

ENHANCED OIL RECOVERY

COREsurf™

The CoreSurf suite is comprised of a cost-effective, versatile and thermally stable multi-functional molecule designed to provide improved flowback and enhanced oil recovery through greater imbibition of the frac fluid. CoreSurf excels at lowering surface and interfacial tension, ultimately improving overall fluid recovery while delivering demulsification properties. Its unique multi-functional molecular structure allows for deeper penetration into the rock fabric, providing increased reservoir contact. Unlike traditional surfactants that can be ineffective due to adsorption onto the proppant pack or complex fluids that break down under reservoir conditions, the robust characteristics of CoreSurf allow for increased oil recovery in both immediate and long-term flow back scenarios.

ADVANTAGES:

- ◆ Ability to lower interfacial surface tension.
- ◆ Significantly lowers water saturation near frac face increasing hydrocarbon recovery.
- ◆ Water-soluble, multi-functional molecule which penetrates further into the formation.
- ◆ Encourages spontaneous imbibition of frac fluid which increases oil and condensate production from tight rock.
- ◆ Customizable to rock type.

MIXING & BLENDING INSTRUCTIONS:

- ◆ Pumped on-the-fly in the slurry at an optimized concentration between 0.1 - 2 GPT.
- ◆ Since the fluid is non-ionic, CS-1 dispersible and compatible with common hydraulic fracturing additives and formation types.

HOW IT WORKS:

COREsurf products are non-ionic, indefinitely dispersible in aqueous fluids and compatible with common hydraulic fracturing additives, brines and formation types. They are added on-the-fly to completion fluids at concentrations between 0.2 and 1 GPT. Lab testing has shown that COREsurf reduces interfacial tension by 44.5% compared to other commercial surfactants when used at concentrations as low as 0.1 L/m³ (GPT). The ultra-low particle size of the surfactant system coupled with ultra-low interfacial tension allows the frac fluid to penetrate deeper into the hydrocarbon-bearing formation and preferentially displace hydrocarbons in low permeability formations such as shales. Additionally, COREsurf exhibits excellent demulsification properties with condensates and crude oils to prevent chemical induced formation damage.

CORESURF IN ACTION:

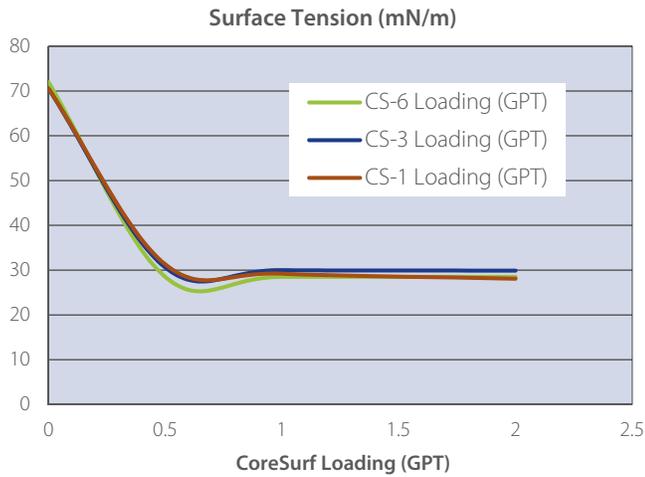
Surfactant performance should be evaluated under simulated wellbore conditions. ChemTerra uses *Amott Cell Spontaneous Imbibition* testing as part of our product evaluation testing. What does Amott cell testing look like? Scan the QR code to the right to see for yourself.



TECHNICAL LAB RESULTS:

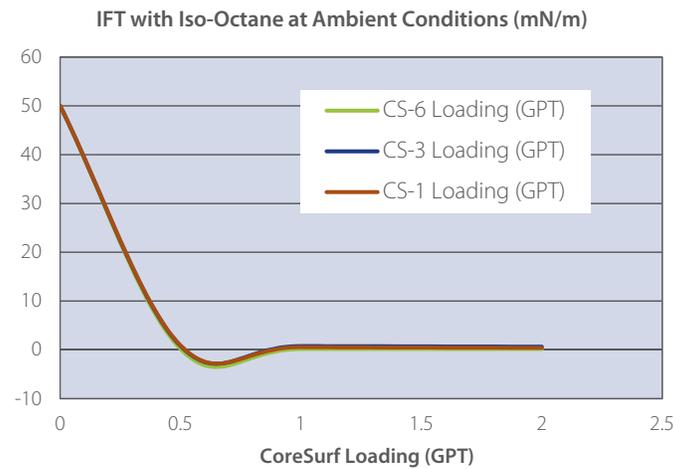
Surface Tension:

COREsurf products significantly lower the surface tension of water-based fracturing fluids which enhances load fluid recovery. Reducing the water invasion can lead to more rapid hydrocarbon recovery in some cases.



Interfacial Tension (IFT):

Demulsification often correlates with low interfacial tension between stimulation fluids and in-situ crude oil. When COREsurf is added to the stimulation fluid (at a minimum loading of 0.1 L/m³), lower interfacial tension is achieved when compared to the use of other commercially available surfactants at equivalent loadings (shown in the graph below).



Spontaneous Imbibition (Amott Cell):

Amott cell tests are used to demonstrate the spontaneous imbibition of stimulation fluid and the displacement of oil from core samples. Testing was performed with Wolfcamp core plugs and Wolfcamp crude oil. After saturating core samples with Wolfcamp oil under vacuum pressure for seven days, they were placed in a 3% KCl brine solution containing 1 GPT of COREsurf or a commercial surfactant. Oil recovery was monitored and recorded at ambient temperature over time.

Figures 1, 2 and 3 below show the visual appearance of the core samples during Amott cell testing. The blank test (Figure 1) exhibits the lowest oil recovery. By comparison, in the presence of COREsurf, an increase in oil drainage is evidenced by smaller droplets of crude oil spontaneously producing from the cores (Figures 2 and 3).

Amott Cell Test - Wolfcamp Core WolfCamp Crude Oil

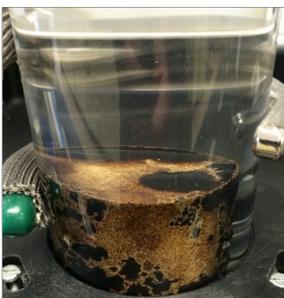
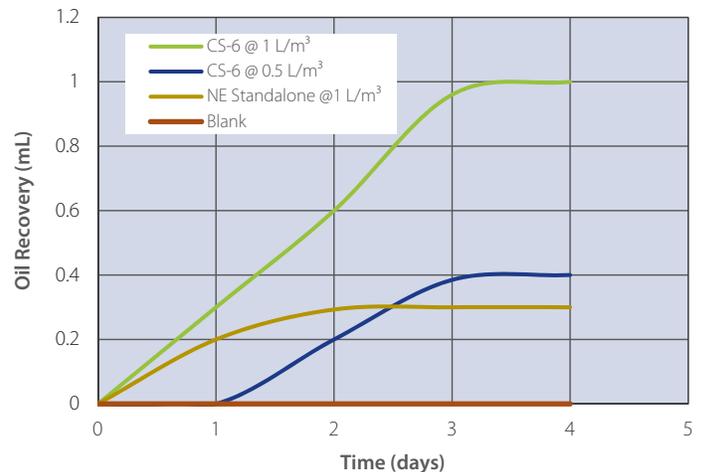


Fig. 1. Blank test demonstrates limited free flow of crude oil.



Fig. 2. Uniform oil droplets produced over entire core in presence of COREsurf.

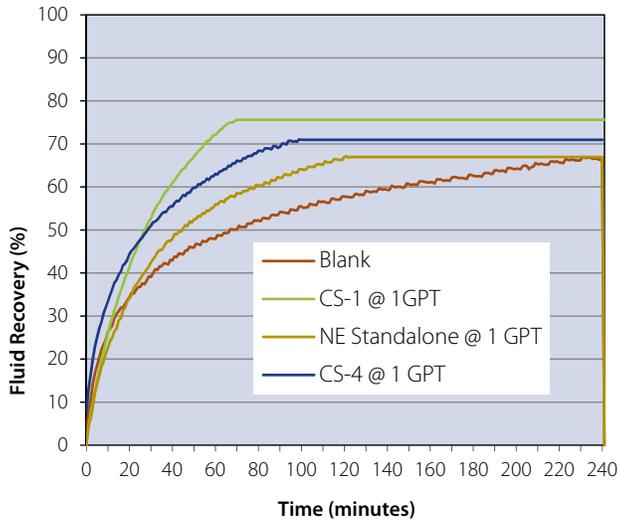


Fig. 3. Produced Bakken crude oil droplets in COREsurf.

Fluid Recovery:

Gravity column drainage is used to determine load fluid recovery at the near wellbore area. The test is performed by placing interbedded layers of sieved 70/140 core cuttings and 100+ US mesh size sand in a glass chromatography column. The column is soaked in surfactant and allowed to sit for 30 minutes. Subsequently, oil is added to the top of the pack and both fluids are allowed to drain through the pack. The recovered fluid is measured over time. The results are shown in the graphs below. The first graph demonstrates the percent of fluid recovery over time in the San Andres formation. When COREsurf was added at a loading of 1 GPT, a higher rate of water recovery was observed in comparison to the blank solution with no additives. In addition to water recovery, oil recovery was seen in the Wolfbone formation when COREsurf was introduced to the pack.

% Load Fluid Recovery - San Andres Formation



% Load Fluid Recovery - Wolfbone Formation

