



**IADC/SPE 08092**

## **Cementing High Pressure Formations in the Kingdom of Saudi Arabia**

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This paper was prepared for presentation at the IADC/SPE Asia Pacific Drilling Technology Conference and Exhibition held in Jakarta, Indonesia, 25–27 August 2008.

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### **Abstract**

Cementing deep high pressure and high temperature (HPHT) gas wells has always been a challenge. Conventional heavy weight cement systems which have been used in the past have often had to sacrifice the set cement mechanical properties such as compressive strength, permeability, and porosity, to provide a slurry design which is stable, mixable and pumpable. Utilizing an optimized High Density High Performance Slurry (HDHPS) the challenge has been successfully overcome for the HPHT in the Ghawar Reservoir in the Kingdom Of Saudi Arabia. The concept of the particle size distribution was applied to provide a cost effective solution to cementing of these HPHT wells.

The packing volume fraction was optimized for the cement blend. As a result, the slurry properties become a function of the dry blend instead of the additives in the slurry system. Particle Size Distribution optimizes both slurry and set cement properties simultaneously. The permeability and porosity of the set cement are reduced due to improved particle packing of the system. In addition, the rheological properties are improved which alleviates settling problems commonly encountered with conventional high density cement slurries.

Extensive lab testing and yard trial prior to field application demonstrated the superior performance of these slurries over conventional cements in both the liquid phase and when set.

To date, four 9 5/8" casing strings and two 7" Liners have been isolated in the Jilh formation using HDHPS technology, with cement weights above 20 ppg (2400 kg/m<sup>3</sup>). Details of the slurry technology are presented along with data documenting the jobs performed to date in Kingdom of Saudi Arabia. The system is widely accepted by Saudi Aramco and is the preferred system for critical high pressure cementing.

### **Introduction:**

While drilling 12" holes for gas wells, in the Kingdom Of Saudi Arabia, a very high pressure zone (Jilh) is encountered, at 10000-11000 ft in the different parts of the Ghawar Reservoir. Currently, mud weights ranging from 18.7 – 23.1 ppg (2245 – 2775 kg/m<sup>3</sup>) are required for primary well control and furthermore there is a very a small window between the pore pressure and the fracture pressure of this formation.

Conventional heavy weight cement systems which have been used in the past have often had to sacrifice the set cement mechanical properties such as compressive strength, permeability, and porosity, to provide a slurry design which is stable, mixable and pumpable. Recently this high pressure formation has been isolated utilizing an optimized High Density High Performance Slurry (HDHPS). The concept of the particle size distribution was applied to provide a cost effective solution to cementing of these HPHT wells.

This paper will briefly describe the slurry technology and present job data documenting the jobs performed to date.