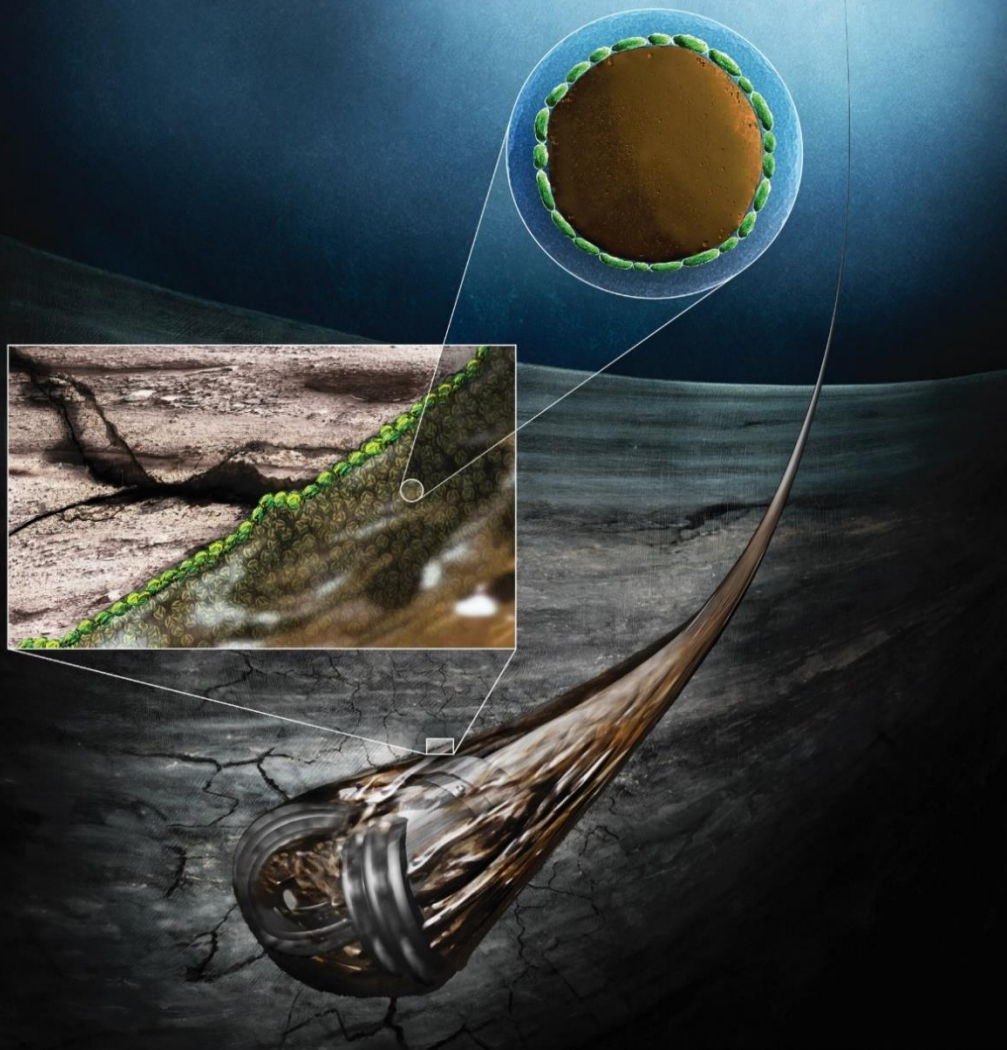


energy & fuels

XXXXX XX, XXXX VOLUME XX

pubs.acs.org/EF



TIGER
BULLETS MICRO

Sustainable & High-Performance Fluid Additives

Prof Qinglin Wu
Renewable Natural Resources
Louisiana State University AgCenter

Sustainable Material Technology for Oil Industry



US Patent 11,028,307 B2

US Patent Application - pending

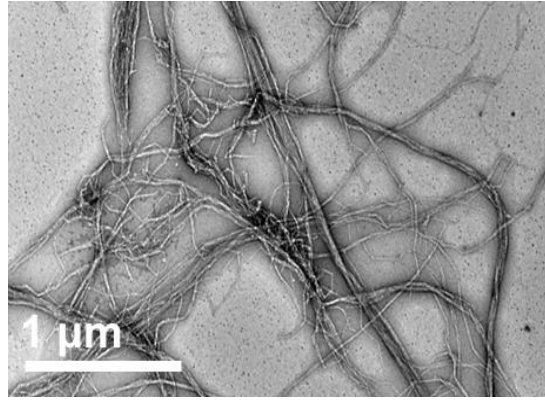


Renewable MicroFiber
Technology

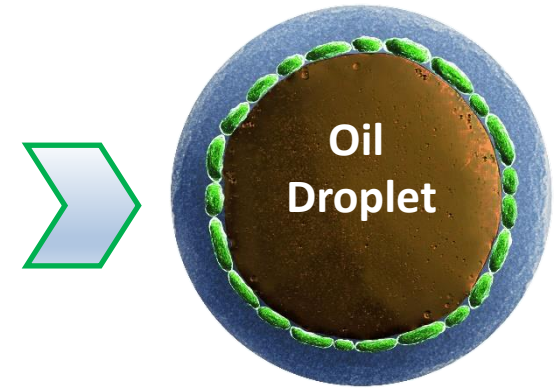


Material & Properties

Both Hydrophilic and Hydrophobic Phases



Pickering Chemistry
For Emulsion Fluids



F.5

Diesel

Water

B.5

SE

Legend:

- : Oil droplet
- : Fibers
- : Lignin particles

Sucrose Ester

CCCCCCCCCCCCCCCCCCCCOC1OC(O)C(O)C(O)C1O

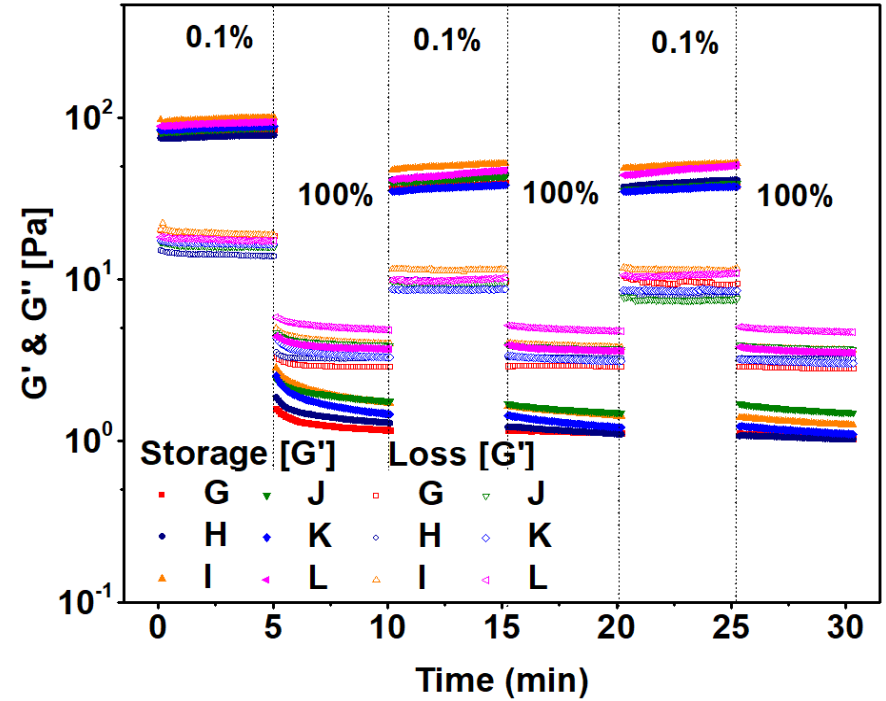
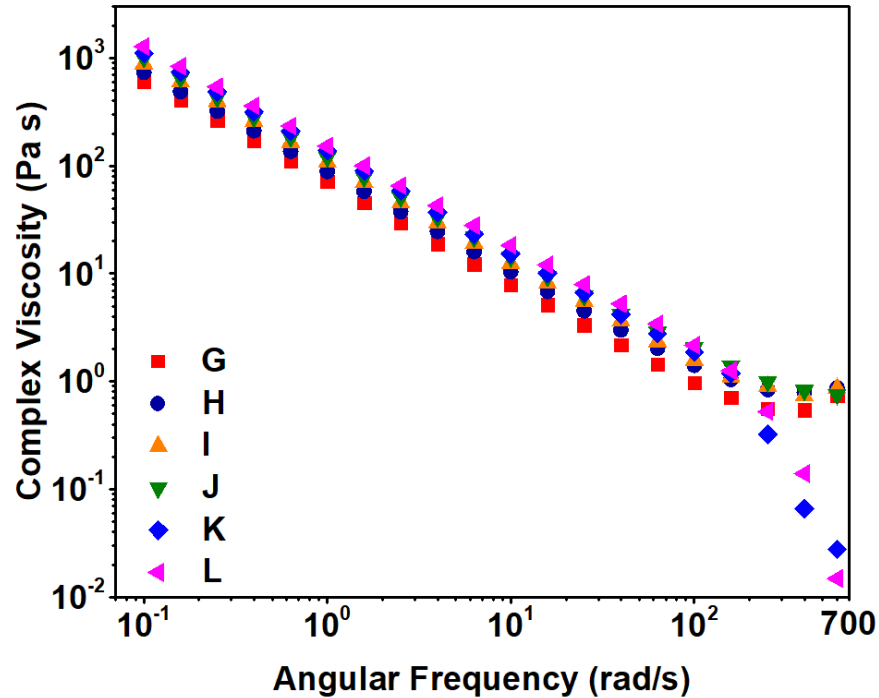
Cellulose Chain

OC[C@H]1O[C@@H](O[C@@H]2[C@@H](CO)O[C@H](CO)O2)[C@H](O)[C@@H](O)[C@H]1O

Lignin

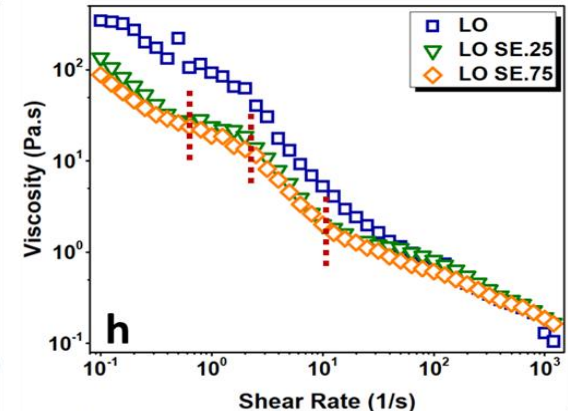
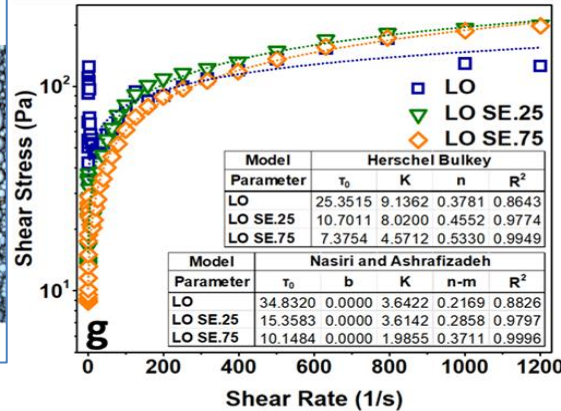
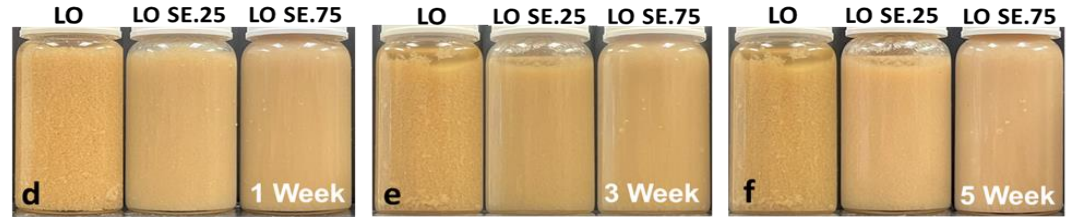
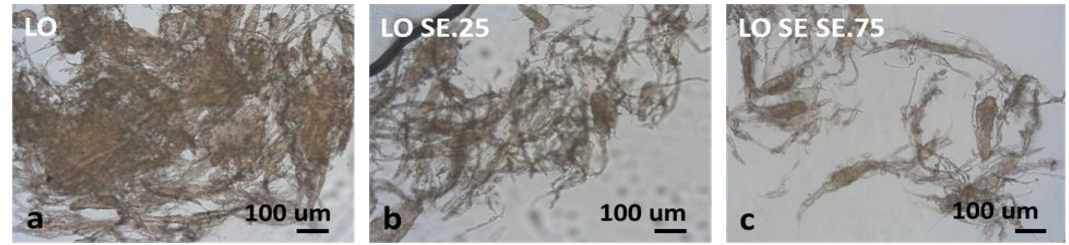
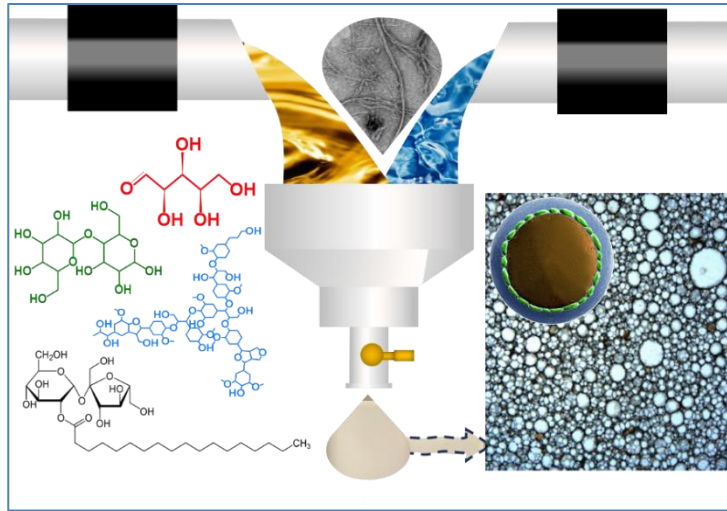
Oc1ccc(Oc2ccc(O)cc2)cc1

Material & Properties

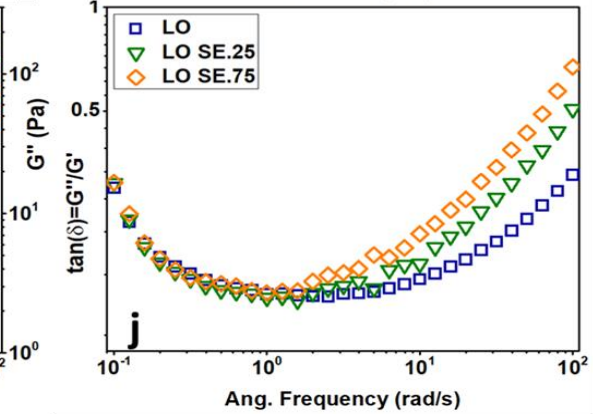
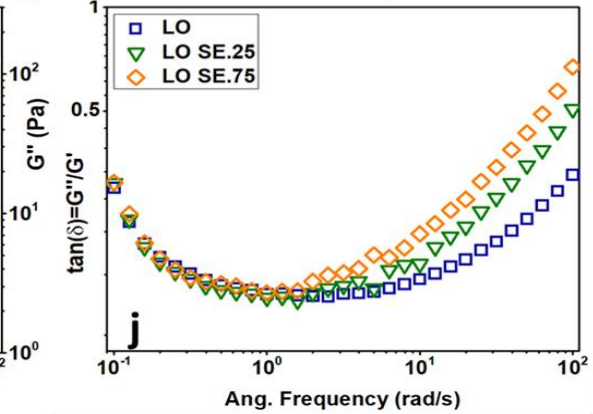
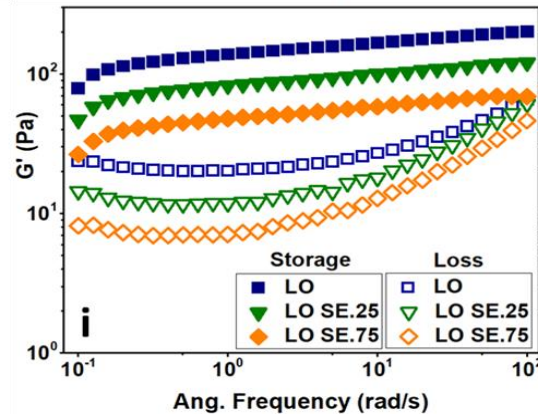


Strong Shear Thinning & Thixotropic Behavior

Material & Properties



Oil/Water Emulsion



Scalable Manufacturing (Dry-Form)

- TigerBullets Micro

Use at Remote Oil/Gas Fields



Material Flow & Distribution

Sustainable Material

F



A



E

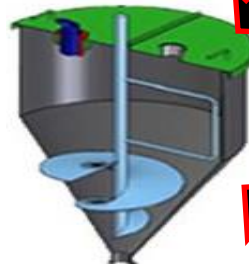
Shipping

Blending & Packaging



Additives

D



Blends

C



Storage

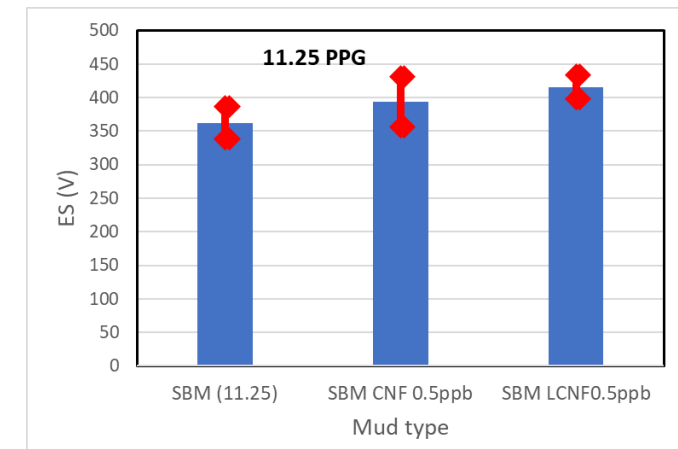
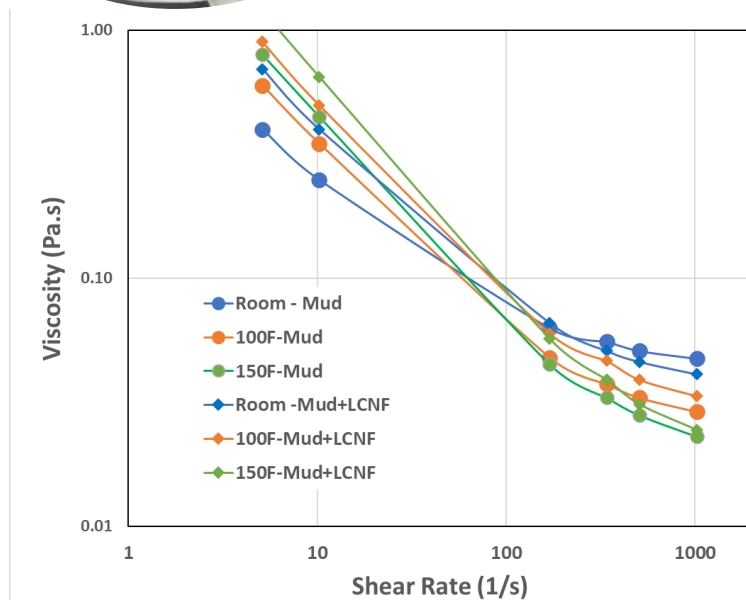
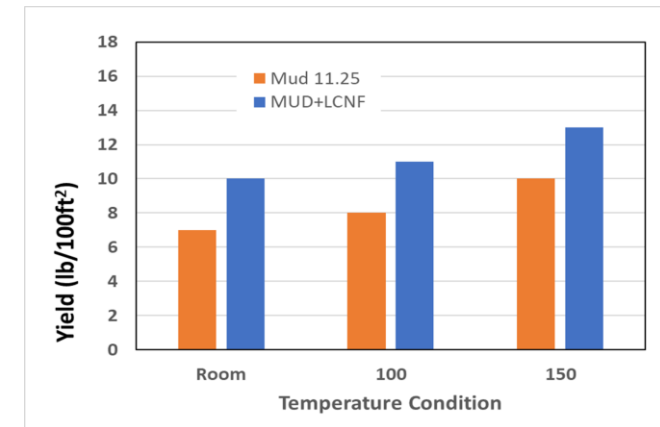
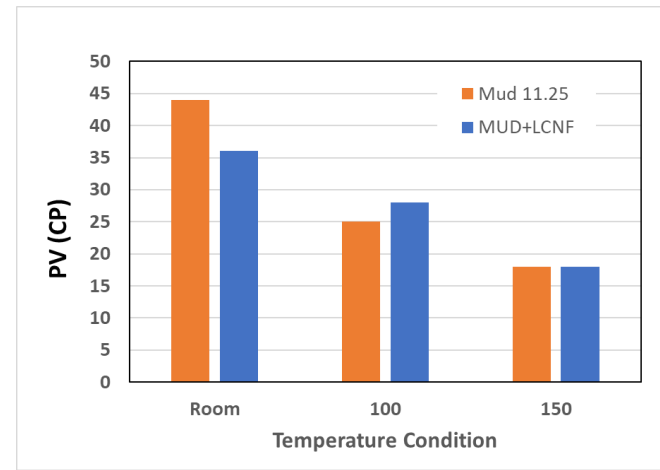
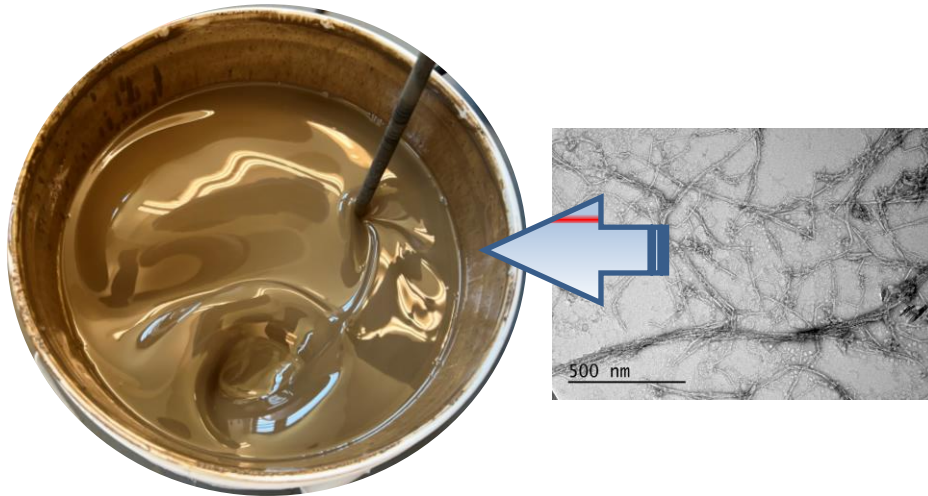


B

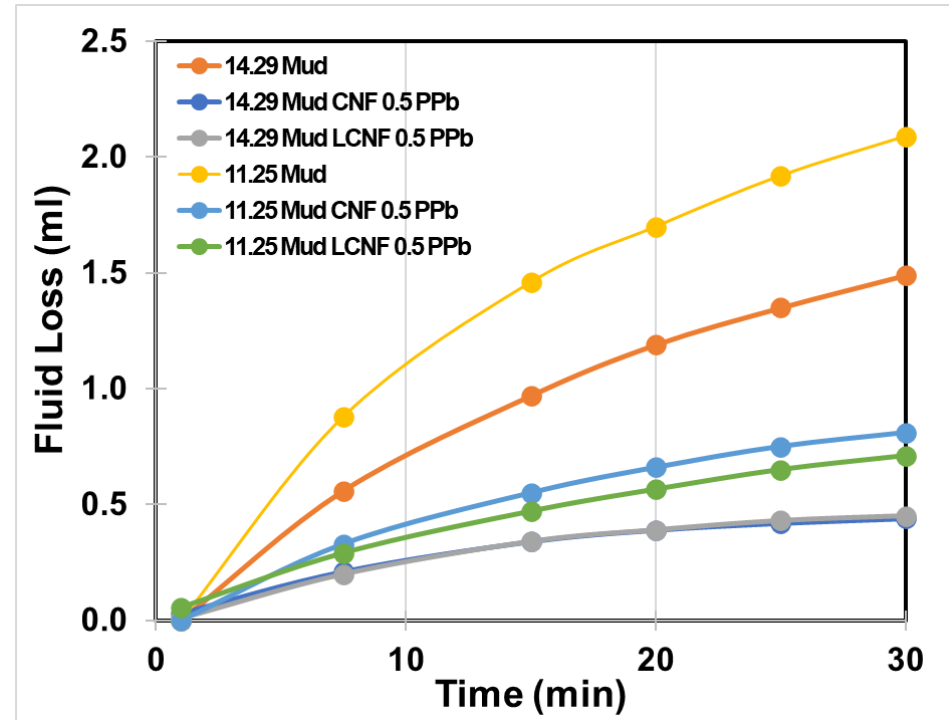
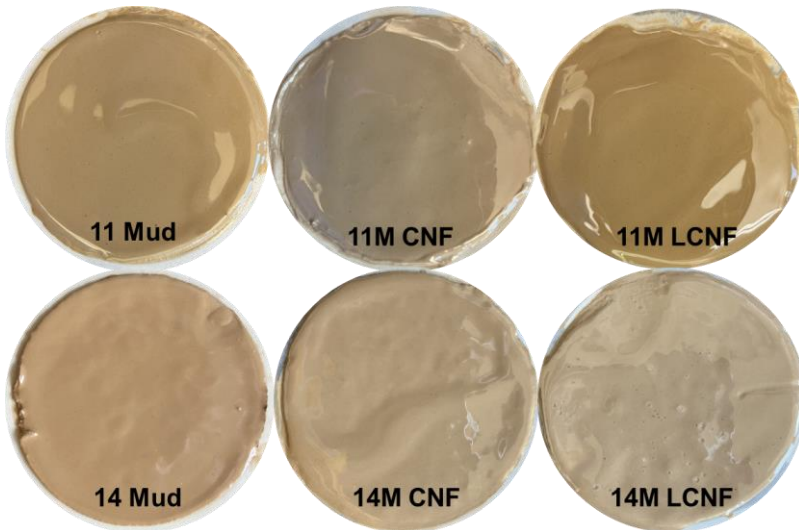
Lab and Field Testing

- Wet-Form Application
- Dry-Form Application

Wet-Form Application: Synthetic Mud System



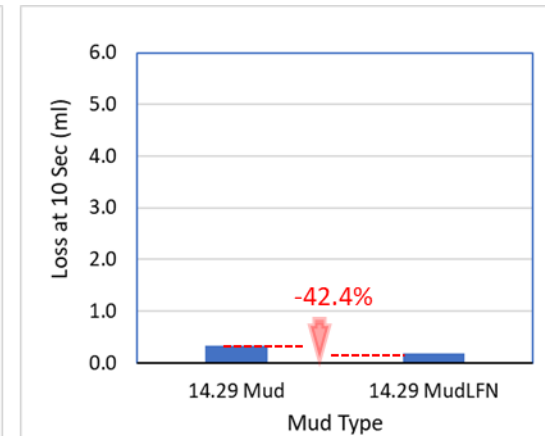
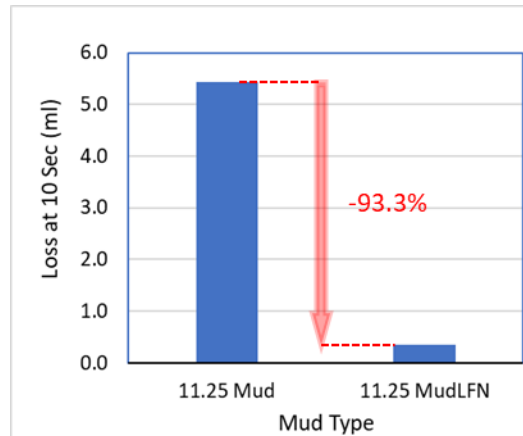
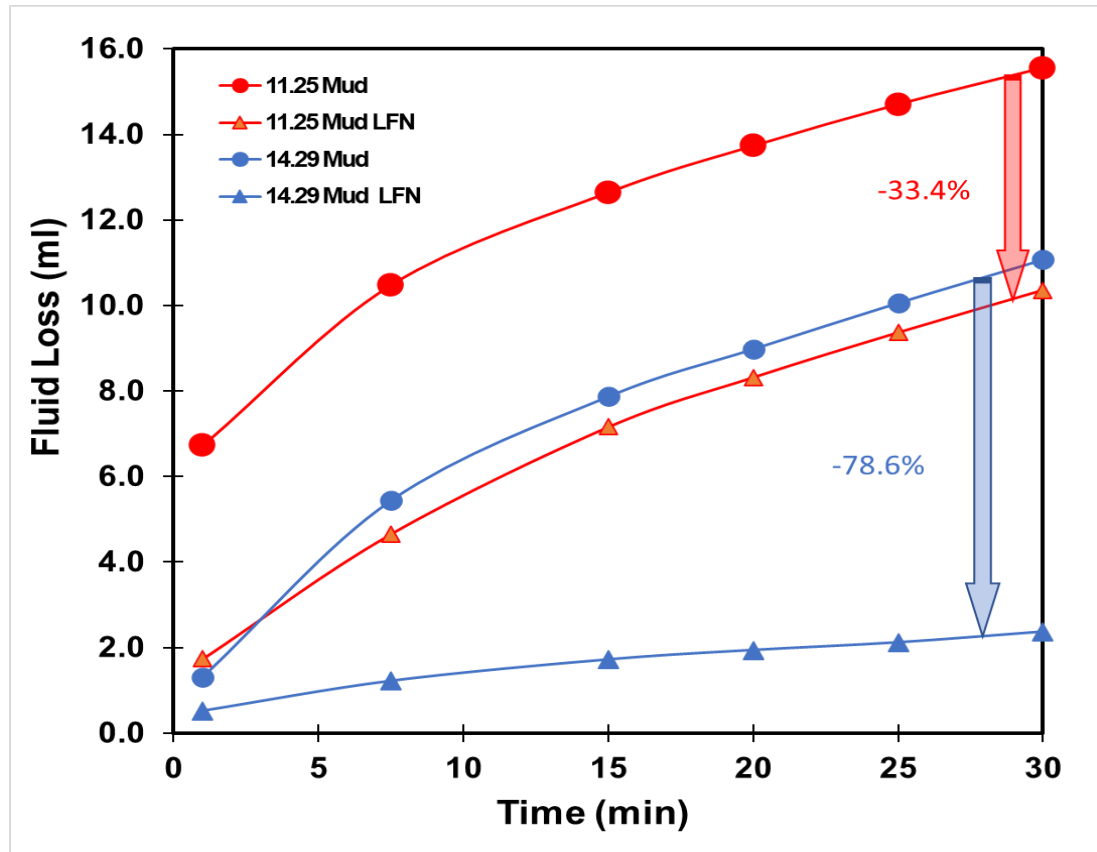
Low Temperature/Pressure Filtration Loss/Permeability



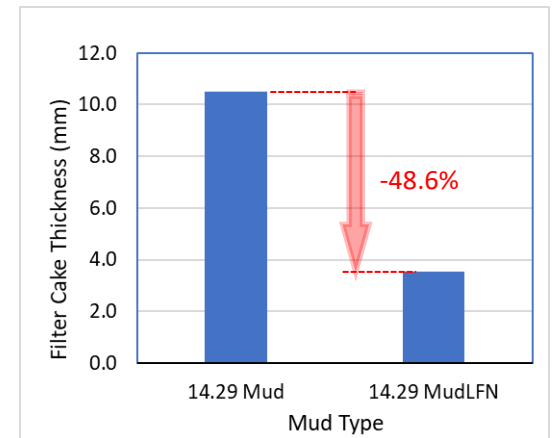
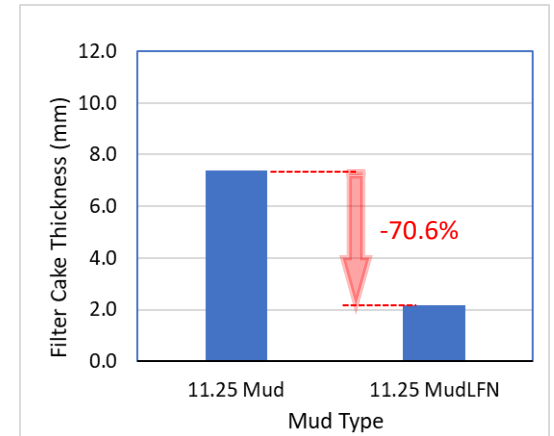
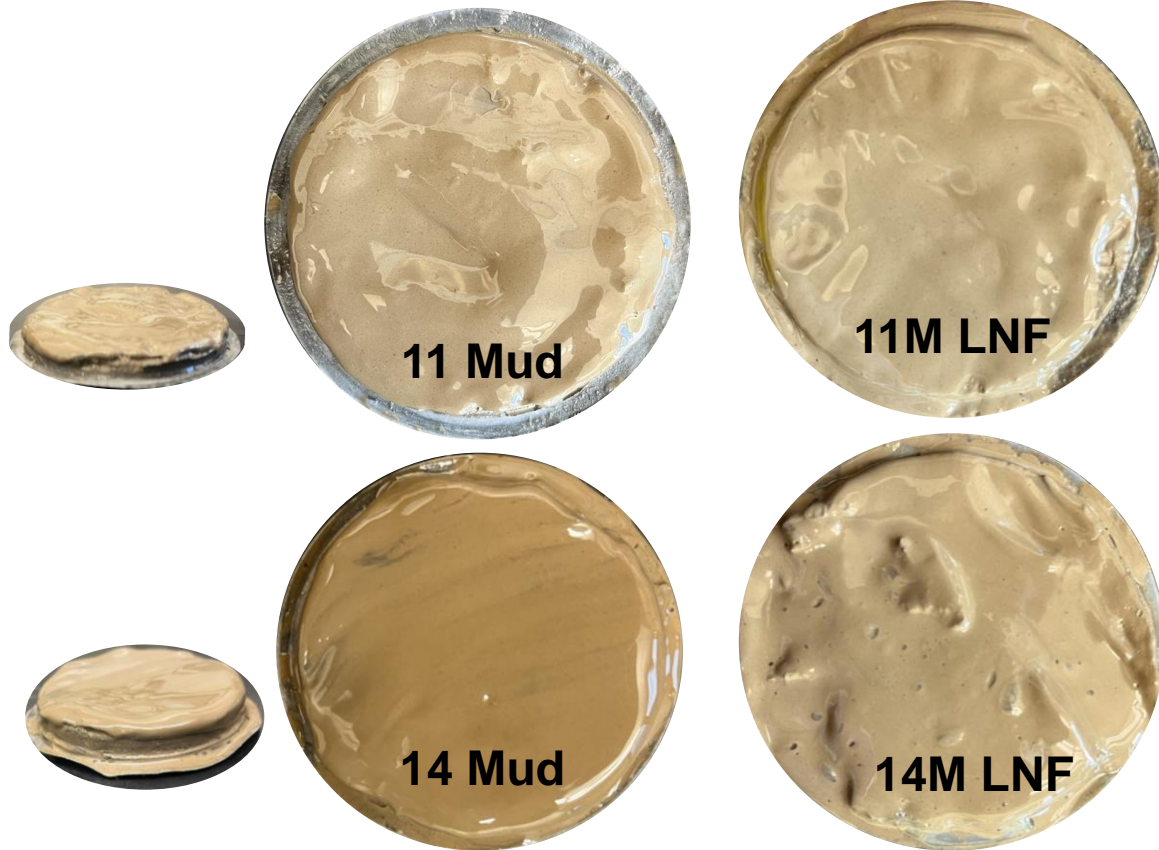
Permeability Kc	11.25 Mud	11.25 Mud CNF	11.25 Mud LCNF	14.29 Mud	14.29 Mud CNF	14.29 Mud LCNF
μ [cp]	1	1	1	1	1	1
t [cm]	0.207	0.131	0.132	0.21	0.126	0.118
q [cm ³ /min]	0.0221	0.0193	0.0166	0.0222	0.0151	0.0137
q [cm ³ /s]	0.0003683	0.0003217	0.0002767	0.0003700	0.0002517	0.0002283
ΔP [atm]	6.5	6.5	6.5	6.5	6.5	6.5
A [cm ²]	45.8	45.8	45.8	45.8	45.8	45.8
Permeability (D)	0.26	0.14	0.12	0.26	0.11	0.09

Reduced fluid loss, filter cake thickness and permeability

HTHP Fluid Loss, SBM LNF 0.5ppb 300°F/500 PSI Pressure Differential

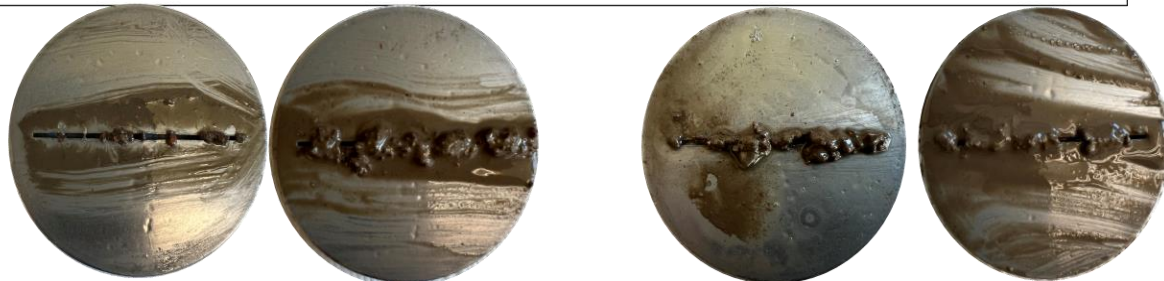
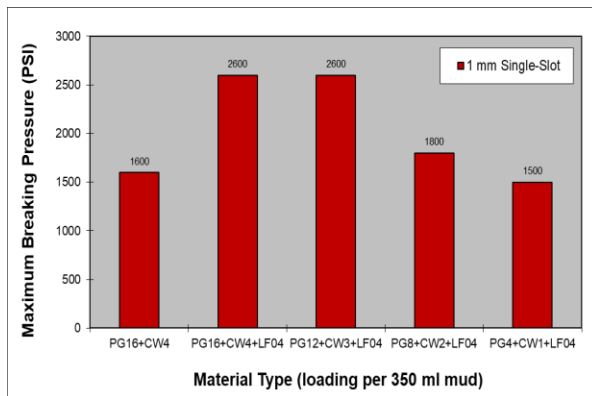
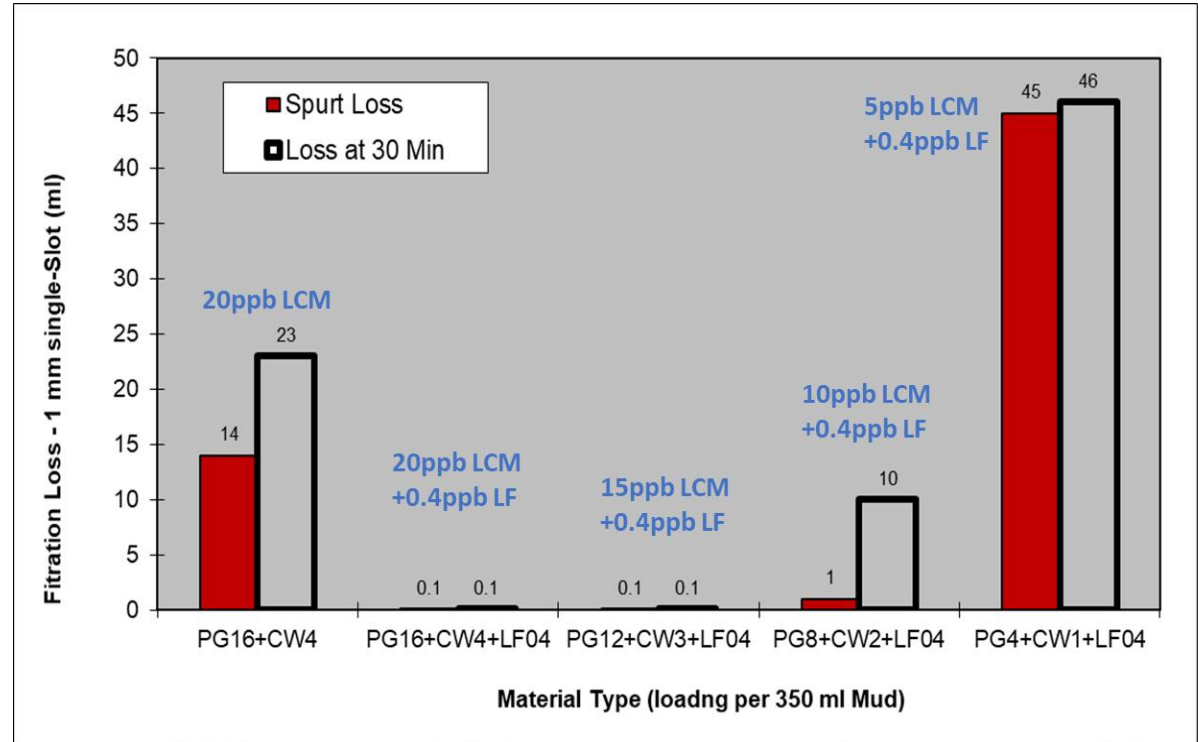


HTHP Filter Cake, SBM LNF 0.5ppb -300F



Filtration (In combination with LCM)

1000 PSI Pressure /30 minutes
 LCM + 0.4 ppb LNF
 1mm single-slot disc
 11.25 ppg SBM

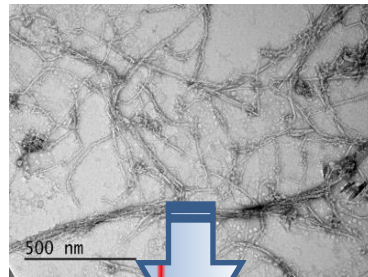


Wet-Form Application: Oil Based Mud System

a: OBM (10.5 ppg): Control

b: OBM + Base fluid + 2.5 ppb (LNF)

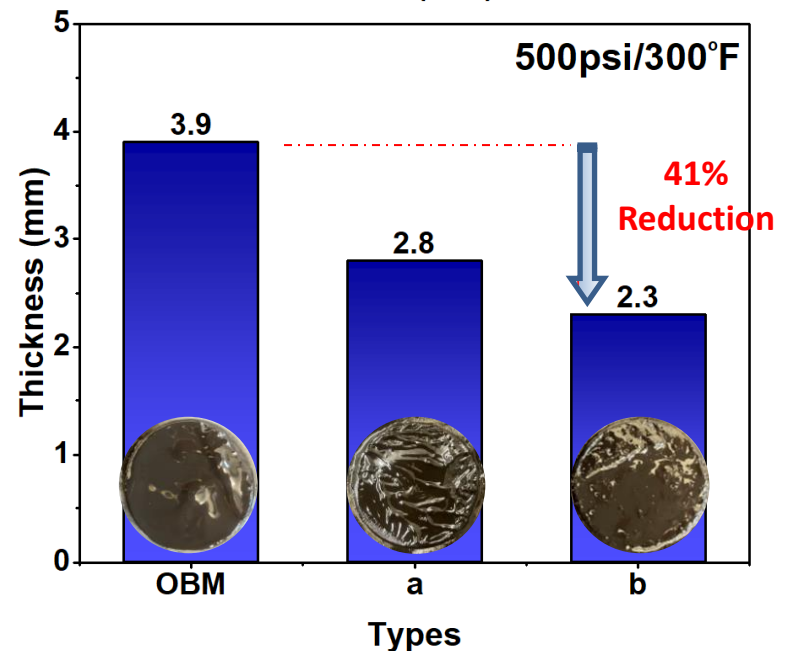
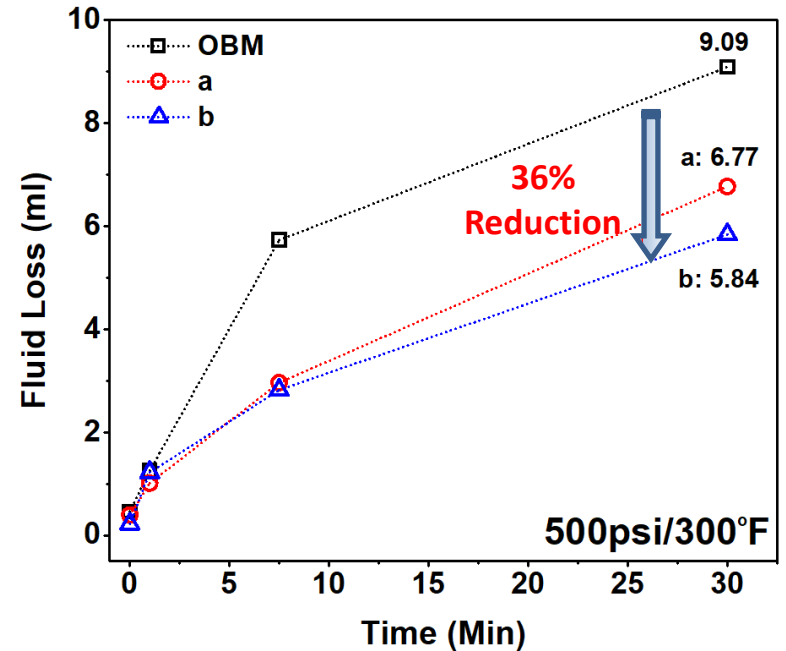
c: OBM + Base fluid + 2.5ppb
(LNF7.5% & SE.25%)



(10.5 PPG)



Material dispersed in CBase-Fluid (NEOFLO 463)



Wet-Form Application: Oil Based Mud System



(10.5 PPG)

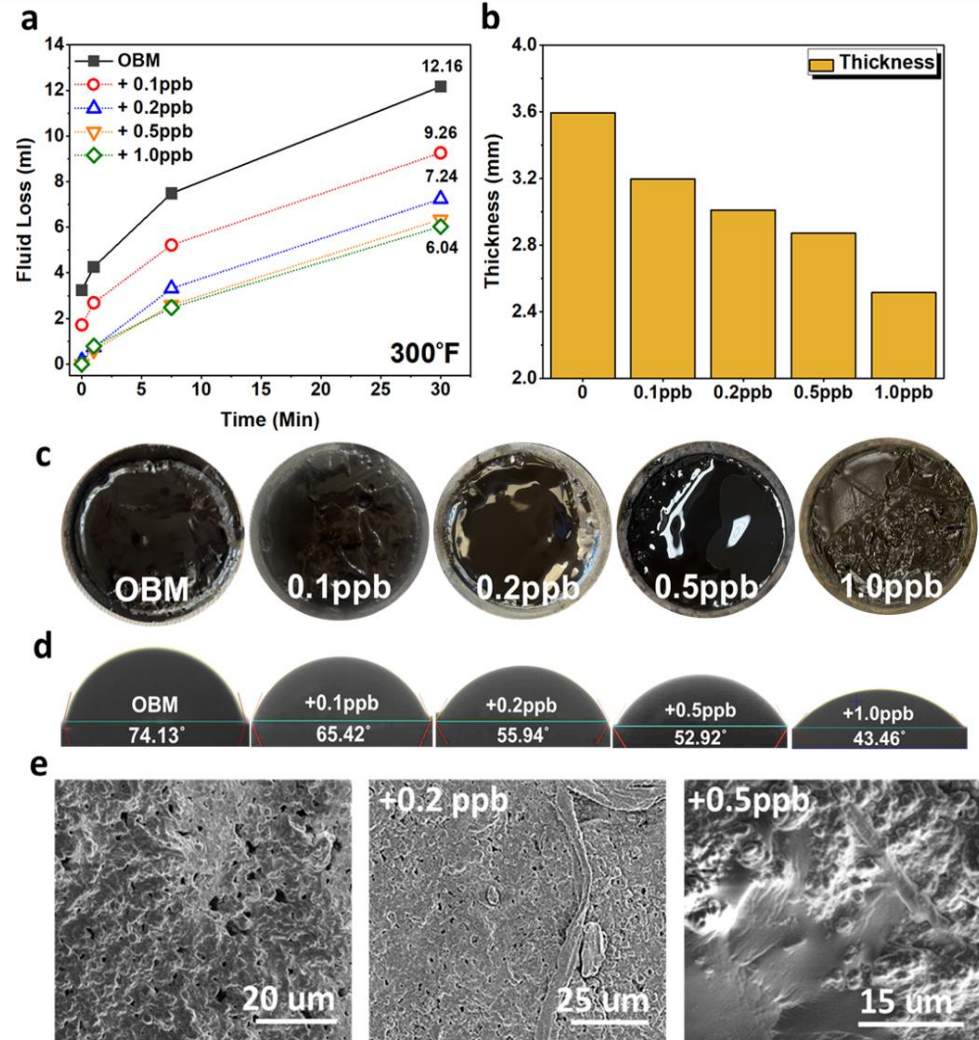


Material dispersed in cotton seed

HTHP Filtration

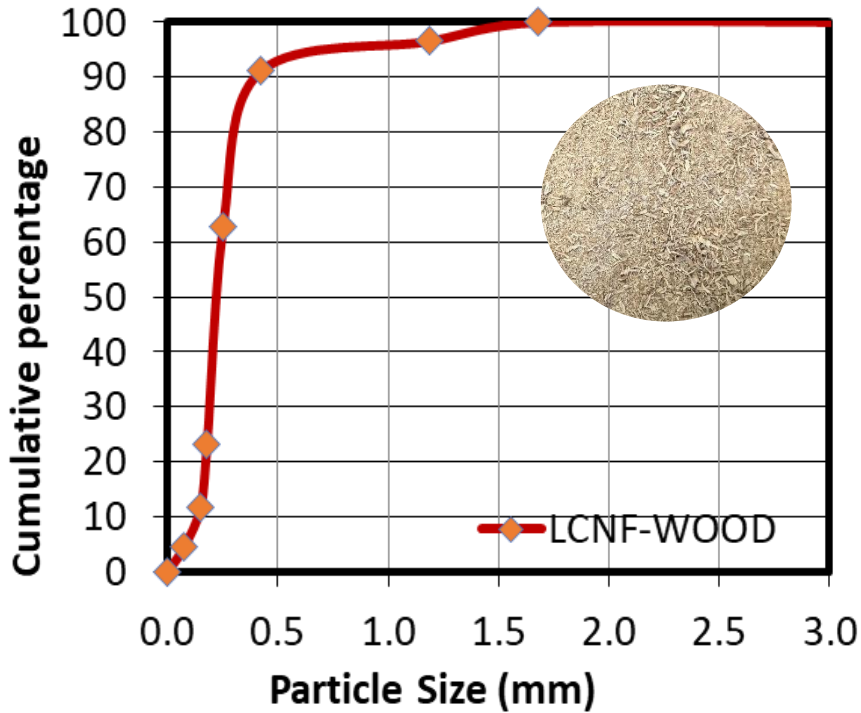
Up to 50%
Reduction

Up to 10%
Reduction

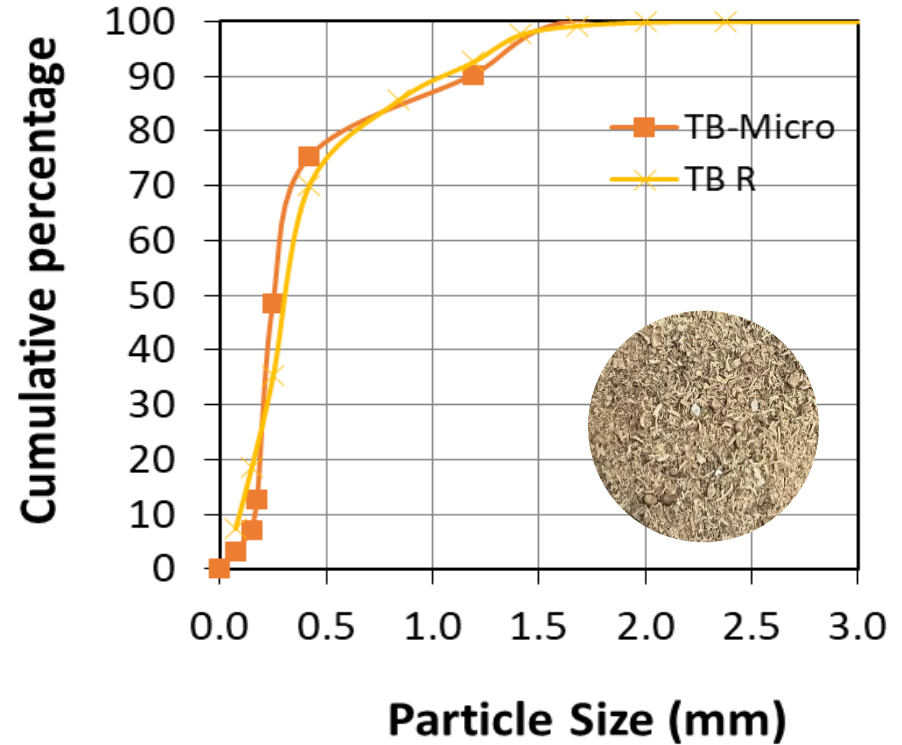


Proper mud formulation needed to maintain mud weight.

Dry-Form Application



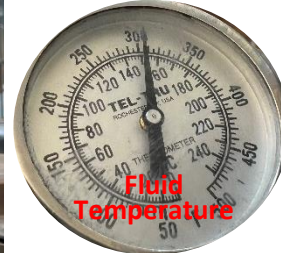
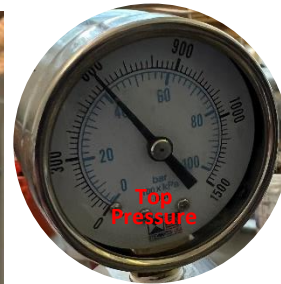
Fine Grade



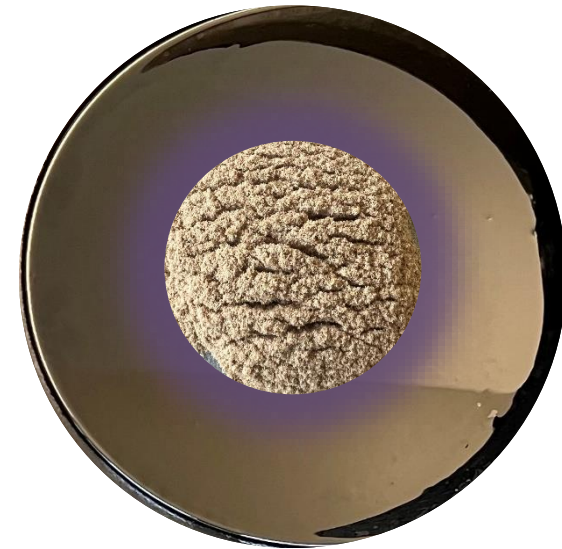
Regular Grade

Commercial Oil-based Mud (cOBM)

- Mud weight = 11.5 PPB
- Electric stability = 450 volts

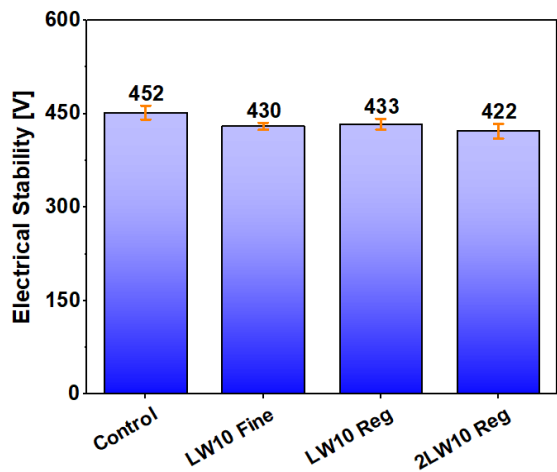
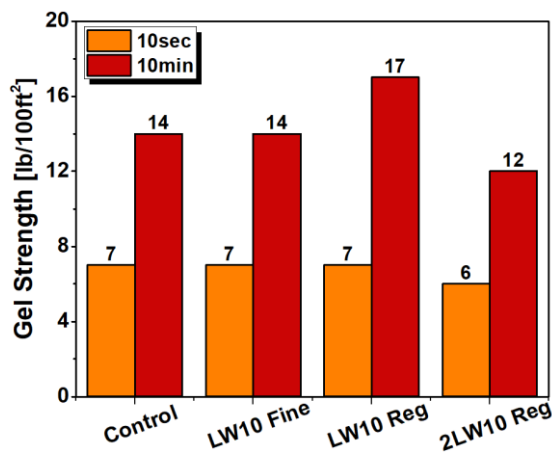
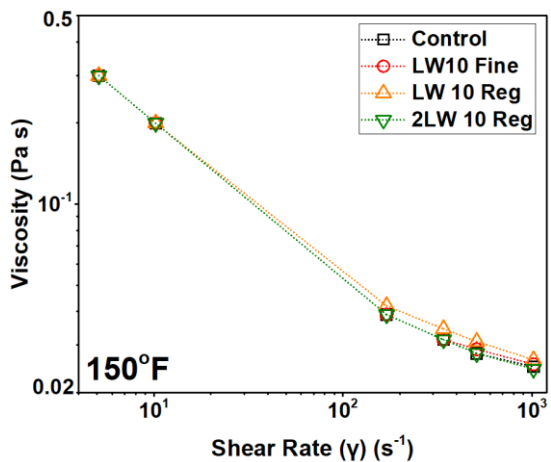
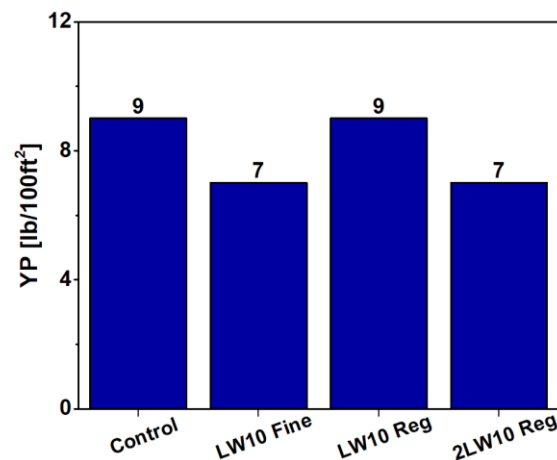
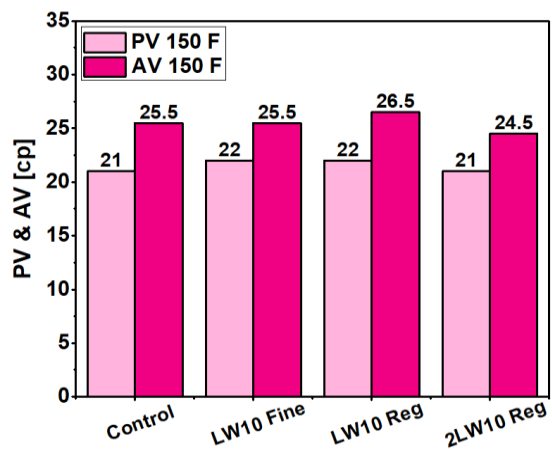
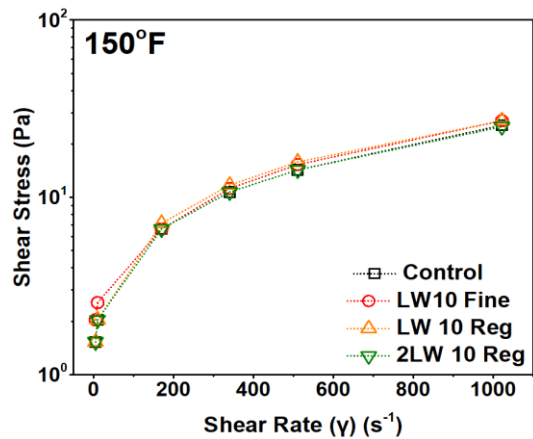


cOBM+
TB Micro (F/R)



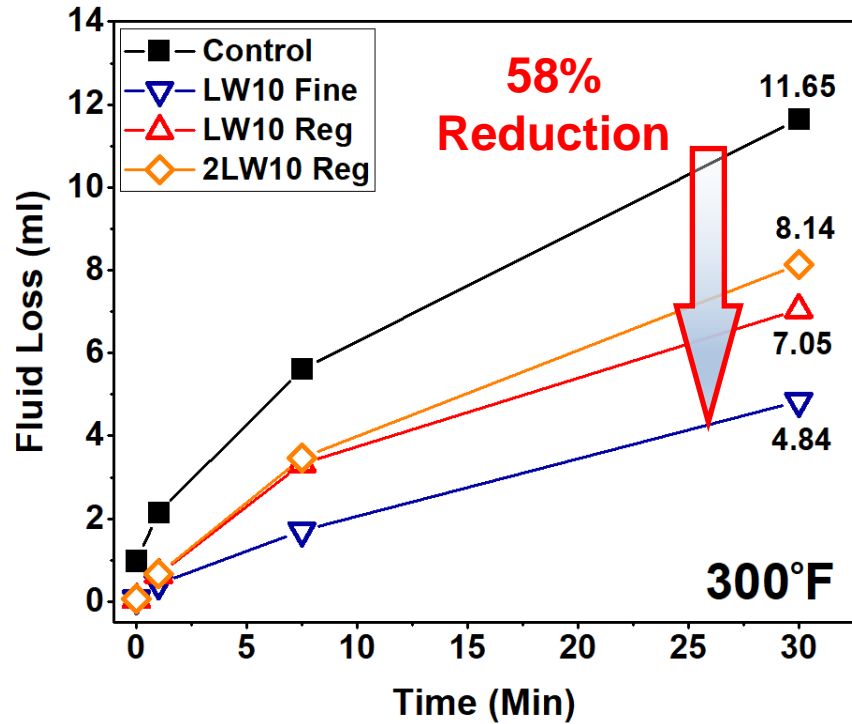
LW₁₀-OBM Properties

LW10: 0.25 PPB; 2LW10: 0.50 PPB

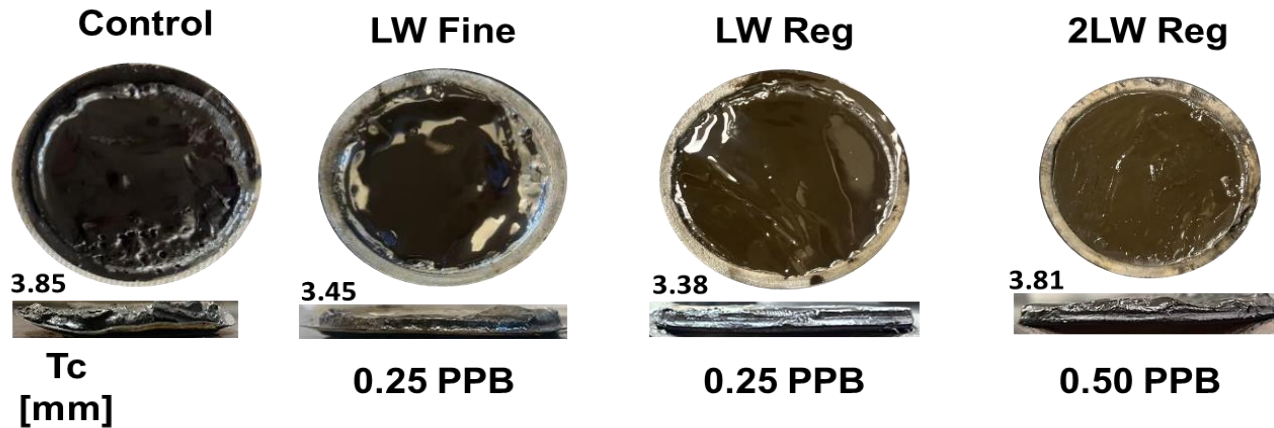
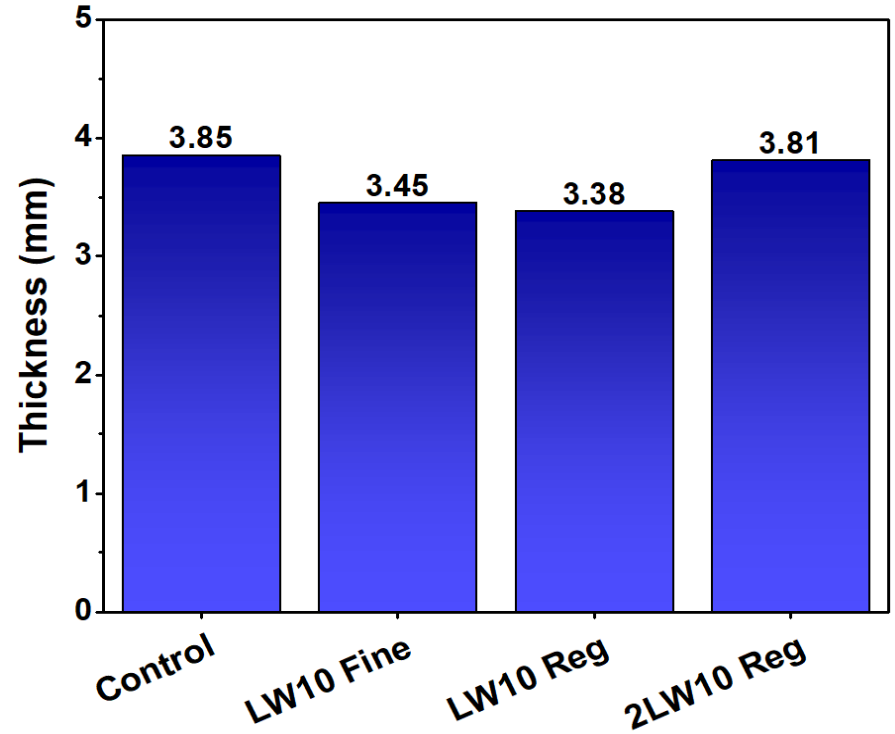


Fine Grade

LW₁₀-OBM Property: Filtration



LW10: 0.25 PPB
2LW10: 0.50 PPB



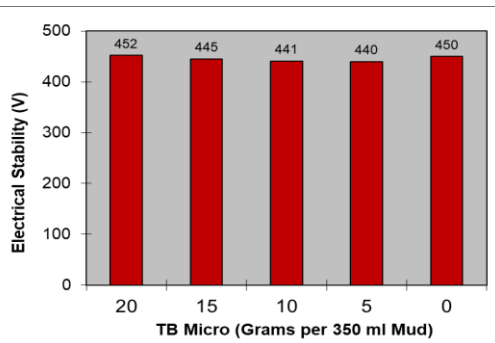
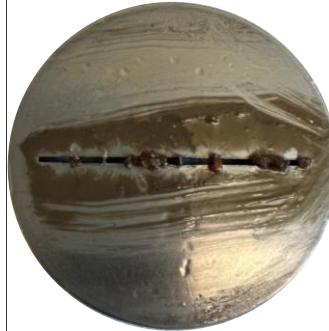
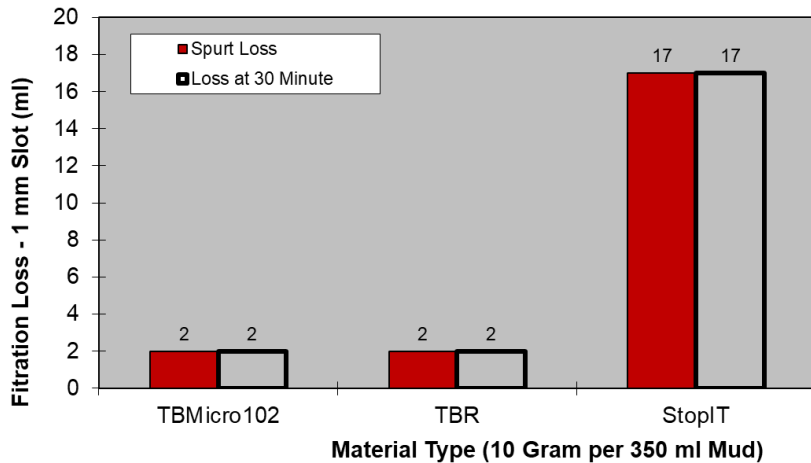
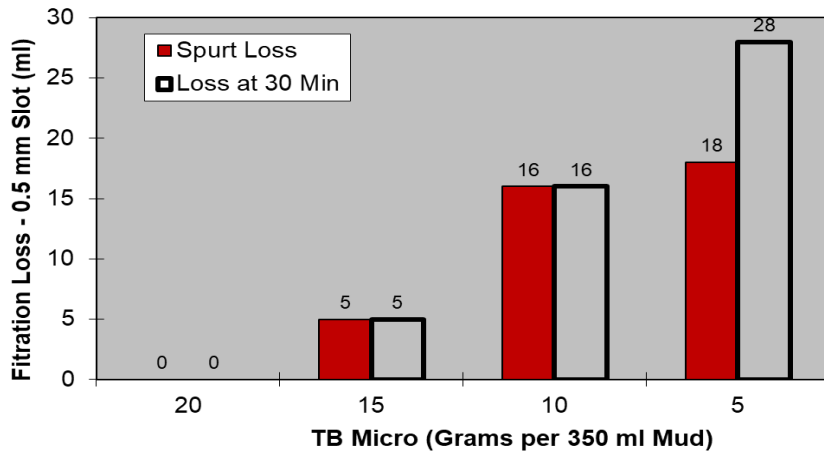
0.25 PPB

0.25 PPB

0.50 PPB

Fine Grade

Regular-grade Formulation

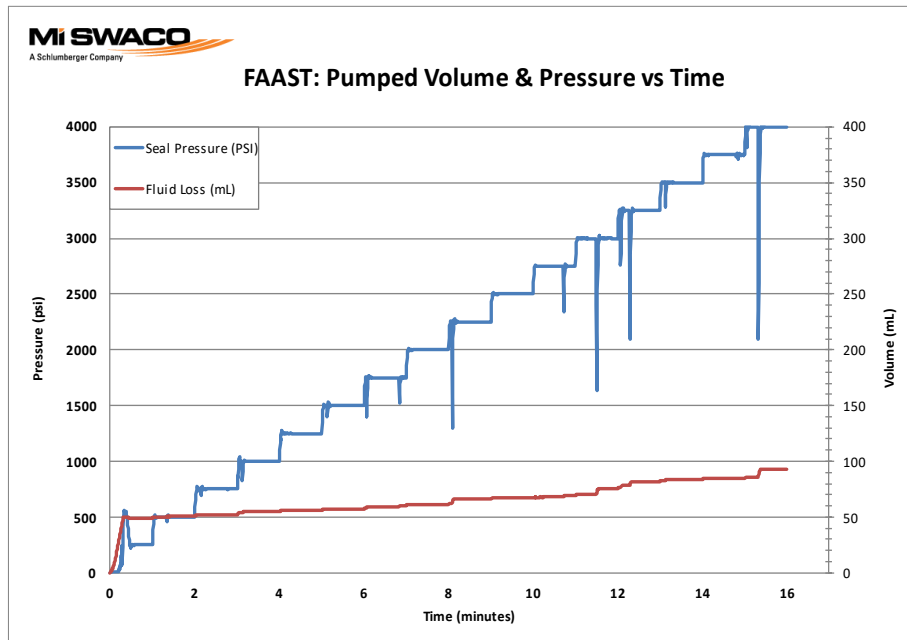


- Mud weight = 11.0 PPB
- Electric stability = 450 volts



Date	4/1/2024		Container #	Material Added	lb/bbl
Client				TIGER BULLETS MICRO	10
Project	TB Change			PALLET 4	
Aperture (µm)	1250				
Pressure Target (psi)	4000				
Base Mud	RGX				
Base Density (ppg)	11.8				
Technician	JDM			Total LCM, lb/bbl:	10

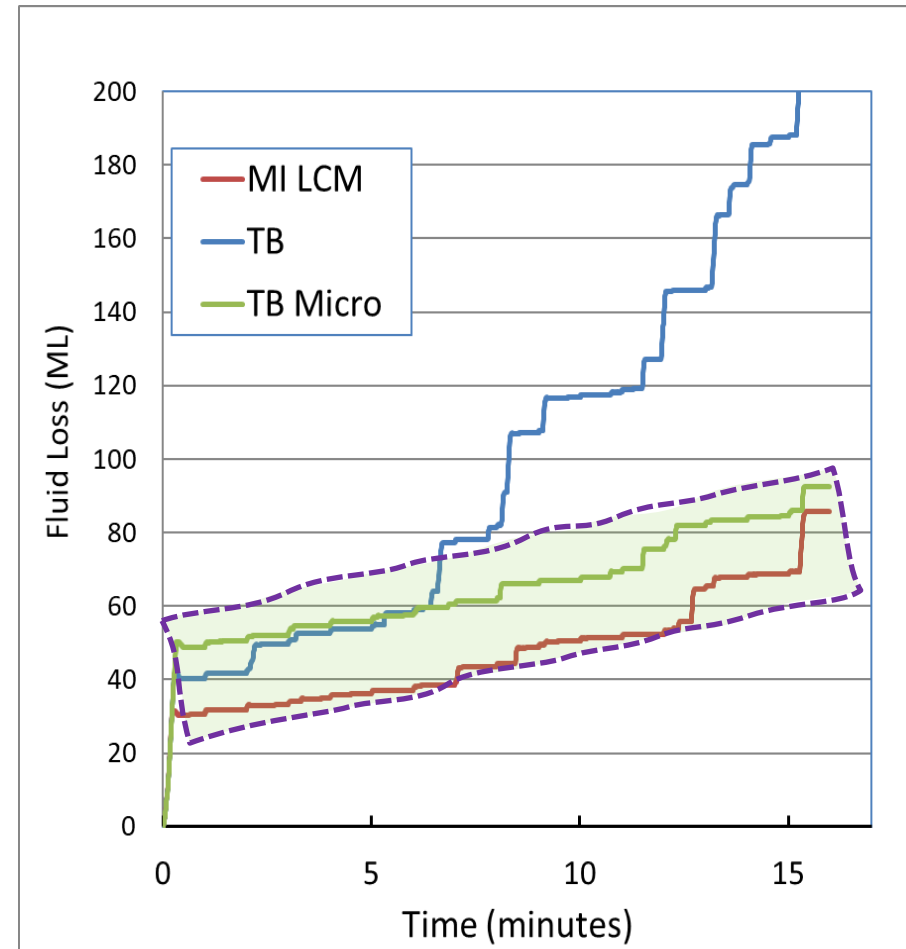
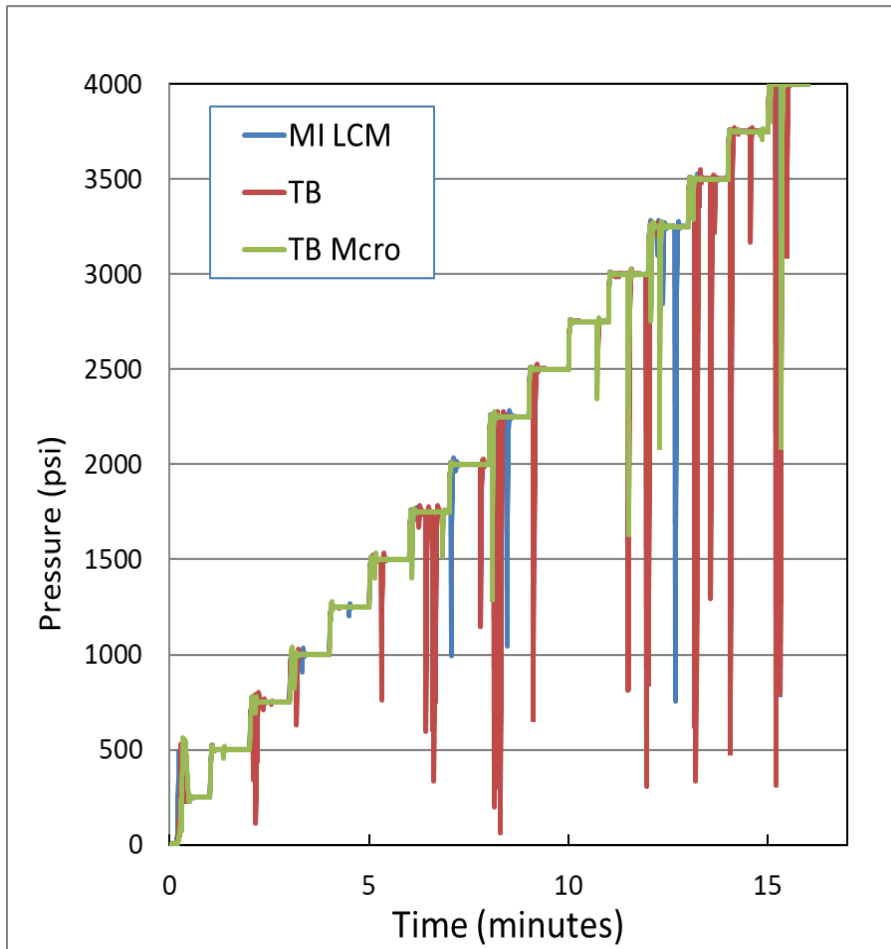
Slurry Test Results:		Volume Pumped to First Pressure Stage, ml:	48.9
Max Pressure, psi:	4000	Initial Bridging Efficiency (IBE), % volume:	86.0%
LCM volume, %:		Volume Pumped to Final Pressure Stage, ml:	92.6
		Final Bridging Efficiency (FBE), % volume:	73.5%
		Bridging Seal Stability, % volume:	85.5%

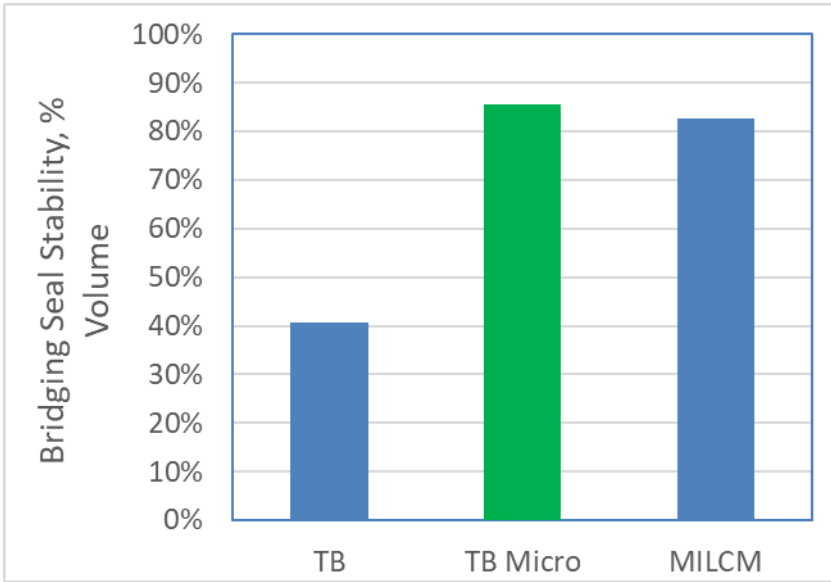


**Fully
Automated
Advanced
Slot Test**

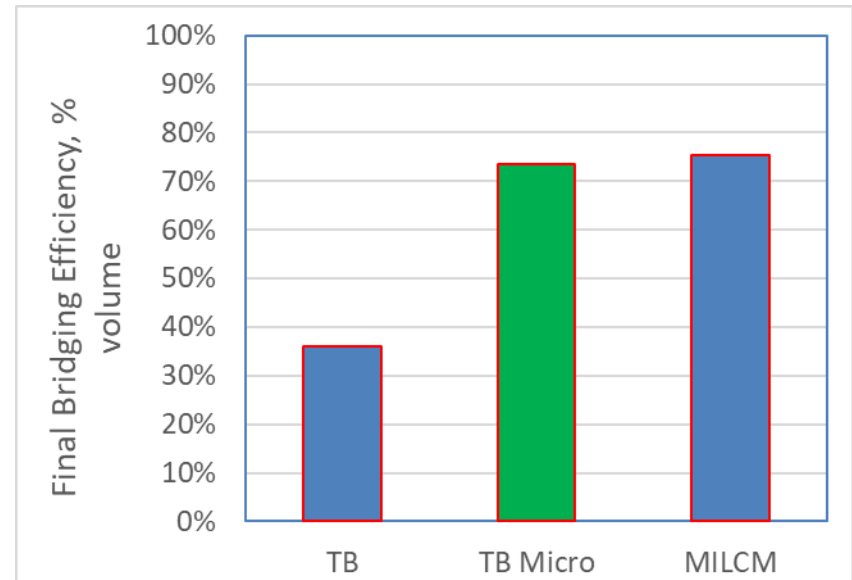
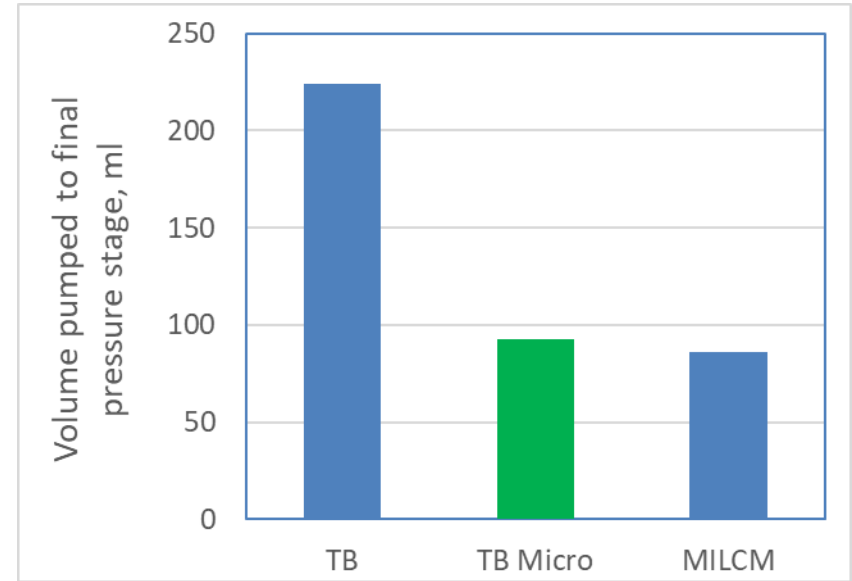
Pressure: 250
psi/minute up to
a max of 4000psi







- **Green Plastic-Free LCM**
- **Compatible with both water-based and emulsion fluids**
- **Providing high-sealing pressure (upto 4000 PSI) with minimum fluid loss**
- **Similar performance properties with MI's reference material**

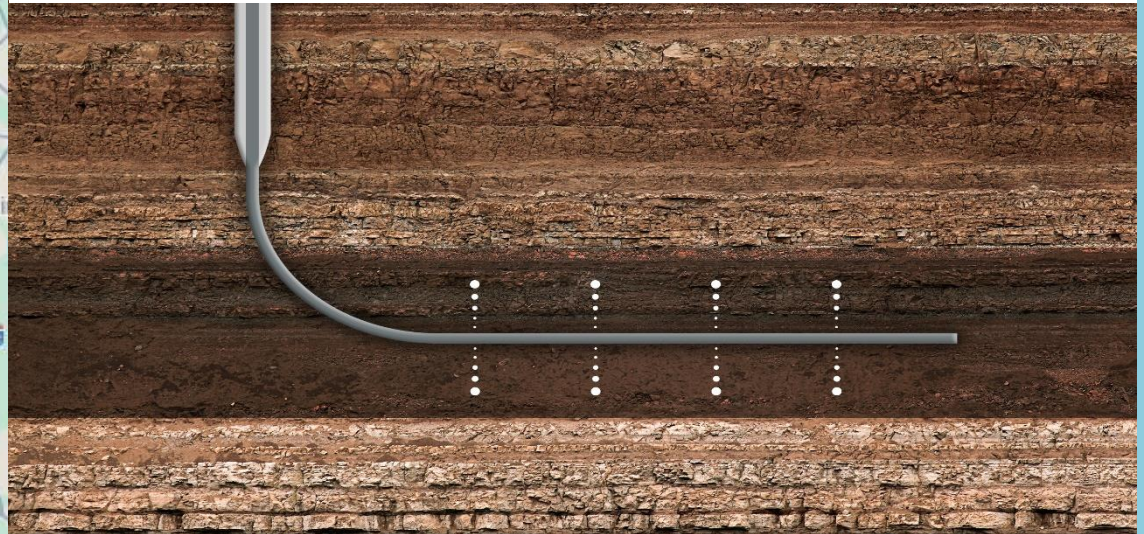


Field Experience with Tiger Bullets Micro®

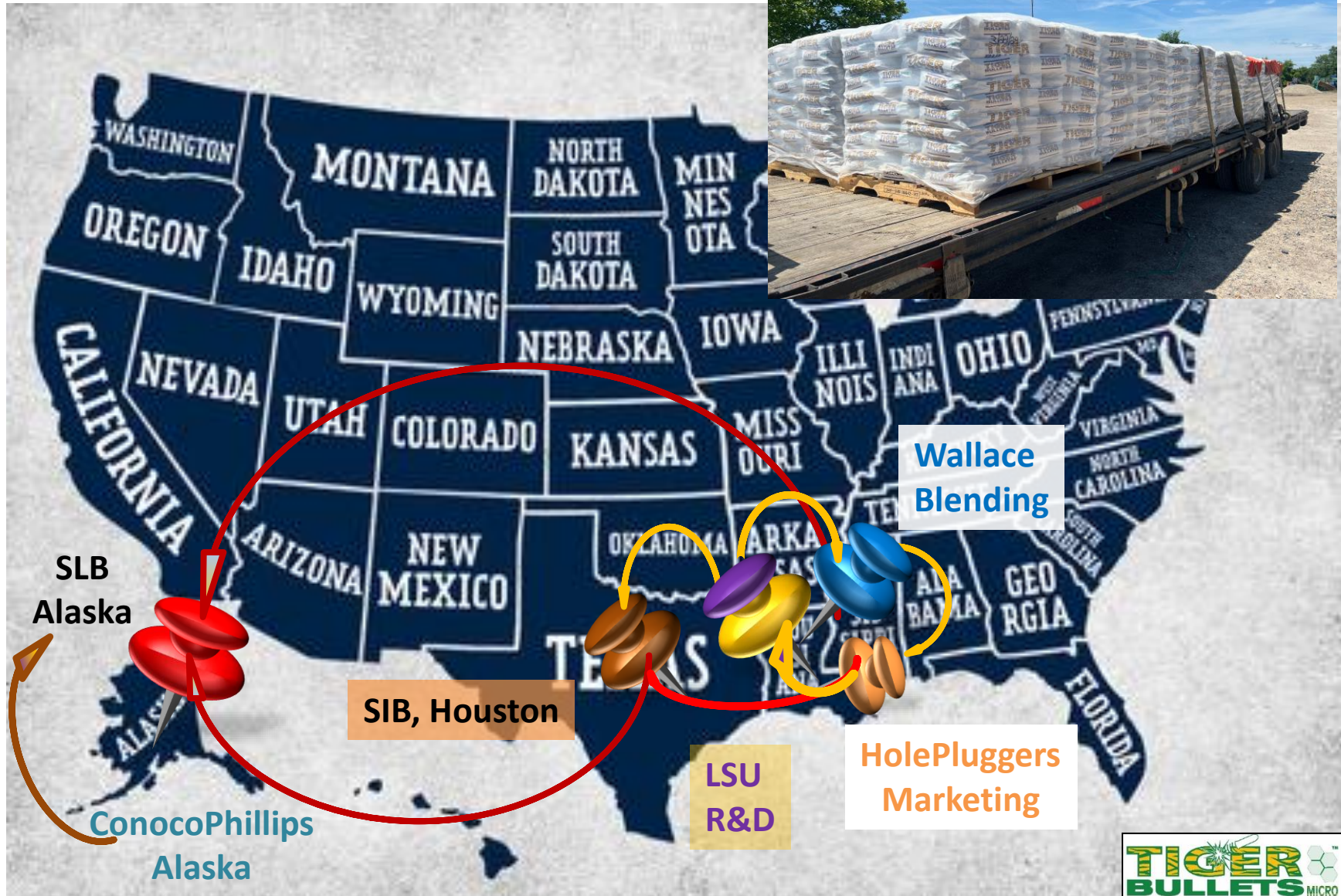
- Partial losses of 15 – 25 bbl/hr began ~1,000' below the 9 5/8" surface casing shoe at 5,300'
- A third-party LCM added directly to the system with no improvement.
- Losses increased to over 40 bbls/hr and over 600 bbls of 12.0 ppg OBM lost to formation. Drilling continued to almost 6,600'
- Two 40 bbl LCM sweeps pumped containing a 35 ppb mixture of TigerBullets Regular and TigerBullets Micro.
- After first sweep cleared the loss zone flow rate resumed to normal levels.
- After second sweep pumped, losses completely stopped.
- Preventative 15 - 20 bbl sweeps containing 5-10 ppb of TigerBullets Micro continued to be pumped every 750' to a MD of 24,800', and there were no further losses experienced.



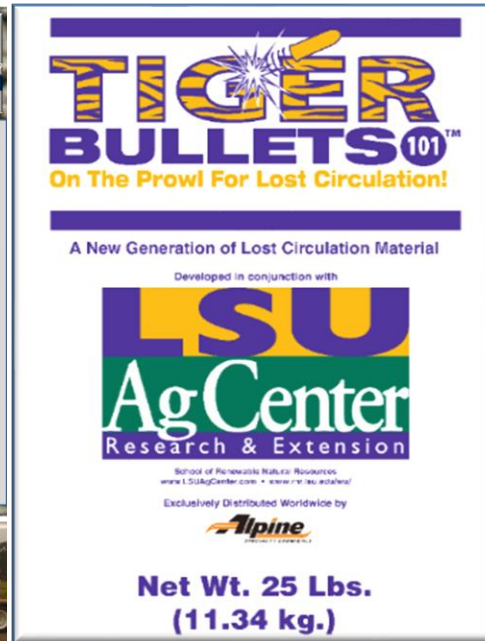
**LaSalle
County**



Alaska Oil Field (Pending)



Commercial prospects



TigerBullets Team

- R&D Facility
- Manufacturing
- Faculties
- Marketing
- Network
- Customer Base



- Plastic free/green
- High performance