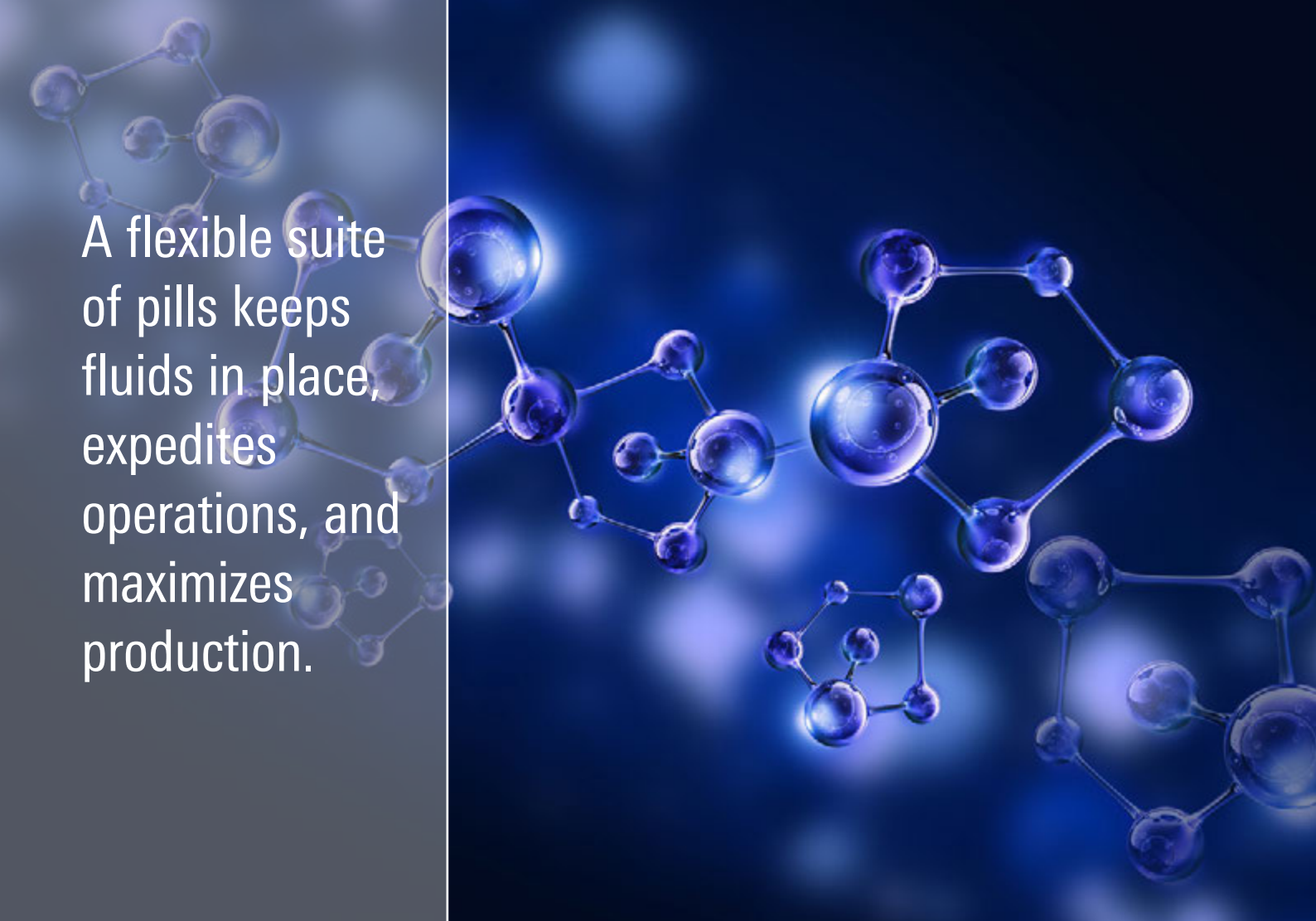




# Completion Fluid Loss Control Systems

Solids-free and solids-laden solutions for controlling losses in all completions



A flexible suite of pills keeps fluids in place, expedites operations, and maximizes production.

Loss of completion fluids to permeable formations will invariably result in increased water saturation, scaling or emulsion generation, or fines migration, which, along with other equally damaging effects, can severely impair production. Additionally, excessive losses can compromise well control, complicate fluid management, and increase project costs.

Our suite of solids-laden and solids-free fluid loss control pills are engineered to control fluid invasion into the formation during and after all perforation and completion operations, providing unrestricted production or injection without costly and challenging remedial treatments.

# Hassle-free, cost-effective chemistries can be used in multiple applications.

## Applications

- Fluid loss control into the formation during any completion
- Loss control during workover and perforating operations
- Inside screens on sand control completions
- Perforation sealing during workover or intervention operations

## Benefits

- Restricts brine invasion
- Minimizes formation damage
- Expedites production or injection startup
- Deposits thin, impenetrable filtercakes
- Cleans up with no remedial treatment
- Reduces costs
- Augments underbalanced perforating
- Helps maximize production and injectivity

## Features

- Inclusive suite of solids-laden, solids-free crosslinked, and solids-free viscous pills
- Customizability to meet project requirements and objectives
- Formulation for a wide range of densities
- Oil-based and water-based systems
- Chemical support for the Schlumberger PURE\* clean perforations system
- Solid-laden filtercakes formulated for easy removal with the startup of production
- Temperature stability for extended static periods
- Specifically sized particles designed for the formation face or the inside of a sand screen

**Our comprehensive and flexible fluid loss control technologies mitigate losses during perforation, in openhole and cased hole completions, and in completions before or after sand control operations.**

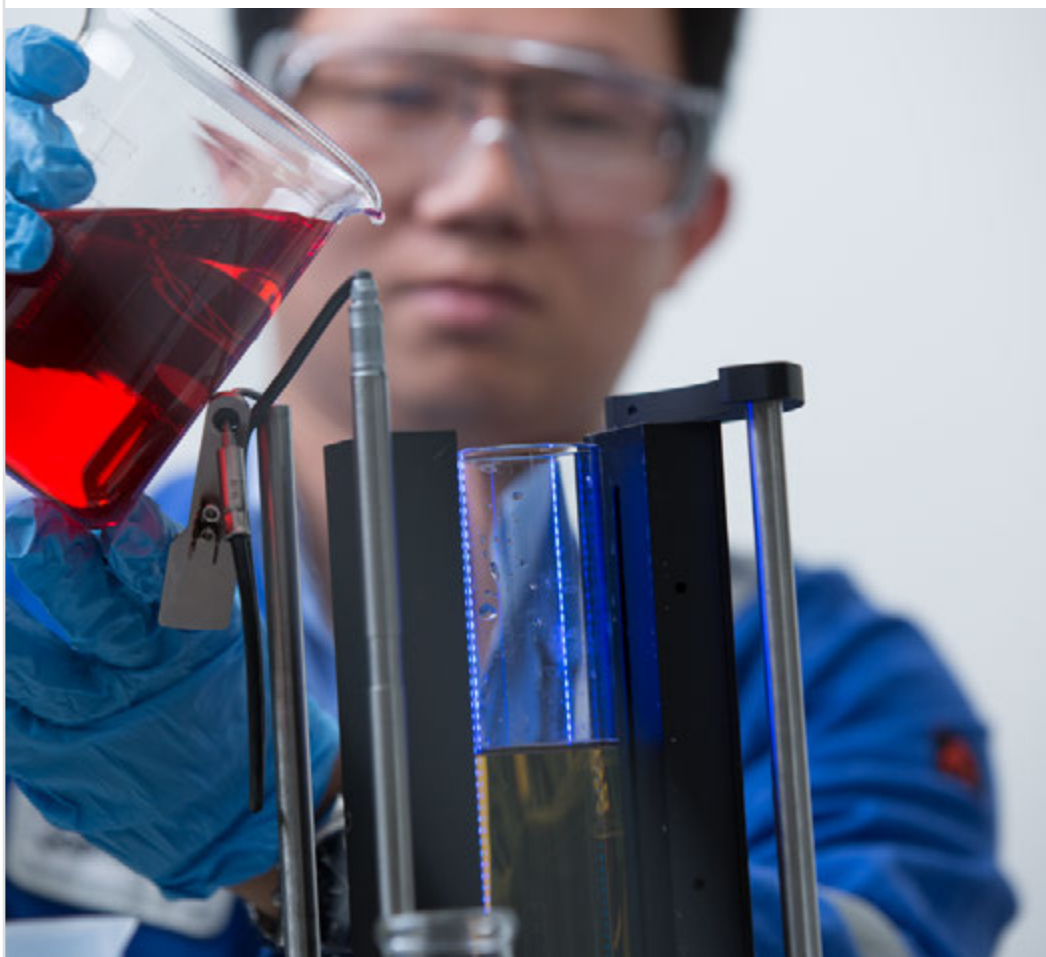
### Solids-free viscous and crosslinked pills

Solids-free viscous and crosslinked pills are typically used in cased hole completions to either reduce losses by increasing fluid viscosity or control fluid loss by creating a polymer network to seal the formation face. Applied prior to the initiation of completion, the solids-free material is readily removed with acid, clearing the way for the remaining completion operations.

### Solids-laden pills

Solids-laden pills are typically used while perforating in nonsand-control completions or after a sand control completion to seal inside the screen. When placed inside a screen, the pills also will peel with the onset of production.

In injection wells, solids-laden pills can be designed for chemical removal during the direct injection process.



## Solids-free viscous and crosslinked pills

# Adaptable and easily formulated solids-free pills mitigate losses during completion and workover.

### Solids-free viscous pills for controlled hydration in all brines

The liquid SAFE-VIS\* polymer fluid loss control additive is a suspension of high-quality, hydroxyethyl cellulose (HEC) polymer used to viscosify and control losses in freshwater, seawater, or halide brine fluids in workover and completion operations. Variations of the SAFE-VIS additive are formulated in specific carriers and customized to meet individual well requirements and local environmental regulations.

All liquid SAFE-VIS additives are designed with a coating that retards hydration until either the programmed time or temperature is met or the solution pH strips the coating from the surface. This retardation allows for more controlled and uniform hydration while avoiding potentially damaging fish-eyes. These acid-soluble, solids-free pills are stable to approximately 225 degF [107 degC] depending on the base brine.

#### The liquid SAFE-VIS additive family includes

- **SAFE-VIS E\* liquid polymer fluid loss control additive**  
in a purified mineral oil carrier, designed to viscosify single-salt,  $\text{CaCl}_2$  brines and all monovalent-salt halide brines.
- **SAFE-VIS HDE\* high-density-brine liquid polymer fluid loss control additive**  
in a water-soluble carrier, specifically formulated for nearly all high-density divalent brines.
- **SAFE-VIS OGS\* oil- and grease-standards liquid polymer fluid loss control additive**  
in a water dispersible, synthetic carrier, formulated specifically to pass oil and grease,  $\text{LC}_{50}$ , and static sheen tests required for use in the Gulf of Mexico. The pill is used to viscosify single-salt  $\text{CaCl}_2$  and  $\text{CaBr}_2$  brines and all monovalent-salt halide brines.

### Uncomplicated control of brine losses in perforated completions

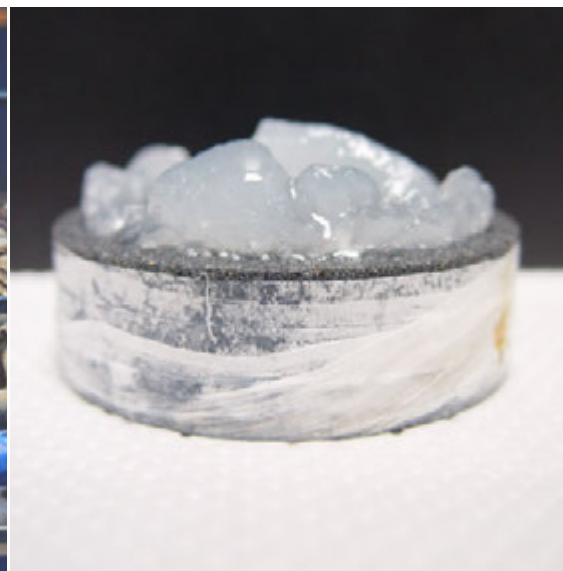
The SAFE-LINK\* completion fluid loss control agent provides an easily formulated and managed solution to controlling loss of clear brine fluid to the formation during completion or workover operations. Formulated for specific densities, the SAFE-LINK agent, which comprises a chemically modified, crosslinked cellulose polymer, applies an extremely viscous seal across the formation face, impeding the flow of completion fluid into the formation. The viscous material cleans up easily with diluted acid.

The SAFE-LINK agent functions through the crosslinked polymer network, which is held in place across the formation face. The effectiveness of the three variations of the SAFE-LINK agent is not dependent on bridging solids or on viscous drag forces within the formation matrix.

The agent is equally effective in nonzinc, halide brines, such as  $\text{CaCl}_2$ ,  $\text{CaBr}_2$ , NaCl, seawater, NaBr, and KCl, in relative densities ranging from 8.6 to 15.1 ppg [1,030 to 1,809  $\text{kg/m}^3$ ]. The SAFE-LINK agent trio is distinguished by the density of the divalent halide brine in which they are prepared:

- **SAFE-LINK 110 agent**  
For approximately 11.0-ppg [1,320- $\text{kg/m}^3$ ] brine
- **SAFE-LINK 135 agent**  
For approximately 13.5-ppg [1,624- $\text{kg/m}^3$ ] brine
- **SAFE-LINK 140 agent**  
For approximately 14.0-ppg [1,681- $\text{kg/m}^3$ ] brine

The SAFE-LINK agent maintains temperature stability up to 250 degF and differential pressure to a maximum 1,000 psi [6.89 MPa].



## Solids-free viscous and crosslinked pills

# Case Studies



## SAFE-VIS OGS additive reduces lost circulation by 85% in Gulf of Mexico

### Challenge

A Gulf of Mexico operator perforated a deepwater well using an overbalanced tubing-conveyed perforating (TCP) technique to maintain well control. However, after the well was perforated, it unexpectedly started taking in fluid at a rate of 24 bbl/h [3.82 m<sup>3</sup>/h]. The operator needed to reduce lost circulation and regain well control before it could pull the TCP guns out of hole.

### Solution

M-I SWACO used the VIRTUAL COMPLETION SOLUTIONS\* completion fluid modeling software package to determine the correct additive. To meet operational and environmental requirements, M-I SWACO proposed using the SAFE-VIS OGS oil- and grease-standards liquid polymer fluid loss control additive—a solids-free, viscous pill.

### Results

In addition to reducing fluid losses into the formation, the additive passed all the required oil, grease, static sheen, and toxicity tests. After treatment with a 20-bbl [3.18-m<sup>3</sup>] pill, the measured loss rate dropped from 24 bbl/h [3.82 m<sup>3</sup>/h] to just 3.5 bbl/h [0.56 m<sup>3</sup>/h], enabling the operator to recover the perforation guns and continue completing the well.



## SAFE-LINK agent deposits effective loss barrier in cased and perforated completions, offshore Abu Dhabi

### Challenge

As part of a stimulation workover, the customer needed to acidize the perforations from three different low-permeability zones while protecting the two lower highly permeable zones. All of the zones were fairly close together, with the upper zones spanning 40 to 170 ft [12 to 52 m] above the lower zones. A barrier was required to be placed across the lower two zones to isolate and prevent losses to these lower zones and assist in diverting acid to the target perforations. The workover was planned to utilize a coiled tubing unit with a 1.5-in coil. Moreover, as the well had been on production, it was filled with formation fluid containing oil.

### Solution

M-I SWACO recommended placing a SAFE-LINK agent across the lower two zones to aid in the acid diversion to the target perforations in the upper zones. Effectively pumping the pill through a 1.5-in coil while maintaining a formation seal was critical. As a solids-free pill, the SAFE-LINK agent could be pumped easily through the coil without excessive pump pressures unlike a solids-laden fluid. Additionally, being acid soluble, it could be easily cleaned up in conjunction with the acid treatment used to stimulate the upper perforations.

### Results

A 10-bbl SAFE-LINK agent was successfully mixed on the coiled tubing barge without requiring any additional equipment. After the SAFE-LINK agent was spotted, the stimulation of the upper zones was performed as programmed, using 28% HCl with flow tests of the well. The effectiveness of the SAFE-LINK agent barrier during the entire acidizing and stimulation process of the upper zones was reflected in no indication of communication between the isolated lower and the stimulated upper zones. After the stimulation of the upper zones was completed, the coil was run to bottom and the SAFE-LINK agent dissolved by pumping 15% HCl acid. Further workover operations were performed as per the program. Between the time the pill was spotted and dissolved, no losses to the lower perforations were recorded.

## Solids-laden pills

# Easily removed solids-laden systems control losses in sand control completions and deliver clean perforations.

### OPTIBRIDGE software

For solids-laden systems, an optimal blend of bridging agents, tailored to the specific formation characteristics, is critical for designing fluid loss control pills that lay down thin, impermeable filtercakes that offer simple removal.

Our proprietary OPTIBRIDGE\* bridging agent selection software gives the M-I SWACO engineer a tool for precisely and quickly selecting correctly sized bridging agents to effectively seal your formation. OPTIBRIDGE software uses formation data and specifications on readily available products to calculate best-fit formulations for the optimal blends of particulate bridging agents. Once engineered, these blends form a tighter and less invasive filtercake to seal pores, fractures, or completion screens.

The benefits of OPTIBRIDGE software calculations are clearly demonstrated in the tough, but easily extricated, filtercakes deposited with the solids-laden CLEANPERF OB\* oil-based perforating pill, CLEANPERF WB\* water-based perforating pill, PERF-N-PEEL\* perforating operations fluid loss control system, SEAL-N-PEEL\* fluid loss control pill, and sized-salt systems.

### Sand control loss prevention

The SEAL-N-PEEL fluid loss control pill is uniquely engineered to control fluid loss inside a sand control screen during the completion process. Designed specifically as a contingency for frac-pack, gravel-pack, or stand-alone screen completions, the SEAL-N-PEEL pill offers a customized solution that seals the internal face of the sand control screen.

The pill contains minimal solids and deposits a thin, impermeable filtercake on the inside surface of the screen. When the well goes on production, the filtercake simply peels away, requiring only production pressure and flow as the lift-off mechanism. As such, the SEAL-N-PEEL pill eliminates the need for remedial washes and the associated risks of screen or formation damage.

The SEAL-N-PEEL pill comprises calcium carbonate particles that are specially sized for the screen openings of each application. This promotes the immediate deposition of a thin but tough filtercake that forms an impenetrable seal to block fluid invasion through the screen.

### Damage control systems

The CLEANPERF WB water-based perforating pill and CLEANPERF OB oil-based perforating pill are used in conjunction with the PURE system, which optimizes perforating operations to increase productivity. The dynamic underbalanced perforating system minimizes the volume of perforation and crushed zone debris left in the perforation tunnel.

Unlike a conventional fluid loss control pill, the water-based CLEANPERF WB and oil-based CLEANPERF OB pills are formulated to assist the PURE system by laying down a low-permeability, solids-based barrier immediately after perforating. The robust, but easily removable, seal is deposited on the sandface, effectively restricting deep invasion of fluids and solids along and within the perforation tunnels. With the minimal adhesive and cohesive properties of its thin filtercake, the pills readily flow back once production is initiated without requiring postcompletion remedial treatment.

The water phases of the low-solids CLEANPERF OB and CLEANPERF WB pills can be formulated with a variety of base brines, including calcium chloride, calcium bromide, or cesium formate, to minimize the amount of total solids required for density.

### Fluid loss control systems

The PERF-N-PEEL perforating operations fluid loss control system is used singularly to control fluids and solids invasion during conventional perforating operations. Likewise designed as oil-based or water-based fluid loss control pills, the PERF-N-PEEL system deposits a low-permeability filtercake that restricts deep invasion along the perforation tunnel and assists in minimizing debris in the tunnel.

The PERF-N-PEEL system also deposits a thin seal that is removed with the commencement of production.

### Sized-salt systems

Sized-salt fluid loss control systems replace conventional calcium carbonate bridging solids with sized sodium chloride particles. Because these bridging solids are water soluble, less aggressive breaker systems can be used in injector well applications.

Sized-salt fluid loss control systems can be used in a wide relative density range above 10.3 ppg [1,234 kg/m<sup>3</sup>] and in a variety of brines. Sized-salt fluid loss control pills can be designed to seal the sandface of the perforation tunnels or on the perforation holes where large void spaces exist in the absence of sandstones. Pills have been designed to seal perforation holes as large as ½ in.

For wells with planned direct injection, these sized-salt pills are easily removed with a combination of undersaturated injection water and the WELLZYME\* starch-specific enzymes.

## Solids-laden pills

# Case Studies



## SEAL-N-PEEL pill halts losses in device-assisted production well, eastern Siberia

### Challenge

The absence of a formation isolation (flapper) valve in the completion assembly and the high-permeability (more than 500 mD) Yak Formation combined for completion fluid losses of more than 314 bbl [50 m<sup>3</sup>] during workover operations. Accordingly, the operator required isolation of the inflow control device (ICD) openhole completion assembly from hydrostatic fluid to facilitate the replacement of new production tubing and an ESP. During the ensuing workover, the operator's objectives were to minimize fluid losses as well as the potential for formation damage and well control issues.

### Solution

M-I SWACO recommended the operator use a SEAL-N-PEEL pill to provide reservoir isolation. The pill was designed to place a temporary filtercake on the inside surface of the sand screen. The use of OPTIBRIDGE software and prejob laboratory testing using a production screen tester optimized the SEAL-N-PEEL pill's formulation, further ensuring fluid loss control.

### Results

Zero losses were observed over the first three days after replacing the ESP and production tubing. The ESP was set and function tested successfully without flow testing the well. After remaining static for one week without any losses, the well was suspended for two months to construct production-handling facilities.



## CLEANPERF WB pill helps lift production twofold in Libya

### Challenge

An operator in Libya required a water-based fluid loss control mechanism that could be dispersed easily without requiring acids, breakers, or other postjob remedial treatments. Further, the solution would have to provide thermal stability for more than 10 days at bottomhole temperatures of 285 degF [141 degC]. Prior to beginning production, the fluid also needed to support a high static overbalance of 1,650 psi [11.4 MPa] in the wellbore during perforating and completion operations.

### Solution

M-I SWACO recommended the operator employ a customized CLEANPERF WB pill, using organophilic components for enhanced flowback capabilities without the need for a postjob chemical cleanup treatment. Potassium formate brine was selected as the base fluid, which would not only provide the required density but would also enhance the thermal stability of the fluid and inhibit any reactive interstitial clays in the reservoir. Multiple fluid compatibility tests were conducted between the crude oil, formation water, and the CLEANPERF WB pill filtrate to evaluate the ability of various emulsion preventers to eliminate potential emulsions.

### Results

Losses of approximately 1.6 bbl [0.25 m<sup>3</sup>] were expected after the CLEANPERF WB pill was spotted and the 5-in liner was perforated. However, only 0.6 bbl [0.095 m<sup>3</sup>] was actually lost within the first two hours of the perforating operation. Losses dropped to zero for the remainder of the job. The CLEANPERF WB pill remained stable over the 11 days required to run the upper completion, after which the well flowed back without the need for a chemical treatment. The production from the well was two times higher than expected, with the reservoir exhibiting low skin values.

**Put our completion fluid loss control solutions to work for you.**

To find out more about our portfolio of completion fluid loss control systems and how they have performed for our other customers, contact M-I SWACO.



[slb.com/completions](http://slb.com/completions)