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

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Abstract

This paper summarizes the results obtained from a comprehensive, joint-industry field experiment designed to improve the understanding of the mechanics and modeling of the processes involved in the downhole injection of drill cuttings. The project was executed in three phases: drilling of an injection well and two observation wells (Phase 1); conducting more than 20 intermittent cuttings-slurry injections into each of two disposal formations while imaging the created fractures with surface and downhole tiltmeters and downhole accelerometers (Phase 2); and verifying the imaged fracture geometry with comprehensive deviated-well (4) coring and logging programs through the hydraulically fractured intervals (Phase 3).

Drill cuttings disposal by downhole injection is an economic and environmentally friendly solution for oil and gas operations under zero-discharge requirements. Disposal injections have been applied in several areas around the world and at significant depths where they will not interfere with surface and subsurface potable water sources. The critical issue associated with this technology is the assurance that the cuttings are permanently and safely isolated in a cost-effective manner.

The paper presents results that show that intermittent injections (allowing the fracture to close between injections) create multiple fractures within a disposal domain of limited extent. The paper also includes the conclusions of the project and an operational approach to promote the creation of a cuttings disposal domain. The approach introduces fundamental changes in the design of disposal injections, which until recently was based
upon the design assumption that a large, single storage fracture was created by cuttings injections.

Introduction
Fracture geometry has a predominant influence on the design of disposal injections, economic feasibility, waste containment and permitting. Until recently, waste-injection design was based on the conservative assumption that a single hydraulic fracture is created. Consequently, very large fractures have been predicted even for the relatively small-scale disposal operations, such as annular injections. However, field experiences indicate that long-term injections into shales and sands, interrupted by shut-in periods (either by design, or dictated by mechanical failures, or by other field operations) do not result in a single fracture, but may result in waste storage in a system of multiple fractures contained within a relatively small area around the point of injection. The disposal-domain concept1 (Figure 1) has been proposed based on injection-pressure behavior of disposal injections in the Valhall Field and has been recently verified experimentally in the laboratory by injections into medium and large blocks of sandstone and shale2.
The Mounds Drill Cuttings Experiment: Determining Placement of Drill Cuttings By Hydraulic Fracturing Injection

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Abstract

The paper describes a comprehensive field experiment (the Mounds Drill Cuttings Injection Experiment) to improve our understanding of the mechanics and modeling of the processes involved in the injection of drill cuttings.

Disposal of drill cuttings from offshore, arctic, and other remote or environmentally sensitive locations is of importance from both economic and environmental perspectives. The transportation of such wastes has the potential for accidental spillage of materials in environmentally sensitive locations such as waterways or wetlands. An attractive disposal option (that is coming into more common use) is to inject the cuttings into deep formations where they will not interfere with surface and sub-surface potable water sources. The major issue associated with this technology is to assure that the cuttings are permanently stored and contained and not transported upward to the surface or toward aquifers.

The paper describes the field setting where the experiment is being conducted, the criteria used for formation selection, the technical scope of work, the series of experiments planned and issues which arise when planning and implementing such an experiment.

The test program includes the deployment of fracture imaging diagnostic tools to determine the size, shape and orientation of the created hydraulic fractures and the drill cuttings in the fractures. The diagnostic imaging techniques are microseismic mapping, surface tiltmeters, downhole tiltmeters and surface monitoring of injection fluids, pressures and volumes. Observation of cores from the affected area will provide direct evidence of the fractures to support information inferred from the microseismic data.

The plan also includes characterization of the mechanical properties of the cores, and laboratory and numerical modeling of the micromechanics of the cuttings injection process.

This experiment is unique in that this is the first time all of these monitoring techniques have been utilized simultaneously at a single location.

The paper will add to the industry's technical knowledge base by providing insight into technical and implementation issues, which arise in planning such a comprehensive experiment. This insight could find applications worldwide for conducting similar field tests.