are the raw materials used in making odinary portland cement and portland cement class G with their main chemical compound consists of Tricalcium silicate, Dicalcium silicate, Tricalcium aluminate and Tetracalcium aluminoferrite. Currently, the class G cement used for the oil and gas wells cementing operations is imported from other countries. To overcome this matter, the suitability studies of locally produced cement were carried out according to the American Petroleum Institute (API) Specification method. Some of the test being run include determination of cement composition, free water, density, fluid-loss rate, compressive strength and slurry thickenig time. Generally, locally produced cement comply to the API Specification 10.

ABSTRAK

Bahan-bahan berkapur dan lempung merupakan bahan mentah utama yang di gunakan untuk menghasilkan simen portland biasa dan simen portland kelas G dengan sebatian kimia utamanya terdiri daripada Tricalcium silicate, Dicalcium silicate, Tricalcium aluminate dan Tetracalcium aluminoferrite. Sehingga kini, kesemua simen portland kelas G yang di gunakan di dalam proses penyimenan telaga minyak dan telaga gas di Malaysia masih lagi di import dari luar negara. Untuk mengatasi keadaan ini, kajian kesesuaian dengan menggunakan kaedah Spesifikasi American Petroleum Insitute (API) ke atas simen keluaran tempatan telah di lakukan. Di antara ujian yang telah di lakukan adalah penentuan kerencaman simen, air bebas, ketumpatan, kadar kehilangan air, kekuatan mampatan dan masa penebalan buburan. Secara amnya, simen keluaran tempatan menepati Spesifikasi API 10.

Introduction

Cement play an important role in sealing the annulus between the wall of the wellbore and the steel casing. Besides providing zonal isolation, cement also perfom two other important functions [iii]:

- to protect the casing against aggressive wellbore fluids, and
- to protect the casing against collapse by rock creeping in on the wellbore.

To achieve these aim, special type of oilwell cement is required and must comply with the specification laid down by the American Petroleum Institute (API) interm of the chemistry and the physical properties which have been accepted worldwide.

Currently in Malaysia, portland cement class G is being used during the oil and gas wells cementing operation and this material is imported from other countries. Therefore, affords have been made to study the suitability of locally produced cement to replace the G type cement.

In the process of evaluating these cements, understanding of the manufacturing process, the chemistry and the physical properties of portland cement are very essentials for the comparison and the modification at latter stage.

Manufacture of cement

The basic raw materials used to manufacture Portland cement are generally a mixture of calcareous (calcium oxide) material such as limestone, chalk or shells, and an argillaceous (silaca and alumina) materials such as clay, shale or blast - furnace slag.

These materials are blended together, either by wet or dry process and then fed into a rotary kiln, which fuses the limestone slurry at temperature from 2600 ^{o} F to 3000 ^{o} F into a material called cement clinker. Upon cooling, the clinker is pulverized and blended with a small amount of gypsum which controls the setting time of the finish cement.

The operations of all cement plants are basically the same. However, there is no typical Portland cement manufacturing plant because every plant has significant differences in layout, equipment or general appearance.

Chemistry of cement

From a chemical standpoint the materials blends may be considered to be a mixture of the oxides of calcium (CaO), alumina (Al_2O_3), silica (SiO_2), magnesium (mgO), iron (Fe_2O_3), potassium (K_2O), and sodium (Na_2O). During heating to the temperature of about 2700 ^{o} F, these oxides combine to form calcium silicates and aluminates which commonly reffered to as clinker.

Materials studied

Locally produce portland cement and imported portland cement class G were studied. Laboratory work were carried out on dry cement powders, liquid cement slurries and hard set cements.The performed tests were chemical analysis by chemical method according to ASTM C 150, free water, density by Preesurized Fluid Density Balance, fluid- loss rate by Filter Press (room temperature, 100 psi.) ,thickening time by High Pressure and High Temperature (HPHT) Consistometer, and compressive strength by Compressive Strength Machine. All the physical properties tests being run according to API Specification 10 method and three tests were run for each sample and the average value is recorded.

Results and discussion

Table 1 shows the oxide minerals and the chemical compounds for both types of cements evaluated during this study. Generally, the content of oxide minerals and chemical compounds are more or less the same except for the content of alumina oxide, Tricalcium silicate and Tricalcium aluminate. The low content of alumina in G cement will result in lowering the Tricalcium aluminate compound and increasing the Tricalcium silicate compound which both of these materials will produce low heat of hydration, high early strength and more resistance to the sulfate attack.

Table 2 shows the amount of free water obtained after the test being conducted. Locally produced cement has a better free water control compared to G cement. These results are expected due to the high heat of hydration being produced during hydration and also because of the higher content of Tricalcium aluminate which will absorb most of the water during the hydration period.

The rate of fluid loss obtained during the test are given in Table 3. Locally produced cement seem to loss the fluid at a lower rate compared to G cement. The high rate of hydration and the high heat of hydration of locally produced cement are reasons why little amount of water being collected at each interval.

The density obtained during the experiment is shown in Table 4. The locally produced cement has a little higher value compared to the G cement and this is caused by the high rate of hydration of the locally produced cement.

For the compressive strength test, samples were cured at 30 ^{o} C and 60 ^{o} C with atmospheric curing pressure for eight hours period. Results of the experiment are given in Table 5. The locally produced cement has a little less strength compared to G cement. High rate of hydration and a little low in tricalcium silicate are reasons why the strength is a little less.

Slurry thickening time samples were tested according to API Specification 10 schedule number 5 and the results obtained during this study are given in Table 6. Locally produced cement tend to harden a little faster due to the high content of Tricalcium aluminate and the high rate of hydration.

Conclusion

The tested locally produced cement prove to have the characteristics and the properties suitable for application in the oilwell cementing operation. However, by lowering the content of Tricalcium aluminate, by adding additives or by blendding with pozzolanas materials, better results can be expected.

Bibliography

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Table 1. Oxide Minerals And Chemical Compound Of Locally Produced And G Cements.

Oxide	G cement %	Local cement %
Silicon dioxide	22.15	20.80
Aluminium oxide	3.44	5.33
Iron oxide	4.64	4.03
Calcium oxide	65.13	64.10
Magnesium oxide	0.71	0.65
Sulfur trioxide	2.18	2.10
Sodium oxide	0.10	0.06
Potassium oxide	0.50	0.67
Loss On Ignition	1.11	1.55
Chemical Compound		
Tricalcium silicate	60.77	55.30
Dicalcium silicate	17.99	18.24
Tricalcium aluminate	1.27	7.31
Tetracalcium aluminoferrite	14.11	12.24

Table 2. Results Of Free Water Test.

Sample	G cement ml	Local cement ml
Sample No. 1	1.30	0.50
Sample No.2	1.20	0.90
Sample No.3	1.00	0.30

Table 3. Fluid Loss Test Results.

Time min.	G cement ml	Local cement ml
0.25	38.0	36.0
0.50	58.0	55.0
1.00	86.0	82.0
2.00	120.0	112.0
5.00	142.0	128.0
10.00	155.0	140.0
15.00	162.0	146.0
20.00	164.0	147.0
25.00	165.0	147.7
30.00	165.8	147.9

Table 4. Density Of The Samples.

Sample	G cement ppg	Local cement ppg
Sample No.1	15.60	15.63
Sample No.2	15.40	15.58
Sample No.3	15.61	15.60

Table 5. Compressive Strength Cured At 30 ^{o} C For 8 Hours Period.

Sample	G cement psi	Local cement psi
Sample No.1	400.0	370.0
Sample N0.2	410.0	390.0
Sample No.3	390.0	365.0

Table 6. Compressive Strength Cured At $60\ ^{o}C$ For 8 Hours Period.

Sample	G cement psi	Local cement psi
Sample No.1	1750.0	1600.0
Sample No.2	1620.0	1570.0
Sample No.3	1700.0	1590.0

Table 7. Thickening Time of The Samples

Sample	G cement min.	Local cement min.
Sample No.1	115.0	95.0
Sample No.2	117.0	100.0
Sample No.3	111.0	98.0