Application of Acid Precursor in Filter Cake Breaker for High Density Environment

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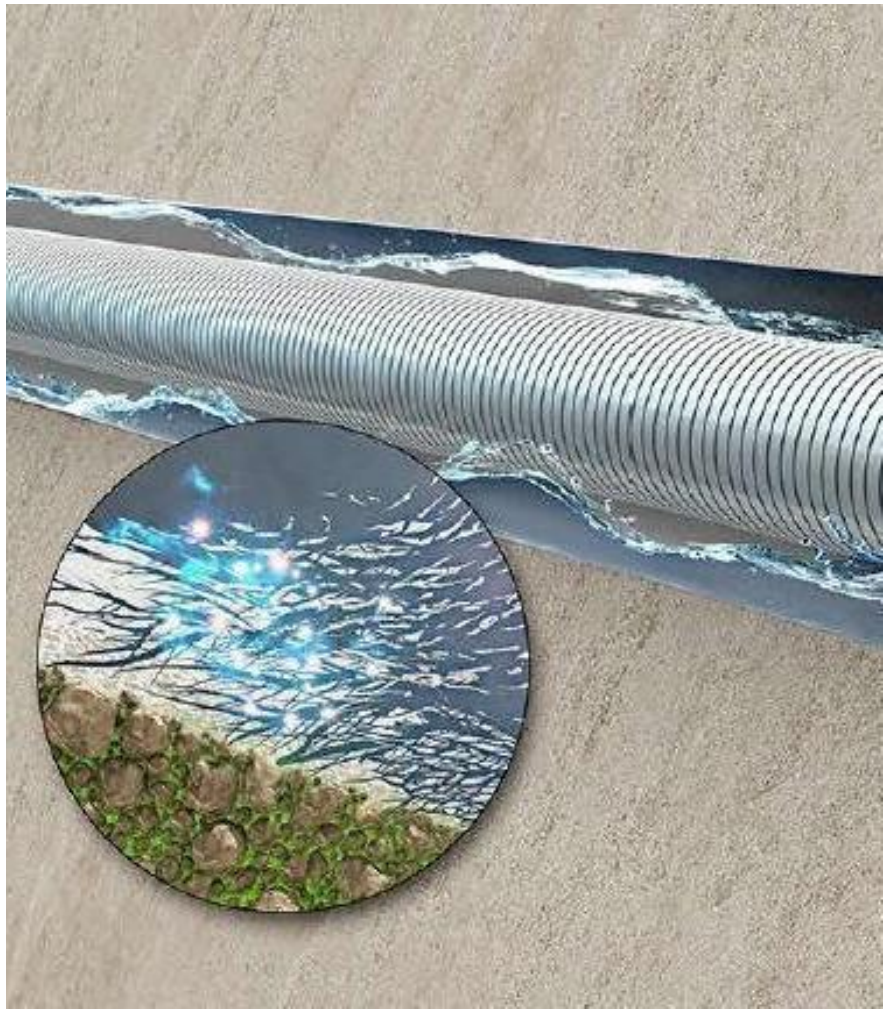
Filter Cake Breaker Application

- Filter cake breaker is a specialty fluid spotted during the lower completion phase.
- It is designed to restore the near-wellbore damage by removing the filter cake.
- **Volume is limited to the open-hole size plus some excess.**
- **Breaker is weighted to the required density for well control purpose.**
- Spotting operation is often conducted with standard rig equipment.



Live Acid Vs Acid Precursor: Filter Cake Breaker Application

Live Acid

→ Aggressive Reaction

- Uncontrolled losses
- Partial coverage in the open-hole
- Uneven filter cake removal

→ Special storage and pumping equipment

- Logistics
- Onsite footprint

→ **HSE risk**

Acid Precursor

→ In-situ reaction with filter cake

- Controlled losses
- Full coverage in the open-hole
- More uniform filter cake removal

→ Standard rig equipment

- Rig pit and pumping setup
- Cement unit

→ **Acceptable HSE profile**

How Acid Precursor React With Calcium Carbonate

Acid precursor falls under ester chemistry. It hydrolyses in the presence of water and coverts to acid.

$$R\text{–}COOR' + H_2O \rightleftharpoons R\text{–}COOH + R'OH$$

Ester

Carboxylic Acid

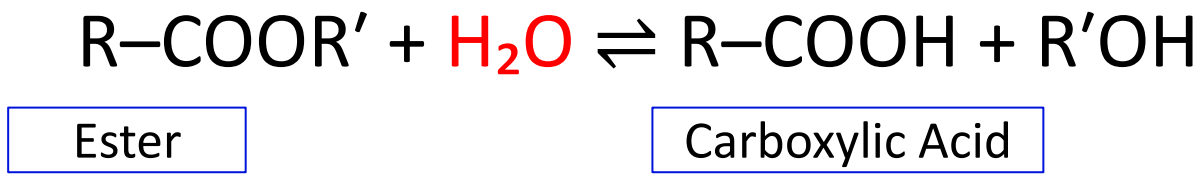
$$2\ R\text{–}COOH + CaCO_3 \rightarrow Ca(R\text{–}COO)_2 + CO_2\uparrow + H_2O$$

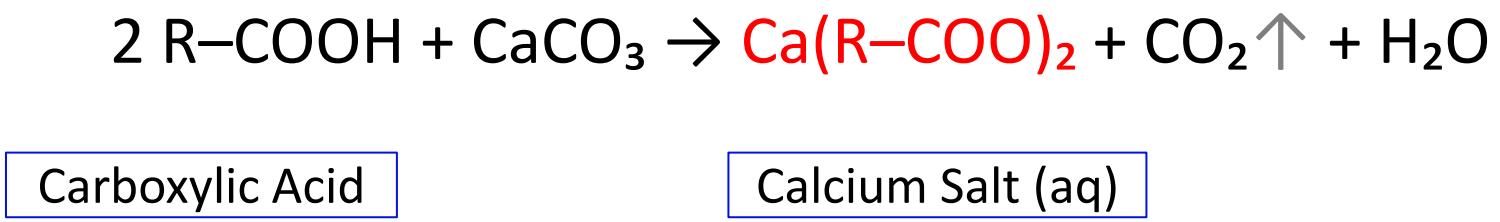
Carboxylic Acid

Calcium Salt (aq)

Acid Precursor in High Density Environment

- **Breaker density – 15.4 – 15.6 lbm/gal**





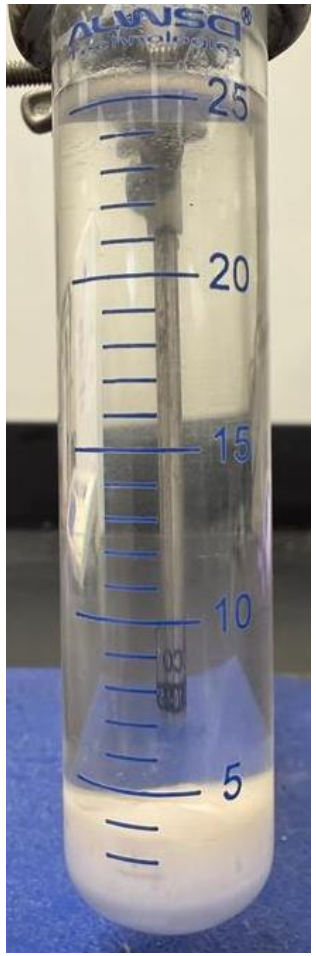
→ Weighted with salt

→ Water is limited in HD Brine

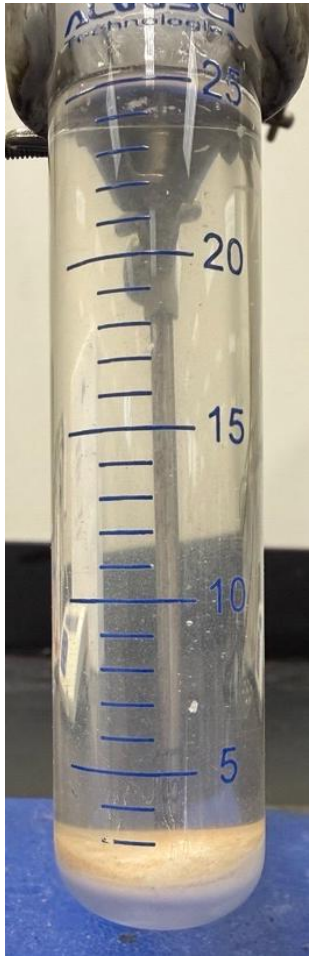
→ Water is needed for

- Acid conversion
- Calcium salt in solution

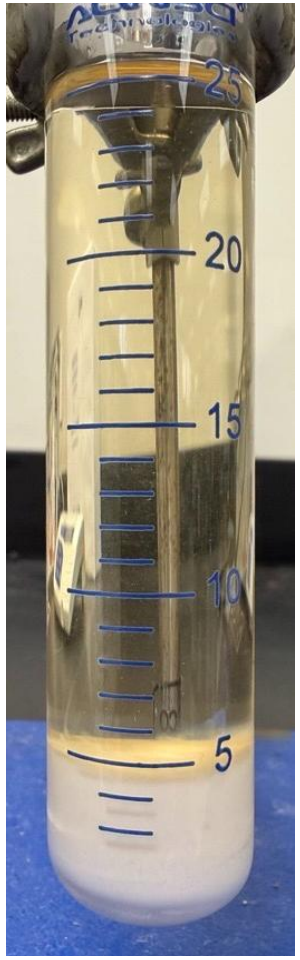
Other Acid Precursors in High Density Environment



Precursor#1



Precursor#2



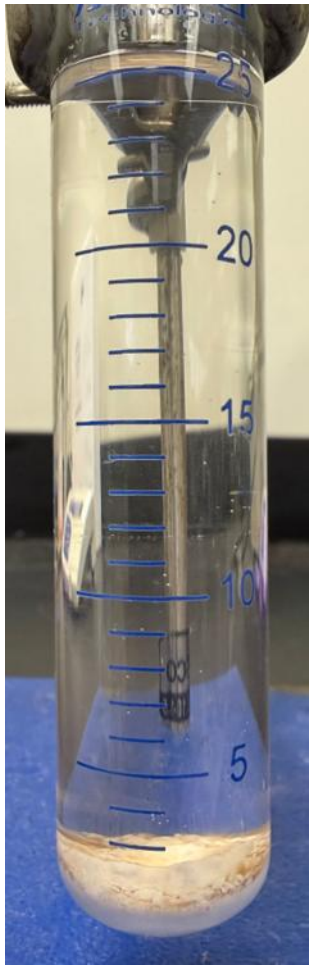
Precursor#3

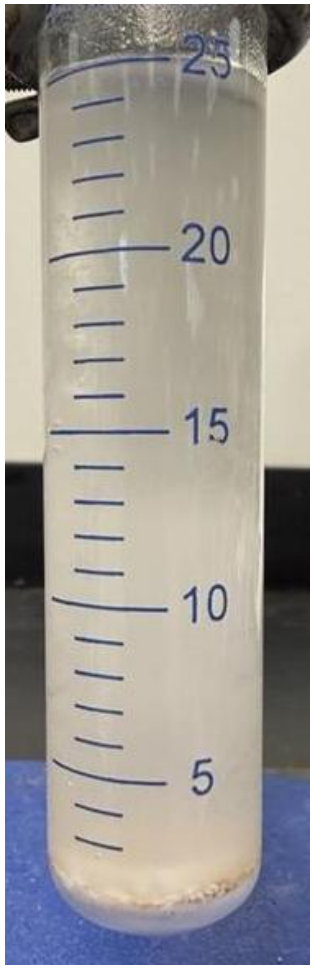
→ 20% Acid Precursor in ZnBr2 Brine

→ 3 g of CaCO3 in 25 mL of Breaker Solution

→ Partial dissolution possible

Other Acid Precursors in High Density Environment





→ 40% Acid Precursor#1 in ZnBr2 Brine

→ 3 g of CaCO3 in 25 mL of Breaker Solution

→ Partial dissolution possible

→ Oversaturated with Calcium salt

Precursor#1 at 40% vol

Oversaturated with Ca Salt

Live Acid Vs HD Acid Precursor in High Density Environment

Live Acid

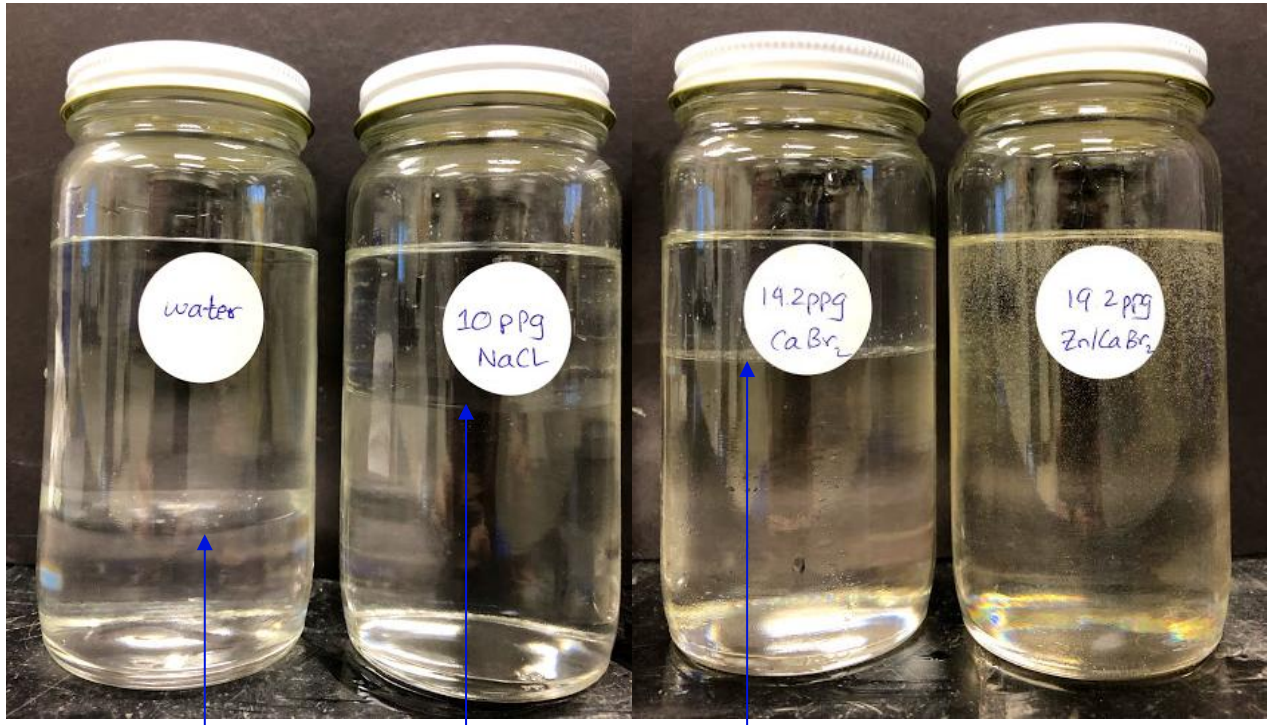
HD Precursor

→ 3 g of $CaCO_3$ in 25 mL of Breaker Solution

→ 12% Formic Acid in $ZnBr_2$ Brine

→ 20% HD Acid Precursor in $ZnBr_2$ Brine

HD Acid Precursor - Operation Window



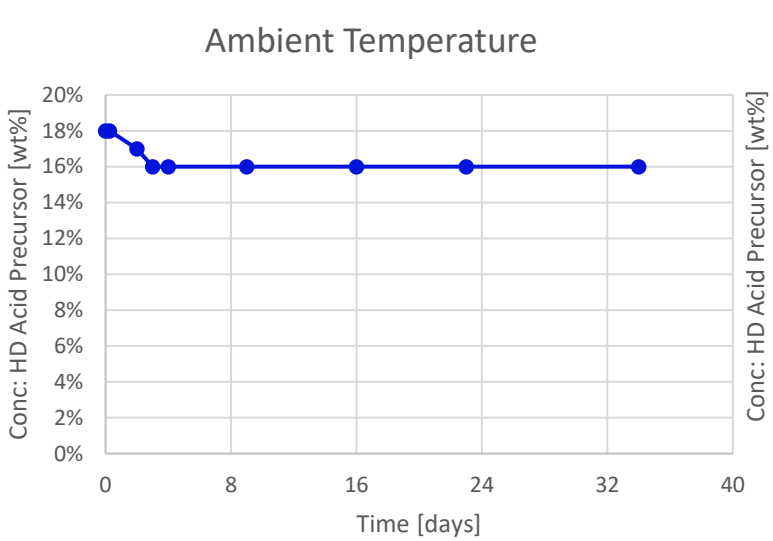
→ Applicable only in ZnBr2 Brine

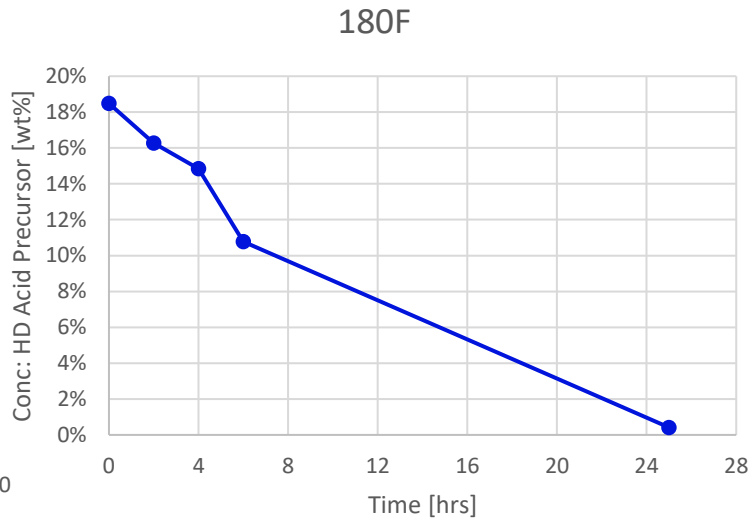
→ Higher density requires higher purity ZnBr2

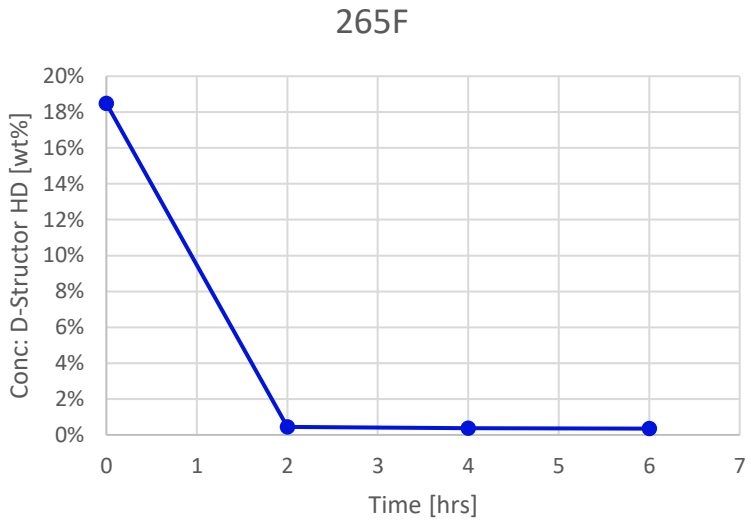
Separation

HD Acid Precursor – Acid Conversion Rate

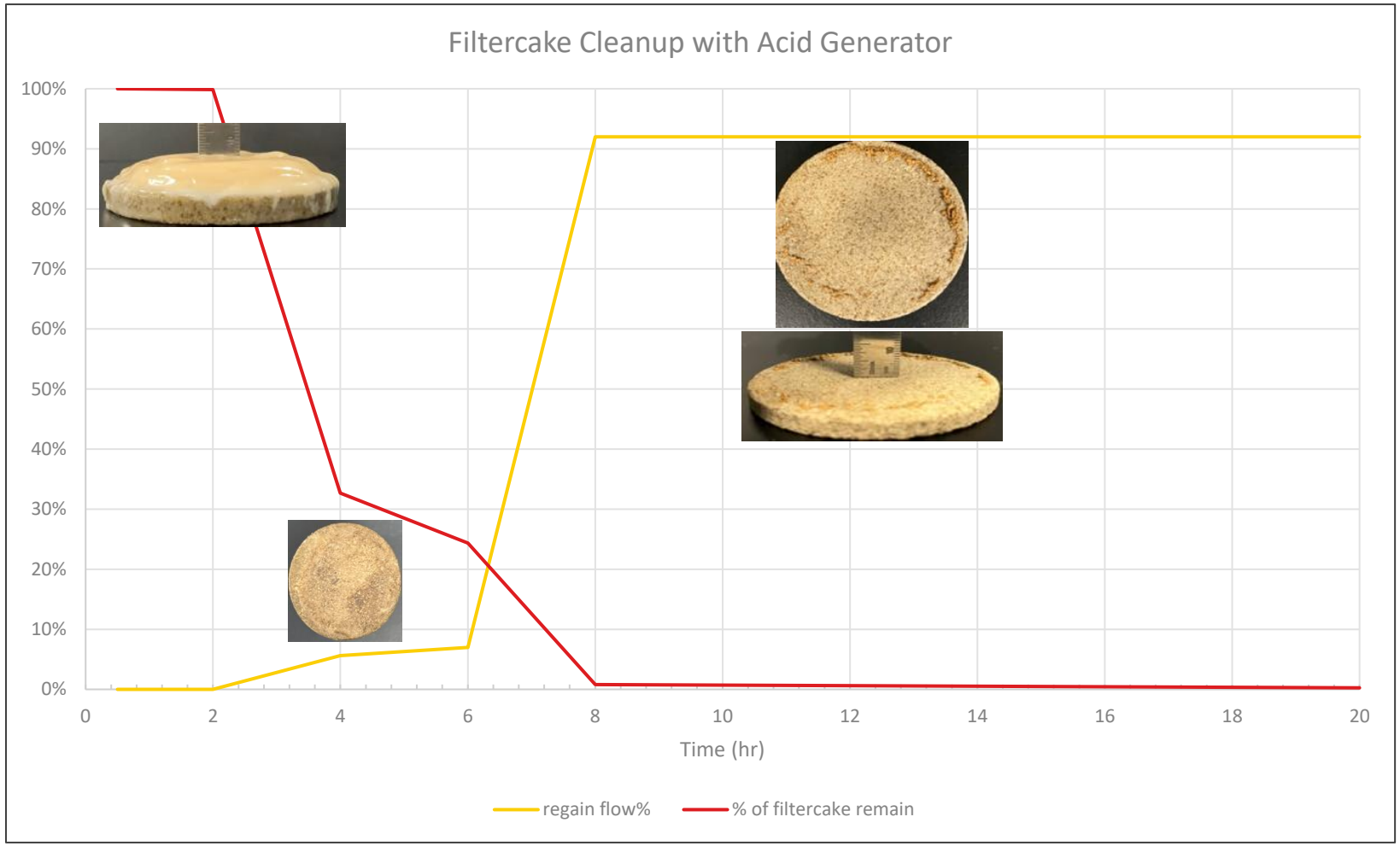
→ Acid precursor concentration monitored by GC-MS







HD Acid Precursor – Soak Time Vs Filter Cake Removal



→ 4 hrs at 265°F

→ 70% filter cake removal

→ 3% regained flow

→ 8 hrs at 265°F

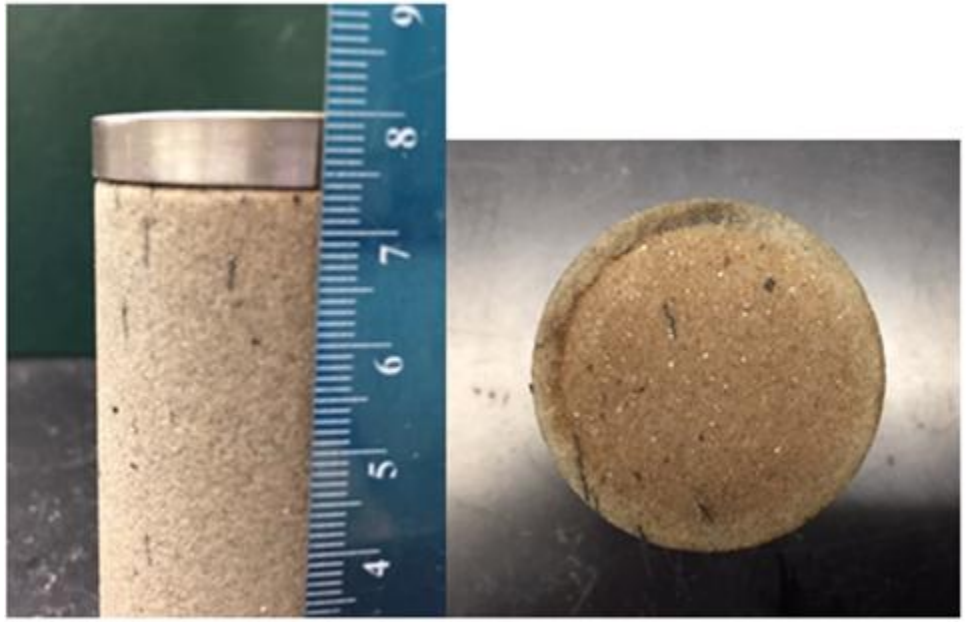
→ 100% filter cake removal

→ >80% regained flow

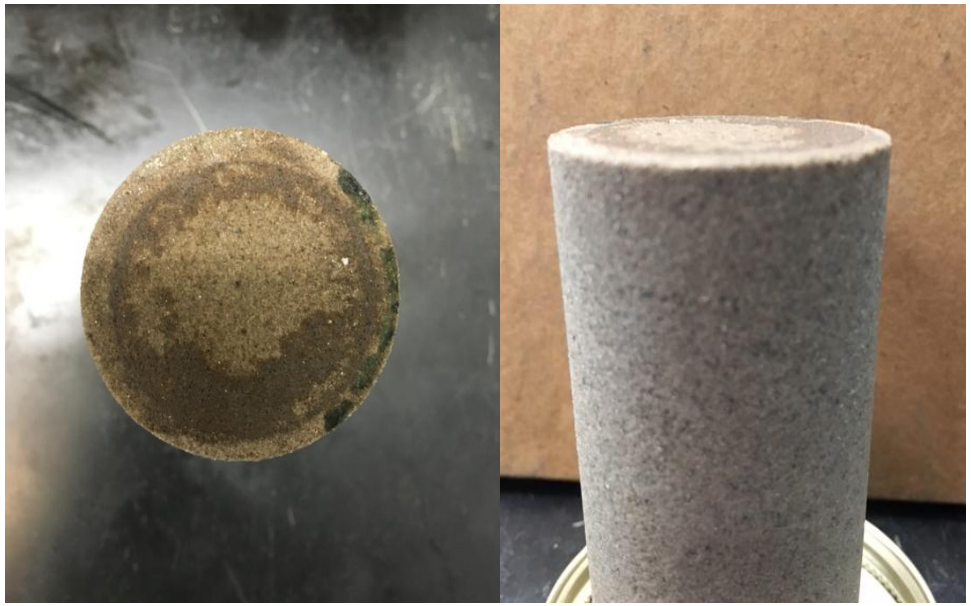
HD Breaker Qualification – Return Permeability Test

Test	Fluid	Breaker Type	Gravel Pack	Initial Permeability	Return Permeability [Production]	Flow Initiation Pressure
#1	HD WBM	15% Formic Acid (Weighted)	No	123 mD	110 mD / 90%	0.5 psi
#2	HD WBM	HD Acid Precursor	No	140 mD	140 mD / 100%	0.8 psi
#3	HD WBM	HD Acid Precursor	Yes	52 mD	44 mD / 85%	0.5 psi

Test#1 - Formic Acid



Test#2 - HD Acid Precursor



Field Record:15.4 – 15.6 lbm/gal HD Breaker

- 9 wells drilled to date (8 OHGP + 1 SAS) ~ 1000 ft 7 in OH
- Breaker was mixed and pumped using cement unit
    - Synchronized breaker mixing with gravel pack
- Controlled losses encountered after breaker placement (10-20 bbl/hr)
    - Breaker volume ~3 x full OH coverage
- Wash pipe pulled out and formation Isolation valve (FIV) closed without issues
- Well production exceeded expectation

Performance at Higher Densities

Density = 16.1

Production	Injection
83%	70%

Density = 16.3

Production	Injection
90%	83%

Density = 16.5

Production	Injection
78%	78%

Conclusion

- HD brine compatible acid precursor is developed as an alternative to live acid.
- HD acid precursor has been tested up to 17.0 ppg.
- Field trials have been successfully executed with satisfactory outcomes.