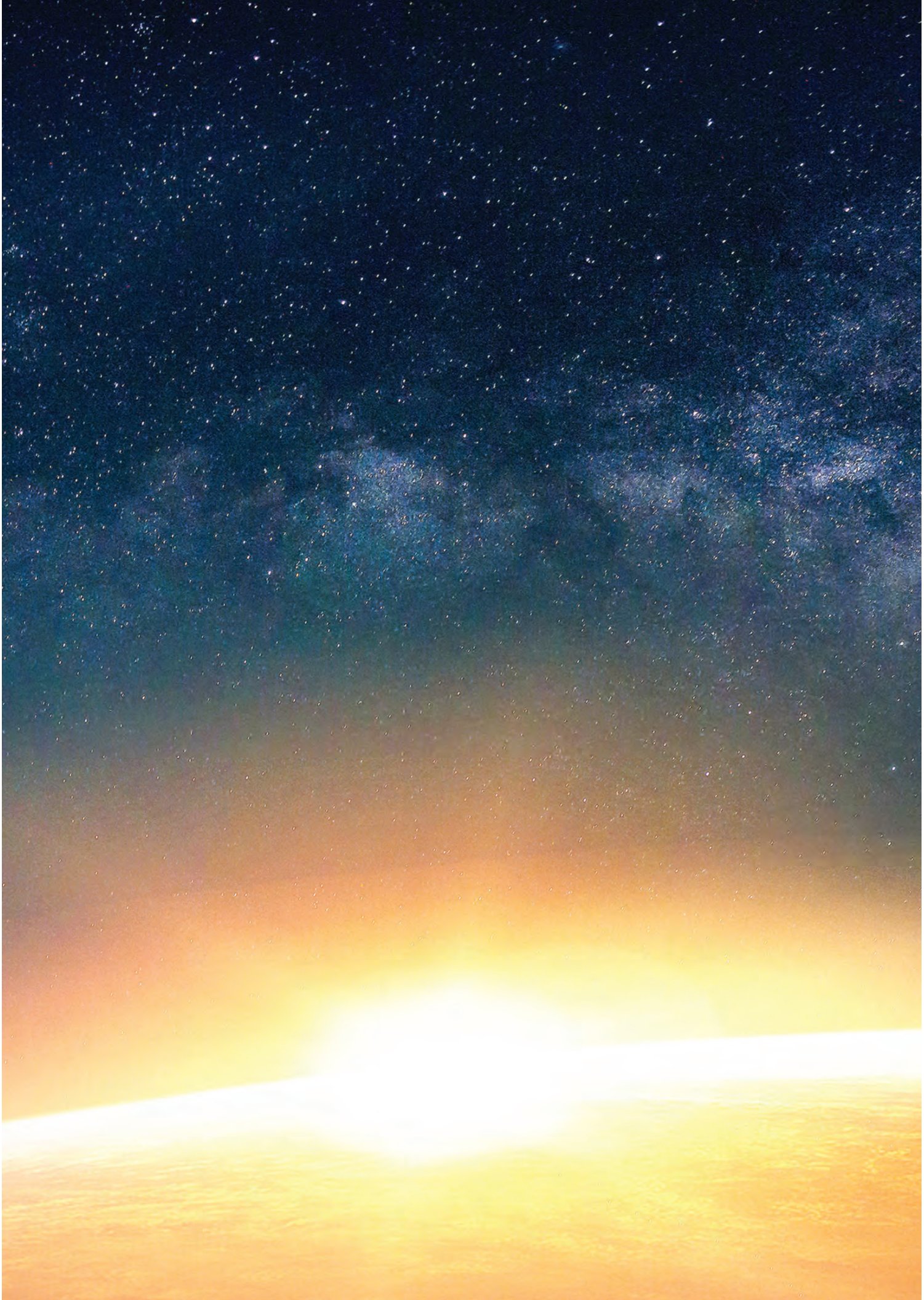

BROADENING HORIZONS

Matthew Offenbacher, AES Drilling Fluids, USA, explores the benefits of modifying existing technologies to face new challenges.

Occasionally, challenges demand a completely new tool, but frequently a new part dramatically expands the operating envelope of an existing one. The technology cycle of most new products includes multiple phases. The first involves the initial deployment and adoption of a new product targeting a known challenge. Once this success is established, the next phase relates to application expansion. Typical questions include 'what else can be done with it?' and 'can it be modified to operate in a slightly different environment?'. These types of questions focus not on a full new design project, but the 'bolt on' modifications that take the established new technology to broader applications.

Operators are seeking a number of 'bolt on' parts to answer some of these questions as they relate to drilling fluids. As with any new solution, the idea is to reduce overall cost in new applications outside of what was originally imagined with the initial fluid design. New drilling fluid additives are taking existing products into a new operating envelope with improved efficiency and expanded capabilities.

Direct emulsion support

In 2017, the EnerLITE direct emulsion system debuted in the Delaware Basin. The EnerLITE system features a saturated salt phase to inhibit washout of salt formations and a dispersed oil phase to lower the density to prevent loss of circulation. The combination of these properties allows operators to merge two well intervals. The first interval is laden with salt requiring a 10 lbm/gal saturated salt brine to prevent washout, and the second interval features a loss prone area with a fracture gradient below 10 lbm/gal.

The EnerLITE system provides a saturated salt fluid option below 10 lbm/gal, eliminating a casing string. This success has been repeated on dozens of wells in the region, saving about five rig days and hundreds of thousands of dollars per well. Drilling plans are now standardised to direct emulsion performance with a three-casing string design versus the old four-string design.

Bespoke lubricant

The EnerLITE design phase focused upon drilling vertical sections with the single objective of eliminating a casing string. The following interval includes a curve section as well as the horizontal interval, typically drilled with an invert emulsion drilling fluid. Some operators began to see an opportunity to continue with the EnerLITE system where invert emulsion performance was not essential.

The curve section requires efficient directional control for a smooth trajectory to minimise torque and drag, improving drilling performance and the ability to run casing. The inherent lubricity of an invert emulsion system facilitates this task. The dispersed oil in a direct emulsion system offers some lubricity, but this effect is limited as the oil is in the non-continuous phase.

Beyond the curve section, customers have sought to use EnerLITE through the horizontal section to simplify logistics, particularly in loss-prone regions where density control remains necessary. While they are accustomed to invert emulsion systems, which are inherently lubricious, water-based systems usually require a lubricant to minimise torque and drag.

There are thousands of lubricant products on the market, but initial testing demonstrated that conventional lubricants induce catastrophic phase separation as their chemistry directly competes with the surfactant intended to disperse the oil phase. An effort to identify chemistry that did not have this effect proved challenging, as some compatible additives did not provide improvement in lubricity.

Chemists developed ENERLUBE LITE, a lubricant designed specifically for the EnerLITE system. It is compatible with EnerLITE while providing superior torque and drag reduction. Figure 2 demonstrates an EnerLITE sample with no lubricant (left), an EnerLITE sample treated with a conventional lubricant (centre), and finally an EnerLITE sample treated with ENERLUBE LITE (right). Torque readings using a standard laboratory lubricity meter show a 55% reduction using just 1.5% v/v ENERLUBE LITE

in a conventional EnerLITE system. Field data is already showing a reduction in torque, with additional trials in deviated sections planned for the near future.

Solids control

EnerLITE performance depends entirely upon density control with oil while preventing washout. While drilling, formation cuttings are incorporated into the system, increasing the density. Solids control equipment helps to remove most of the solids, but fine solids will pass through the equipment and continue to increase the density. The only way to address these fine solids is through dilution or larger additions of base oil, which increases cost and requires additional volume. A critical element to further lowering cost is to reduce the amount of base oil required. Fewer trucks, smaller volumes, and less waste were the next big steps to lower cost in the EnerLITE system.

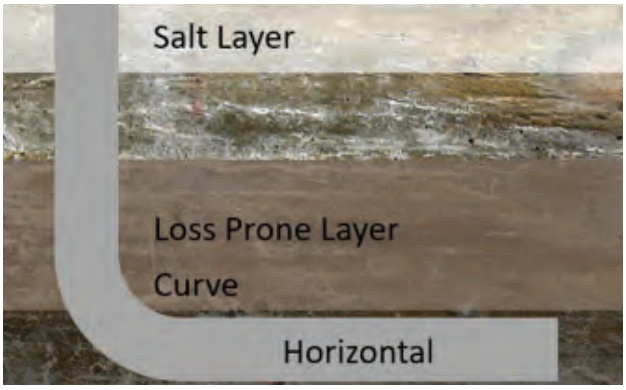

Figure 1. *The EnerLITE system was designed to vertically drill through the salt and loss prone layers. Building upon that success, operators are seeking to continue drilling with EnerLITE through the curve, and, in some cases, the horizontal section using EnerLITE. ENERLUBE LITE lowers torque and drag to address these challenges outside of the original EnerLITE design.*

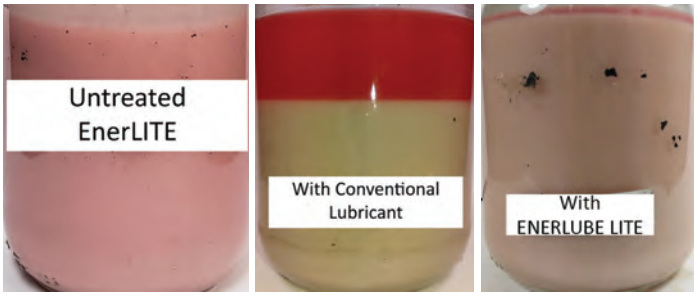

Figure 2. *Untreated EnerLITE appears as a single phase after hot roll (left), conventional lubricants risk dramatic phase separation, destabilising the emulsion (centre) and the new ENERLUBE LITE lubricant provides a stable system (right).*

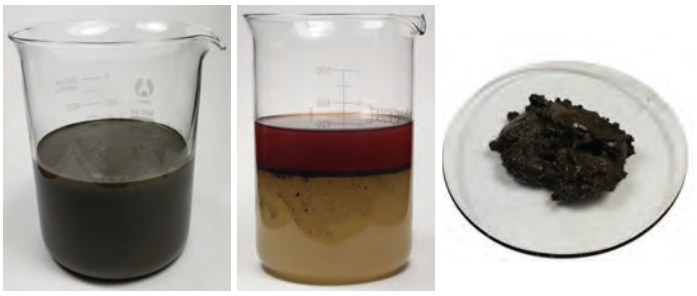

Figure 3. *EnerLITE RECOVER: initial EnerLITE system (left) with the separated liquid phase (centre) and solids (right).*

Laboratory chemists spent a significant amount of time attempting to replicate rig scenarios to improve cost. The chemical treatments evaluated the ability to separate and recover the oil for use in more EnerLITE or invert emulsion drilling fluid as well as to enhance the solids removal efficiency of rig equipment. After an extended screening phase, a treatment process was developed to manage the complex chemistry associated with a multiple phase fluid.

EnerLITE RECOVER is designed to remove more fine solids, and, when desired, recover the base oil used in the system. The blend of chemicals flocculates the fine solids in the fluid into larger clumps for easier separation using a rigsite centrifuge. With more efficient solids removal, less oil is required. This is particularly beneficial at high drill rates where lots of solids are incorporated into the system in a short period of time.

When the EnerLITE system is no longer needed, such as at the end of a pad, the EnerLITE RECOVER system allows for separation of the base oil, brine phase, and solids. In a recent yard test, 70% of the EnerLITE base oil was recovered for reuse. The base EnerLITE had a high concentration of drilled solids. After treatment with the EnerLITE RECOVER system, the brine phase was clear and essentially free of solids, making it available for reuse or recycling. The solids were highly concentrated, reducing overall waste and subsequent disposal costs (Figure 3).

Loss prevention support

Lost prevention and lost circulation are persistent concerns for operators in the Delaware Basin and beyond. Customers prefer solutions for performance and simplicity, but in many cases a 'one size fits all' option cannot cover all scenarios. In many cases, a product is designed for a challenging formation or a particular issue that a customer faces. EOSEAL II was designed to address common loss scenarios using a blend of optimised particles and cellulose materials. In most cases, EOSEAL II performs and nothing more is required beyond standard treatments.

Wellbore strengthening

In wellbore strengthening applications, a fracture is induced and loss prevention materials seal the fracture mouth, eliminating fracture propagation at the point of initiation. This strengthening effect requires a tight, effective seal at the fracture mouth that remains in place even when stresses are lowered, such as when pumping stops. When the seal fails, lost circulation follows.

EOSEAL MAX was developed to supplement the EOSEAL II blend for these complex scenarios. It features a supplemental blend of granular particles for wellbore strengthening as well as a nano-material to aid in tighter packing in the mouth of a fracture. The particles enhance the resiliency of the material so that it remains in place throughout the drilling process. This blend contributes to lower initial fluid loss, known as spurt loss, and enhances fracture sealing up to about 300 microns.

EOSEAL MAX improves economics because its special blend only has to be added to EOSEAL II blends when it is needed. It also limits the requirements for extra materials at the rigsite by offering a pre-blended solution to address common lost circulation scenarios. These supplements provide options to enhance proven products and make them apply to specific challenges without a total redesign.

Summary

Research and development projects always start with a set of design criteria intended to address a specific set of problems. Those deliverables can take considerable time and resources, but tend to provide significant and transformative impact as the original challenge is met. The next natural question is, 'what else can be done with it?' The answer to that question lies in supplementing the existing technology for these new environments.