Environment: Cuttings re-injection moves to fore

IADC/SPE 59115

The Mounds Drill-Cuttings Injection Field Experiment: Final Results and Conclusions

Drill-cuttings disposal by subsurface injection, if properly engineered and executed, is an economic and environmentally advantageous solution for oil and gas production operations with zero-discharge requirements. Disposal injections have been previously performed in several formations and at significant depths where it is unlikely that contamination of fresh-water aquifers could occur. Unlike many of these previous efforts, however, the Mounds Drill Cuttings Field Experiment represents a comprehensive consortium-based effort to definitively locate and characterize the disposal domain of the injected slurry. Having completed the Mounds Field Experiment, the results can now be used by the oil and gas industry as a well-documented, case-history example in striving to work within federal and state guidelines for fracture slurry injection and engineering reliable and cost effective solutions to cuttings disposal.

This paper summarizes the results of the Mounds Field Experiment which had the overall technical objective of improving the understanding of the mechanics and modeling of the processes involved in the subsurface injection of slurrified drill cuttings. The project was executed in three phases: drilling an injection well and 2 observation wells; conducting more than 20 periodic cuttings-slurry injections into each of two disposal formations while imaging the fracture geometry with surface and downhole tiltmeters (measuring earth deformation) and downhole accelerometers (detecting and locating microseismic events); and verifying imaged-fracture geometry by drilling/coring 4 coring sidetracks from an observation well through the imaged-fracture system.

—Z.A. Moschovidis, Advantek
—RP Steiger,
Exxon Production Research Co

IADC/SPE 59117

Silica Micro-Encapsulation Technology for Oil and/or Hydrocarbon Contaminated Drill Cuttings

IADC/SPE 59120: The CHK-140W blew out in 1996 at the surface, with the primary broach some 25 m from the well head. The ultimate recovery plan involved challenging snubbing objectives and innovative fluid dynamics.

Silica micro-encapsulation is a new technology that has significant economic and environmental value, since it allows disposal of oil and/or hydrocarbon contaminated drill cuttings, either onshore or offshore, in an environmentally safe manner.

Silica micro-encapsulation is a process by which the oil attached to the drill cuttings is physically encapsulated in an insoluble matrix of amorphous silica. The process consist of 2 stages:

• Application of an emulsifier, in an acidic environment, to the hydrocarbon or oil-contaminated cuttings, which emulsifies the oil into microscopic droplets (less than 10 microns);

• Application of reactive silicate to the emulsified oil. An instantaneous acid-base reaction occurs between the reactive silicate and the acid, producing solid amorphous silica that surrounds and traps the micron-size oil drops. The silica micro-encapsulation emulsifiers are designed to cover hydrophilic-lipophilic balance requirements for a broad range of oils such as synthetic oils, mineral oil, diesel, crude oil and bitumen.

Results indicate that silica micro-encapsulation eliminates the environmental impact for discharge of cuttings in on-shore and off-shore drilling operations.

—L Quintero, J M Limia and S K Stocks,
Baker Hughes Inteq

IADC/SPE 59118

Assurance Increased for Drill Cuttings Re-Injection in the Panuke Field Canada:

The Panuke wells in Nova Scotia Canada use oil based mud to drill sections deeper than 1,290 m MD. These wastes are injected in a currently existing injection Well PI-I. In order to assure the containment of fractures, investigations were conducted on the design of the injection process using a fully 3-dimensional hydraulic fracturing simulator. Panuke Well PP3C and the existing Well PI-1 were picked for the case study. A total cuttings slurry volume of 96,000 bbl has been injected so far into Well PI-1 through casing. Well PP3C is another candidate injection well through the 11 3/4- x 9 5/8-in. casing annulus. This paper assesses the affects of multilayer formation and varying permeability and elastic modulus injection rate, solids concentration and other operational procedures on fracture geometry and containment.

—Q Guo, TerraTek Inc, *et al*

IADC/SPE 59119 (ALTERNATE)

Environmental Management, Cost Management and Asset Management for High Volume Oilfield Waste Injection Projects

Ongoing exploration and production activity, combined with increased regulatory requirements, are increasing the volume and costs associated with disposal of oilfield wastes, including produced oily sands and tank bottoms, drilling muds and cuttings, crude contaminated surface soils, and naturally

occurring radioactive materials. A cost-effective and environmentally sound disposal option is to re-inject waste material into the subsurface into non-productive and/or depleted zones under controlled fracture conditions.

High volume injection, which may involve several hundred thousand barrels or more of material and injection over several years, requires specific and detailed formation evaluation, completions designs, and operating strategies. However, there are few guidelines available to industry to optimize and manage this process. In some instances injection zones have filled or pressurized prematurely; well casings have been sheared by excessive formation movement; and in extreme instances waste material has broken out of zone and to the surface. Large volume and long-term injection projects require optimum strategies tailored to specific waste materials and target formation properties, combined with appropriate and continuous monitoring, to accomplish 3 goals:

• Maintain waste containment in the target interval (environmental management);

• Sustain injectivity with minimum equipment repairs and well workovers (cost management);

• Maximize formation storage capacity and well life (asset management).

In this paper we first present field data from several large-scale oilfield waste injection operations in the US and Canada. These have involved injection of several hundred thousand barrels of waste slurry into a variety of formations, with extensive monitoring and diagnostic data. We discuss formation response and operational issues unique to high volume injection, supported by specific field examples. Finally we present design and operating strategies to manage high-volume oilfield waste injection projects.

—M S Bruno, Terralog Technologies Inc.

IADC/SPE 59120 (ALTERNATE)

The Blowout at CHK-140W

The CHK Gas Field, located approximately 2 hours south of Taipei, is one of the largest and oldest on the island of Taiwan. Beautiful, steep mountains covered with dense jungle-like growth characterize Taiwan. Average annual rainfall is high. Landslides are common. As a result, drilling locations are small, confined to the valley floor, have limited access, and are in very close proximity to the general population.

The CHK-140W was dually completed in 1993 from perforations at 11,693 ft to 11,831 ft and 12,346ft-12,803 ft. The combined open flow potential of these 2 zones was calculated to be approximately 22 MM cu ft/day. The bottom hole pressure was measured to be 5,500 psi and the gas contained approximately 50% carbon dioxide.

During routine production in July 1996, the CHK-140W blew out at the surface.

The primary broach was approximately 25 m from the well head. By December 1996, surface recovery operations had included several failed kill attempts. After careful consideration by the **Chinese Petroleum Co**, a new prime contractor was selected. Surface recovery operations were resumed in early March 1997. A new recovery plan was adopted involving challenging snubbing objectives and innovative fluid dynamics.

Several airplane loads of equipment and materials were air lifted to Taiwan. The CHK-140W was successfully controlled on 21 May 1997 according to plan and procedure. The success of the project is a tribute to the cooperation between the employees of the Chinese Petroleum Co and her international service providers. This paper chronicles the interesting recovery effort.

—R D Grace,
Grace Shursen Moore & Associates Inc
—B Cudd, Bobby Joe Cudd Co
—J Chen, Chinese Petroleum Co

Posters explore Chinese drilling

A SPECIAL POSTER session on the afternoon of Thursday, 24 February focused on achievements and activities by Chinese drilling professionals. Scheduled papers include:

• IADC/SPE 59259, "Automatic Inclination Controller: A New Inclination Controlling Tool for Rotary Drilling", **Y Liue** and **Y Su**, **RIPED**;

• IADC/SPE 59260, "Underbalanced Drilling in High Loss Formation Achieved Great Success: A Field Case Study", **S Luo**, **Southwest Petroleum Institute;**

• IADC/SPE 59261, "A New Drilling Fluid for Formation Damage Control Used in Underbalanced Drilling", **S Luo**, **Southwest Petroleum Institute**;

• IADC/SPE 59262, "Method of Rapid Stabilizing Shut-in Drillpipe Pressure for Blowout Wells", **X Li**, **University of Petroleum-Beijing**;

• IADC/SPE 59263, "Improved Procedure in Exploration Well by Underbalanced Drilling: A Case History in BS7 Well in People's Republic of China", **Y Guo**, **China National Offshore Oil Corp**;

• IADC/SPE 59264, "Model and Calculation of In-Situ Stresses in Anisotropic Formations", **Y Wang**, **Jianghan Petroleum University**;

• IADC/SPE 59265, "Experimental Study of Slimhole Annular Pressure Loss and Its Field Application", **H Wang, RIPED**, *et al*;

IADC/SPE 59266, "HTHP Mud p-q-T Behavior and Its Effect on Wellbore Pressure Calculations", **H Wang** and **Y Su**, **RIPED**;

• IADC/SPE 59267, "Research and Application of Recirculating Foam Drilling and Completion Fluid", **Y Sui**, **Shengli Petroleum Administration Bureau**, *et al*.