# Cementing operation key to effective zone isolation

**ZONAL ISOLATION IS CRITICAL** to delivering a successful oil or gas well completion as well as being a key to safety. Cementing operations are particularly challenging in difficult formations and complex well configurations.

A session at the 2002 IADC/SPE Drilling Conference in Dallas, 26-28 Feb, focuses on how to provide effective isolation. **D T Mueller** chairs the session.

## REDUCING FAILURE RISK

One of the main objectives of a primary cementing job is to prevent formation fluids from migrating into the annulus. To achieve this objective, the cement sheath should withstand the stresses induced by the various operations and maintain integrity during the life of the well.

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**IADC/SPE 74497**

IADC/SPE paper 74497, "Improve the Economics of Oil and Gas Wells by Reducing the Risk of Cement Failure," reports on a design procedure developed for estimating the risk of cement failure as a function of cement sheath and formation properties and well loading.

Examples of the loading are cement hydration, pressure testing, well completion, and production.

**K Ravi**, **Halliburton Energy Services** and **M Bosma**, **Shell International,** prepared the paper for the Conference.

The design procedure is based on a rigorous finite element analysis and simulates the sequence of events from the time the well is drilled through cement hydration, well completion, hydraulic fracturing and production. Cement failure modes simulated are de-bonding, cracking and plastic deformation.

An appropriate nonlinear material model, including cracking and plasticity, is used in the analysis. The cement is assumed to behave linearly as long as its tensile strength or its compressive shear strength is not reached.

The material model adopted for undamaged cement is a Hookean model bounded by smear cracking model in tension and an appropriate model such as Mohr-Coulomb in the compressive shear. The shrinkage/expansion of cement is included in the material model.

## SALT ZONE CEMENTING

Salt zone cementing is still a challenge. IADC/SPE paper 74500 presents a unique theoretical and experimental research project developed to support salt zone cementing operations in Campos basin, offshore Brazil.

The approach includes the development of a numerical simulator that reproduces the mass transfer phenomena involved in the displacement of a cement slurry in front of a salt formation. The formulation is based on the solution of a well-known diffusion-convection equation for the flow of a fluid through an annular section, being the external wall soluble.

Experimental work includes the determination of salt mass transfer rates to cement slurries flowing through a large-scale flow loop where the internal wall was formed by real halite cores. Mass transfer coefficients are then fed into the computer model.

"Dynamic Simulation Of Offshore Salt Zone Cementing Operations," was prepared for the Conference by **A L Martins** and **C Miranda**, **Petrobras**.

The results obtained by running the simulator allow proper slurry composition design and the definition of hydraulic parameters required for minimizing salt dissolution.

## SPACER RHEOLOGY

IADC/SPE paper 74498 presents a new method to design the optimum composition of a spacer fluid used for mud removal in a cement job.

The method integrates two steps: determining the ideal spacer properties from the knowledge of well conditions, mud and cement properties; and designing the fluid composition to achieve these properties. "Optimization of Spacer Rheology Using Neural Net Technology," was prepared by **B E Theron**, **D Bodin** and **J J Fleming**, **Schlumberger**.

The first step is based on well-accepted requirements for spacers, including friction pressures and density hierarchy criteria. The second step is based on a neural network model developed from an extensive database of fluid properties, where all key variables were moved—composition, spacer density, and temperature.

A software module simulates and displays the mud-removal performance of the proposed design.

Several years of field experience demonstrate this integrated method has advantages in two areas, according to the authors. First, the display of mud-removal performance in a graphical way enables better and faster job design. Second, the method achieves fluids with the required properties in significantly less time than conventional methods because fewer fluid samples are mixed.

## REMOTE LOCATIONS

Innovative solutions for drilling problems can be developed offsite, concurrently with the drilling operations, for implementation in remote areas having no local support.

IADC/SPE alternate paper 74501, "Support Requirements and Innovative Solutions for a Remote Location with Difficult Cementing Challenges," describes a project in Kazakstan. It was prepared by **B M Piot**, Schlumberger; **K F Lamb** and **E L Biessen**, **Texaco**; and **A Zhukin**, **R Schafers** and **A Ferri**, Schlumberger.

Drilling and cementing problems in Kazakstan's remote Magistau area brought the innovative implementation of a new slurry technology based on engineered particle size distribution, which was designed to solve the problems resulting from gas influx and fluid losses during cementing.

North Buzachi is an undeveloped onshore field 180 km north of Aktau. In the exploratory phase both vertical and horizontal well technology were effective, and there were no drilling problems. Local technical support for the cementing operations consisted of a coordination engineer in Aktau and laboratory capability from 1,000 km away.

The appraisal phase was based on conventional procedures used in the exploratory phase. Wells drilled in new parts of the reservoir experienced unanticipated fluid losses and gas influx. These problems continued despite continuous improvements devised with available materials.

To solve these problems, the service company's area client support laboratory engineered several new designs for removing mud and controlling losses and gas influx at the same time.

A solution based on the worst-case scenario was used, and a cement program was designed that improved mud removal and incorporated a preblended low-density slurry, the authors report. The flexibility of the new system enabled selection of a very low density that would prevent losses in the weakest parts of the reservoir while preventing gas influx. The design also enabled density increases of 1 lbm/gal without affecting slurry properties.

The new slurry was used in the last 4 wells of the campaign. Density was varied on site without logistical difficulties or impairment of performance. The results from these 4 wells were the best obtained in the campaign, as shown by the cement bond logs.

## FILTER CAKE REMOVAL

Removal of the filter cake formed during drilling is essential for a successful cementing job.

Today, the use of synthetic base fluids makes it important to evaluate the efficiency of the washers/spacers in removing filter cake and to guarantee the wettability inversion of the formation from oil to water wet.

IADC/SPE alternate paper 74502, "A New Method of Evaluating the Filter Cake Removal Efficiency," describes a new method of evaluating the filter cake removal performed by different washers using a core. The process is followed by x-rays and the removal efficiency is calculated using x-ray tomography.

This method makes it possible to quantify the remaining filter cake compared to the original filter cake.

The paper was prepared for the Conference by C R Miranda, Petrobras SA; **J C Leite**, **Petrobras Research Center**; and **R T Lopes** and **L F de Oliveira**, **Federal University of Rio de Janeiro**.

According to the authors, the process makes its possible to follow the period of contact of the wash with the formation.

It also makes it possible not only to select the most appropriate wash for a given drilling fluid, but also to predict the necessary contact time between the wash and the formation to achieve an appropriate filter cake removal. ■