HPHT Solutions
Trusted to handle the heat and pressure worldwide
From the ultra-deepwater Gulf of Mexico to Southeast Asia, operators continue to explore deeper, hotter and more overpressured horizons, pushing the technological boundaries further than ever before. Conventional simply does not apply to drilling and completing a well under elevated downhole temperatures and pressures – and that’s true of every phase of the well construction cycle. Engineering a drilling fluid with high-temperature stability and corrosion resistance is only part of the challenge. The acceptable drilling fluid density range can be extremely limited, while the equivalent circulating densities (ECD) and equivalent static densities (ESD) must be carefully monitored and controlled. Failure to account for challenges like these can lead to poor drilling performance, increased non-productive time (NPT) and costs, and possible severe well control and HSE issues.

As temperature and pressure rise, trust the industry leader. M-I SWACO, a Schlumberger company, can help you meet the challenges of extremely high temperatures and pressures.

As the undisputed industry leader in engineering drilling fluid systems and related technologies for ultra-HPHT applications, we are trusted by operators worldwide. We develop solutions that will help you drill your most critical wells safer and faster, with minimal NPT and at the lowest possible cost.

With a field-proven portfolio of HPHT drilling fluid systems, related services and modeling software, 59%* of operators named M-I SWACO as the drilling fluids market leader for HPHT applications.

Our technologies include high temperature fluids that carefully control ECD and perform in overpressured formations and weak zones. The result is a significant reduction in drilling-related non-productive time.

* Welling Report 2014. 59% of operators stated M-I SWACO as the drilling fluids market leader for HPHT applications.
A portfolio of market leading technologies

We have built our reputation on pioneering water and invert emulsion-based drilling and completion fluid technologies for the most demanding applications. Our expertise extends far beyond chemical solutions to include pacesetting software packages and new generation pressure control solutions. The M-I SWACO HPHT portfolio routinely enables operators to drill their most challenging wells, even those once considered undrillable.

**RHELIANT PLUS³** flat rheology non-aqueous drilling fluid system
- Consistent rheological properties with thermal stability up to 350 degF (177 degC)
- Enhanced gel structure with reduced gel strength progression
- Reduces sag potential
- Improves well construction and reduced whole mud losses

**RHADIANT†** ultra-high temperature fluid system
- Non-aqueous drilling fluid system
- Provides excellent logging conditions and well deliverability at ultra high temperatures
- Resists acid gas contamination
- Works in excess of 500 degF (260 degC)

**WARP†** fluids technology
- Micron-size weighting agents for ECD management and improved tripping conditions
- Reduced viscosity and barite sag mitigation enables easier downhole detection of any drilling related issues
- Lowers friction, torque and drag

**ENVIROTHERM NT†** fluid system
- Polymer-based water based drilling fluid system
- Optimizes drilling performance in temperatures over 400 degF (204 degC)
- Low reactive solids content

**DURATHERM†** fluid system
- Low-colloid, contaminant-resistant system
- Stable up to 500 degF (260 degC)
- May also be used as a packer fluid
FORMIX™ reservoir drill in fluid (RDF) systems
- Formate base low solids RDF systems for critical environments
- HSE acceptable systems
- Minimize formation damage and control formation pressures

WELL COMMISSIONER™ liner-top test tool
- Performs inflow and negative tests
- Dresses off liner top profile
- Evaluates well integrity during well construction phase

VIRTUAL HYDRAULICS™ management software
- Software package for evaluating and designing critical-well drilling hydraulics
- Examines impact of pressure and temperature
- Integrated suite of engineering modules

PRESSPRO RT™ real-time downhole performance measurement software
- Software package for real-time measurement of drilling operations
- Complements annular pressure-while-drilling data
- Provides continuous up-to-date ESD and ECD values, even when tripping

Managed Pressure Drilling (MPD) technologies
- Prevent, detect, and mitigate potential HPHT well control events
- Optimize wellbore stability in overbalanced and underbalanced drilling operations
- Safe and efficient drilling and monitoring in high-pressure environments

DRILLING FLUID TEMPERATURE CONTROL SYSTEM™
- Reduces fluid losses and NPT while increasing rig safety
- Designed to constantly maintain optimal mud temperature
M-I SWACO HPHT Experience

- United States
- Canada
- Mexico
- Venezuela
- Trinidad and Tobago
- Brazil
- Argentina
- Chile
- Colombia
- Peru
- Tunisia
- Algeria
- Turkey
- Israel
- Romania
- Austria
- Italy
- United Kingdom
- Norway
- Denmark
- Congo
- Equatorial Guinea
- Cameroon
- Gabon
- Angola
- Ghana
- Cote D’Ivoire
- Nigeria
- South Africa
- Tanzania
- Pakistan
- Egypt
- India
- Saudi Arabia
- United Arab Emirates
- Iraq
- Yemen
- Kuwait
- China
- Russia
- Kazakhstan
- Ukraine
- Azerbaijan
- Thailand
- Singapore
- Malaysia
- Vietnam
- Australia
- and more...
Producing ultra-high temperature wells faster with HPHT drilling fluid systems

As more wellbores approach 500 degF (260 degC), the pressure on the drilling fluid to remain stable throughout the well construction and open hole logging operations increases proportionately. M-I SWACO meets that pressure head-on with the RHADIANT non-aqueous drilling fluid system, the ultimate extreme-temperature system.

Whether circulating or static, the uniquely engineered RHADIANT drilling fluid system is the industry’s leading, non-aqueous drilling fluid with the field-proven capacity to maintain stable rheological properties at up to 500 degF (260 degC) bottom hole static temperatures (BHST). The unique formulation and superior characteristics of the RHADIANT drilling fluid system yield ultra-low fluid invasion, clearing the way for trouble-free drilling, tripping and logging under the most extreme downhole conditions.

The RHADIANT drilling fluid system has consistently demonstrated its capacity to minimize lost circulation, excessive ECD, stuck pipe, ballooning, well control and other issues typically associated with ultra-high temperature wellbores. The system also resists acid gas contamination and maintains stability during prolonged static periods of tripping, logging and cementing. In fact, the low, non-progressive gel structure, excellent HPHT filtration control and superb filter cake quality of the RHADIANT drilling fluid system combine to deliver a wellbore superbly conditioned for exceptional open hole logging and prospect evaluation.

The components of the RHADIANT drilling fluid system are engineered to work synergistically to maintain complete stability throughout the construction and evaluation of an ultra-high temperature well. The RHADIANT drilling fluid system performs equally well with various paraffin base fluid chemistries, providing the flexibility to formulate a system tailored to meet specific downhole and environmental demands.
Proven in the Gulf of Thailand: RHADIANT drilling fluid system meets drilling and logging demands at 432 degF BHST

The Situation
The operator requested a drilling fluid formulation that could efficiently drill and log an ultra-high temperature exploration well in the “Ring of Fire”. The operator expected up to 453 degF (234 degC) BHST with high concentrations of H2S and CO2, and a well plan that called for a maximum inclination of 51.94° and a 6 ¾-in. production zone. Along with the extreme drilling challenges, the operator’s primary concern was achieving acceptable logging performance.

The Solution
After evaluating the well parameters, M-I SWACO specialists recommended the RHADIANT paraffin-based drilling fluid system. Past experience showed that the system could more than meet the client’s twofold drilling and evaluation objectives.

The Results
With actual BHST of 432 degF (222 degC) as recorded on wireline logging tools, the RHADIANT drilling fluid system met all drilling expectations, delivering superior filtration control and filter cake quality with stable rheological properties while drilling the 6 ¾-in. interval with zero lost circulation or other problems. That same efficiency extended to the logging operation. Not only were the trips smooth, but a total of seven open-hole wireline logging runs were performed successfully with minimal issues, despite the fluid remaining in a static condition for more than 90 hrs.
“Logging performance is the biggest concern of our client. RHADIANT fluid helped to provide an excellent hole condition which led to a successful of logging operation up to 432 degF (234 degC) over 90 hours.”

- M-I SWACO Specialist
Meeting the highest temperature and environmental demands

Optimize drilling and minimize environmental impact in high-temperature applications with the next generation water-base drilling fluid system.

Our polymer-based ENVIROTHERM NT water-base drilling fluid system optimizes drilling performance in bottomhole temperatures (BHT) exceeding 400 degF (204 degC) and pressures requiring densities up to 18.5 lb/gal (2.2 sg). The chrome-free ENVIROTHERM NT drilling fluid system delivers the environment benefits and reduced waste management costs you expect from an aqueous-based drilling fluid.

The field-proven stability of the ENVIROTHERM NT drilling fluid system derives largely from its low reactive-solids content and capacity to resist gelling at excessive temperature, optimizing drilling performance with fewer pressure spikes. The system maintains stable properties also during the prolonged static conditions in tripping, logging and testing operations. The system is characterized by low and stable rheological properties and low HPHT fluid loss and minimizes hole problems, providing shale inhibition and resistance to contamination for extreme conditions of density and temperature.

Our high-temperature water-base drilling fluid suite also includes the DURATHERM low-colloid, contaminant-resistant system. The system has demonstrated stability up to 500 degF (260 degC) and consistently provides superb inhibition, minimizing clay migration and swelling. For HPHT applications, the DURATHERM system delivers high ROP and improves solids removal capability while minimizing formation damage to reduce operational costs and optimize completion efficiency.

The DURATHERM system can also be used as a packer fluid. This low-colloid system remains stable in the presence of acid gases, salts, and drill solids. The system’s stability can be maintained by minimizing the concentration of active solids and using polymeric materials for viscosity requirements. This reduces gelation caused by the flocculation of active clays at high temperature, as well as the viscosity increase resulting from saltwater flows, acid gases, or salt.
Proven in Romania: DURATHERM drilling fluid system cuts drilling time 21% in high-temperature hole

The Situation
In its offset wells, the operator used a KCl system, which failed to maintain stability under the high downhole temperatures prevalent in the area. Consequently, high viscosity and gels as well as hole instability were commonplace.

The Solution
For the client’s next high-temperature well, M-I SWACO recommended a DURATHERM low-colloid, contaminant-resistant fluid engineered specifically for high-temperature drilling applications.

The Results
The DURATHERM system more than met the operator’s objectives, delivering comparatively trouble-free drilling and faster rates of penetration (ROP), reducing rig time by 21% compared to offsets. Despite the high-temperature environment, the DURATHERM system reverted quickly to a fluid state upon agitation.
“The wells drilled in Western Romania are known for abnormal temperature gradients and bottom-hole temperatures that can exceed 360 degF (182 degC) at 8,200 ft (2499 m). By using the DURATHERM system, the operator avoided all the problems that plagued earlier wells and, in the process, cut 21% off the historical drilling time.”

- M-I SWACO Specialist
Controlling ECD to reduce non-productive time

Our technologies include high temperature fluids that carefully control ECD and perform in overpressurized formations and weak zones. Extended-reach or slim-hole wellbores typically require high viscosities to suspend barite, but this could compromise ECD management and drilling performance. Operators traditionally had to choose between conventionally weighted fluids with potential settling problems or high-density and very costly solids-free brines.

M-I SWACO resolves this dilemma with advanced WARP Fluids Technology that employs specially treated micron-size weighting agents to increase density, reduce rheological properties and optimize ECD management. Ideal for all oil- and water-based drilling and completion fluids, the WARP technology increases densities while reducing viscosity and sag. The pretreated, micronized barite incorporated in WARP Fluids Technology produce fluid systems with low plastic viscosities, yield points and low-shear-rate viscosities. Grinding the weighting material to extremely fine particle sizes of just 0.1 to 10 microns ensures that fluids formulated with WARP Fluids Technology dramatically reduces the chances of settling or sag.

WARP Fluid Technology has also lowered friction factors by up to 10% in cased hole and 25% in open hole, thus reducing torque and drag.
When properly designed, WARP fluids are non-damage to producing formations and completion hardware and improve pressure drops in narrow annuli, allowing greater flexibility for optimizing flow rates and pump pressures. While reducing ECD values, WARP Fluid Technology can also enhance signal strength for logging tools. In HPHT managed pressured drilling operations the low gel strengths provide easier detection of pressure spikes compared to any conventional systems. And in all wells where there is a narrow drilling window between pore pressure and fracture gradient, the WARP fluids greatly enhance tripping conditions with low gel strength and thereby tripping speeds.

The WARP Fluids Technology incorporates no heavy metals, while the specially engineered, micron-size weighting materials are much smaller than standard API barite, allowing them to flow easily through 300-mesh shaker screens, with virtually 100% of drilled cuttings possibly removed on the first pass. With the micronized weighting agent allowing for finer shaker screens, solids-removal efficiency is increased while overall dilution and discharge volumes are reduced. The HSE benefits also extend to completion fluids where the WARP Advanced Fluids Technology is shown to be a cost-effective and more environmentally acceptable option than many high-density, clear-brine systems.

Although drilling-related non-productive activity can be common in HPHT environments, WARP Fluids Technology keeps non-productive time to a minimum.
The Situation
The operator’s upcoming well in the Norwegian North Sea was expected to encounter bottomhole temperatures up to 365 degF (169 degC) and pressures estimated at 14,000 psi (966 bar). Controlling wellbore pressures was critical, requiring optimized drilling fluid rheology to minimize the risk of sag while maintaining an acceptable ECD. The operator had been using a competitor’s oil-based mud in the area, but sag had made ECD control problematic. On one offset, fluid density at the surface varied unacceptably between 16.91 lb/gal (2.03 sg) and 19.16 lb/gal (2.30 sg).

The Solution
On the next HPHT well, the operator selected an M-I SWACO drilling fluid incorporating WARP Fluid Technology to drill the historically troublesome 8 ½-in reservoir section. The unique, low rheology of the PARATHERM-WARP technology combination ensured optimal suspension of barite and ECD management for drilling, while enabling a screened completion to be run without blockage or other production-restricting issues.

The Results
The WARP technology tandem allowed the operator to reach TD, where after three days static no evidence of fluid density fluctuation was observed. The mud weight “in” measured at 16.95 lb/gal (2.035 sg) and mud weight “out” remained relatively unchanged at 16.99 lb/gal (2.040 sg). Fine 310 and 250-mesh shaker screens were deployed to effectively control drilled solids concentration. The well was completed with a 325-mesh wire wrapped Reslink® screen using the WARP system as the completion fluid. The production was higher than that predicted.

Proven in the North Sea: WARP Fluid Technology manages ECD and sag risk at 365 degF
“WARP technology has proved to be the drilling and completion fluid of choice for high-temperature/high-pressure drilling offshore Norway.”

- M-I SWACO Specialist
M-I SWACO is the recognized industry leader in the formulation of minimally damaging and HSE-acceptible Reservoir Drill-in Fluid (RDF) for critical well environments. Conventional low solids water base RDF systems begin to lose stability above 275 degF (135 degC). These fluids can be formulated with thermal extenders to improve stability to 325 degF (163 degC) for specific applications and densities.

FORMIX Technology from M-I SWACO permits formulating RDF systems up to 19.1 lb/gal (2.29 sg) and stable to greater than 350 degF (177 degC). Sodium, potassium, cesium formate and the blend of these brines create the basis for the highly stable RDF fluids. The formates provide thermal protection for the biopolymer viscosifiers and fluid loss control agents to deliver excellent shear thinning behavior and tight filtration control respectively. Filter cake breakers can also be formulated with FORMIX Technology to destroy the filter cake prior to the production phase.

M-I SWACO has been using formates since 1991 and remains the leader in the use of formate fluids not only in water base but also in oil base systems. The high density cesium formate brine can be readily emulsified in oil to create high density/low to no solids fluids. These fluids may be used for perforating, production screen running and/or well abandonment for long periods of time.

Once the drilling phase is complete, our clear formate brine fluids are displaced in the well to minimize formation damage and control reservoir formation pressures. These monovalent salts are compatible with most reservoir fluids, as well as completion hardware metallurgy. As a result, these high-performance, chemically stable fluid systems help maximize production in many HPHT applications. FORMIX Technology provides a low solids completion compatible alternative to solids laden HPHT invert emulsion fluids.
Proven in Norway: FORMIX Fluid Technology used to successfully drill and complete a series of HPHT wells

The Situation
The operator needed to drill and complete a total of six 8 ½-in well intervals with bottomhole static temperatures of 293 – 329 degF (145 – 165 degC) with densities from 15.9 - 16.6 lb/gal. (1.91 – 1.99 sg)

The Solution
The cesium/potassium formate based fluids provided shear thinning fluids that controlled equivalent circulating densities and eliminated the need for managed pressure drilling equipment. The fluids were designed with a calcium carbonate bridging package to seal the formation face. This was critical as some of the intervals were cored and there was a concern for invasion where high overbalance existed. This bridging particle size distribution was monitored and maintained while drilling the interval.

The Results
The FORMIX technology remained stable throughout the drilling and completion operations. The fluids were reconditioned after each well, by removing the bridging agents through fine mesh shale shaker screens. The bridging package was remixed for each subsequent well. The other fluid properties were easily maintained over the 20-25 days used to drill and complete each roughly 1640 ft (500 m) interval.
“The FORMIX dual formate RDF formulated with PTS-200 thermal extender exceeded customer expectations, allowing the operator to drill, log, and complete two HPHT wells trouble free.”

- M-I SWACO Specialist
M-I SWACO offers a wide range of high-efficiency specialized tools for wellbore cleanup operations suited for HPHT operations and the most complex well designs.

Our new-generation of specialized tools are the result of an industry-wide study we conducted on best practices in wellbore cleanup techniques. These fit-for-purpose tools remove all mud residue and other debris that can damage completion and impede production, ensuring that wellbore and downhole components are clean, delivering a clear path for unrestricted production. M-I SWACO wellbore cleanup tools are engineered for safe and effective single-pass cleanups, which reduce NPT and project costs.

Our portfolio includes the WELL COMMISSIONER liner-top test tool that enhances efficiency and cuts rig time during high density displacements.

In a single trip, the WELL COMMISSIONER liner-top test tool allows for the sequential drilling out the liner-top, dressing the liner-top, scraping the packer setting area, reducing hydrostatic pressure under controlled conditions, conducting a negative liner-top test and displacing with the completion fluid. The packer element activates and deactivates by setting weight down and taking weight off respectively.

Prior to running the WELL COMMISSIONER tool, M-I SWACO specialists will review the specific conditions in the well. Afterwards, drilling and milling operations can be performed with the tool in the string. The standard tool is rated to a 5,000 psi differential up to 302 degF (150 degC), while the high pressure tool is rated to a 7,000 psi differential up to 347 degF (175 degC).
Proven in the Netherlands: WELL COMMISSIONER tool enables one-day cleanup of HPHT Well

The Situation
Located in the North Sea off the Netherlands, an HPHT well was expected to reach 13 to 15,000 psi (897 to 1034 bar) bottomhole pressure with temperature of 296 degF (146.6 degC). The well was drilled with high mud weight, the operator wanted to perform an inflow test on the 7 and 4 ½-in liner and displace the mud to seawater in a single clean up trip. Base oil fluid weighing 6.6 lb/gal (0.79 sg) would be pumped down the drill pipe to achieve the required differential pressure for the 7-in liner test. This would exceed surface equipment operating pressures and be close to the maximum for the downhole equipment. On offsets, these requirements could only be achieved with as many as five trips into the hole, rather than on a single run.

The Solution
To meet the demanding requirements, M-I SWACO recommended a BHA comprising:

- A WELL COMMISSIONER tool installed in the clean-up string for the inflow test, scraping and dressing the 7-in liner Polished Bore Receptacle (PBR)
- A MULTI-FUNCTION CIRCULATING TOOL† (MFCT) to increase flow rates during clean-up and displacement at the bottom of the 9 5⁄8-in casing
- Two WELL PATROLLER† tools: one inside 9 5⁄8-in casing, and the other inside 7-in liner to filter and recover debris to surface
- Select sizes of the RAZORBACK† tools to scrape the respective casing and liners
- A MAGNOBACK† magnetic retrieving tool to collect metallic debris and swarf

The Results
The use of the WELL COMMISSIONER test tool permitted a critical inflow integrity test on two liner tops, cleaned up the well and completed the displacement in one trip instead of five. Moreover, the capacity to conduct a 24-hr inflow test at a differential pressure of 6,380 psi (440 bar) is a duration record for an inflow test at high pressure. The expected problems with the high differential pressures while displacing 6.6 lb/gal base oil into the drill string for the inflow test were overcome with careful modeling prior to the job, detailed planning and execution of the work instructions.
“A 24-hr inflow test at a differential pressure of 6,380 psi (440 bar) is a duration record for an inflow test at high pressure.”

- M-I SWACO Specialist
Modeling HPHT environments to plan and overcome potential downhole challenges

When operators are preparing to drill an HPHT well, it is crucial that all potential problems are identified and prepared for beforehand.

The M-I SWACO proprietary VIRTUAL HYDRAULICS® software package is the industry standard for evaluating and designing critical-well drilling hydraulics under simulated downhole conditions. As the first engineering software tool to examine the impact of pressure and temperature on downhole fluid density and rheology, the VIRTUAL HYDRAULICS software has set the benchmark for planning and designing fluids capable of handling ultra-extreme temperatures and pressures.

The fully integrated suite of engineering modules enables operators to design fluid systems for critical applications, including ECD, ESD, temperature, hole-cleaning and tripping profiles in critical wells. The VIRTUAL HYDRAULICS software is a new-generation planning tool for evaluating the hydraulics and rheological behavior of synthetic-, oil- and water-base drilling fluids in extreme temperatures and/or pressure environments. This optimizes drilling fluid performance, while minimizing NPT and overall costs. The integrated software suite uses state-of-the-art models for hydraulics, mud rheology, temperature profiles, hole-cleaning performance, and surge/swab pressures that consider the dramatic effects of pressure and temperature on downhole fluid properties.
Gain real-time insight into fluid behavior

The PRESSPRO RT software package delivers real-time measurement of fluid behavior while drilling and is an integral component of ECD management.

The PRESSPRO RT software package complements the pressure-while-drilling (PWD) tool. While the PWD tool provides a single-point measurement at the bit, the PRESSPRO RT software calculates complete profiles of downhole hydraulics and mud behavior. Additionally, it can substitute for the PWD tool when it is unavailable, for instance when running casing, when the tool is non-operational, or when temperatures or pressures exceed tool limitations.

The PRESSPRO RT software links a dedicated computer to an existing rig data-acquisition system to acquire surface measurements and then calculates downhole pressure profiles and fluid properties in real time during drilling, tripping, and other critical operations. The technology provides up-to-the-minute ESD and ECD values at any point in the wellbore during drilling. It also delivers surge and swab pressure measurements, as well as ECD while tripping drillpipe or setting casing. Traditional methods require manually inputting data to calculate downhole pressure profiles and fluid behavior during drilling and tripping operations.

The data PRESSPRO RT software delivers provides vital real-time insight that prevents or minimizes lost circulation-induced fluid losses while transmitting early detection of impending problems, thereby eliminating mud-related NPT. The predefined screens of the software can be observed and managed onsite as well as remotely, a crucial benefit in today’s drilling environment.
Proven in the North Sea: PRESSPRO RT software package secures success of HPHT well

The Situation
The HPHT well in the Central North Sea was programmed with a tight operating window and a projected bottomhole static temperature (BHST) of 380-400 degF (193-204 degC). An Annular Pressure While Drilling (APWD) tool was to be run; however, it was not certain it would function at the expected bottomhole temperatures. In addition, APWD tools do not provide data when tripping/running casing.

The Solution
The PRESSPRO RT software package was recommended to complement the APWD tool in case of failure and to provide pressure predictions when tripping and running casing.

The Results
The PRESSPRO RT software was instigated in the 12 ¼-in section to help familiarize crews with the technology and control swab and surge within the hydraulics window of 14.6-16.2 lb/gal. As there was no APWD tool in the 12 ¼-in assembly, the PRESSPRO RT software was calibrated to the standpipe pressure while drilling. Bottomhole circulating temperature (BHCT) was available from the measurement-while-drilling (MWD) tool. An APWD was run in the 8 ½-in section, which had a hydraulics window of 17.1-18.1 lb/gal. The PRESSPRO RT software was used in tandem in this section, primarily to monitor and control swab and surge pressures when tripping, where the lack of circulation meant that no APWD data could be obtained. The PRESSPRO RT software was particularly invaluable when the APWD data became intermittent and eventually stopped altogether at 17,265 ft (5,262 meters). Confidence in the PRESSPRO RT software led the operator to continue without the APWD tool. The BHCT, standpipe pressure and previously recorded trends contributed to the accuracy of the PRESSPRO RT software predictions. A comparison between the ECD recorded by the APWD tool and the same values predicted by the PRESSPRO RT software showed close correlation.
“The quality of the PRESSPRO RT model and care with which it was calibrated resulted in the team gaining real faith in the data it provided, faith further confirmed by the agreement of the PWD data. It allowed us to obtain a real sense of being able to ‘see’ what was going on downhole.”

- Client Drilling Superintendent
Managed Pressure Drilling (MPD) to maximize control in HPHT environments

An unstable borehole or uncertain pressure can lead to safety concerns and create greater levels of complexity, especially in HPHT wells. M-I SWACO MPD and pressure control solutions enable operators to safely manage the pressure barrier in the well, ensure wellbore integrity and drill more efficiently. That means greater stability, less risk and less non-productive time.

M-I SWACO is an industry leader in engineered solutions for HPHT, MPD and underbalanced drilling (UBD), delivered through the comprehensive resources and expertise of its @balance® Services and selection of pressure control products. @balance Services looks at every aspect of a drilling project to assess the expected conditions and risks. It then aligns the specific objectives of the project with components from a technology portfolio that ranges from a suite of high-pressure rotating control devices (RCD), drilling pressure controls and drilling chokes to kick detection, fluid separation and flow monitoring.

Supported by sophisticated engineering software tools, @balance Services has everything it takes to prevent, detect and mitigate risks during HPHT drilling, and optimize wellbore stability and productivity. Onshore or offshore, M-I SWACO has the technologies and capabilities to design and deliver HPHT project-specific solutions that combine fit-for-purpose control systems with pressure control equipment and fluid expertise to effectively manage the downhole pressure barrier and meet operators’ drilling, economic, and HSE objectives.
An operator wanted to explore deeper hydrocarbons in sands under HPHT conditions, but had minimal petrophysical information. There was no data available from any of the surrounding wells that could assist in modeling the pore pressure and fracture gradients as inputs for well design. There were also uncertainties due to high-pressure ramps, while weak sands made reaching TD of the section extremely challenging.

@balance Services proposed managed pressure drilling (MPD) to map the pore pressure and fracture gradient to identify the safest operating window during the drilling phase. Converting the wellbore to a closed-loop automated managed pressure drilling circulating system also enhanced operational safety. The system enabled real-time bottomhole pressure management using the DYNAMIC ANNULAR PRESSURE CONTROL (DAPC) system from @balance Services. Dynamic flow checks (DFCs) and dynamic formation integrity tests (FITs) meant it was possible to identify pressure ramps early, and identify and control wellbore breathing to maintain the required BHP.

@balance Services used MPD to identify weaker formations below the shoe which defined the true upper limit of the drilling envelope. This was done by conducting dynamic FITs and DFCs at regular intervals and after drilling through any suspected weak zone. DFCs were also conducted to identify and control wellbore breathing. As a result it was possible to drill deeper than planned, which led to the deepest HPHT well in Malaysia to date. The well penetrated huge gas-bearing discoveries, and the project’s success means that MPD technology has become a pertinent application for HPHT exploration wells in the area.

Proven in offshore Malaysia: @balance Services enabled managed pressure drilling of HPHT well
In HPHT wells, even the most temperature-tolerant drilling fluids have their limits. At a certain point, these muds begin to break down or behave erratically, resulting in problems such as fluid loss, reduced viscosity, stuck pipe and unstable filter cakes.

Overheated oil-based muds can also release fumes creating uncomfortable and hazardous breathing conditions for rig crews, while fluids heated beyond their limits can produce inaccurate readings from MWD, LWD and other critical downhole measurement tools. They can also create excess wear on the elastomers of the MWD, LWD tools, as well as those in BOP, riser, shakers, centrifuges and mud pumps.

The M-I SWACO DRILLING FLUID TEMPERATURE CONTROL SYSTEM™ improves safety and drilling efficiency in HPHT applications. The system is focused on efficient heat transfer in drilling fluids and reduces risks and drilling complications while simultaneously increasing safety and decreasing operating costs.
Proven in the Red Sea: DRILLING FLUID TEMPERATURE CONTROL SYSTEM (DFTCS) reduces temperature

The Situation
Operations in the Red Sea with a TD ±13,800 ft (4,200 m) and BHT of ± 330 degF (166 degC), predicted flow line temperatures in excess of 220 degF (104 degC) when drilling the 6-in hole interval. These temperatures create an HSE concern since they can reach the flash points of the oil based drilling fluid being used. Additionally, when exposed to these temperatures, the MWD and LWG tools are at risk of experiencing hole problems due to increased thermal stress.

The Solution
The DRILLING FLUID TEMPERATURE CONTROL SYSTEM (DFTCS) is skid mounted and incorporates a single or dual plate heat exchanger designed in accordance with ASME codes and standards. The system includes a complete piping assembly, gauges and manually operated butterfly valves for drilling fluid and cooling water. The use of the drilling fluid temperature control system provides a high thermal efficiency on a very small foot print; it can be easily opened for inspection and maintenance and includes titanium plates to eliminate the risk of corrosion.

The Results
The DFTCS worked very effectively on the 6-in hole interval drilled from 11,900 ft to 12,800 ft (3,627 m to 3,901 m) with 9.5 ppg – 9.6 ppg at a flow rate of 250 gpm to 400 gpm. The reduction in flow line temperature was estimated to be ± 20 degF (16 degC), from 129 degF to 109 degF (54 degC to 43 degC). The reduction in the MWD temperature at BHT was estimated to be ± 45 degF (from 280 degF to ± 230 degF).

A significant increase in the flow line and inlet drilling fluid temperature was observed when the DFTCS was turned off for several hours in order to establish its performance. Additionally, the use of the DFTCS significantly improves the working environment on the rig floor, the shaker house and mud pit room due to less evaporation rates and heat emissions indicated.
Between drilling and completion fluids that deliver the utmost in stability, value and environmental superiority and new generation supporting technologies, we have everything it takes to keep your HPHT well on track. When the heat's on and the pressure rises, put your trust in M-I SWACO - partner of choice for the most demanding HPHT applications.

To learn more about our industry-recognized HPHT solutions and how they are performing for our other customers worldwide, contact the M-I SWACO representative nearest you.
WE CAN TAKE THE HEAT
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