



Integrated Borehole Strengthening Solutions (I-BOSS)

The suite of integrated solutions that prevents lost circulation




I-BOSS: Fully engineered integrated solutions to maintain wellbore integrity, reduce lost circulation

Wellbore instability and lost circulation are the costliest downhole problems encountered during well construction, especially in deepwater applications. Non-productive time (NPT) spent managing stuck pipe and other ramifications of severe lost circulation in fragile, depleted and otherwise unstable, wellbores, increases drilling costs exponentially and all-too-often delivers marginal results.

With I-BOSS[†] wellbore strengthening while drilling, M-I SWACO, a Schlumberger company, has engineered an integrated suite of preventative loss-mitigation technologies that allows operators to construct wellbores in zones with low fracture gradients, and help reduce NPT-related expenses. The I-BOSS suite employs geomechanical services, chemicals, and equipment to stabilize and strengthen wellbores while drilling. In addition, the specially engineered I-BOSS MANAGED PARTICLE-SIZE RECOVERY[†] (MPSR[†]) system recycles wellbore-strengthening materials, thereby reducing material maintenance additions and associated waste cleanup issues and costs.

The I-BOSS suite exploits geomechanics to cut your losses, before they happen

A large, close-up photograph of an hourglass. The top bulb is filled with a thick, golden-brown liquid, likely oil. The narrow neck of the hourglass is visible, and a thin stream of the same liquid is falling into the bottom bulb. The background is a plain, light color.

Features

- Geomechanical approach to lost circulation prevention
- Laboratory-validated solution designs
- Proactive approach for well planning and service integration
- Flexible solutions tailored for each well
- Computer-optimized solution development
- Rigsite validation equipment
- Broadly applicable for permeable matrices
- Novel solution for shale applications
- Technologies to optimize Wellbore Strengthening Material (WSM) recovery, while removing drilled solids from the fluid system

Benefits

- Reduces NPT
- Increases the potential of drilling difficult plays
- Facilitates exploration through and below depleted zones
- Mitigates potential for stuck pipe
- Enhances possibility of eliminating one or more casing strings
- Optimizes HSE profile
- Reduces loss-related expenses

While advanced lost circulation materials (LCMs) effectively cure most lost returns following an event, the proactive I-BOSS suite develops solutions to prevent losses before they begin. The I-BOSS suite, a customized strengthening strategy, combines extensive pre-planning with an integrated chemical and mechanical methodology to effectively stabilize and strengthen the wellbore while drilling. I-BOSS wellbore strengthening draws upon the results of more than 1,500 lab tests and a wide range of proven tools. These integrated components form a seamless, engineered approach to deliver an optimum outcome.

When operators have no choice but to drill an interval above the fracture initiation pressure, there are a number of techniques at their disposal. The customized I-BOSS suite identifies the most appropriate technique, and engineers the optimum solution for your specific application. I-BOSS wellbore strengthening development employs industry recognized theories, such as:

- Hoop-stress enhancement
- Fracture closure stress
- Fracture propagation resistance
- Fluid casing

Each approach utilizes specifically selected and sized WSMs and chemicals applied in a carefully controlled and efficient manner.

The mechanics of I-BOSS wellbore strengthening

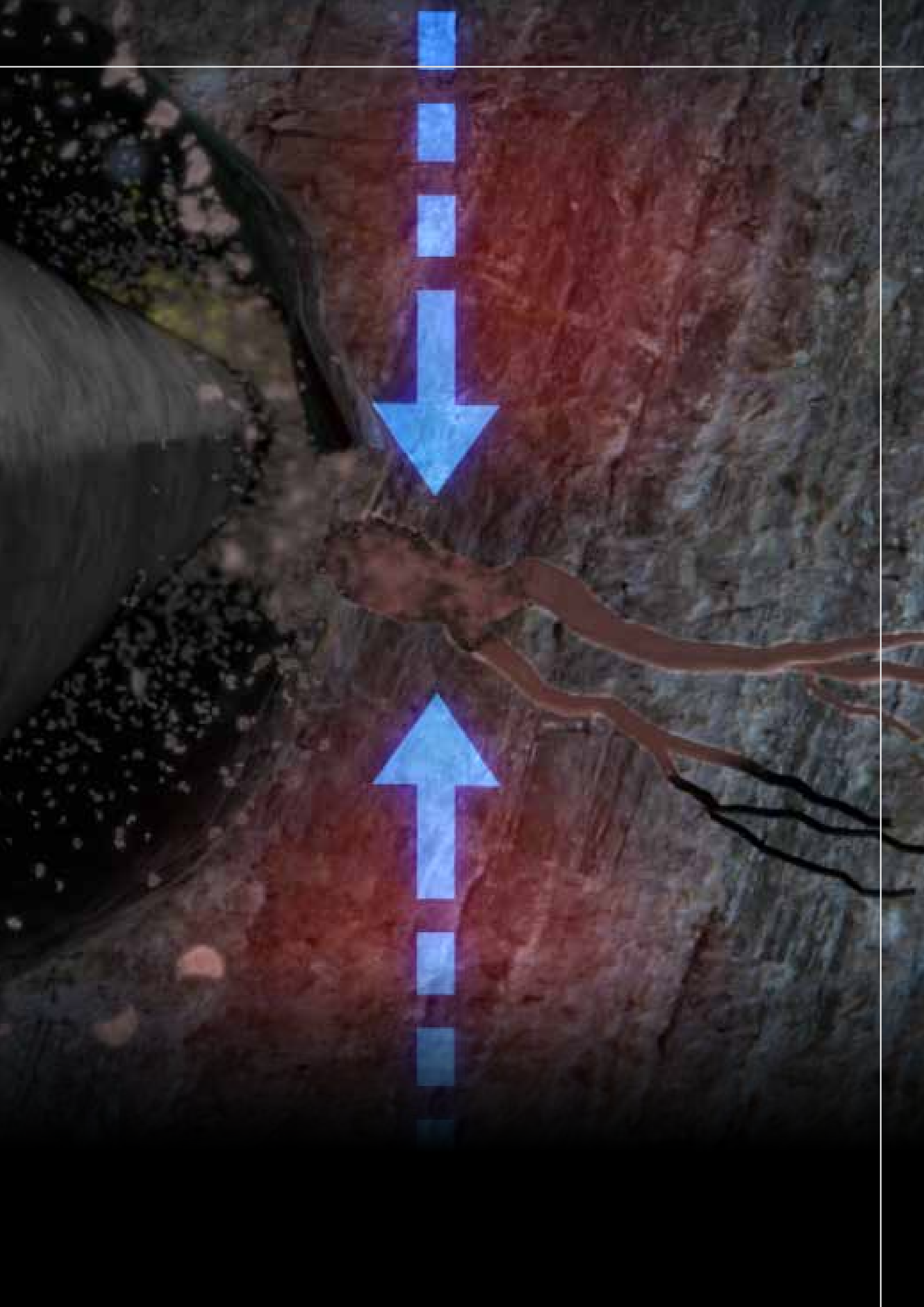
A significant and fundamental difference between a straightforward lost-circulation cure and a wellbore-strengthening solution is that remediating lost-circulation only manages losses of whole mud. Wellbore strengthening, on the other hand, focuses on increasing the apparent fracture gradient by applying geomechanical principles and bridging and sealing technologies to effectively seal fractures and prevent untimely extension or reopening.

I-BOSS wellbore strengthening provides options for enhancing the formation strength and stability by building and redistributing latent stresses in and around the wellbore. This geomechanical re-engineering of the apparent rock character can dramatically improve the effective fracture gradient and allow drilling to continue, despite the presence of low-strength formations.

Engineering an I-BOSS suite for your application

Before beginning an I-BOSS wellbore strengthening project, the M-I SWACO specialist first gathers the pertinent information about the proposed well. Once collected, the specialist processes the information using our proven procedures, software, and laboratory testing equipment to determine the most favorable approach and identifies the specific WSM for the specific application and objectives.

While planning an I-BOSS wellbore strengthening procedure, we employ our proprietary OPTI-STRESS¹ software to design particulate-based solutions. This proprietary software uses accepted and recognized predictive algorithms that determine the most likely induced-fracture aperture for formations under the expected stress and pressure conditions. The software then determines the type and concentration of WSM required to most effectively bridge and seal predicted fracture widths.



Specialized WSM tailored for any application



M-I SWACO uses its proprietary software, products, testing equipment, and procedures throughout the well construction process to further ensure we deliver the most cost-effective solution for your well. While-drilling solutions include a broad portfolio of specially formulated wellbore strengthening materials.

G-SEAL PLUS[†] graphite additive:

Comprised of a blend of synthetic and industrial graphite, these additives provide a range of sized plugging agents to bridge and seal porous and fractured formations. G-SEAL PLUS graphite additive is applicable in water-, oil-, or synthetic-base mud systems. It can be used to aid in controlling losses, ranging from seepage to severe lost-circulation. G-SEAL PLUS graphite additive is completely inert and does not affect the rheological properties of drilling-fluid systems. In addition, it can significantly increase lubricity, thereby reducing torque and drag.

VINSEAL[†] cellulose fiber: This product is a granular cellulosic WSM that is preferentially oil wet. VINSEAL fiber is ideal in invert emulsion muds as both a bridging material and sealant and is highly effective in high-permeability/high-porosity zones. VINSEAL cellulose additives are available in three different grind sizes: fine, medium,

and coarse. Each grind size has a specially selected particle-size distribution (PSD) optimized for sealing in a wide range of formations. Unlike many conventional cellulosic LCMs, VINSEAL fiber does not adversely impact the electrical stability of an invert-emulsion system.

OPTISEAL[†] WSM: This proprietary, all-inclusive blend of WSM is delivered as a single-sack additive for use when it is not possible to use OPTI-STRESS software to estimate potential fracture aperture dimensions. OPTISEAL WSM is offered in four standard premixed blends designed for treating partial and severe-to-total losses in fractures with apertures less than 1500 microns. The universal design of the blend is ideal for applications where the probable fracture size is unknown or the geomechanical information is very poor or unreliable.

SAFE-CARB 750[†] ground marble: This proprietary, acid-soluble marble material is designed for use as a primary bridging agent for fractures. SAFE-CARB 750 additive is used primarily for wellbore strengthening in conventional drilling fluids. As a wellbore strengthening agent, it is added to pills or the entire active fluid system to provide primary bridging.

Fundamental to the continual success of the I-BOSS wellbore strengthening strategy is our proprietary new-generation software and engineering tools to both plan and evaluate potential solutions. During drilling, M-I SWACO also employs a suite of advanced monitoring tools to continually measure the effectiveness of the I-BOSS suite. As drilling progresses, continual sampling, monitoring, and adjusting keep the wellbore-strengthening process optimized for real-time drilling conditions.

VIRTUAL WELLBORE STABILITY[†] software helps identify potential wellbore stability problems related to drilling pressures and the geomechanical forces present along the well path.

VIRTUAL HYDRAULICS[†] software, featuring **VIRTUAL HYDRAULICS NAVIGATOR[†]** downhole visualization software, provides a virtual snapshot of downhole fluid behavior, before drilling begins and while the well is in progress.

Wet Sieve Analysis is used for monitoring the particle size distribution (PSD) and the concentration of the wellbore strengthening additives in the drilling fluid to verify the correct size and concentration of materials is maintained.



DELTA 2

TIME	ALTITUDE	VELOCITY	ACCELERATION	GROSS WEIGHT	NET WEIGHT	CENTER OF GRAVITY	MOMENT OF INERTIA	ROLL RATE	PITCH RATE	YAW RATE
00:00	0	0	0	0	0	0	0	0	0	0
00:01	100	100	100	100	100	100	100	100	100	100
00:02	200	200	200	200	200	200	200	200	200	200
00:03	300	300	300	300	300	300	300	300	300	300
00:04	400	400	400	400	400	400	400	400	400	400
00:05	500	500	500	500	500	500	500	500	500	500
00:06	600	600	600	600	600	600	600	600	600	600
00:07	700	700	700	700	700	700	700	700	700	700
00:08	800	800	800	800	800	800	800	800	800	800
00:09	900	900	900	900	900	900	900	900	900	900
00:10	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000

ASST. OF TRAJECTORY

SAND



WSM recovery ensures optimum concentration and reduces costs

The success of an I-BOSS wellbore strengthening approach depends on maintaining an effective concentration of properly sized and optimally distributed WSM in the drilling-fluid system. To ensure the proper WSM concentration, M-I SWACO has developed specialized equipment and recommends its use to return the desired size strengthening material to the active drilling fluid system.

The patented M-I SWACO MANAGED PARTICLE-SIZE RECOVERY (MPSR) system significantly improves the cost-effectiveness of the wellbore-strengthening treatment. The MPSR captures and returns specially sized primary and secondary bridging materials

that otherwise would be separated from the returning fluid system when using conventional solids control packages. Consequently, the innovative MPSR system helps reduce the consumption and expense of graphitic materials and other premium additives.

While the MPSR system approach can be executed with a number of equipment combinations — shakers to augers to VERTI-G[†] cuttings dryers to hydrocyclones — the most effective configuration is based on the MD-3[†] triple-deck shale shaker.

The MD-3 shale shaker provides three decks of automated, effective solids control in a small footprint. The MD-3 shale shaker can ensure the effective

concentration of properly sized WSM is maintained in the drilling-fluid system to allow wellbore strengthening while drilling. This latest-generation shaker is the primary, and many times only, element used in the most-effective MPSR system approaches. Therefore, when a number of methods for recovering WSM are available, M-I SWACO recommends the MD-3 shale shaker as the clear choice.

Put the I-BOSS suite to work for you

To learn more about how our I-BOSS wellbore strengthening while drilling suite is performing for our other customers worldwide, contact the M-I SWACO representative nearest you.



The I-BOSS wellbore strengthening while drilling approach proves itself in the field



Gulf of Mexico: I-BOSS heads off risks of catastrophic losses in depleted sands

The Situation

In planning a Gulf of Mexico well in 5,000 ft (1,524 m) of water, the operator wanted to drill the 12 ¼-in interval through a series of significantly depleted sands to exploit an underlying and non-depleted series of sands buried considerably deeper. One of the most problematic sands was depleted by approximately 4.0 lb/gal (0.48 sg) with an estimated new fracture gradient equivalent of between 11.1 to 12.3 lb/gal (1.33 to 1.47 sg). That next most problematic, and deeper, sand was estimated to have a fracture gradient of 11.1 to 11.7 lb/gal (1.33 to 1.40 sg) equivalent. Given the planned well configuration, a mud weight of 12.8 lb/gal (1.53 sg) would be required, which would result in a while-drilling equivalent circulating density (ECD) of 13.2 lb/gal (1.58 sg), a minimum of 1.5 lb/gal over the estimated fracture gradient.

In addition, the operator intended to use a liner hanger with limited clearance space when running the casing. These factors required the tight space be free of any obstructions, especially sizeable lost circulation materials (LCM) as the resulting surge pressures while running casing would be extreme. Geomechanical studies of the depleted formations indicated that given the required density and rheological properties of the mud system and the expected drilling conditions, the fluid column could generate fractures in the depleted zones with apertures up to 3000 microns. If these expected fractures propagated, the loss of premium synthetic-based mud (SBM) would be massive and possibly jeopardize the project.

The Solution

M-I SWACO recommended a customized I-BOSS wellbore strengthening approach to augment the drilling fluid system with additives that went well beyond what was considered possible with traditional wellbore strengthening technology. The traditional approach used for this well defined a fluid formulation with traditional hoop stress enhancement capabilities that could only handle fracture apertures of up to 800 microns. An augmentation plan was developed that employed a blend of three to four larger than normal granular materials with sufficient hardness and resiliency to facilitate stabilization and rapid plugging of the large fractures. This augmentation plan was then tested and validated in the laboratory using an advanced slot test device.

The composite wellbore strengthening solution was designed for deployment as a continuous wellbore strengthening system in a flat rheology SBM. The hoop stress enhancement and WSM were maintained in the circulated system at all times while drilling. The shakers were bypassed while both drilling and circulating.

The Results

The 12 ¼-in interval was drilled trouble free in a single run with the programmed mud weight of 12.8 lb/gal (1.53 sg) and an ECD of 13.2 lb/gal (1.58 sg). The operator encountered no measureable losses or stuck pipe. The drilling overbalance of the depleted sands was estimated to have reached 4800 psi, thus expanding the drilling window by an equivalent density of approximately 2 lb/gal (0.2 sg).



North Sea: I-BOSS suite reduces fluid losses by 94%

The Situation

The operator expected to lose more than 6,000 bbl of fluid on a well in the North Sea while drilling over pressured shale and depleted-sand sequences. To stabilize the shales, a drilling-fluid weight of 11.3 lb/gal (1.36 sg) had to be used, putting the sand sections at risk.

The Situation

A custom-designed M-I SWACO I-BOSS suite was employed to induce and plug fractures in the troublesome formations.

The Results

Using the I-BOSS suite, the operator successfully drilled the problematic 7,200 ft (2,194.6 m) long formations with no stuck pipe or other encountering other major problems. Fluid losses were limited to about 400 bbl, compared to the 6,000 bbl of losses experienced on offset wells. Tripping in and out of the hole was trouble free, fluid properties and hole cleaning were consistently effective, and drilling torque and stick-slip all remained within limits.

Gulf of Mexico: MPSR system enhances efficiency, cuts costs

The Situation

For an operator in the Gulf of Mexico, it was important to maintain the proper concentrations of G-SEAL PLUS graphite additive, and VINSEAL fiber in the drilling fluid. With a conventional solids-control system, more than 70% of these necessary additives would be removed, thus increasing the costs and severely reducing the desired level of fluid-loss prevention.

The Solution

M-I SWACO recommended its patented MANAGED PARTICLE-SIZE RECOVERY (MPSR) system to increase the WSM percentage in the drilling fluids.

The Results

The MPSR unit ran continuously for the 7 days required to drill the two intervals. The unit recovered 141,907 lb (64,368 kg) of commercial WSM additives. Laboratory analysis showed that the recovered material consisted of 55% G-SEAL PLUS additives and 45% VINSEAL fiber and clay. The recovery unit also permitted a much higher continuous concentration of WSM in the drilling fluid than would have been obtained without the recovery unit. The capacity of the MPSR system to effectively carry higher concentrations of the desired WSM enhanced the overall effectiveness of the desired I-BOSS suite.



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