Proper cementing operations key to zonal isolation

CEMENT DESIGN

The need to design a fit-for-purpose cement sheath was recently emphasized in the HPHT Shearwater Field when on all production wells, annular pressures were observed after the displacement fluid was changed over to a well-completion fluid (in preparation for under balanced perforation). Such annular pressures may result in an inability to produce the reservoir, which fully erodes the value of the asset.

This paper discusses the troubleshooting of a failed cement design experienced in the Shearwater Field. The methodology was used to optimize the design of future Shearwater wells (and similar HPHT fields), resulting in the specification of improved cement systems/methods.

Optimizing the Cement Sheath Design in the HPHT Shearwater Field (SPE/IADC 79905) by **M Bosma**, **Shell International E&P**;' **O Gasebled**, **TNO Construction and Research**; **K Ravi**, **Halliburton Energy Services**.

PRESSURE GAUGES

Several problems can be experienced during liner cementing operations. While most are minor and do not compromise the well performance, they can increase well costs. The main problem areas are in the performance of wiper plugs, pressure variations when setting liners and shearing of ball seats. This paper discusses how downhole pressure measurements can be used to improve liner installation operations.

Use of Pressure Gauges in Liner Running Strings During Liner Cementing Operations (SPE/IADC 79906) by **J Brehme**, **Mobil North Sea**, **A D Bain**, **Weatherford Completion Systems**; **A Valencia**, **Halliburton**.

TIEBACK CEMENTING

New cementing technologies have been applied to cementing production tieback strings in hot, deepwater wells in the Gulf of Mexico. Applied in two separate fields, the purpose of these technical advances is to maintain long term bonding to keep tieback strings from failure during high temperature production.

The paper explains the purposes and details of these new tieback cementing technologies, including slurry design, equipment layout and job procedures.

Advances in Tieback Cementing (SPE /IADC 79907) by **K L Harris**, **E S Snell**, **Halliburton**; **D R Algu**, **D P MacEachern**, **SEPCO**; **M Cowan**, **Shell International E&P**.

Foamed cement has been successfully introduced and fulfills the requirements of cementing. Data from five conventional and nine foam cement jobs in the Eldfisk field indicate that foam outperforms conventional cement for zonal isolation. Foam cement piping is shown above on the Eldfisk platform.

SHOCK RESISTANT CEMENT

New cement slurries that focus on optimizing the mechanical durability of the set cement property through the implementation of particle size optimization and micro-ribbon technology have been developed for oil well cementing applications. These slurries have resulted in significant improvements in the efficiency and cost reductions to operators for sidetracking operations

The new cement system can reduce average sidetracking time by more than half. By applying micro-ribbon technology and particle size optimization the mechanical properties of the set cement have been optimized to improve durability, impact resistance and resistance to fracture propagation far beyond conventional cement systems. This new technology can be used wherever cement is submitted to extreme mechanical stresses during the life of the well.

New Shock Resistant Cement Reduces the Required Time for Side-Tracking from Kick Off Cement Plugs (SPE /IADC 79908) by **A Babasheikh**, **E Cunningham, H Helou**, **Schlumberger**; **C Hun**, **ADCO**.

SELECTING FOAM CEMENT

During the development phase of the Shearwater HPHT field in the Central Graben area of the North Sea, poor zonal isolation led to significant annulus pressure on five of the six production wells.

To satisfy considerations for future development of this field, the zonal isolation process previously employed was investigated. A detailed engineering study was completed to determine the mechanical properties necessary for the cement slurry and further to design such a cement system to achieve these properties.

This paper describes the design criteria for the cement slurry, the rationale behind selecting a foamed slurry, and the subsequent job execution.

Selection of Foam Cement for HPHT Gas Well Proves Effective for Zone Isolation - Case History (SPE/IADC 79909) by **M Pine**, **Shell UK E&P**; **J Adam, J E Griffith**, **L Hunter**, **J Mutch**, **Halliburton**.

FOAM CEMENT IN N SEA

Data gathered from 14 (five conventional, nine foam) production wells on the Eldfisk field in the North sea indicate that foam cement outperforms conventional cement for zonal isolation and dynamic curing of losses.

Foamed cement has been successfully introduced and is believed to have fulfilled the requirements of cementing in this challenging field. Since its introduction nine jobs were performed with success. The criteria for success have been measured from operational performance, fluid diversion during stimulation and CBL evaluation.

Foam Cementing on the Eldfisk Field - Case Study (SPE/IADC 79912) by **K M Green**, **P G Johnson**, **Phillips Petroleum**; **R Hobberstad**, **Halliburton**.

CEMENT EXPANSION

Ongoing problems with sustained annular gas pressure on producing wells worldwide is a prime indicator that more work is needed in understanding how cement system design can impact long-term annular isolation. One important area is the relative expansion or shrinkage of cement systems as they hydrate in the annulus of a well.

The authors detail new methodology and test equipment that allows for the tracking of cement shrinkage and/or expansion real-time, under downhole conditions of pressure and temperature.

Real-Time Cement Expansion/Shrinkage Testing Under Downhole Conditions for Enhanced Annular Isolation (SPE/IADC 79911 - Alternate) by **V C Gobancan**, **R L Dillenbeck**, **BJ Services Co**.

FORMATION STABILITY

Managing formation stability should be an integral part of well construction from drilling through cementing and completion operations. Formation stability while drilling has been recognized and is an ongoing study in the petroleum industry. Given a stable wellbore at the end of the drilling phase, if the cement and space properties are not optimized then the formation could be de-stabilized during cementing. This could adversely impact the well construction and subsequently the well productivity.

Understanding Formation (In) Stability During Cementing (SPE/IADC 79913 - Alternate) by **K Ravi**, **U Tore**, **J Heathman**, **Halliburton Energy Services**.

Directional drilling technology reaching new lengths

CASING DIRECTIONAL DRILLING

Growing commercial activity indicates increasing acceptance of drilling with casing to reduce drilling costs and solve drilling problems. Most of this activity has been focused on drilling vertical intervals, but interest in drilling with casing in directional wells is increasing as the processes for drilling straight holes become proven and more versatile tools become available.

The Tesco Directional Casing Drilling system wireline retrievable directional drilling assembly, positioned in the lower end of the casing, replaces the directional tools used in a conventional BHA.

These tools have been retrieved and rerun at inclinations exceeding 90 degrees. The casing can be reciprocated and circulation maintained while running or retrieving the tools to assure that the casing does not become stuck.

The authors will provide a description of the tools that are used for directional drilling with casing; show Casing Drilling results for both low angle and high angle wells; discuss BHA selection for use with Casing Drilling operations; and show the viability and advantages of Casing Drilling in directional wells.

Directional Drilling with Casing (SPE/IADC 79914) by **T M Warren**, **G Modell, B Houtchens**, **Tesco Corp.**

AZIMUTH AND INCLINATION

An alternative technical solution introducing the ability to control both azimuth and inclination through standard rotary BHA is discussed. It is based on a patented principle consisting of the ability to master bit and BHA walk-tendencies, through 'down-hole friction management', at the level of a given stabilizer. An innovative technical solution is proposed, through a simple and fully mechanical stabilizer combining variable blade and 'clutchable' non-rotating sleeve.

This large-hole rotary steerable system was designed, tested and deployed by BP and Schlumberger over a period of nine months.

A group of companies, led by TotalFinaElf, has enabled the design, construct and field-test of a prototype of a new tool called 'Gyrostab' which has demonstrated the new trajectory control principles and potentials.

Gyrostab Project "The Missing Link": Mastering Azimuth and Inclination Through New Principles Adapted to Standard Rotary BHAs (SPE/IADC 79915) by **J M Genevois**, **TotalFinaElf**; **J G Boulet**, **SMF International**; **C J A Simon**, **Drillscan**.

ROTARY STEERABLE SYSTEM

A successful introduction and application of a rotary steerable system for large hole sizes (17 1/2-in. and 18 1/4-in. in.) is described. BP and Schlumberger created and deployed this new capability while working on a major development project. Together, they focused on the rapid acceleration, construction, and field testing of the rotary steerable system.

Over a period of nine months, the rotary steerable system was designed, tested, and deployed by teams working concurrently in the UK and the USA. Initial field trials proved successful with the system achieving the required kickoff from vertical of more than 3°/100 ft buildup rate.

Development and Application of a Large-Hole Rotary Steerable System: Accelerating New Technology Introduction Through Successful Collaboration (SPE/IADC 79916) by **K Armagost**, **BP**; **D Pafitis, M Wernig**, **Schlumberger**.

DIRECTION AND INCLINATION

The measurement of continuous real-time inclination provides near instantaneous calculations of build-up rate tendency of the bottomhole assembly in both rotary and slide drilling modes. The addition of an accurate azimuthal measurement now allows for the calculation of wellbore position with this continuous data. When wellbore position is calculated with the continuous surveys a significant discrepancy from the stationary surveys can occur.