FRACTURING

Exhibit 1

Halliburton Shale Stimulation Process – A Life-cycle-based Approach to Developing Shale Reserves (ShaleStim[™] Service)

Understanding the Shale Production Mechanism and Composition Can Help Optimize Asset Performance

Halliburton's design and application process for developing shale reservoirs (ShaleStimSM service) is tailored to the specific shale production mechanism and composition. The process follows the life cycle of the reservoir which includes these phases:

Phase 1 - Regional Resource Reconnaissance (Reservoir Assessment) - Initial look at reservoir potential and extent which includes evaluating the shale and quantifying reservoir quality.

Phase 2 – Local Asset Evaluation (Start-up Exploration) - Trial investigation of fracture design and production prediction in conjunction with experimental development of drilling and completion techniques.

Phase 3 – Early Development (Mass Production) - Data base methods and benchmarking during early development permits rapidly achieving an optimized design.

Phase 4 – Mature Development (Reserve Harvesting/Cash Flow Cycle) - Reservoir production history matching, adjusting reservoir model and data base imaging.

Phase 5 – Declining Phase (Maintenance and Remediation) - Identification of remedial stimulation candidates leading to improved decline curves.

Shale Asset Development Technologies

Halliburton's approach includes technologies to help operators enhance asset value throughout the shale reservoir life cycle.

- ShaleEval® service Shale evaluation including total organic carbon (TOC) content, shale maturity (vitrinite reflectance Ro), gas content (scf/ton), free and adsorbed gas content, fracture flow tests, x-ray, scanning electron microscope (SEM) and acid solubility analysis.
- ShaleLog[®] service Log identification of sweet spots based on total organic carbon (TOC), brittleness, gas in place (GIP), initial production (IP) and estimated ultimate recovery (EUR).
- Shale fracturing design service –Application of design technologies and modeling tailored to the unique properties of shale.





Enhancement Dockets.Justia.com

Production

Exhibit 1

ShaleEval® Service

Halliburton's ShaleEvalSM shale formation evaluation service through the Duncan Technology Center is designed to help operators, geologists, and engineers answer key questions at critical junctures during the life of the shale asset (Figure 1).

The ShaleEval Service Team

The heart of ShaleEval service is a team of experts applying proven analytical and interpretive skills to provide better understanding of the shale reservoir. No other service company can match the years of combined experience of the team members.

The ShaleEval service team's direct link to Halliburton's technical experts in the various shale production areas around the world enables close collaboration with Operators. Working together to rigorously implement the ShaleEval service process is helping make shale reservoirs more productive.

The ShaleEval Service Process

The evaluation process is divided into four stages:

1) Formation screening process helps determine whether the shale is a petroleum reservoir and if it is producible (Figure 2).

2) Fluids screening process determines whether the particular formation is sensitive to fresh water, acid or both.

3) Fracture treatment screening process assists in deciding which fracturing treatment will help maximize production.

4) Fracture evaluation and candidate selection process helps determine how effective the treatment was and assists in identifying candidates to be refractured.

ShaleEval service capabilities enable Halliburton to offer a complete, optimized analysis of a shale reservoir all the way through post-treatment



Figure 1 – ShaleEval service may include the use of special flow test equipment available only from Halliburton that can measure nano-Darcy flow through core plugs. US Patent 5263360



Figure 2 - The wide variety of shale lithologies makes it clear why a thorough evaluation is critical to help determine viability and producibility of shale reservoirs.

ShaleLog® Service

ShaleLog analysis service combines petrophysical analysis, borehole imaging and mechanical rock properties to help design the best completion strategy (Figure 3).

- Multi-mineral analysis to estimate kerogen volume and TOC percent.
- Estimate gas in place.
- Detect natural fractures.
- Identify brittle from more ductile rock (Figure 4).



Figure 3 - ShaleLog analysis service can assist in the decision about where to perforate for optimized fracture placement and height growth. The decisions can be based on the brittleness and ductility determination in both vertical and horizontal wellbores.







Figure 4 - ShaleLog analysis can help define brittle and ductile shale regions. Each type shale will require a different approach to achieve an effective fracturing treatment.

Shale Fracturing Design Service

Technologies for fracturing design and modeling for shale are constantly being refined due to the varying characteristics of shale formations. Halliburton's Digital Asset[®] workflow approach includes mapping fractures with microseismic sensors and tilt meters to increase understanding of the complex fracture networks and enable real time management of the process. (Figures 5 and 6).



Figure 5 – Improved understanding of fracturing shale has shown that shale often fractures in a very complex network rather than the bi-wing fractures commonly created in other types of reservoirs. This makes designing successful shale fracture treatments significantly different from the process for conventional reservoirs.



Figure 6 - Microseismic fracture mapping reveals the complex network of fractures created in shale reservoirs.

Shale Fracturing Fluid Additives

HAL 18903

Large volume water fracs introduce foreign chemicals and solids into an environment previously in chemical equilibrium. This injection can cause many instabilities and reactions between the fluids injected, the rock face contacted and the reservoir fluids present.

Halliburton has developed chemicals and processes designed to prevent or remediate formation or fracture flow damage and loss of network conductivity (Figures 7, 8 and 9). These chemicals and processes help address the following issues:

- Remove polymer accumulation in remediation treatments and enhance polymer flowback in initial treatments.
- Reduce the capillary end effects and aid in recovery or removal of injected water.
- Remove scale deposits and enhance overall surface area and conductivity using a reactive fluid. The fluid has also been used to improve initial fracture injection and reduce treating pressures.
- Control and stabilize shale fines.
- · Control bacteria in injected fluid.
- · Control sludge and emulsions.
- · Control new scale deposition from source water.



HAL18908

Exhibit 1



Figure 7 - Reactive fluid etching (left) and deposited scale (right).



Figure 9 - Bacterial corrosion.



Figure 8 - Porosity plugging due to fines migration.

For more information about how a life-cycle-based approach can help make your shale assets more profitable, contact your local Halliburton representative or email stimulation@Halliburton.com.

© 2009 Halliburton. All rights reserved. Sales of Halliburton products and services will be in accord solely with the terms and conditions contained in the contract between Halliburton and the customer that is applicable to the sale. H05254 07/09

www.halliburton.com



Production Enhancement