

ISOTHERM NT

Advanced insulating packer fluid for arctic and low-temperature reservoir applications



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Complications from thawing permafrost in the arctic and climbing viscosities in other low-temperature reservoirs can undermine well integrity and production rates. Similarly, high heat loss to the environment may cause wax or hydrate blockages to form in the production string. Steadily melting permafrost causes subsidence in arctic wells and low surface arrival temperatures in onshore heavy oil plays can increase crude oil viscosity, resulting in high pressure losses in the tubing that can seriously affect the production rates.

The ISOTHERM NT¹ non-aqueous-based insulating packer fluid from M-I SWACO, a Schlumberger company, uses low-thermal-conductivity based fluids regarded as environmentally acceptable in a majority of applications. In the sensitive arctic ecosystem, the ISOTHERM NT insulating fluid elevates the operator's environmental profile by helping minimize impact to the permafrost.

ISOTHERM NT insulating packer fluid maintains your well integrity, produced fluid quality and production rates

Features

- Oil based system
- Low thermal conductivity and elevated yield stress
- One-sack system
- Thermally stable
- Resistant to contamination
- Compatible with various base oils, including mineral oils and synthetic oils

Benefits

- Prevents wellbore subsidence and production-line blockage
- Suitable for zero-discharge systems
- Uniquely engineered to minimize convective and conductive heat loss
- Aids in maximizing production
- Low corrosion profile typical of most oil-based muds
- Increases flowing surface temperature
- Helps enhance produced fluid quality
- Ensures compatibility with a wide range of elastomers, fluids and surface processing equipment
- Reduces operating costs
- Reduces annular pressure buildup
- Lowers thermal conductivity for concentrated effectiveness below the mudline
- Promotes easy removability during intervention

The M-I SWACO ISOTHERM NT insulating packer fluid is the only one-sack system that helps ensure your well and your production are not left to the mercy of the cold. Using new proprietary chemistry, the advanced formulation of ISOTHERM NT insulating fluid offers maximum protection against low-temperature-related well integrity and production complications. The ISOTHERM NT insulating fluid lowers thermal conductivity, while also arresting thermal convection to reduce temperature loss from the produced fluid.

The temperature-stable, solids-free ISOTHERM NT insulating fluid heads off melting permafrost that can impair the integrity of arctic wells and raise serious environmental concerns. Likewise, the new generation insulating fluid puts the brakes on rising viscosities to help optimize produced fluid quality. ISOTHERM NT insulating fluid can also help reduce well flow heating costs.

All this and more makes ISOTHERM NT insulating fluid the most cost-effective solution to help maximize the value of your arctic producer or any land-based asset with issues arising from low reservoir temperatures. What's more, ISOTHERM NT insulating fluid can be modified to meet the unique demands of the deepwater environment and even most low pressure steam injection wells.



ISOTHERM NT insulating fluid stops production-robbing problems where they start

ISOTHERM NT insulating packer fluid, formulated with only a single chemical and the base fluid helps head off temperature-related problems that can reduce, or even bring production to a halt. Used in conjunction with proprietary modeling software like TPRO ST[†], ISOTHERM NT insulating fluid consistently demonstrates its capacity to overcome problems associated with:

- The transfer of heat to permafrost, causing it to melt and resulting in wellbore subsidence
- The transfer of heat away from produced fluids, resulting in a product that is incompatible with the available surface processing equipment
- Multiple casing strings where heat is transferred into unvented annuli, which can increase temperature and pressure in the sealed space, posing a very serious risk of casing collapse
- Viscosity spikes that can adversely affect production rates
- Wax buildup, hydrate formation and salt precipitation, resulting in production blockages and serious operational risks
- Well shut-ins for short-term suspensions and intervention operations in which thermal expansion and contraction of the tubular goods induces excessive stress in the metal that can disrupt casing/cement bonding
- Loosening makeup torque of threaded connections, potentially compromising elastomer and cement seals, which can impact well stability

ISOTHERM NT insulating fluid keeps the heat where it belongs to keep production flowing

Specifically engineered for the permafrost and low reservoir temperatures, ISOTHERM NT non-aqueous-based insulating packer fluid helps ensure that the integrity of your well and the quality of your production are not compromised by a cold environment. Thermally stable over extended time periods, ISOTHERM NT insulating fluid is resistant to thermal convection, free of suspended solids, and provides densities close to those of the base fluids.

In the coldest temperatures, ISOTHERM NT insulating fluid delivers thermal protection for your well and your produced oil by:

- Suppressing convective heat loss in the annulus
- Minimizing conduction of heat away from the production string
- Helping control pressure buildup in sealed annuli
- Increasing flowing surface temperature to maintain consistent produced-fluid quality that is well within the temperature criteria of processing equipment
- Ensuring compatibility with a broad spectrum of fluids, elastomers and other well components
- Maintaining low viscosity in heavy oil facing declining production string temperatures
- Maintaining steam quality in low pressure steam injection wells
- Possessing a novel rheological behavior
- Remaining thermally stable and non-corrosive over a wide range of temperatures and pressures for extended periods of time
- Eliminating convection for minimal stress on tubing, casing, seals and cement bonds

- Reducing pressure cycling and thermal expansion for retention of optimum makeup torque and uncompromised threaded connections
- Eliminating the need for mechanical insulation of tubing couplings when used with vacuum-insulated tubing

Yield-Power-Law behavior ensures better insulation

The ISOTHERM NT insulating fluid is a temperature-stable, solids-free system based on oil-soluble components. The absence of solids both prevents density differentials from forming over time and the settlement of solids on bottom. The absence of phase, or “top-oil,” separation often spells the difference between avoiding convective heat loss or not. The thermally stable rheology of ISOTHERM NT insulating fluid produces a fluid that provides insulation from the bottom to the top of the well.

Unlike water, brine or water-miscible solvents, the base-oil of the system delivers low thermal conductivity, with values 80% less than water and 40% less than the “best” water-miscible solvent system. What’s more, since the base fluid is inherently non-corrosive, the ISOTHERM NT insulating fluid is fully compatible with production tubulars, especially corrosion-resistant alloy (CRA) materials.

In addition, ISOTHERM NT insulating fluids provide heat-loss control through stopping convection that is up to 48 times greater than that of water. Based on a polymer that dissolves and forms micelles in hydrocarbon-base fluids, the ISOTHERM NT insulating fluid shows yield-power law behavior.

As a non-aqueous-based fluid, the ISOTHERM NT insulating fluid may be formulated with olefins, mineral oils, paraffins, and highly refined mineral oils. They are easy to place and are low in both conductive and convective heat losses.



Designed, validated to keep convection-related heat loss problems at bay

Depending on the thermal conductivity of the fluid, controlling convection keeps heat loss to a minimum. If not, the initiation of convection can quickly increase total heat loss by a factor of 30 or more.

Used in conjunction with ISOTHERM NT insulating fluid, the proprietary Thermal Conductivity and Heat Capacity Test Device measures both thermal conductivity and heat capacity as material properties. The design is optimized for low-thermal-conductivity (0.16 to 0.07 BTU/hr/ft/degF), highly viscous, Herschel-Bulkley fluids.

The Thermal Conductivity Tester comprises a small power supply, a data processing

unit, and a probe/test cell assembly. The device has a small footprint and uses a standard PC for data collection. Obtained datasets of temperature, current, voltage, and time are converted into thermal conductivity values using the appropriate mathematical formulas.

What is more, a study on the effect on heat loss of using different completion fluids in permafrost wells indicate that in some cases an oil based insulating fluid will outperform vacuum insulated tubing. For the university study a block of artificial permafrost was built in a laboratory and several wells placed at regular intervals. The wells were fitted with thermistors to heat the wells from the inside, tubing and a packer fluid. In one of the wells

the thermistor was fitted inside vacuum insulated tubing. Temperature sensors and a thermal camera were used to record the heat loss from the wells and the thaw rates in the permafrost. Even though the thermistor in the vacuum insulated tubing gave off less heat than the two in ordinary tubing before they were inserted into the wells, the well with the oil based insulating fluid installed was the one to give off least heat during the experiment.

Put our ISOTHERM NT aqueous-base insulating packer fluid to work for you

To find out more about our ISOTHERM NT insulating fluid and how it is performing for our other customers, contact your local M-I SWACO representative.

ISOTHERM NT fluid successfully used to protect production well on Alaskan North Slope

The Situation

An operator on the North Slope of Alaska needed to provide thermal protection for production wells. Wells in the arctic permafrost region require thermal protection to reduce the rate of permafrost thaw. Excessive thaw rates can destabilize wells and cause integrity issues as wells age, seriously jeopardizing the long-term success of projects. A properly formulated insulating fluid is essential to prevent convective currents and provide the best possible protection for the well.

The Solution

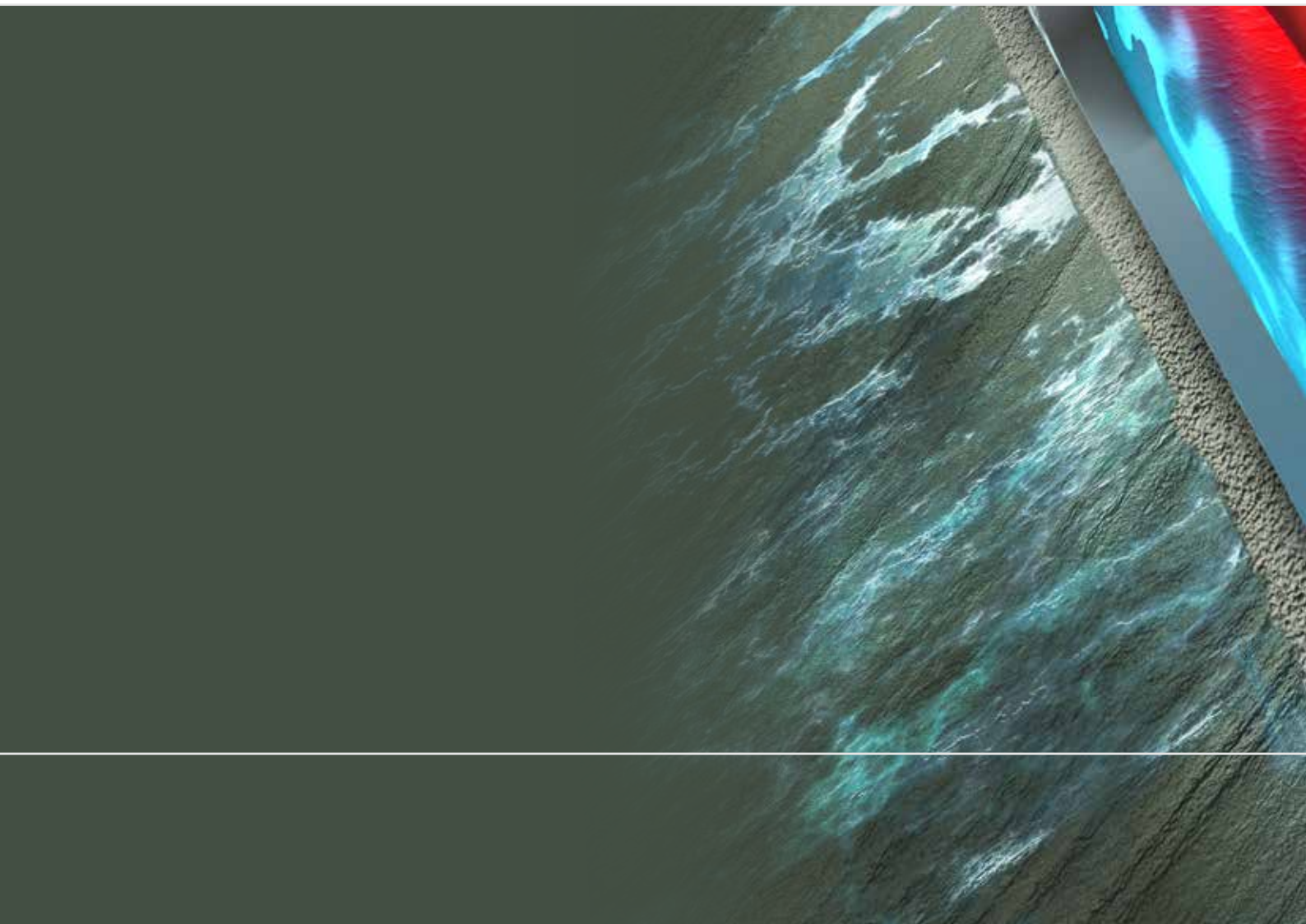
M-I SWACO recommended ISOTHERM NT, an oil-based thermal insulating packer fluid. ISOTHERM NT fluid is designed with very low thermal conductivity (k) and high yield stress (τ_y) to minimize heat loss through conduction and convection for the full temperature range expected during oil production, thus offering maximum prevention from heat transfer to the environment. The k -value for a specific ISOTHERM NT fluid is given by the base-oil used. The yield stress at temperature is achieved with a polymer concentration determined by laboratory testing. To account for the maximum expected temperature in the well, the fluid used for this application was designed with a polymer concentration that provided a yield stress of 19 lbs/100 ft² at 150 degF.

The Results

ISOTHERM NT fluid was successfully installed in the upper part of the outer annulus of the well down to approximately 2,000 ft TVD to cover the permafrost zone. The ISOTHERM NT fluid was placed by bullheading it down the annulus behind a flush of treated seawater. By substituting the commonly used arctic diesel with an oil-based insulating fluid across the permafrost interval of the annulus, the permafrost was protected from the heat of the produced fluid as well as leaving the well freeze protected.







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