



Driving efficiency with Encapsulated Drilling Lubricants

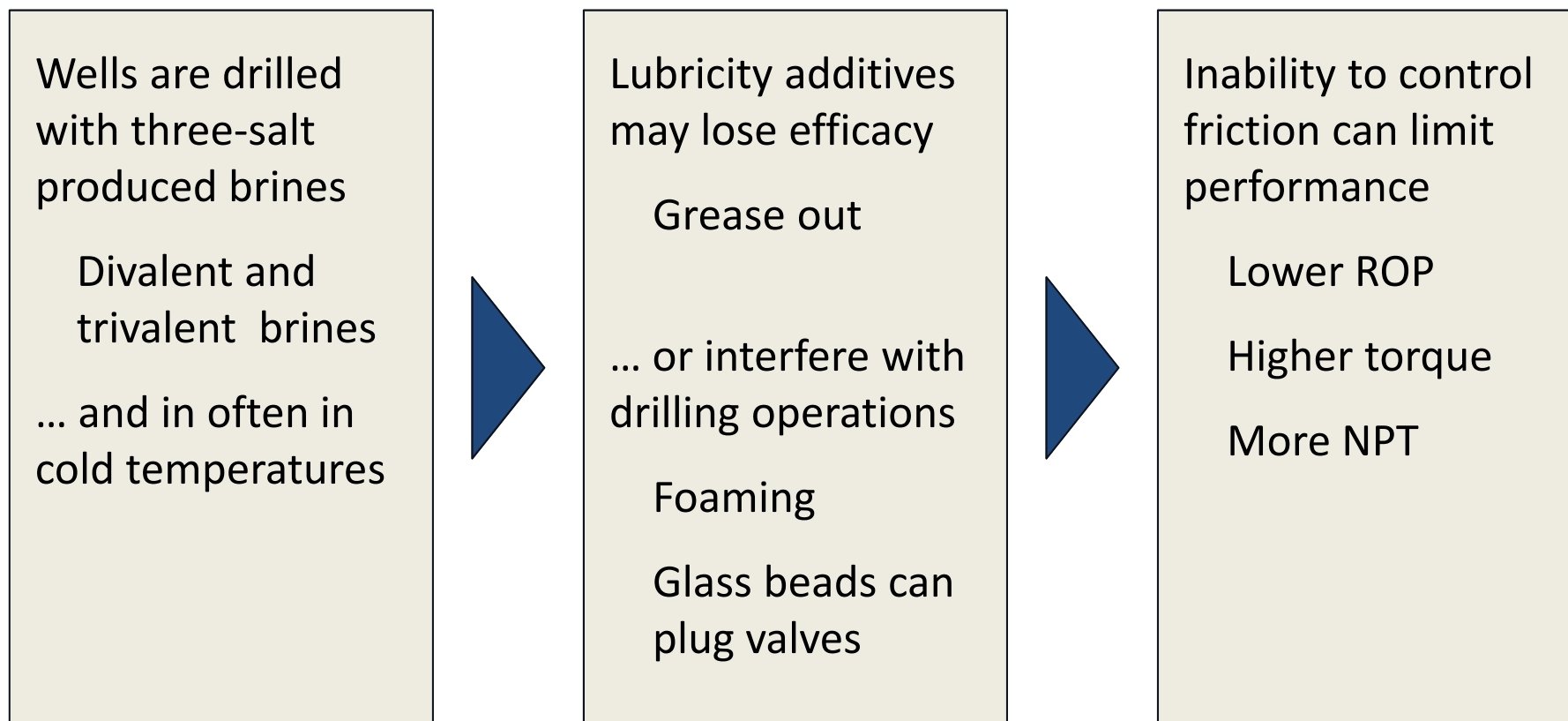
Technology for Operational and Economic
Improvements
April 30, 2015

2015 | **WILLISTON BASIN
PETROLEUM CONFERENCE**

INTRODUCTION

- Given continuing low oil prices, improving operational performance is critical to operators in the Williston basin
- Friction reduction can drive operational performance improvements but is often difficult to achieve
- Results in the field demonstrate how new microencapsulated lubrication technology helped drive operational improvements through reducing friction

FRICITION REDUCTION IN THE WILLISTON BASIN IS CHALLENGING



ENCAPSO WAS DEVELOPED TO ADDRESS THESE CHALLENGES

Encapso scientists custom-engineer oil-containing capsules to improve traditional lubricant models through a unique encapsulated design

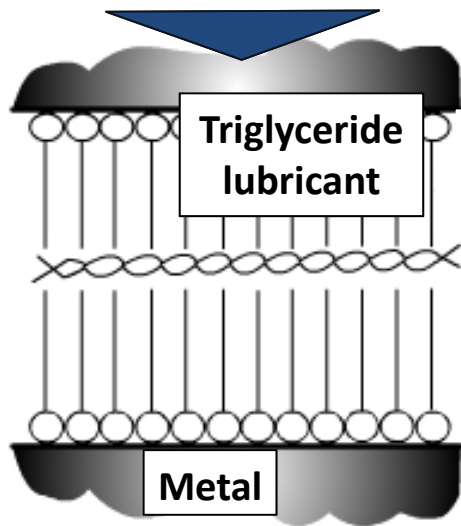
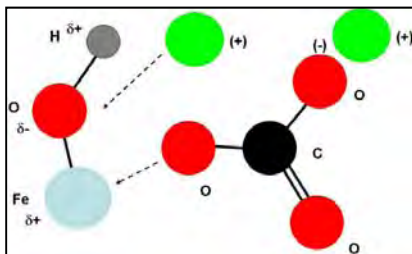


8 μm

Each capsule is between 5 & 10 microns wide in solution – smaller than a human hair (which is about 100 microns wide)

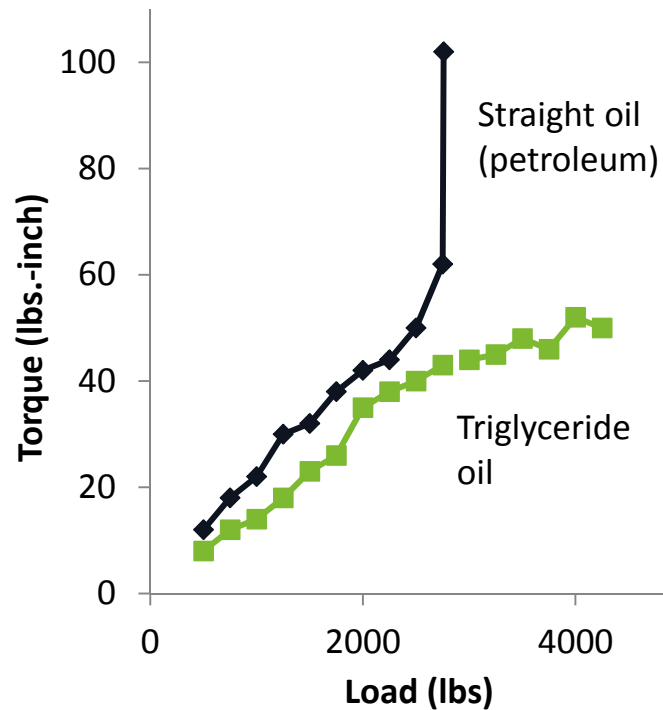
ENCAPSO IS BASED ON ESTERS THAT ARE GENERALLY SUPERIOR TO PETROLEUM LUBRICANTS AT METAL-METAL LUBRICATION

Triglyceride esters are polar and favorably interact with metal oxides...



...leading to improved lubricity compared to non-polar petrochemicals...

Comparison of Torque at increasing load (Lbs-inch vs. lbs)



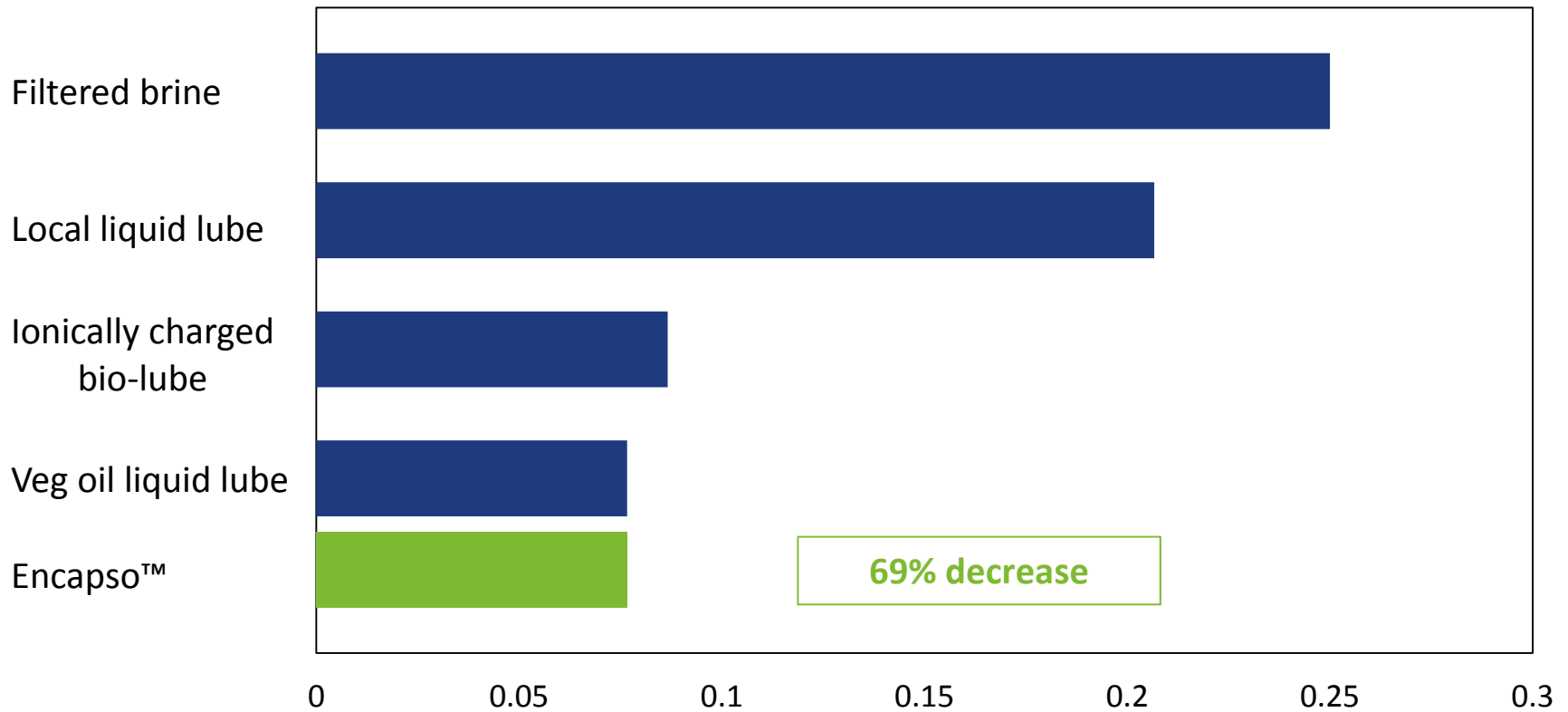
...which is key in directional drilling.

Casing and drill string metal-metal contacts can lead to high friction while drilling



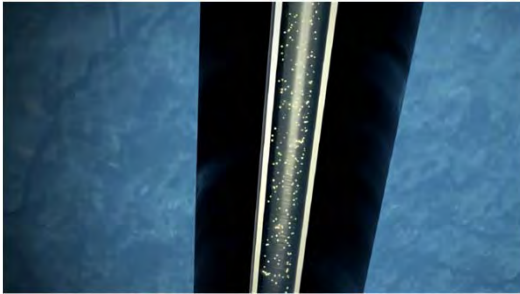
ENCAPSO PROVIDES IMPROVED LUBRICITY RELATIVE TO OTHER LUBRICANTS USED IN THE WILLISTON BASIN

Coefficient of Friction in Brine (Pin and Vee Block Tester)
750 ft.*lbs.



ENCAPSO™ WORKS PROACTIVELY AND EFFICIENTLY TO REDUCE NPT

ENCAPSO



Encapsulated lubricant is proactively added to avoid potential drilling problems.



Encapso circulates freely within the drilling system, dispersing but remaining intact until needed. It does not adversely affect mud properties.



Capsules rupture when they encounter friction – releasing oils exactly where needed at a high concentration. Unused capsules are recirculated.

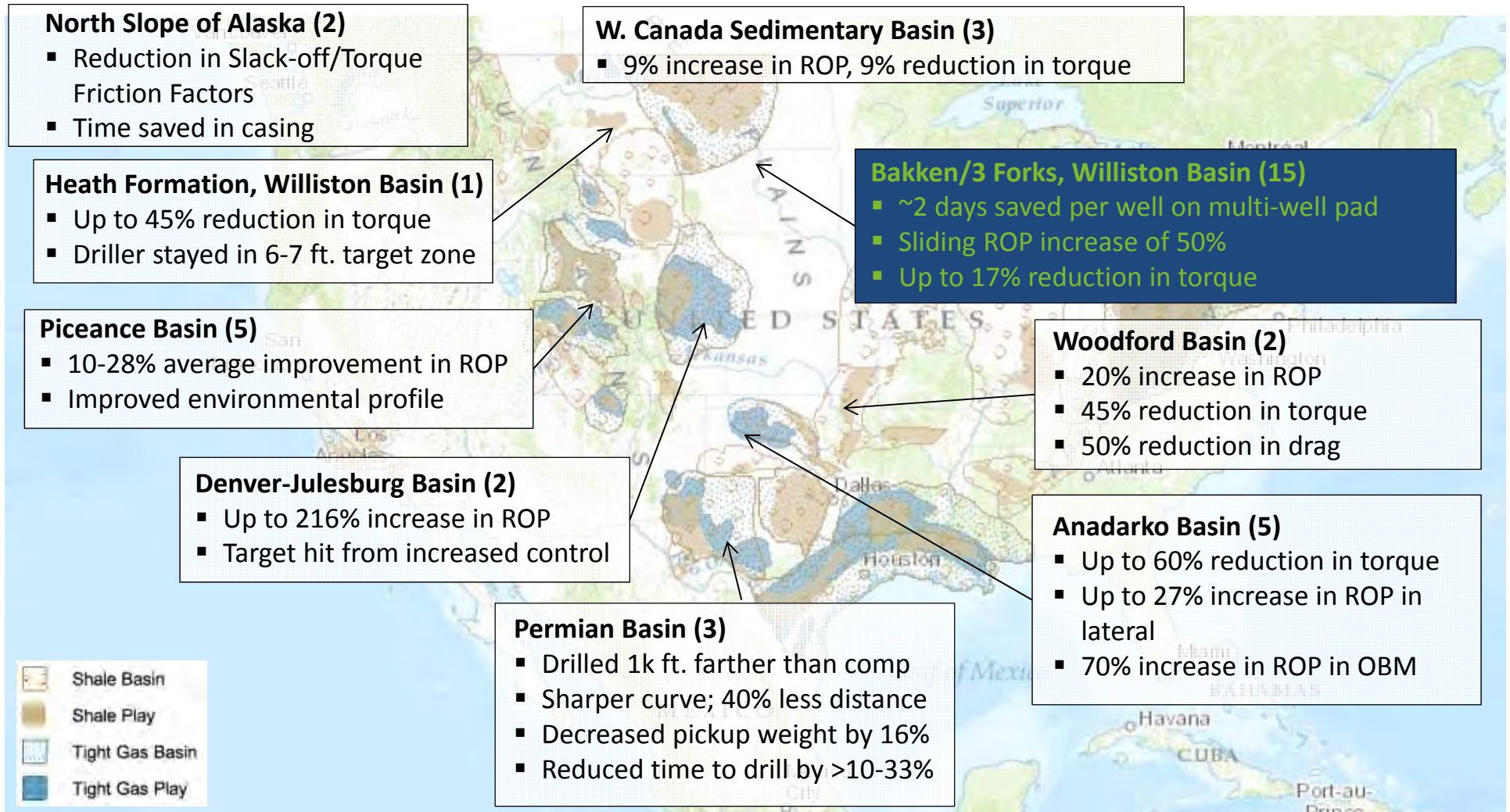
INCUMBENT LUBRICANT

Liquid lubricant is added at high concentrations only when drilling problems occur.

Liquid lubricant becomes lost within the drilling system.

Present in the well at low concentration. Not reusable once effectiveness is lost.

ENCAPSO HAS BEEN SUCCESSFULLY USED ACROSS NORTH AMERICA IN OVER 35 COMMERCIAL WELLS



Visit www.encapso.com for full list of case study results

ENCAPSO WAS USED IN A RECENT WELL IN THE THREE FORKS

Background

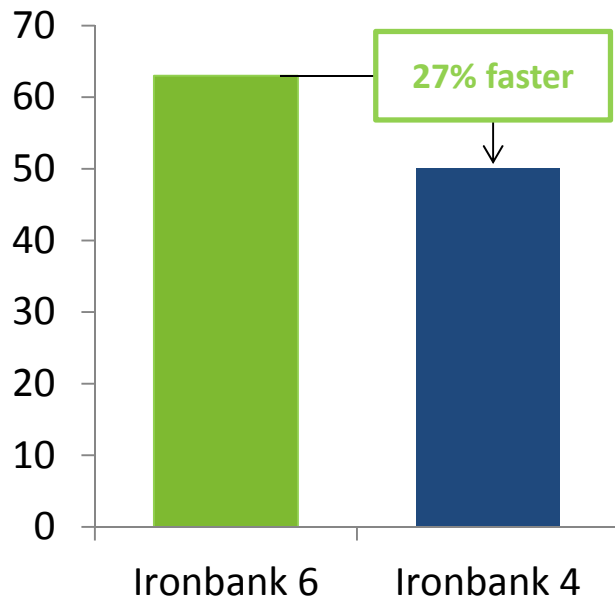
- Encapso lubricant was used in a well drilled in the Three Forks formation with three-salt produced brine mud
- Encapso was used exclusively in roughly the first 4,000' of the lateral section
- Results were compared against the first ~4,000' of the lateral section of a well drilled previously on the same pad with an incumbent liquid lubricant

ENCAPSO PROVED EASIER TO USE AND WAS ASSOCIATED WITH FASTER PENETRATION

- 27% increase in ROP
- Directional driller was impressed with ease of use

Rate of Penetration (ROP)

Avg ft per hr



Feedback from directional driller

Days, feet

“The product works as stated and is MUCH easier to manage and handle than large volumes of liquid lube in 55 gallon containers. Also the product is not affected by temperature so use of heated lube trailers is not required, saving cost.”

ANOTHER OPERATOR EXPERIENCED OPERATIONAL IMPROVEMENTS THROUGH USING ENCAPSO

Background

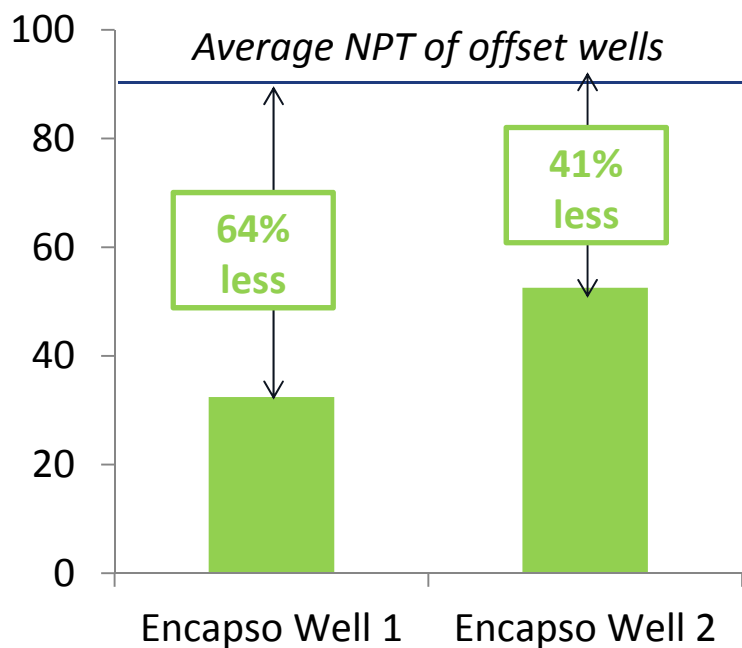
- An operator used Encapso on a 3 well pad south of the river in North Dakota, drilled using a produced brine-based mud system
- Encapso was used exclusively throughout the entire lateral section of each well
- Performance was compared to 2 other wells drilled nearby with traditional liquid lubricants
- Due to substantial differences in geometry for first well, only 2 wells drilled using Encapso were compared to the 2 offset wells
- Encapso brine was reused across all 3 wells on pad, adding maintenance dosing as product was used up

THE OPERATOR SAVED 2.3 DAYS ON AVERAGE USING ENCAPSO

- ROP increased by about 20% overall, and by 54% for sliding
- Reduced torque by 16%
- Reduced NPT by about 50% on average (2 fewer trips on average)

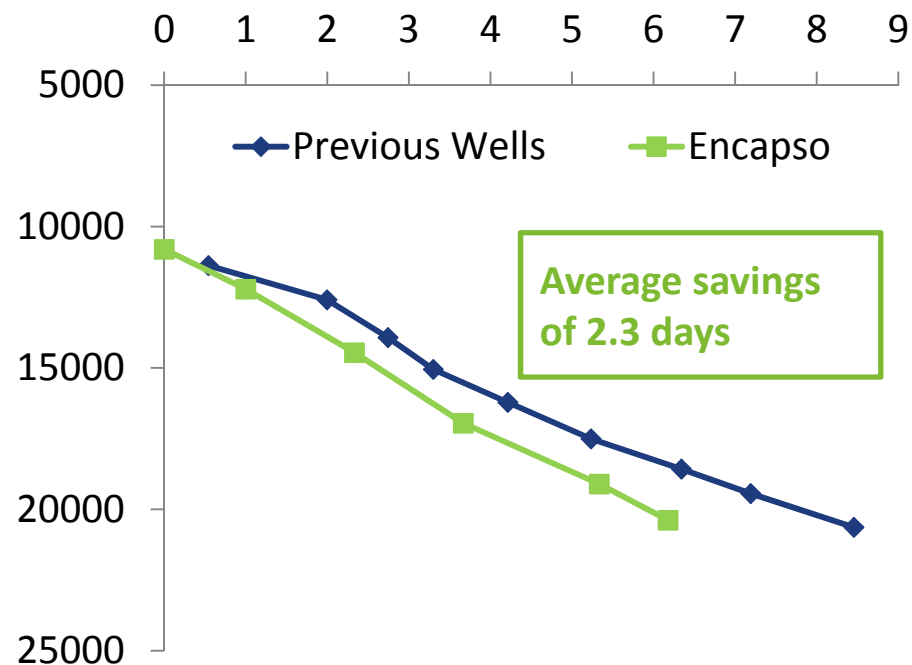
Non-productive time (NPT)

Hours



Days vs. Measured Depth (MD)

Days, feet



THANK YOU

Questions?



APPENDIX



WE HAVE PUBLISHED TECHNOLOGY PAPERS IN SPE AND AAE

SPE and AAE Conference Papers



SPE-169547-MS

Characterization of Encapsulated Oil as an Additive to Water-Based Drilling Fluids: Operational Improvements in Lubricity, Drag, and ROP

F.J. Schuh, Drilling Technology; A. Coragliotti, C.D. DiCicco, and R.A. Nagatani, Solazyme Inc.; A. Rea, T. Carlton, ARC Fluid Technologies; Cathedral Energy

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Abstract

Description of Properties

As the drilling industry pursues more horizontal wells with increasingly complex design (e.g., extended-reach wells, high angle wells), challenges from high friction (e.g., reduced Rate of Penetration [ROP], stuck pipe, severe doglegs or corkscrews) grow more pronounced. These challenges are particularly pronounced in Water Based Muds (WBM), which have an inherently higher Coefficient of Friction (CoF) than Oil Based Muds (OBMs) or Synthetic Based Muds (SBMs). While there are many lubricity additives that are available to reduce frictional force, these additives may present challenges ranging from adversely affecting the properties of the drilling fluid (e.g., liquid lubricants that may change rheology or interact with other additives) to interfering with drilling equipment (e.g., glass beads that plug valves in mud pulse telemetry systems). To address these challenges, we have developed a novel method for encapsulating lubricant for use as a lubricity additive. Characterization of encapsulated oil in the lab has shown the ability to reduce the CoF of water based mud systems by



AADE-14-FTCE-10

Field Results for Encapsulated Oil as an Additive to Water-Based Drilling Fluids: Operational Improvements in the Alliance/Northern Denver-Julesburg and Heath Basins

P. Johnson, Sr. Drilling Engineer, Fidelity Exploration and Production; A. Rea, ARC Fluid Technologies, LLC; A. Coragliotti, C.D. DiCicco, and R.A. Nagatani, Solazyme Inc.

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This paper was prepared for presentation at the 2014 AADE Fluids Technical Conference and Exhibition held at the Hilton Houston North Hotel, Houston, Texas, April 15-16, 2014. This conference was sponsored by the American Association of Drilling Engineers. The information presented in this paper does not reflect any position, claim or endorsement made or implied by the American Association of Drilling Engineers, their officers or members. Questions concerning the content of this paper should be directed to the individual(s) listed as author(s) of this work.

Abstract

significantly decreases the effective weight on bit, thereby reducing the effective power of the bit to drill through formation. Additionally, substantial torque increases can lead to sinusoidal or helical "buckling" of drill pipe, which increase points of contact (thereby increasing total friction) and can damage drill pipe¹. As horizontal wells get longer, challenges from frictional force increase significantly as more surface area of drill pipe come into contact with formation and as the cumulative frictional force (e.g., normal force times the coefficient of friction) on horizontal drill pipe increases due to longer sections of pipe being horizontal (thereby increasing the normal force). Challenges from friction also significantly increase when torsional friction makes it difficult to turn the tool face of the BHA in directional drilling. Inability to keep the drilling path to plan can lead to severe doglegs or corkscrewing from course-correction to achieve the target depth. As these severe geometries lead to more frictional force on the drill pipe and impede a straight path for the weight of the drill string to apply force at the drilling bit, they constrain the potential of the horizontal section of the well.

SPE reference : 169547-MS

AADE reference: 14-FTCE-10

Conference Presentations



2014 Western North American and Rocky Mountain Joint Conference and Exhibition



2014 AADE National Fluids Conference & Exhibition



ENCAPSO IS NON-TOXIC AND CONTAINS SIGNIFICANTLY LOWER AMOUNTS OF ENVIRONMENTALLY-REGULATED CHEMICALS

Contaminant	Max value ¹	Encapso
TPH	500 mg/kg	Undetected ¹
Semi-Volatile Organic compounds	0.022 mg/kg to 1000 mg/kg	Undetected
Benzene	0.17 mg/kg	Undetected
Ethylbenzene	100 mg/kg	0.16 mg/kg
Xylenes (total)	175 mg/kg	1.5 mg/kg

EH&S: Encapso is a fully bio-degradable non-toxic powder

- If spilled, clean up is simple and does not require soil remediation (like liquid lubricants do)
- Meets ultimate bio-degradability (ASTM) – 95% in 28 days

Eco-toxicity results

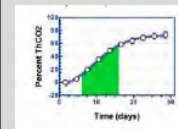


Acute Daphnia: low toxicity, EL50 >240 mg/L



Acute Fish: no mortality, EL50 >240 mg/L

Biodegradability



Meets criteria for "Ready Biodegradability" designation (OECD)

¹ Based on environmental regulation in Colorado