

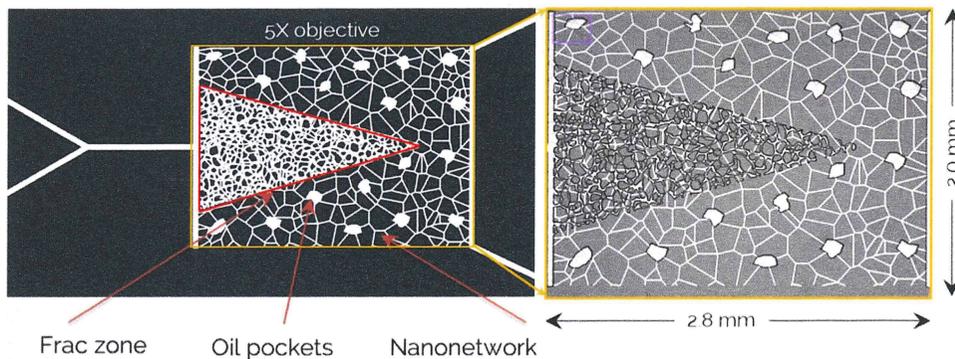
## Flowback Performance Evaluation

Interface Fluidics · Calgary, Alberta, Canada

Nissan Chemical America Corporation is committed to innovative product development. Third-party evaluation provides valuable and unbiased insight into the effectiveness of our solutions and are an integral part of our pursuit of greater product performance and increased customer profitability.

### Methodology

Interface Fluidics Flowback Test uses a porous pattern analogue that replicates the inherent geometries of the reservoir rock. The analogue simulates the relevant porosity, permeability and pore throat size distribution of the reservoir.



Prior to testing, the analogue is saturated with brine and oil, and the systems wettability is modified to reflect the reservoir. Testing is conducted at specified reservoir conditions. During testing, frac water/additive is injected from left to right, then allowed to soak at the same flow rate, followed by continuous oil flowback from right to left.



The primary performance metric is the total volume of oil produced during the first half hour of steady state flowback. Steady state oil flowback is representative of the flow of oil from the reservoir, once the pressure equilibrium is reached after fracturing. Secondary performance metrics are also evaluated including displacement efficiency and wettability modification.

## Summary

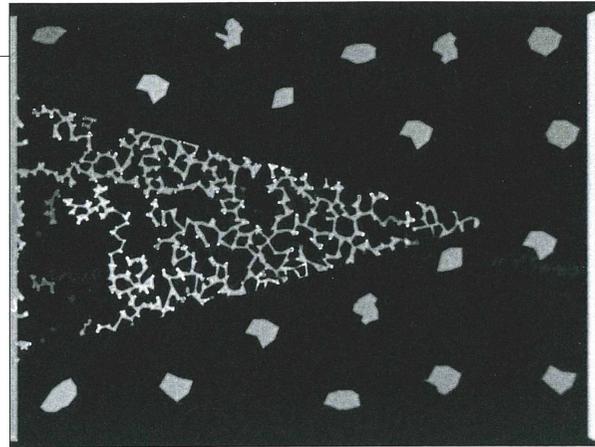
Flowback tests using nanoActiv® HRT and nanoActiv® EFT were conducted in a Wolfcamp reservoir analogue, in both oil-wet and water-wet conditions. The results are compared to a highly-effective surfactant control. Both nanoActiv® products were able to modify wettability by reducing interfacial tension and contact angle. Oil fragmentation was also observed.

### nanoActiv® HRT

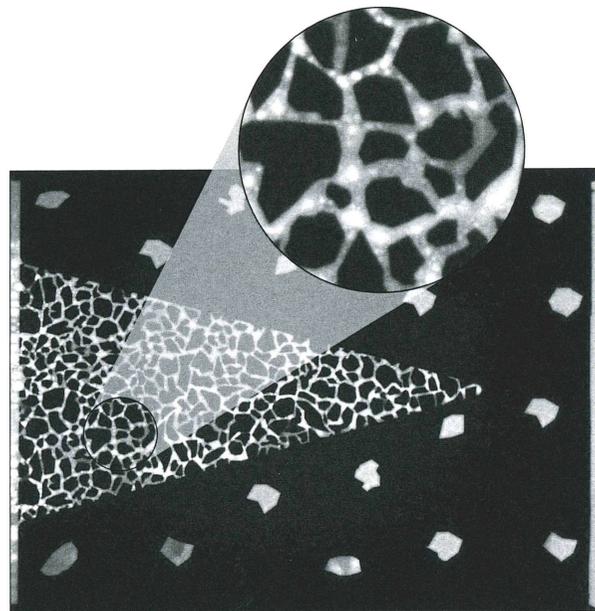
- At 5 wt% concentration, increased oil flowback in oil-wet conditions by 74% and at 5 wt% in water-wet conditions, outperformed the control by 13%
- Completely saturated the frac zone after flowback, for potential use of all possible flow paths

### nanoActiv® EFT

- At 1 GPT concentration, was the top performer in both oil-wet and water-wet test conditions, significantly increasing oil flowback in oil-wet conditions by 236% and in water-wet conditions by 119% over the control
- At 1.0 GPT on flowback exhibited the greatest flow rates through preferential/efficient flow paths



*nanoActiv® EFT flowback at 1.0 GPT in oil-wet conditions exhibits efficiently created flow paths*

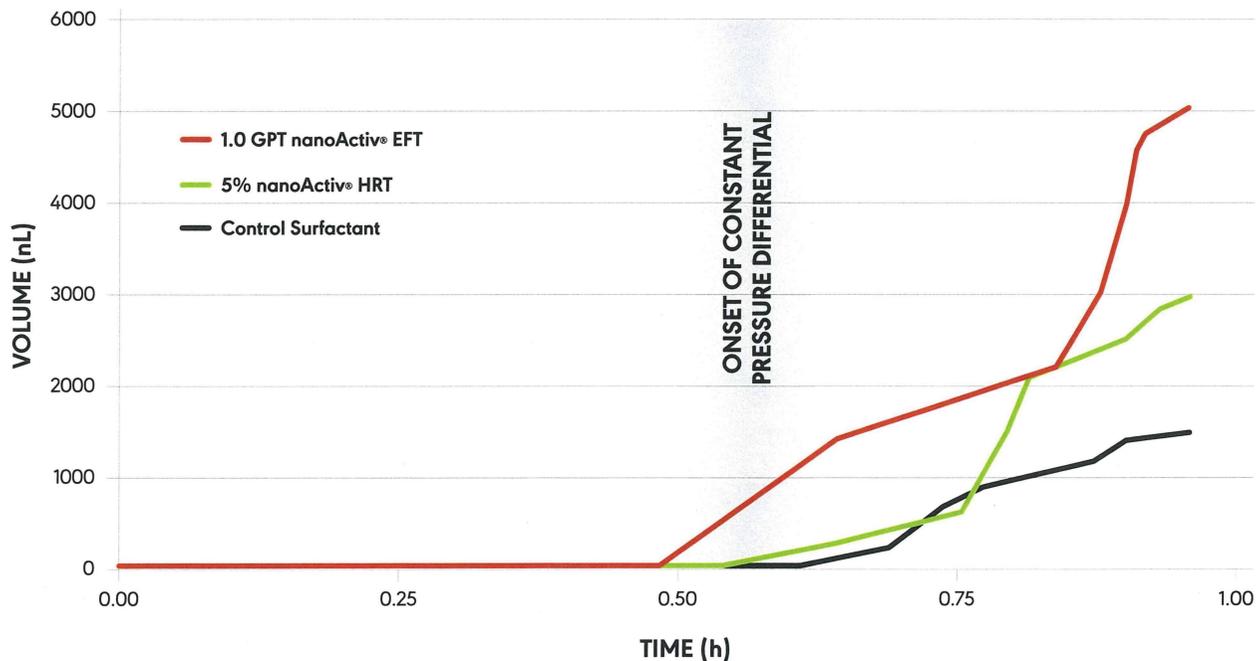


*Oil fragmentation was observed during flowback.*

	Flowback Aid	Loading	Volume of Oil in 30 Minutes of Constant Pressure Drop (nL)	Improvement Over Control (%)
Oil-Wet	Control Surfactant	1.0 GPT	1633	0%
	nanoActiv® HRT	5.0 wt%	2836	74%
	nanoActiv® EFT	1.0 GPT	5494	236%
Water-Wet	Control Surfactant	1.0 GPT	1736	0%
	nanoActiv® HRT	5.0 wt%	1968	13%
	nanoActiv® EFT	1.0 GPT	3804	119%

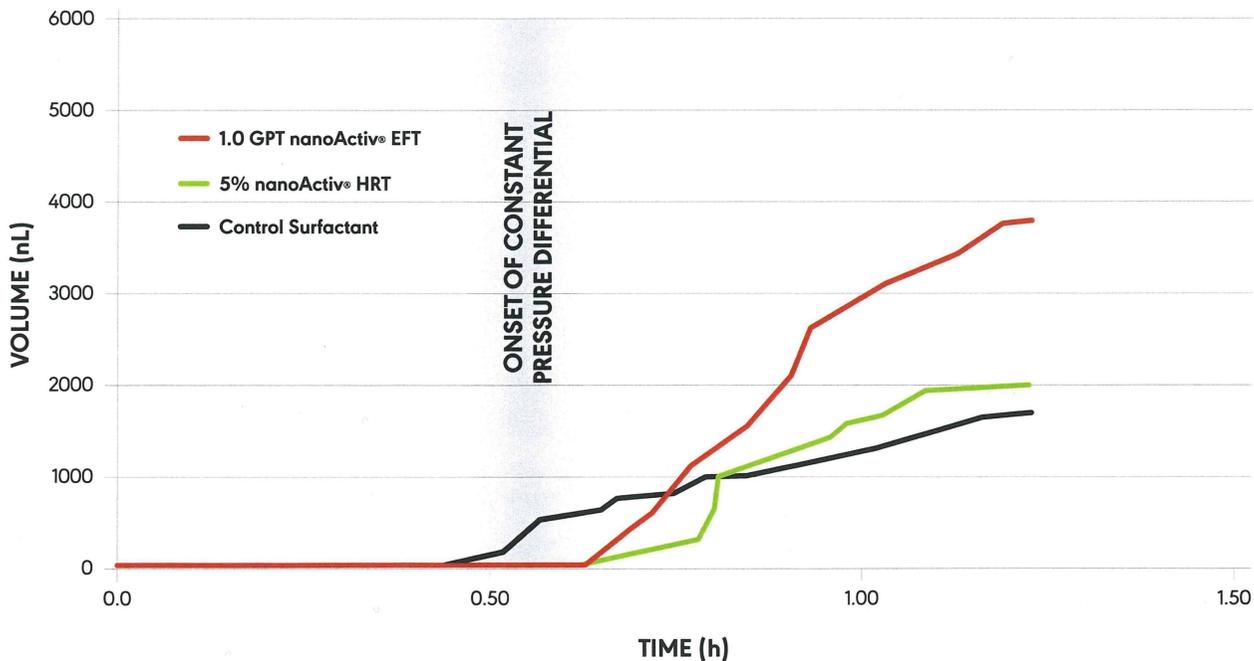
### INTERFACE FLOWBACK TEST · OIL-WET

VOLUME PRODUCED IN THE FIRST HALF HOUR OF FLOWBACK AT CONSTANT PRESSURE DROP

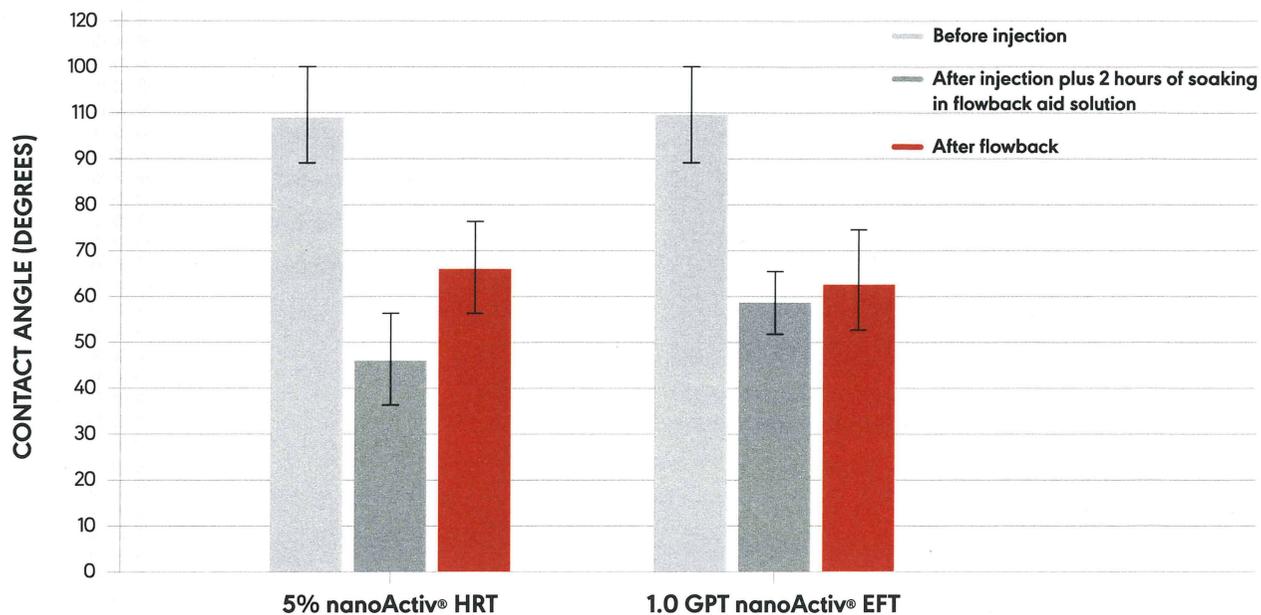


### INTERFACE FLOWBACK TEST · WATER-WET

VOLUME PRODUCED IN THE FIRST HALF HOUR OF FLOWBACK AT CONSTANT PRESSURE DROP



### WETTABILITY MODIFICATION: OIL-WET TO WATER-WET CONDITIONS



Enhancing Hydrocarbon Recovery

[nanoActiv.com](http://nanoActiv.com)



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## Solutions Matrix

nanoActiv® solutions employ inorganic nano-sized particles in a colloidal dispersion, harnessing their power to penetrate porous media on a nanoscopic scale. nanoActiv® particles create a Brownian-motion, diffusion-driven mechanism known as disjoining pressure—greatly facilitating and accelerating the mobility of gas, oil, and water in a wide range of oil and gas applications.

### Products

	Applications	Features and Benefits
nanoActiv® HRT	Completion Remediation IOR/EOR Frac Hit Mitigation	<ul style="list-style-type: none"> <li>• Standard grade</li> <li>• Functionalized nanoparticle dispersion</li> <li>• Enhanced hydrocarbon recovery</li> </ul>
nanoActiv® HRT-78	Completion Remediation IOR/EOR Frac Hit Mitigation	<ul style="list-style-type: none"> <li>• High temperature stable grade</li> <li>• Functionalized nanoparticle dispersion</li> <li>• Enhanced hydrocarbon recovery</li> </ul>
nanoActiv® HRT-EF5	IOR/EOR	<ul style="list-style-type: none"> <li>• High salinity stable grade</li> <li>• Functionalized nanoparticle dispersion</li> <li>• Enhanced hydrocarbon recovery</li> </ul>

nanoActiv® EFT	Completion Remediation IOR/EOR Frac Hit Mitigation	<ul style="list-style-type: none"> <li>• Functionalized nanoparticle micellar dispersion</li> <li>• Synergistic combination of surfactant, solvent and nanoparticles</li> <li>• Enhanced flowback technology</li> </ul>
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nanoActiv® CET-EX	Cementing	<ul style="list-style-type: none"> <li>• Nanoparticle based free water control agent</li> <li>• HTHP stable grade</li> </ul>
nanoActiv® CET-SA	Cementing	<ul style="list-style-type: none"> <li>• Nanoparticle based cementing additive</li> <li>• Multiple benefits for low density cement systems</li> </ul>

## Methods

	Application	Features and Benefits
<b>nanoActiv® HnP</b>	Remediation IOR/EOR Frac Hit Mitigation	<ul style="list-style-type: none"> <li>• Synergistic combination of nanoActiv® HRT and EFT pushed with gas</li> <li>• Enhance Hydrocarbon recovery</li> </ul>
<b>nanoActiv® Frac Hit Mitigation</b>	Remediation Frac Hit Mitigation	<ul style="list-style-type: none"> <li>• Synergistic combination of nanoActiv® HRT and EFT pushed with gas</li> <li>• Enhance Hydrocarbon recovery</li> </ul>



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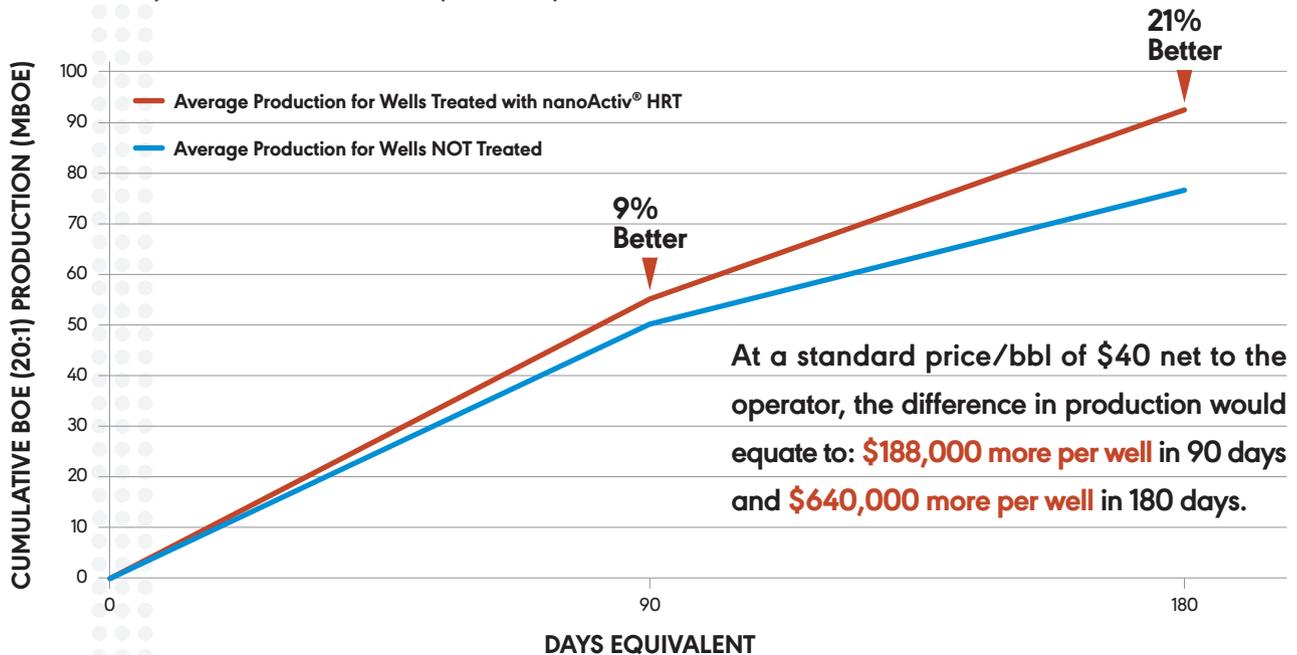
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# The Results Speak Volumes

**78 well production comparison in the Wolfcamp formation: 13 Wells Treated with nanoActiv<sup>®</sup> HRT vs. 65 Wells NOT Treated**

## nanoActiv<sup>®</sup> HRT Treated Wells\*:

- 90 days—4,700 more bbls per well produced
- 180 days—16,000 more bbls per well produced



\*Weighted difference in average BOE (20:1) cumulative production. nanoActiv<sup>®</sup> HRT treatment vs. offsets (2017-2018). New well frac'd completions located in the Midland and Delaware Basins. Data was limited to direct offsets with reasonable data quality as reported to Texas RRC.

**180 Days**

**3:1 Return**

**186% ROI Per Well**

**Start getting better returns today!**

[nanoActiv.com](http://nanoActiv.com)