

The Effect Of Adding Palm Oil Fly Ash To The Development Of Strength On Oilwell Cement

Shahrin Shahrudin, Ariffin Samsuri, Ahmad suhaimi,
Abu Samah Nasir and Zainuddin Ahmad
Cement Research Group
Petroleum Engineering Department

ABSTRACT

Calcareous and argillaceous materials are raw materials used in making oilwell cement class G with their main chemical compound consists of Tricalcium silicate, Dicalcium silicate, Tricalcium aluminate and Tetracalcium aluminoferrite. Pozzolanic reactions existed in some of the fly ashes when added with water helps in improving the cement strength when they are added to the cement. Therefore, palm oil fly ash, a locally waste material is chosen for the study. Chemical analysis according to ASTM C 115 were carried out to determine the composition. Compressive strength tests were carried out according to American Petroleum Institute Specification 10 and were conducted at simulated reservoir condition. The analysis and the results proved that palm oil fly ash is a pozzolan material and can be used to improve the strength development of the oilwell cement.

INTRODUCTION

Cement plays an important role in sealing the annulus between the wall of the wellbore and the steel casing. Besides providing zonal isolation, cement also perform two other important functions:¹ 1) to protect the casing against aggressive wellbore fluids, and 2) to protect the casing against collapse by rock creeping in on the wellbore

In oil and gas production, the cement strength data are useful for:² 1) establishing Wait On Cement (WOC) time, 2) determining the optimum time to perforate, and 3) monitoring the stability of the set material

From a chemical standpoint, the material 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 1450°C , these oxides combine to form calcium silicates and aluminates which commonly referred to as clinker.

Fly ashes are heterogenous fine powder consisting mostly of rounded or spherical particles of variable silica (SiO_2), alumina (Al_2O_3) and iron (Fe_2O_3) content. The structures, composition and properties of the particles depend upon the structure, composition and the combustion processes by which they are formed.³

Currently, only coal ash is the popular pozzolan being used as a pozzolanic material that is added to the blended cement. With the same characteristics and chemical composition, palm oil fly ash, a locally waste material has been chosen to be studied with the class G cement for its suitability as a pozzolanic material.

The purpose of this paper is to present the results of laboratory studies on the development of strength of class G cement when it is added with a different percentage of palm oil fly ash by weight of cement.

LABORATORY WORK

Palm oil fly ash and imported class G cement were studied. Laboratory works were carried out on dry palm oil fly ash, dry cement powder and hard set cement. The performed tests were chemical composition and the compressive strength development. The chemical analysis was done by wet analysis method. The compressive strength development tests were conducted by closely followed the Specification for Materials and Testing for Well Cements (API) Specification 10, Fifth Edition, July 1, 1991).⁴ and was tested at simulated reservoir condition.

COMPRESSIVE STRENGTH TEST

Slurry is prepared according to section 5 API Specification 10, and immediately poured in the prepared molds in a layer equal to 1/2 the mold depth and puddled for 25 times per specimen with a puddling rod. After puddling the layer, the remaining slurry is stirred to eliminate segregation and the molds are filled to overflowing and puddled as before. The prepared molds are then placed in the high pressure high temperature curing chamber and cured according to schedule 5g, Well Simulation Test Schedules for Curing Compressive Strength Specimens for a period 8 hours, 24 hours, 3 days and 7 days and then removed and crushed with the compressive strength testing machine.

RESULTS AND DISCUSSION

CHEMICAL ANALYSIS

Table 1 shows the oxide minerals of the palm oil fly ash and the class G cement. The oxide minerals existed in the palm oil fly ash are reasonably good in terms of their pozzolanic activities as their content fall within the Malaysian Standard (MS 1226 : 1991) set for the ashes to be used in the blended cement. For G cement, at 1450 ° C these oxides will react between each others and will form the four major compounds that existed in the end product and their percentage is shown Table 2. With quite low in aluminium oxide content the produced Tricalcium aluminate will be reasonably low and the cement will serve its purpose as a high sulfate resistance cement with low rate of hydration.

COMPRESSIVE STRENGTH TEST ANALYSIS

Results of compressive strenght test cured for different period are shown in Table 3. There is an increased in cement strength for 8 hours, 1 day, 3 days and 7 days curing period when 5 % of palm oil fly ash is added to the neat cement. The pozzolanic reactivity provided by the ash has helped in developing the extra gel of tricalcium silicate hydrate which contribute to the strength development. The results also shown that, by increasing the ash content further to 10 %, 15 % and 20 %, a further increase in strength development of the cement can be achieved. It was found that, the best results in strength development of the cement can be achieved when 15 % of the ash is added to the cement. A reduction in cement strength can be noticed when 20 % of the ash is added but the strength is still higher as compared to the neat cement strength. Further increase the ash content to 25 % will results in a reduction of strength below the strength of the neat cement and this is due to the too much pozzolanic activities which does not further helps to enhance the strength of the cement but to reduce the strength. The strength development progress for these cement mixture are clearly shown in Figure 1,2 and 3.

CONCLUSION

From the chemical analysis and the laboratory studies, it proves that palm oil fly ash is one of the ashes that has a good pozzolanic materials in it. Its also helps in improving the strength development of the cement and the increase in strength development is proportion to the amount of the ash added to the neat cement. The best results can be achieved when 15 % of the ash is added to the neat cement and further increased to more than 20 % of the ash will result in a decreasing in strength.

REFERENCE

1. John Bensted, 1987. Cement with a specific application - oilwell cement, pg 72-79.
2. Exxon Production Research Company, Completion Section, December 1983
3. Richard Helmuth, Fly Ash in Cement and Concrete, Portland Cement Association, Research and Development Laboratories, Old Orchard Road, Skokie, Illinois 60077, USA.
4. API Specification 10, July 1, 1990. Specification For Materials and Testing For Well Cements. American Petroleum Institute, 1220 L Street, Northwest, Washington DC, USA.

TABLE 1
OXIDE MINERALS OF CEMENT AND PALM OIL FLY ASH

OXIDE	G CEMENT (%)	FLY ASH (%)
CALCIUM OXIDE	65.13	18.48
SILICON DIOXIDE	22.15	48.05
IRON OXIDE	4.72	8.33
ALUMINIUM OXIDE	3.57	5.87
MAGNESIUM OXIDE	0.71	4.47
SULFUR TRIOXIDE	2.18	1.21
POTASIUM OXIDE	0.35	8.54
LOSS OF IGNITION	1.13	4.3

TABLE 2
CHEMICAL COMPOUND OF G CEMENT

COMPOUND	PERCENT
TRICALCIUM SILICATE	59.7
DICALCIUM SILICATE	18.81
TRICALCIUM ALUMINATE	1.48
TETRACALCIUM ALUMINOFERITE	14.37

TABLE 3
COMPRESSIVE STRENGTH CURED AT DIFFERENT PERIOD ACCORDING TO SCHEDULE 5G API SPECIFICATION 10.

SAMPLE	8 HOURS STRENGTH (psi)	1 DAY STRENGTH (psi)	3 DAYS STRENGTH (psi)	7 DAYS STRENGTH (psi)
G CEMENT	1650	2800	3100	3120
G CEMENT + 5 % FA	1700	3000	3200	3260
G CEMENT + 10 % FA	1850	3250	3500	3550
G CEMENT + 15 % FA	2000	3500	3800	3850
G CEMENT + 20 % FA	1900	2700	3500	3300
G CEMENT + 25 % FA	1500	2650	3000	2950

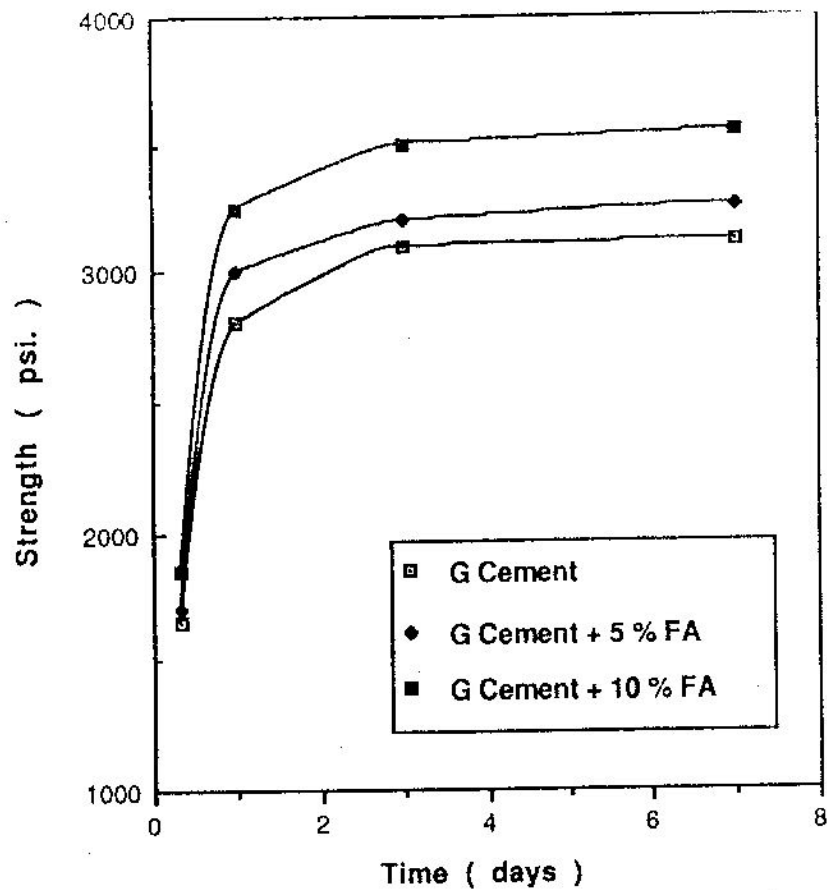


Figure 1: Strength profile cured according to schedule 5g Api Specification 10.

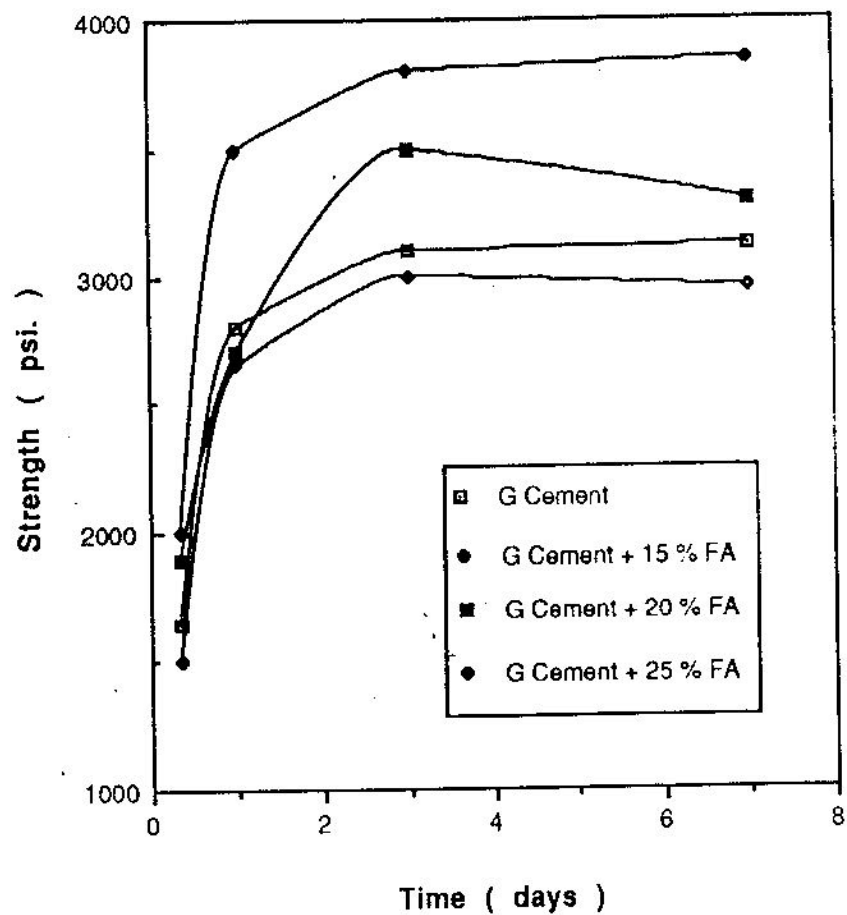


Figure 2 : Strength profile cured according to schedule 5g API Specification 10.