11th International Conference
on Advanced Materials
Rio de Janeiro Brazil
September 20 - 25
ICAM2009

Effect of curing temperature on the mechanical behavior of oilwell cementing composites

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Abstract – Composite cementing slurries for oilwell applications were cured under different temperatures and subsequently evaluated by compressive strength tests. Contrary to plain Portland slurries, no considerable loss in strength was observed by increasing the curing temperature. X-ray diffraction and fluorescence tests indicated the presence of Xonotlite as well as low Ca:Si ratio in hardened slurries with high strength and low permeability cured at 280 ºC.

Steam injection is a recovery technique commonly applied to heavy oils. The injection of steam at temperatures ~200 ºC and high pressures reduces the viscosity of the oil and increases its mobility towards the production well [1]. Although conventional cementing slurries withstand high temperatures and pressures, thermal cracking usually occur as result of their brittle nature. Polymers can then be added to the composition of slurries to increase their fracture energy under thermal cycling. In addition, silica is also added to the slurries to prevent retrogression above 110 ºC [2-3]. The objective of the present study was to cure plain and composite slurries containing silica and a temperature-resistant polymer under low (47ºC) and high temperature (280 ºC) and evaluate the resulting compressive strength. All samples were initially cured in thermostatic bath during 28 days. After that, some samples were further cured under the same conditions for 7 additional days, whereas a group of samples were cured in a chamber at 280ºC during the same period of time. The latter procedure simulates the conditions encountered during a cementing operation at 500 m with further steam injection. The hardened samples were tested in a Shimadzu Autograph AG-I mechanical testing machine. Tested samples were crushed and characterized by X ray diffraction and fluorescence.

The samples cured only in thermostatic bath depicted low strength even with the addition of silica or polymer. Silica partially replaces the cement whereas the compressive strength of polymers is naturally lower that that of the cement. Upon further curing at 280 ºC, only the plain samples depicted low strength. Slurries containing silica were characterized by high strength, even those containing a polymer in their composition. The addition of silica prevents the retrogression of the slurry, which compensates for the addition of polymer. The net result is composite slurries with compressive strengths higher than those depicted by the plain slurry and adequate for oil well cementing (> 17.9 MPa) [4]. X-ray diffraction and fluorescence tests indicated the presence of Xonotlite as well as low Ca:Si ratio in hardened slurries with high strength cured at 280 ºC. This phase results from the transformation of hydrated calcium silicate of the cement above 150 ºC.

References

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