Slik-Vis™
Advanced Slick Water Fluid System

Unconventional thinking for an Unconventional world
Company Overview

Downhole Chemical Solutions, LLC (DCS) was formed in October of 2015, with a founding vision to disrupt the existing, highly inefficient chemical supply chain model that still exists in today’s oil and gas industry. With a combination of world class personnel, proprietary offerings and innovative thinking, DCS aims to connect the application to the molecule. DCS focusses on eliminating inefficiencies in the supply chain and providing increased value to the end user.

*Unconventional thinking, for an unconventional world.*

Core Competencies

- Slick water fluid system development and optimization
- Frac design and optimization
- Analytical and R&D services
- Blending and inventory management
- Field service support
- Water life cycle management
Company Capabilities

Midland, TX Facility

- 24 hour operations
- 6 acres with 20,000 sq. ft. of warehouse and office
- State certified truck scale for all inbound and outbound loads
- 2 – 5,000 gallon stainless blend units
- 4,500 gallon emulsion/slurry blend unit
- 200,000 gallons of bulk finished goods storage
# Slik-Vis™ Summary

## Details

- **HiFlow 5** – Unique, moderate molecular weight polyacrylamide that provides enhanced proppant carrying capabilities and exceptional friction reduction properties.
- **EnviroSurf** – Fluid modifier that provides reservoir permeability enhancement, increased polymer performance, non-emulsification properties and lowers IFT.
- **ClayBlok 35** – Advanced, multi-functional, polymeric clay control additive.
- **PolyBreak** – Liquid oxidizing breaker that provides a controlled, clean break and leaves virtually no residue on the formation or proppant pack.

## Results

- 14,000+ Slik-Vis™ stages completed in the DJ Basin, Bakken, Barnett Shale, Haynesville, Permian, Eagle Ford and TMS since January 2014.
- Excellent proppant carrying capabilities.
- Lower chemical usage, reduced water usage, lower treating pressures.
- Enhanced well productivity.

## Additional Notes

- **Compatible.** System can be run with most scale and biocide chemistries.
- **Robust.** Field proven with 100% produced water re-use and 100,000 ppm TDS.
- **Flexible.** HiFlow 5 can be run from 0.5 – 5.0 gpt depending on sand concentrations.
- **Simple.** Easy to run, nominal learning curve.
Apparent Viscosity Explanation

- Single measurement at a single speed.
- Not indicative of a fluid's ability to transport a solid.
- A reference measurement, useful for quick analysis of polymer hydration and fluid “thickness”.
- Useful data for fluids that will be in a static state, i.e., drilling fluids when making a connection on the rig while drilling or coming out of the hole.
- Aside from the quick analysis mentioned above, not useful for determining effective sand carrying capacity of Slik-Vis.
Flow Index & Consistency Index Explanation

• Power Law Model, multiple measurements and multiple speeds. Viscosity vs. Shear and/or Shear vs. Stress curve.

• Indicative of a non-Newtonian fluids reaction to flow and shear stress.

• Useful data for fluids that will be in a dynamic state, i.e. fluids during stimulation that are in constant motion and are exposed to varying degrees of shear stress.

• Flow Index of 1 is water, < 1 is Pseudoplastic or Shear Thinning.

• Lower Flow Index indicates increased unwinding of polymer coils when exposed to shear stress, reducing resistance to flow and increasing polymer particle surface area.

• Externally the fluid is in a laminar state, reducing treating pressures & requiring less horsepower. Internally, polymer particles have become unwound, creating more polymer surface area and increasing the fluid’s ability to transport proppant.

• Principles of the Random Coil Model for Polymers.
Regain Permeability Study

**Lab Regain Data**

**Figure 1** - Graphic Results
Conductivity – 50 Hour Regain

**Figure 2** - Graphic Results
Permeability – 50 Hour Regain

**SlikVis Mixing Composition:**

- HiFlow5 - 3.0 gpt
- EnviroSurf2 - 1.0 gpt
- PolyBreak5 - 1.0 gpt

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### Table 1 - Baseline Results, 238°F, between Ohio Sandstone Cores

<table>
<thead>
<tr>
<th>Stress (psi)</th>
<th>Conductivity (mDfT)</th>
<th>Permeability (Darcy)</th>
<th>Width (in)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,000-Final</td>
<td>12781</td>
<td>625</td>
<td>0.246</td>
</tr>
<tr>
<td>2,000-0hrs</td>
<td>8724</td>
<td>429</td>
<td>0.244</td>
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<tr>
<td>2,000-24hrs</td>
<td>8473</td>
<td>421</td>
<td>0.242</td>
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<td>2,000-50hrs</td>
<td>8394</td>
<td>417</td>
<td>0.242</td>
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</tbody>
</table>

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### Table 4 — Slik-Vis Fluid Injection

Zero Stress Width = 0.265 inch
Pack bulk density = 1.65 g/cc

<table>
<thead>
<tr>
<th>Stress (psi)</th>
<th>Fluid Injection (ml)</th>
<th>Fluid Leak-off (ml)</th>
<th>Width (in)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,000</td>
<td>467</td>
<td>266</td>
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### Table 5 — Conductivity Test Data: Slik-Vis Fluid Injection

Regain Permeability = 97.84%

<table>
<thead>
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<th>Stress (psi)</th>
<th>Conductivity (mDfT)</th>
<th>Permeability (Darcy)</th>
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<td>2,000-50hrs</td>
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Table 5: Regain Results, 238°F, between Ohio Sandstone Cores
Particle Size Reduction Study

The purpose of this project was to assess the effect of temperature and an oxidizing breaker on the molecular weight and particle size distribution of HiFlow 5, the polymer component of Slik-Vis.

Testing Method:

Dynamic Light Scattering (DLS) is a photometric technique in which a laser is transmitted through a cross-section of a suspension, interacting with the liquid as it passes through.

- Photons from the laser are bounced off the particles in the liquid at various angles and collected to determine particle size from Brownian motion.
- Large particles move more slowly in suspension and produce a localized signal and intense.
- Where small particles move faster and produce a signal that is wider and less intense.
- If characteristics of the material being analyzed are known, the data can also be used to determine additional qualities like molecular weight.
# Particle Size Reduction Study

## Slik-Vis exposed to temperature

<table>
<thead>
<tr>
<th>d(nm)</th>
<th>G(d)</th>
<th>C(d)</th>
<th>d(nm)</th>
<th>G(d)</th>
<th>C(d)</th>
<th>d(nm)</th>
<th>G(d)</th>
<th>C(d)</th>
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<tr>
<td>60.6</td>
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<td>32</td>
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48 hour shut in time at 200°F

<table>
<thead>
<tr>
<th>Particle Size (nm)</th>
<th>MW (10^6 g/mol)</th>
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<tr>
<td>302.8</td>
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## Slik-Vis exposed to oxidizing breaker and temperature

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<tr>
<th>d(nm)</th>
<th>G(d)</th>
<th>C(d)</th>
<th>d(nm)</th>
<th>G(d)</th>
<th>C(d)</th>
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<th>G(d)</th>
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<td>486.2</td>
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</table>

48 hour shut in time at 200°F

<table>
<thead>
<tr>
<th>Particle Size (nm)</th>
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</tr>
</thead>
<tbody>
<tr>
<td>97.2</td>
<td>1.32</td>
</tr>
</tbody>
</table>
Performance Comparison – Wolfcamp Shale (Delaware)

Stage 2 – Pumping Company Chemicals

Stage 3 – Pumping Company Chemicals

Stage 4 – Slik-Vis™ Fluid System
Performance Comparison – Wolfcamp Shale

Typical Slik-Vis™ Performance

- Hybrid design: 6,300 bbls fluid, 375,000 lbs sand, 100 bpm rate, 78 min pump time
- Slick Water Section – Up to 2 ppg 100 mesh, 0.75 gpt HiFlow5, treating pressures from 6,100 down to 5,800 psi.
- Hybrid Section – Up to 4 ppg 40/70 mesh, 2.5 gpt HiFlow5, treating pressures from 5,800 down to 5,100 psi.

Typical Slick Water Fluid System Performance

- Slick Water Design: 9,200 bbls fluid, 375,000 lbs sand, 100 bpm rate, 109 min pump time.
- Slick Water Section – Up to 1 ppg 100 mesh, 1.0 gpt FR, treating pressures from 7,100 down to 6,800 psi.
- Hybrid Section – Up to 2 ppg 40/70 mesh, 2.0 gpt FR, treating pressures from 6,600 up to 6,800 psi.
Ultimate Flexibility – Spraberry Formation

Reducing Risk through On-The-Fly Changes

**Treating Chart**

- **Surface Treating Pressure**
- **Slurry Rate**
- **Proppant Concentration**
- **FR Concentration**

**Markers:**
- **Pressure “rollover”**
- **Losing perfs?**
- **Increasing FR Concentration**

**Axes:**
- **Pressure (psi)**
- **Rate (bpm)**
- **Proppant Concentration (ppa) / FR Concentration (gpt)**

**Elapsed Time (minutes):**
- 0 to 100 minutes
Thank You For Time & Consideration