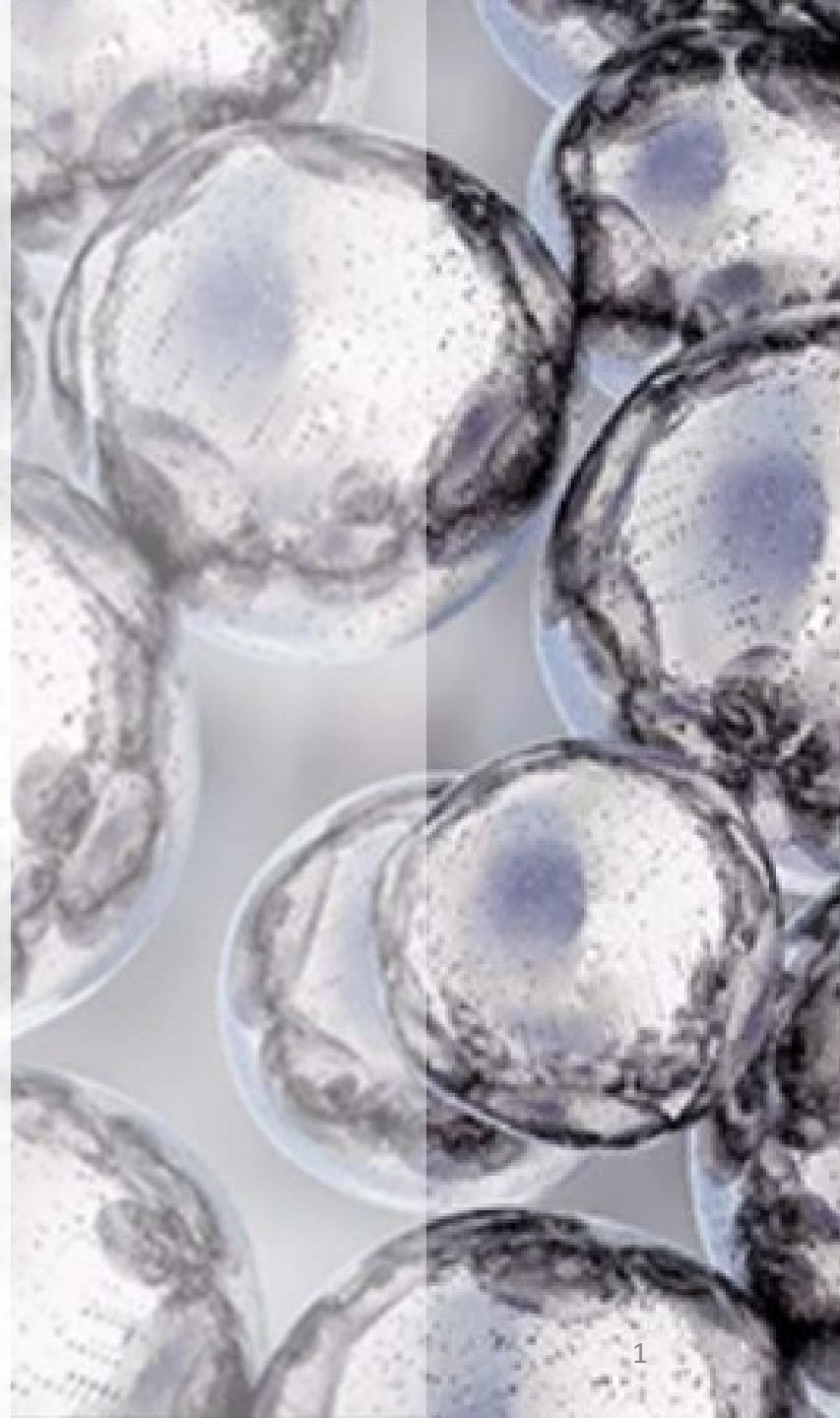
Specialty Chemicals To Improve Oil Recovery

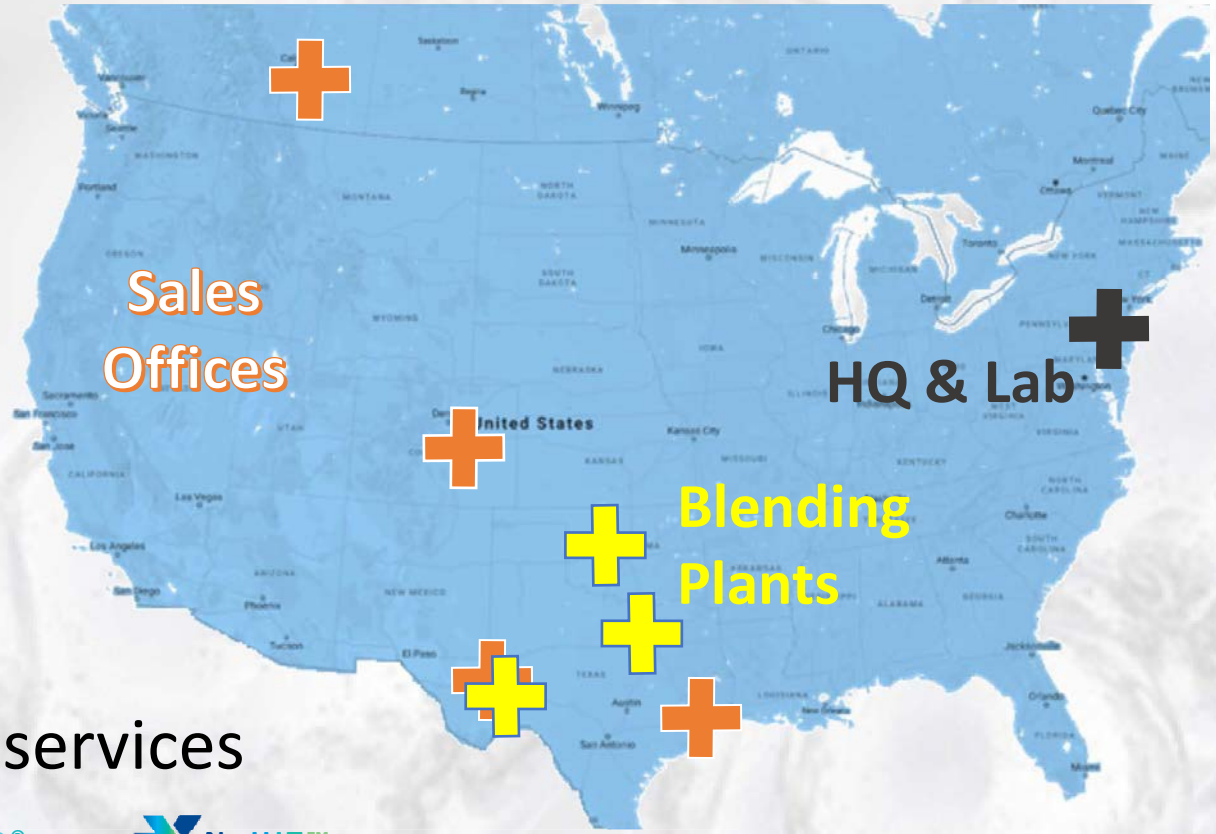
PumpMoreOil.com

Corporate Overview



About TenEx

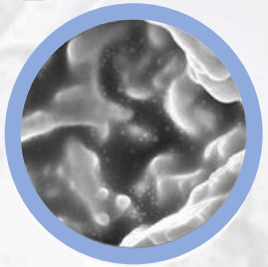
- Tenex was founded in 2016, with R&D in Philadelphia and in-basin sales and operations
- We develop chemical technologies that improve your return on capital for new and producing wells
- We offer complete logistics and lab services
- Our products include:



MICROHOLD™

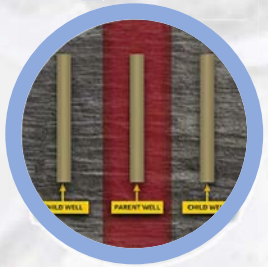
Penetrate Micro-Fracs

NANOCLEAR®



Increase Oil Recovery

NoHIT™

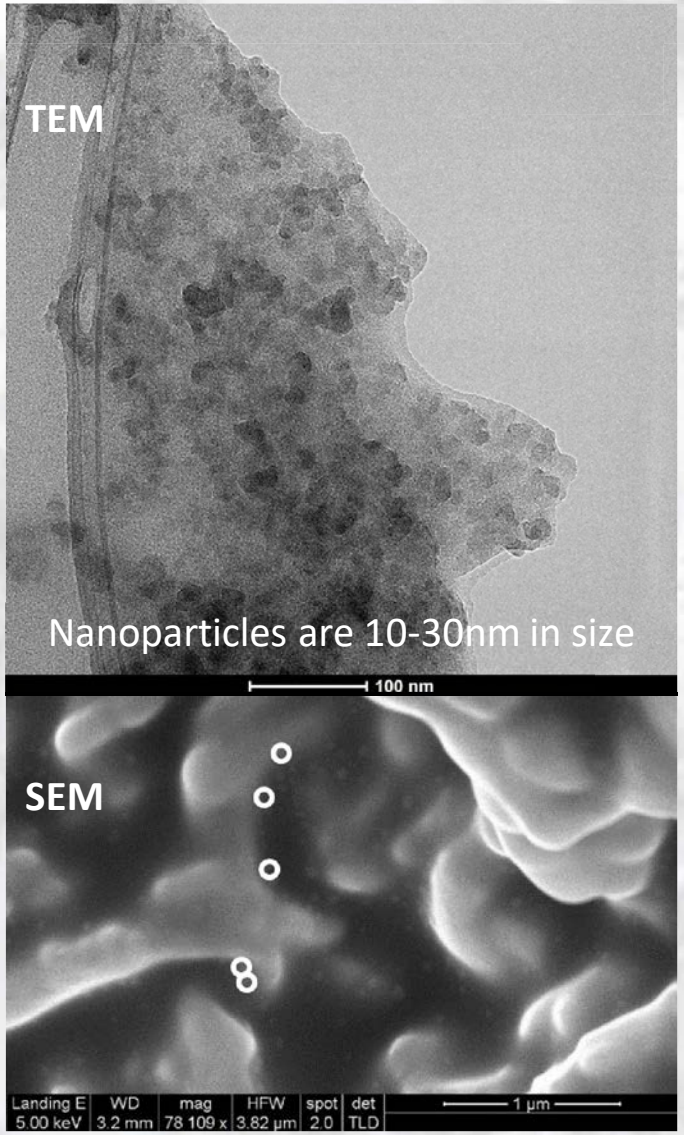


Stop Frac Hits

What is NanoClear®?

- NanoClear is a dual-nanoparticle fluid developed specifically to provide:
  - Long-term wettability alteration
  - Reduced residual oil saturation
  - Increased relative oil permeability

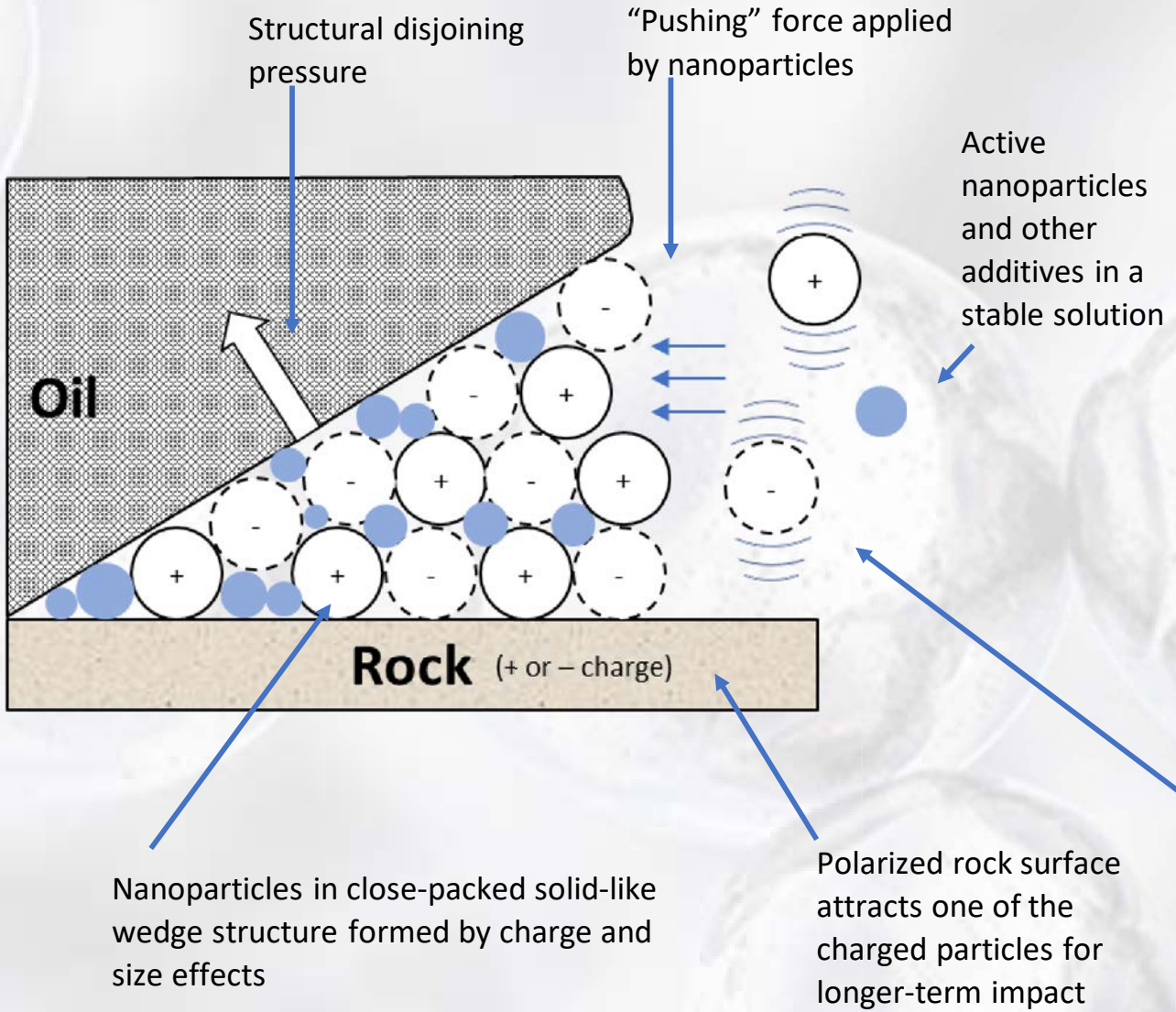
- There are more than 10^{17} nanoparticles/gallon of with a surface area of more than 200 m^2, aiding in wettability alteration

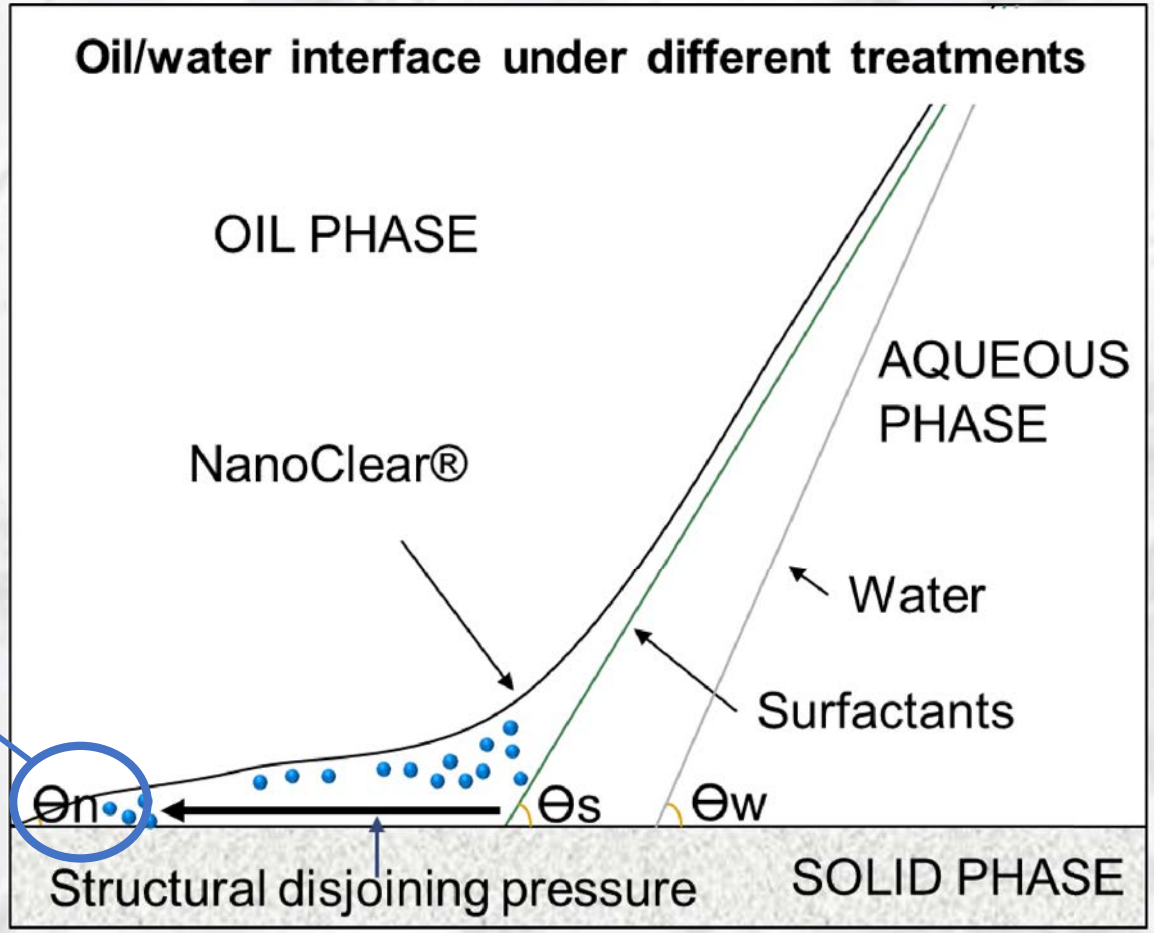


Nanoparticles are 10-30nm in size

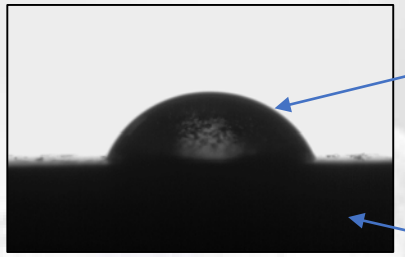
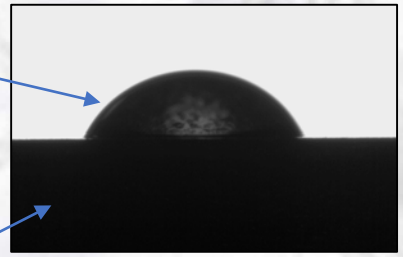
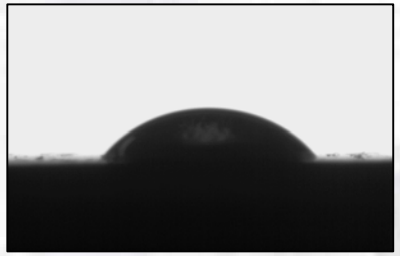
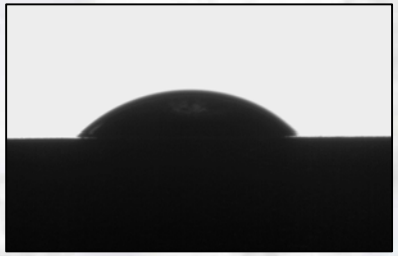
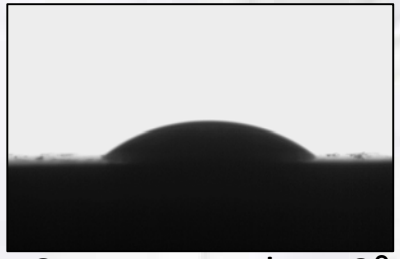
Nanoparticles coating rock surface

How Does NanoClear® Work?





Lab Results on Oil Coated Rock

	Pretreated with Surfactant	Pretreated with NanoClear® TENEX
Time: 0.2 min	 Contact Angle: 76°	 Contact Angle: 67°
Time: 10 min	 Contact Angle: 58°	 Contact Angle: 48°
Time: 20 min	 Contact Angle: 40°	 Contact Angle: 29°

Brine Drop

Pretreated Oil-Coated Shale

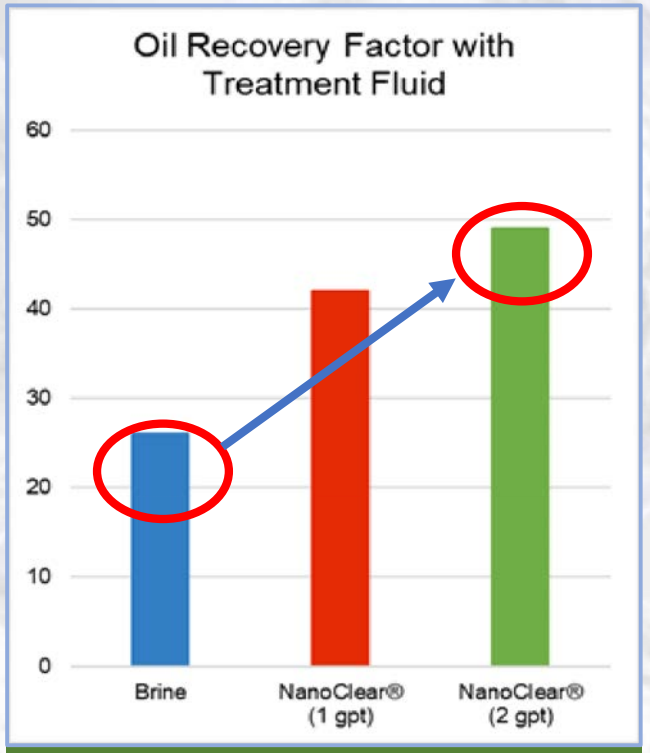
Lab Results in Core Flood Apparatus

Test Materials & Parameters
- Tight sandstone core (<1mD)
- n-Decane (light oil)

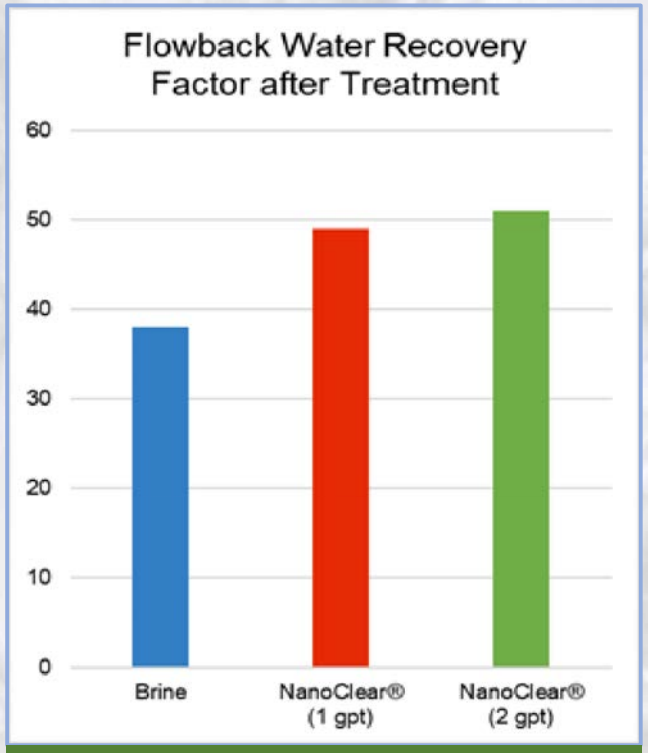
Additives Tested
- NanoClear® @ 1 and 2 gpt
- 3% brine solution

Test Methodology
- Condition the core
  - Water (brine) flow stage
  - Oil flow stage
- Simulate the treatments
  1. Introduce treatment fluid (brine or 2 gpt NanoClear®)
  2. Oil flow stage at the same rate as previous stages
  3. Oil flow stage at higher rates

Results – Effective Oil Permeability Increase
- 3% brine solution: 16%
- NanoClear @ 2gpt: 40%



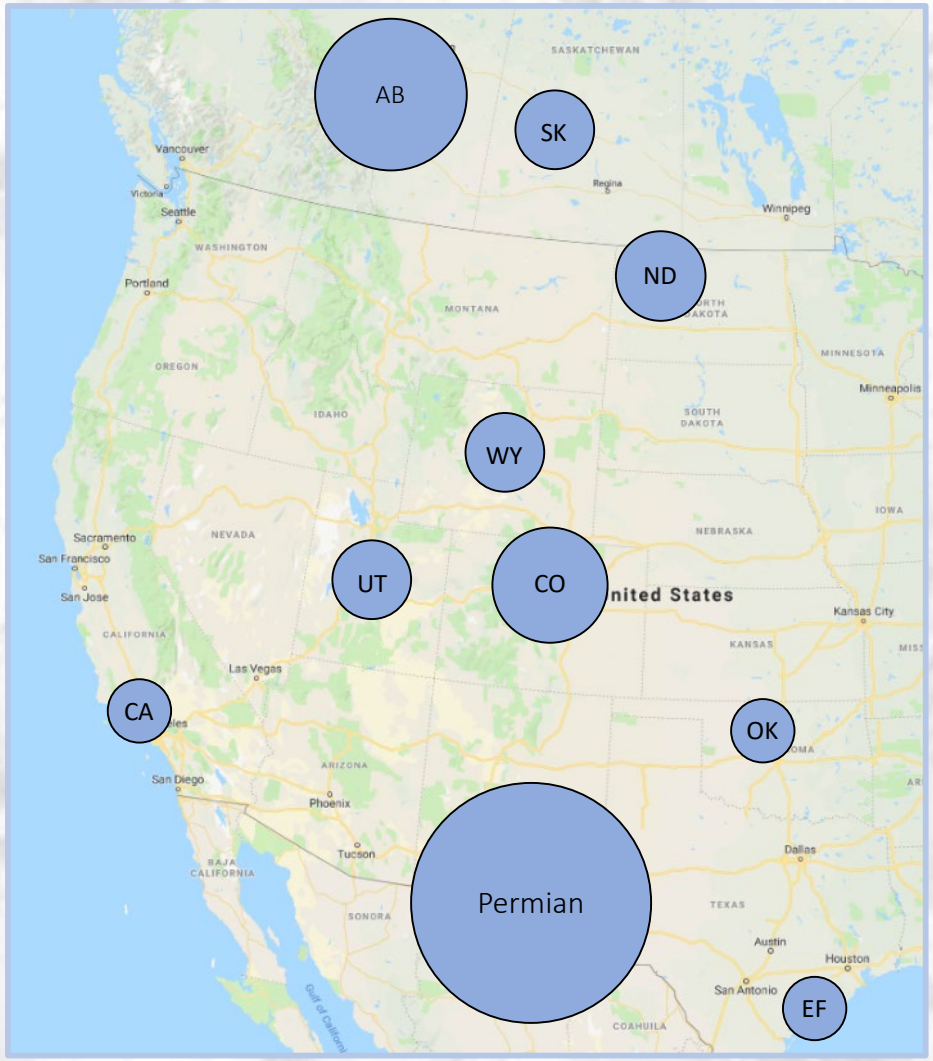
Step 1: Oil recovery tested 80% higher with NanoClear @ 2 gpt



Step 2 & 3: Water flowback 30%+ higher with NanoClear®

NanoClear® Treatment History

- First well treated in Apr. 2018
- Since then, 110+ producing wells and 20+ new completions have been treated
- To date, over 300,000 gals of NanoClear® have been pumped
- Numerous formations have been treated
- NanoClear® has been used for:
  - New completions
  - Producing well formation damage remediations
  - Producing well waterflood treatments
  - Frac protect treatments



Field Results – New Completion

Treatment Overview
Legacy Reserves trial in the Permian (Martin Country) with NanoClear and three competing offsets

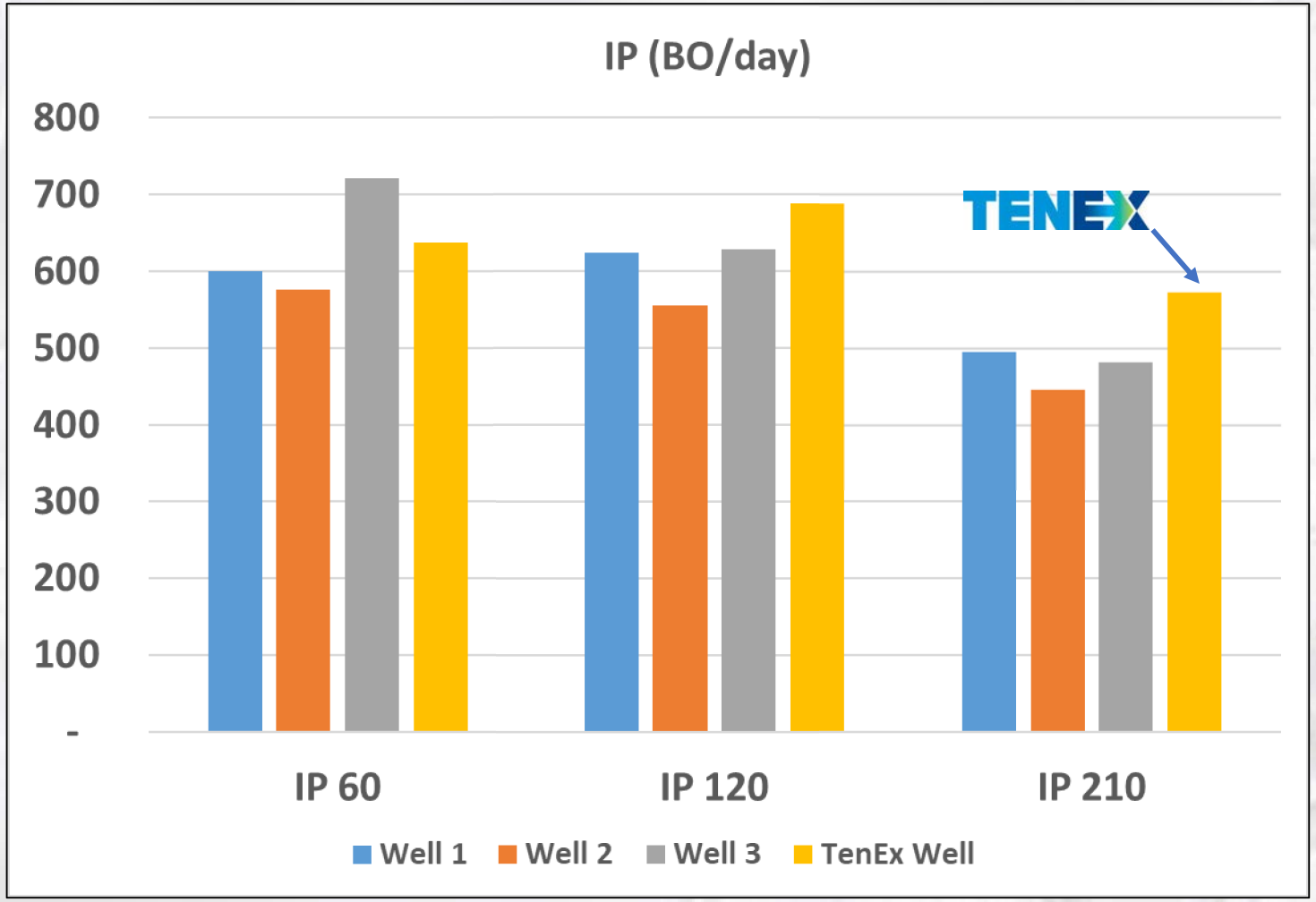
Well Attribute	Value
Wells in Trial Note: All wells were on the same pad, with similar completion designs	Well 1 (outer) – Treated with premium surfactant Well 2 (inner) – Treated with premium surfactant Well 3 (inner) – Treated with competing nanoparticle product Well 4 (outer) – Treated with NanoClear® (DR ORSON E4BH)
Stages	52 each
Type	Horizontal
Lateral Lengths	~1.7± mi
TVD	~9,700± ft
Well Spacing	660 ft, no evident communication
NanoClear® Quantity	14,000 gals
NanoClear® Concentration	1 gpt on average

First Day of Reporting: 12/15/2018
Most Recent Day of Reporting: 9/17/19 – 270 days of reporting

Geology Attribute	Value
Porosity	6-10%
Permeability	4-250 nD
Avg. Pore-Throat Size	5-100 nm
Temperature	150° F
Pressure	6000 psi
Wettability	Oil-wet to Intermediate-wet

Reservoir Attribute	Value
Formation	Permian
Reservoir	Wolfcamp B
Oil Density	0.792 g/ml
Oil API	47°
Oil Viscosity	4.3 cP at 24° C

210-Day IP Results



Based on IP 210, the TenEx well averaged 16% more BO/D than the next best well

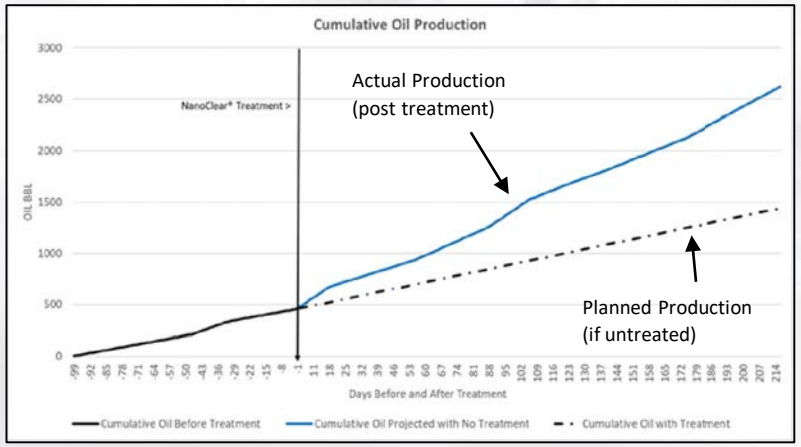
NanoClear's strong IP 210 performance highlights its long-term wettability alteration characteristics

Notes
- Non-producing days have been excluded to provide for an even playing field for the comparison
- Production has been normalized for lateral length (BO/10,000" LL)

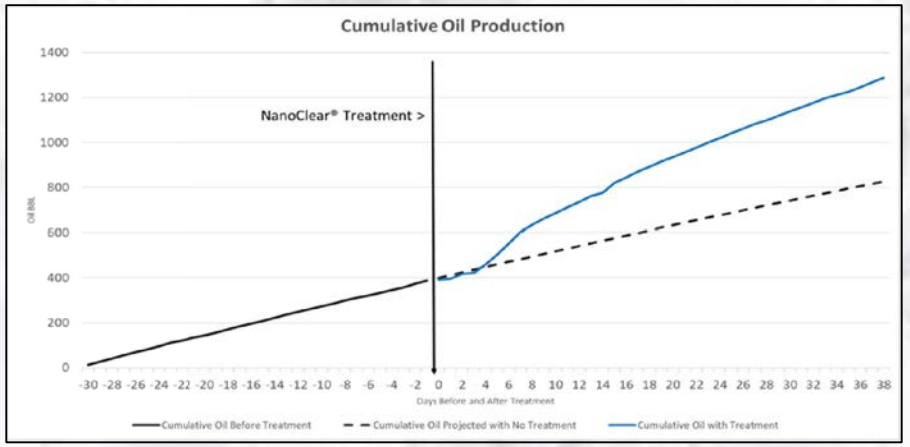
Field Results of Remediation Treatments

APPARENT CROSS-BASIN APPLICABILITY	Well 1	Well 2	Well 3
Basin	Permian, TX	Uinta, UT	Deep Basin, AB
Formation	Spraberry/Wolfcamp	Multiple	Glauconite
Rock Type	Shale + Sand/Limestone	Sandstone & Carbonate	Sandstone
Well Type	Vertical	Vertical	Horizontal
Porosity	10%	10%	10%
Oil API	40°	32°	26°
TVD/MD	10,750 ft	6,020 ft	6,312 ft / 11,237 ft
NanoClear® Qty	1,380 gals	1,110 gals	1,380 gals

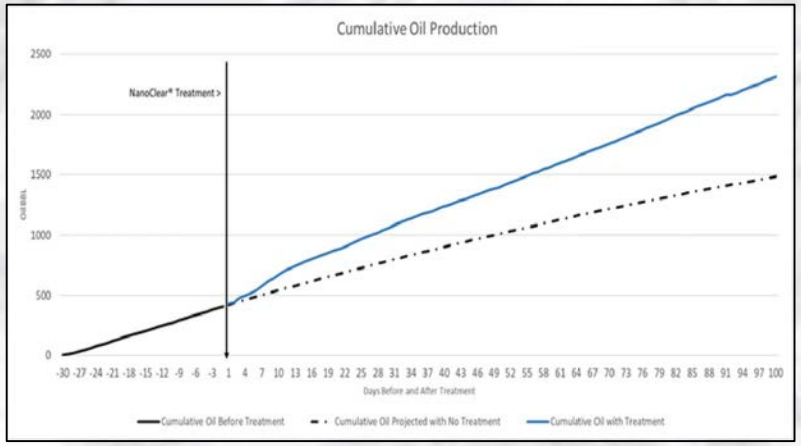
TREATMENT RESULTS	Well 1		Well 2		Well 3	
	Pre	Post	Pre	Post	Pre	Post
Measurement Period	107 days	237 days	30 days	38 days	30 days	100 days
Avg Oil Production	14 bbl/day	19 bbl/day	13 bbl/day	24 bbl/day	14 bbl/day	19 bbl/day
% Avg Oil Increase		36%		85%		36%
Water Cut	71%	56%	37%	40%	26%	29%
Days to ROI		71 days		27 days		38 days



Well 1



Well 2



Well 3

Shale Microfracture Networks

- Extensive networks of microfractures (1-100 µm) exist in most shales
  - Mostly located in organic-rich zones
  - Up to 90% of the total treatment fluid can access the microfractures
    …But no proppant can – not even 200M (74 µm)
- Unpropped microfracs can contribute to initial production but they do rapidly close

What is MicroHOLD™?

- Engineered micro-proppant slurry precisely designed for natural/induced microfracs
- Much smaller and stronger than 200M. Much less costly than microceramic spheres products
- Delivered as an aqueous slurry containing ~50 wt% glass quality silica (SiO_2=99.7%)
- Engineered microparticle size tailored to be big enough to prop microfracs but small enough to get into

	D90 (um)	D50 (um)	D10 (um)
MicroHOLD™-625	**75 – 85**	**18 – 23 (625 Mesh)**	**1 – 2**
MicroHOLD™ (Tailored)	15 – 150	5 – 70	1 – 5

MicroHOLD™ Benefits

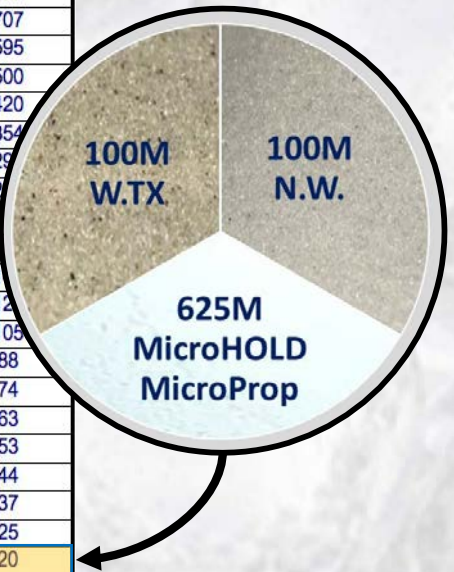
Production Benefits	Prop of induced and natural micro-fractures: • Expand the connected fracture network (effective SRV) • Decrease decline rate • Increase recovery factor
Operational Benefits	Reduction of treatment water leak-off into natural-fractures: • Reduce screen-out potential • Improve flowback • Reduce treatment pressure (less HHP) • Indirectly slow down well communication Lessen frac entry restrictions (a scouring agent) • Erode perfs and near-wellbore restrictions

Ideal PSD and Superior Crush Resistance

Particle Size Distribution Before & After 15k ISO Crush

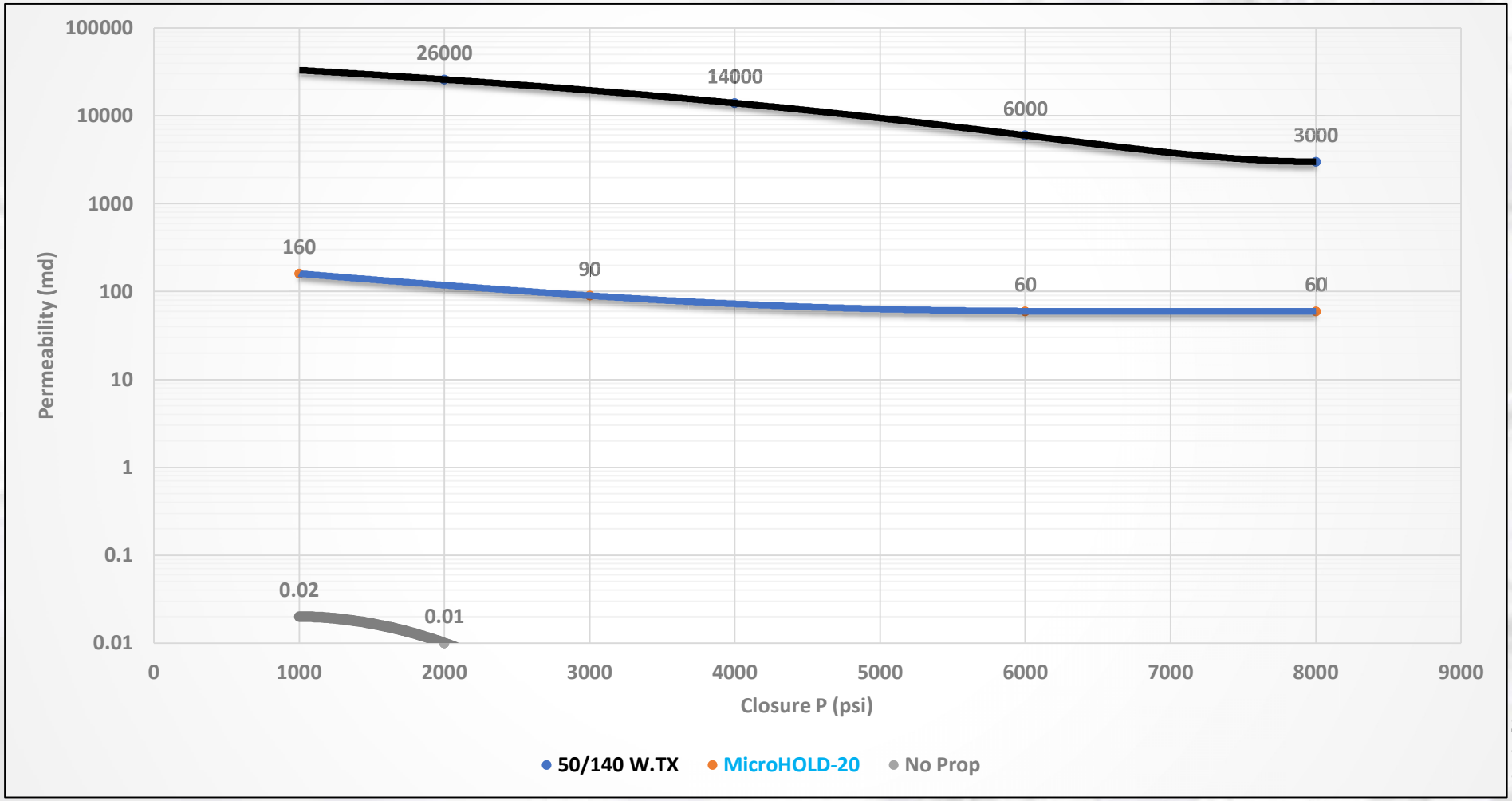
	D90 (um)	D50 (um)	D10 (um)
Before Crush	84	23	1
After 15k Crush	80	21	1

Comparative Particle Size:		
U.S. Mesh	Inches	Microns
10	0.0787	2000
12	0.0661	1680
14	0.0555	1410
16	0.0469	1190
18	0.0394	1000
20	0.0331	841
25	0.0280	707
30	.0232	595
35	.0197	500
40	.0165	420
45	.0138	354
50	.0117	29
60	.0098	2
70	.0083	2
80	.0070	1
100	.0059	1
120	.0049	12
140	.0041	105
170	.0035	88
200	.0029	74
230	.0024	63
270	.0021	53
325	.0017	44
400	.0015	37
550	.00099	25
625	.00079	20
1250	.000394	10
1750	.000315	8
2500	.000197	5
5000	.000099	2.5
12000	.0000394	1



Permeability (MicroHOLD™-625 vs. 100M W.TX vs. Unpropped)

Test Conditions: 2% KCl, 150 ^{0}F & 2.0 lb/ft^2

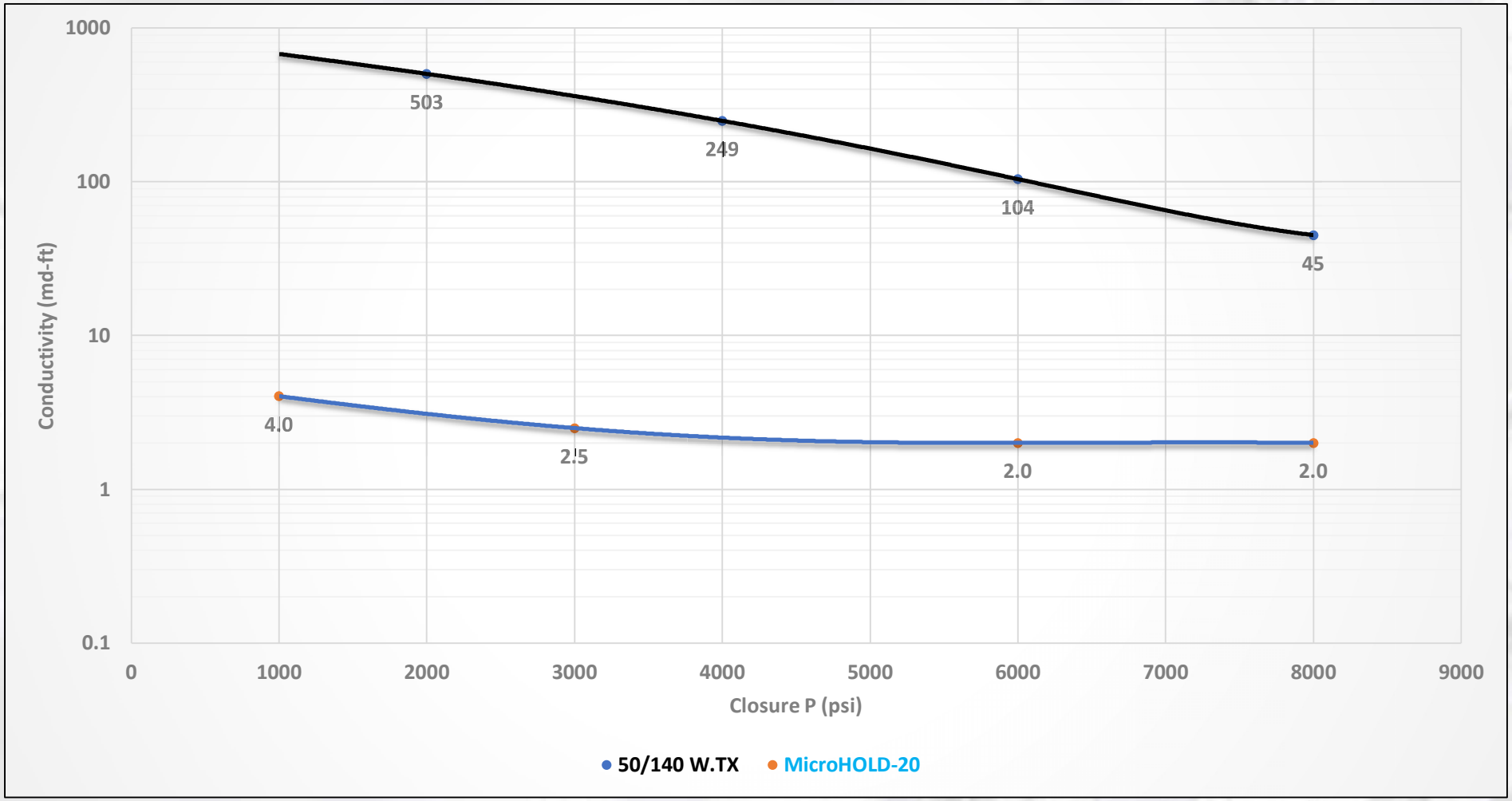


Source:

- 50/140 W.TX: Hi Crush Website
- Unpropped data: SPE 174060 & 167092

Conductivity (MicroHOLD-625vs. 100M W. TX)

Test Conditions: 2% KCl, 150 ^{0}F & 2.0 lb/ft^{2}



Source:

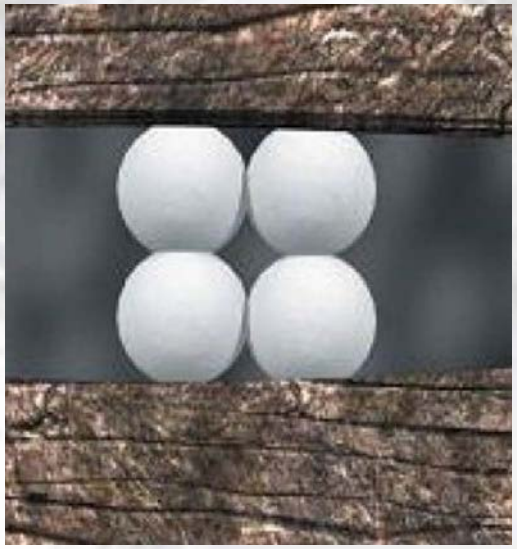
- 50/140 W.TX: Hi Crush Website
- MicroHOLD20: PropTester Report

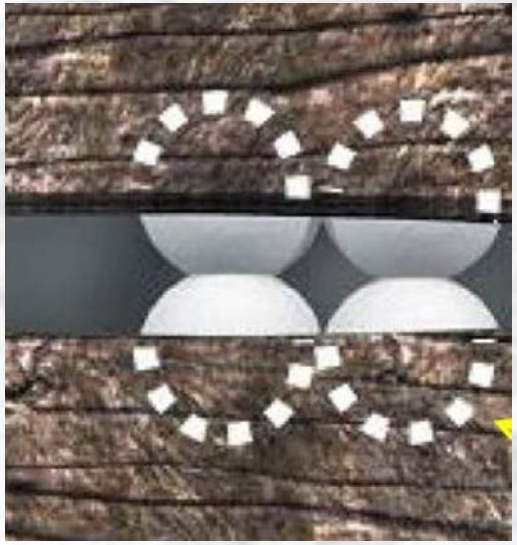
Delivered as Stable Slurry

- Delivered to wellsite via standard fluid containers
- Injected via standard chemical pumps (ideally rigged into suction side of a blender)
- Mixed on-the-fly with the pad @ 20 - 40 gpt
- 850 – 1,200 gal/stg (i.e., 5,000 – 7,000 lb/stg)
- No dust or OSHA considerations

Ideal Shale Conditions for MicroHOLD™

- Hard rock with low embedment potential
- Low water-sensitive clay content (i.e., *smectites and illites*)
- Weak water-weakening effect
- Evidence of pressure-dependent leak-off behavior during fracturing
- Slickwater pad fluids





MicroHOLD™ Operational Trial: SCOOP – WDFD
Grady, Oklahoma

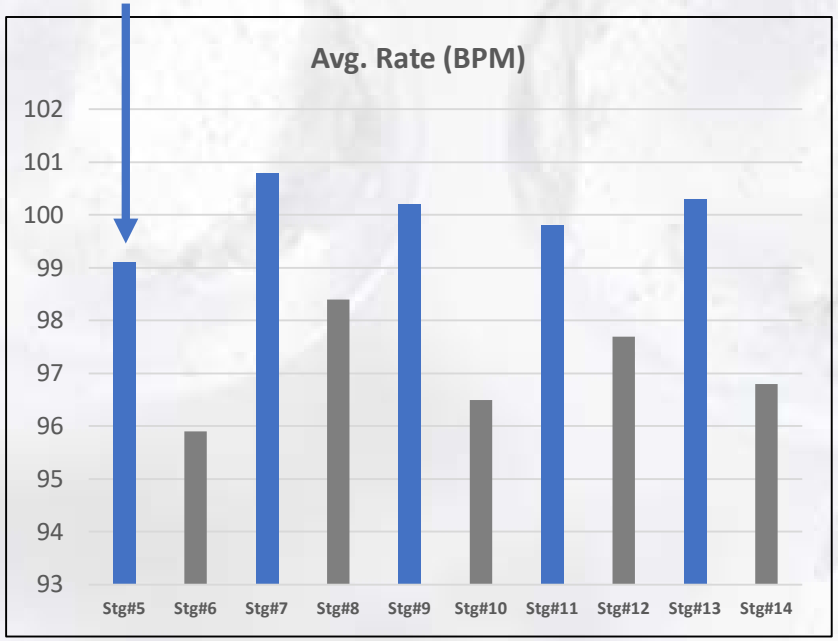
	Untreated	MicroHOLD™	% Diff.
Avg. Rate (BPM)	97	100	3.0%
Avg. P (psi)	9,165	8,972	-2.2%
ISIP (psi)	4,070	4,316	5.7%

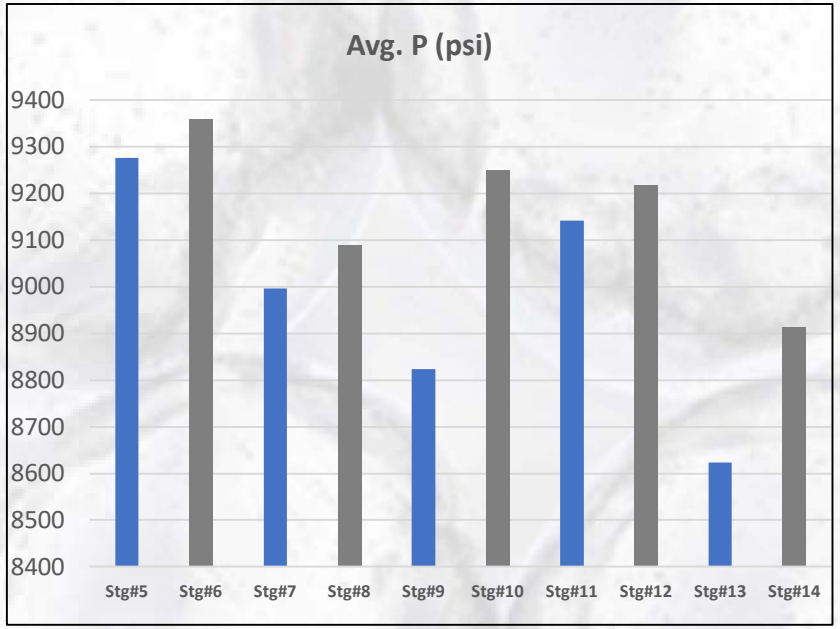
MicroHOLD™ stages enjoyed lower treatment pressures and higher inj. rates

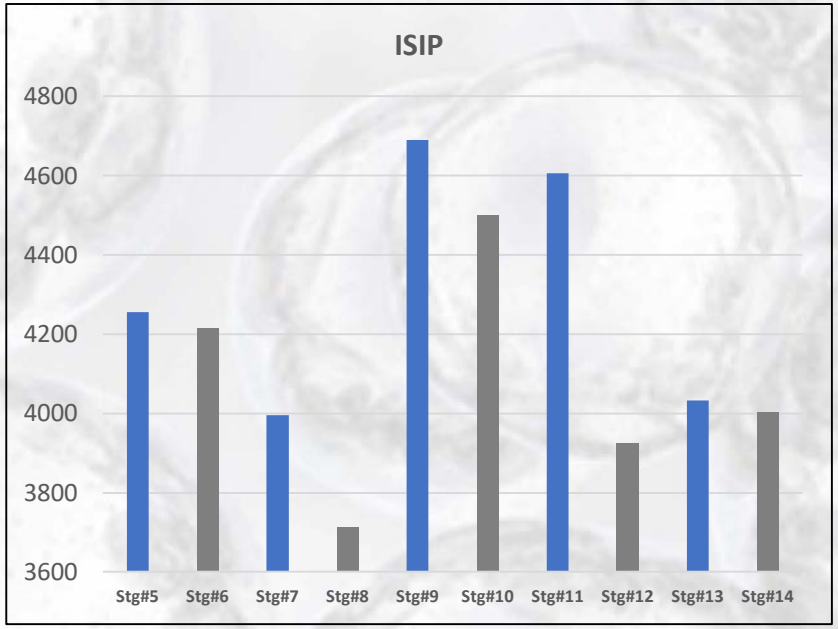
MicroHOLD™ stages showed higher ISIP indicating improved fracturing

TENEX

Blue-shaded stages were treated with MicroHOLD™







NoHIT™ - Fight Pressure with Pressure

Patent-pending frac-hit mitigation technology via in-situ gradual and controlled pressuring of depleted rock intervals around parent well

PRESSURIZE

Temporarily pressurize the depleted rock around parent and increase the associated rock stress

ENERGIZE

Energize the rock surrounding the parent and propped frac pack that could improve parent productivity

How NoHIT™ Works

- NoHIT™ is pumped with a preload or active load treatment into the parent well and produces a slow in-situ gas generation reaction over 2 – 5 days.

- The Science:
  NoHIT™ is based on atomized aluminum technology that creates a slow exergonic gas-generating reaction with water downhole when promoted with selective activators at reservoir conditions
  - NoHIT™: Atomized aluminum slurry
    (3,000 – 7,000 gal/parent well)
  - Activator: Liquid activators based on reservoir temp
    (100 – 500 gal/parent well)

NoHIT™ Impact on Depleted Formation

Current Parent SRV Conditions: 1000 psi & 150 ^{0}F

4,000-gal of NoHIT™ will:

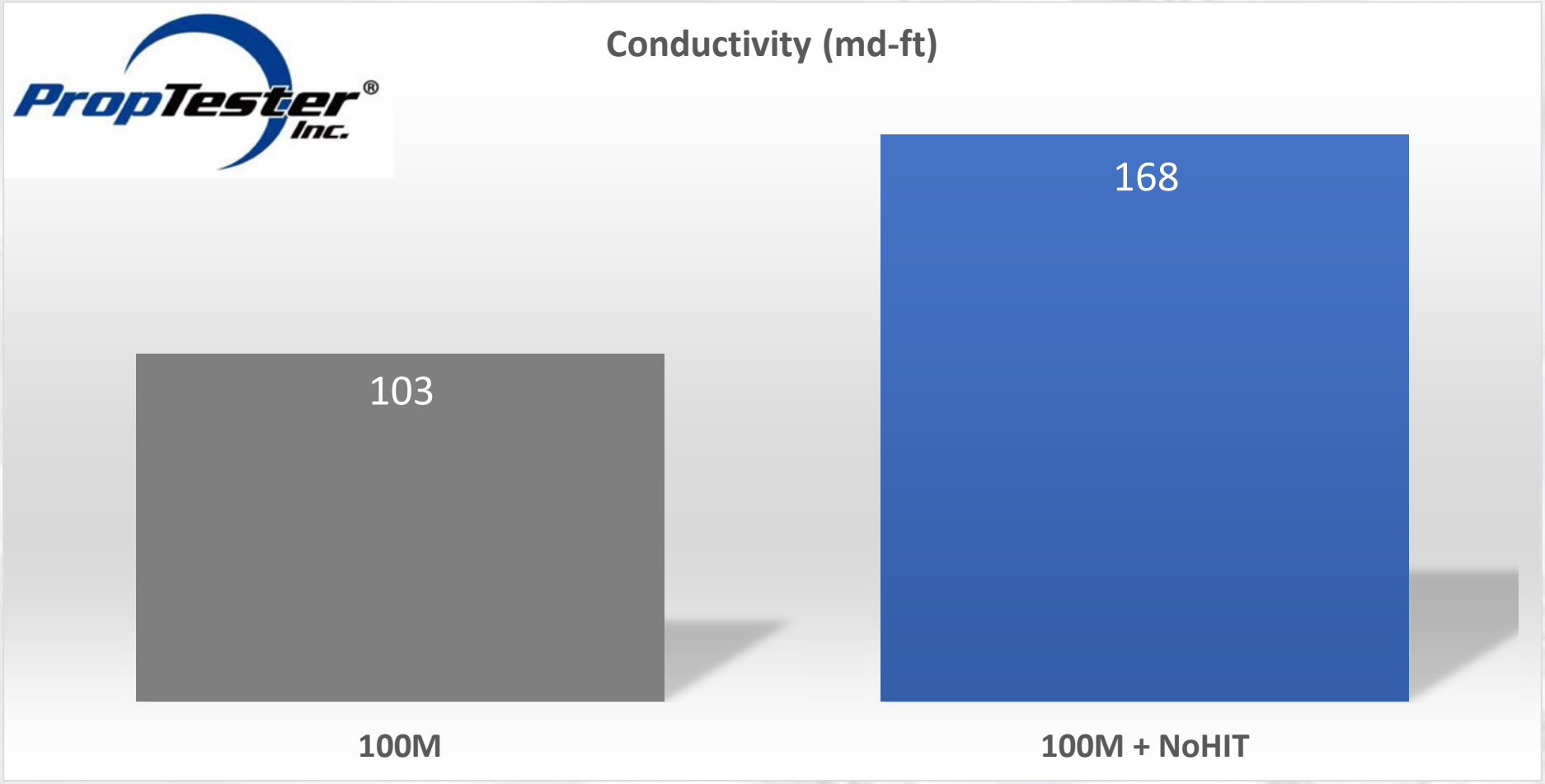
Increase "regional" reservoir pressure to ~**4,960 psi**
→ assuming a modeled expansion of the gas by 300%

Generate ~**645,000 scf** of H_2 gas in-situ
→ ~160 scf of H_2 /gal of NoHIT™

Induce ~**2,200 ft^3** of gassy pore volume inside propped pack
→ The vol. of generated gas @ increased pressure (4300 psi)

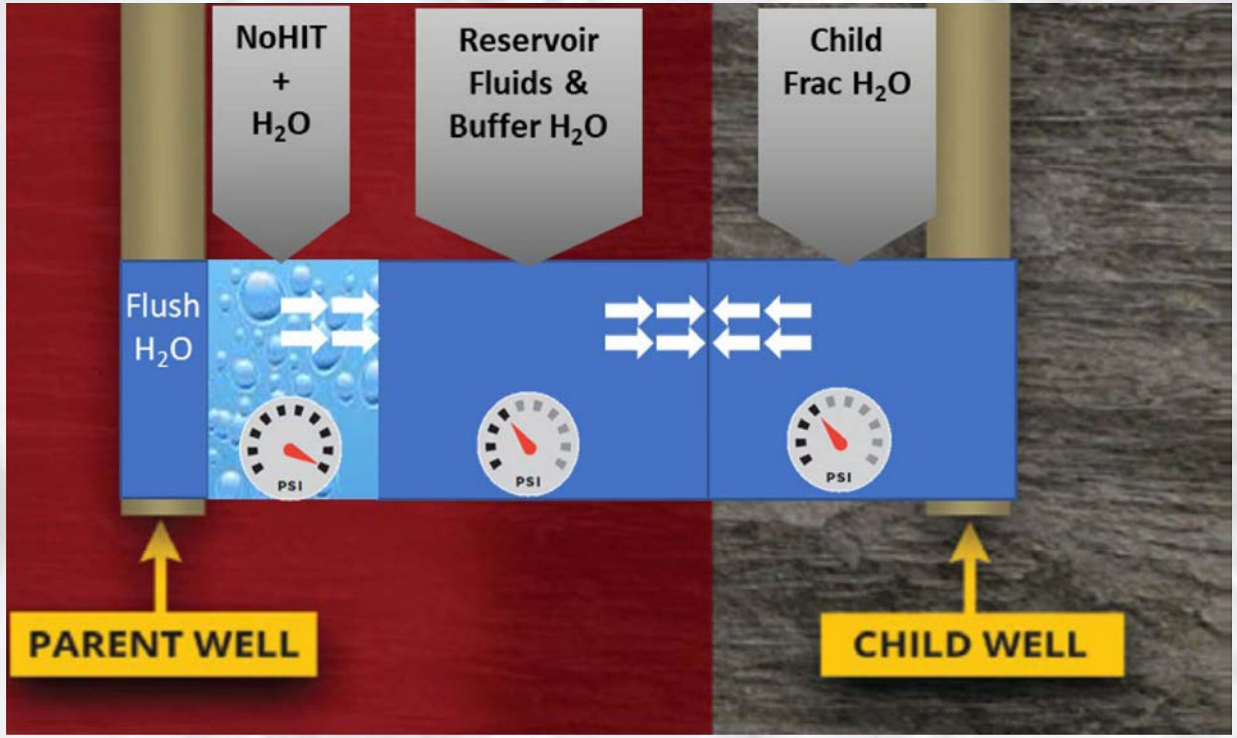
NoHIT™ Impact on Parent's Propped Frac Pack

Test Conditions: 8000 psi, 150 ^{0}F, 24 hr, 2% KCl & 2.0 lb/ft^{2}



NoHIT™ Simple Application

- NoHIT™ is delivered to wellsite in ISO/chemical tanker trucks
  - The activator is provided in totes
- Pumped with active/pre-loading fluids on the fly, with the activator at very low rate (i.e. 5 BPM)
- Bullheaded/spotted into the depleted clusters (most vulnerable to frac hits)



- Buffer H_2O – Acts as a water bank to reduce migration of the continuously generated gas
- NoHIT+H_2O – Delivers NoHIT™ to depletion zone
- Flush H_2O – Causes NoHIT™ to generate gas in the rock instead of the wellbore