



nano**Activ**[™] **HRT**



Enhancing Hydrocarbon Recovery



Nissan Chemical America Corporation

Nissan Chemical Industries

Where unique and solutions meet.

Deep Financial Strength

- Annual sales of more than \$2 Billion

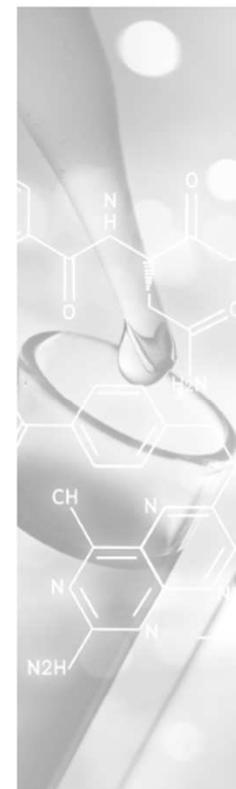
Bringing Advanced Science to Industry

- Worldwide Manufacturing and Offices

An Innovation Powerhouse in:

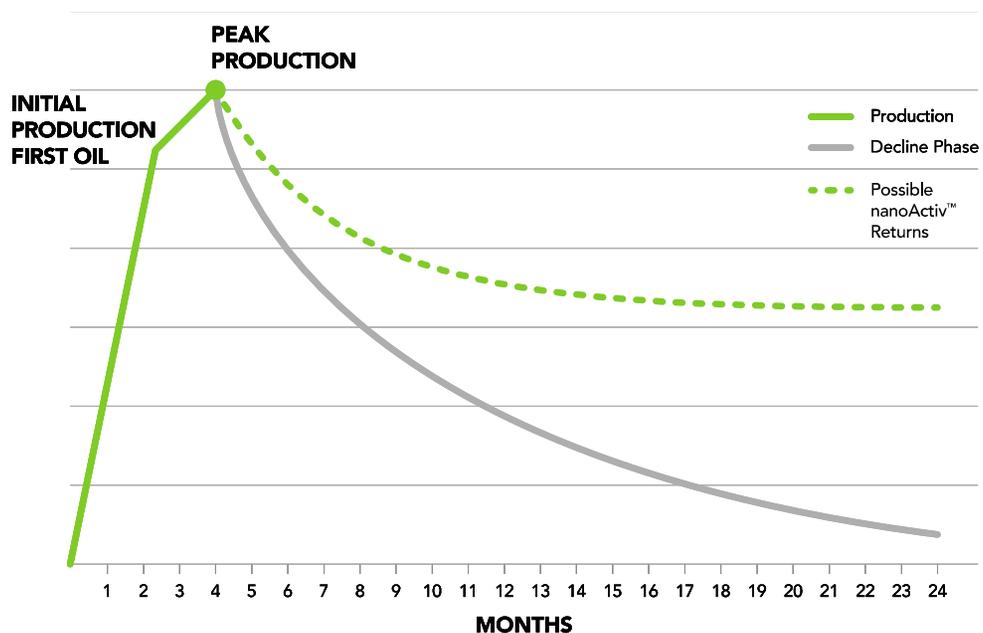
- Ultra-Fine Particle Control
- Functional Polymer Design
- Fine Organic Synthesis
- Biological Evaluation
- Optical Control

More than 130 years of advanced chemistry to improve the world.

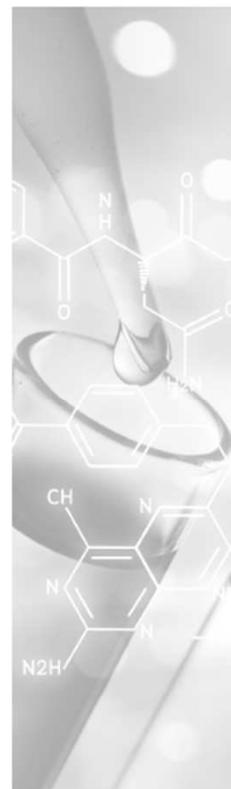


The Production Challenge

Steep production decline curves mean there is intense pressure to keep replacing the production lost year after year.



If only we could get more oil out of existing wells without expensive re-fracturing or other intervention technologies.



The Well Stimulation Challenge

At an SPE presentation Craig Cipolla, with Hess Corporation, said, “From analyzing production and treatment data in over 1000 fracture treatments in the Marcellus (as well as other unconventional reservoirs), **less than 15%** of the available fracture network (natural fractures) **received any proppant!**”

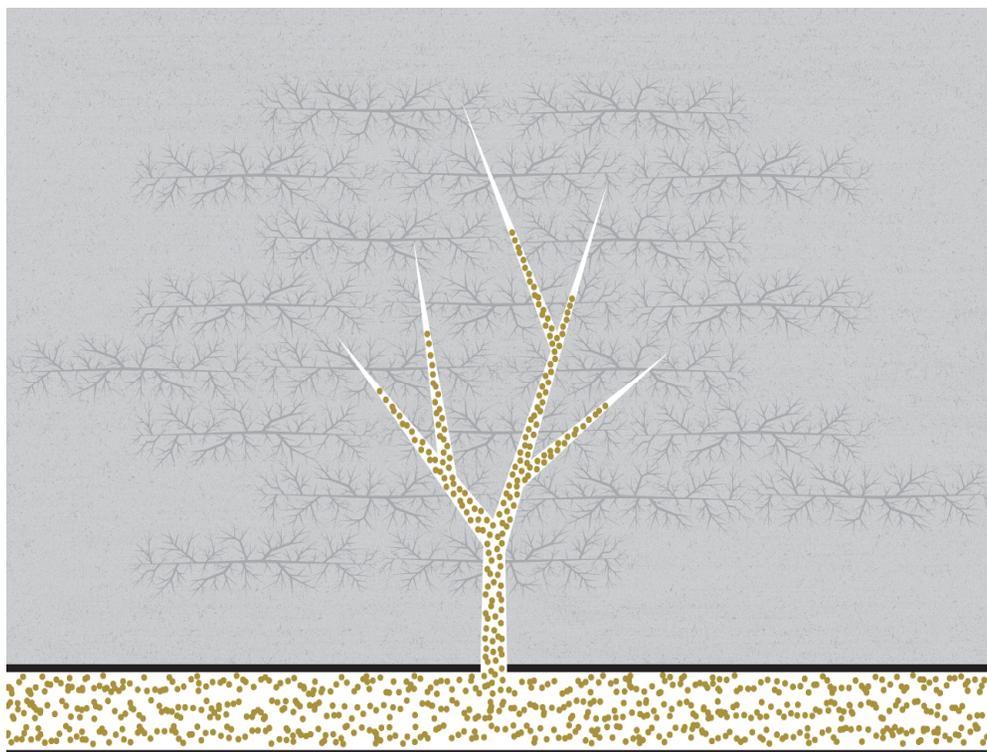
That means...

85% of the available natural fracture network is not reached by traditional proppants.



The Proppant Problem

Conventional proppants (including 100 mesh) are just too big to penetrate 85% of the natural fracture network.



The Solution

Reach further into the induced and natural fracture networks to produce more oil and gas.

Today we can do that like never before with:

The logo for nanoActiv™ HRT. The word "nano" is in a smaller, lowercase font, followed by "Activ" in a larger, bold, lowercase font with a trademark symbol. To the right of "Activ" is "HRT" in a bold, uppercase font. Above the "i" in "Activ" are five red dots of varying sizes arranged in a cluster.

Enhancing Hydrocarbon Recovery

Nissan Chemical America Corporation





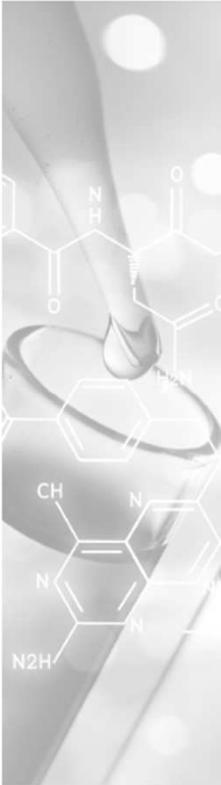
nanoActiv™ HRT

Enhancing Hydrocarbon Recovery

nanoActiv™ HRT is a high efficiency Hydrocarbon Recovery Technology well intervention additive package and method—made in the U.S.A. by Nissan Chemical America Corporation.

nanoActiv™ HRT works faster and is effective longer, enabling higher volume hydrocarbon recovery.

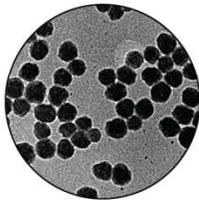
Nissan Chemical America Corporation



Small is BIG

nanoActiv™ HRT particles are so small they reach into the fracture network where no proppant has ever been able to go.

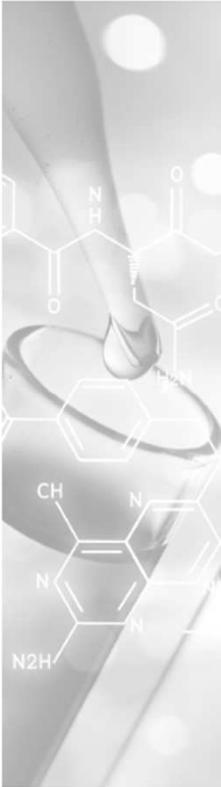
<u>nanoActiv™ HRT</u>	$\times 100,000 =$	<u>Typical Proppant – Sand</u>	$\times 2,400,000 =$	<u>US Quarter</u>
<ul style="list-style-type: none">• 1 nm = 1 billionth (10^{-9}) of a meter• one 10 nanometer (nm) nanoActiv™ HRT particle• visible only under transmission electron microscope (TEM)		<ul style="list-style-type: none">• 1 millimeter (mm) average grain of sand• 1 mm = 1 million nanometers• = 100,000 nanoActiv™ HRT particles across		<ul style="list-style-type: none">• = 24 grains of sand across <p>OR</p> <ul style="list-style-type: none">• = 2.4 million nanoActiv™ HRT particles across



200,000 × Magnification

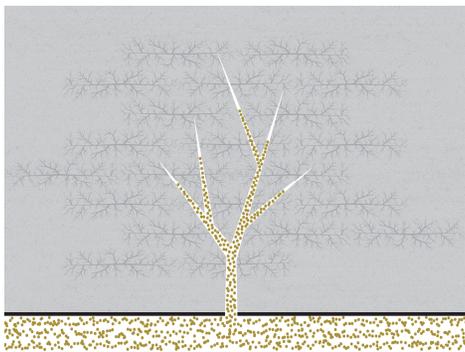


Actual Size

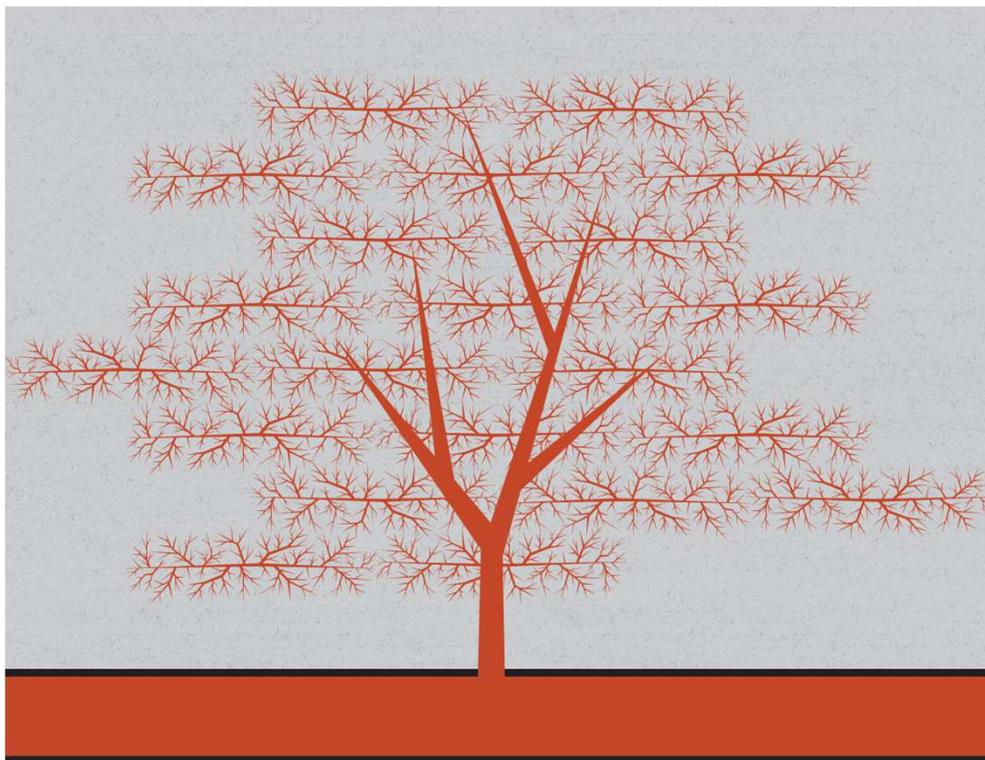


Well Beyond

nanoActiv™ HRT
penetrates the natural
fracture network on a
nanoscopic scale.



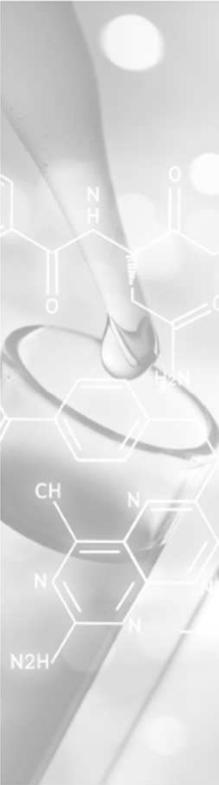
Typical Proppant



Well Beyond

nanoActiv™ HRT utilizes nano-sized particles in a colloidal dispersion. These particles produce a Brownian-motion, diffusion-driven mechanism known as “disjoining pressure” to produce long efficacy in the recovery of hydrocarbons in conventional and unconventional reservoirs.

nanoActiv™ HRT moves throughout the fracture network releasing hydrocarbons as it goes deeper and farther than any product on the market today.

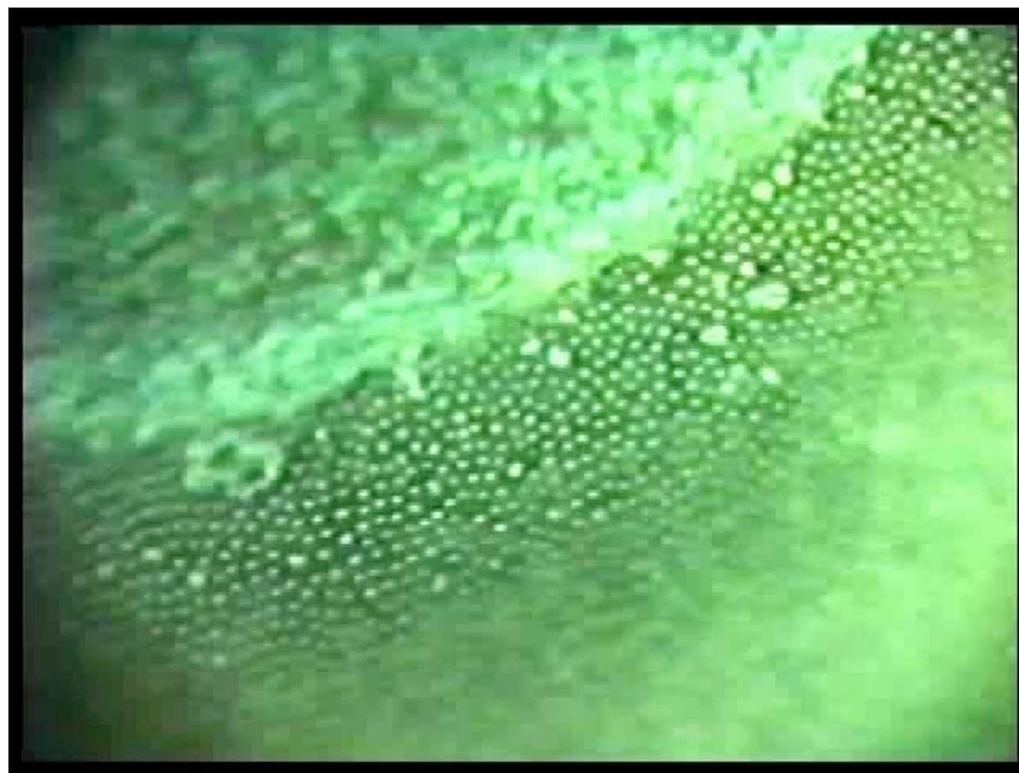


Disjoining Pressure

This video was shot at a fixed focal length.

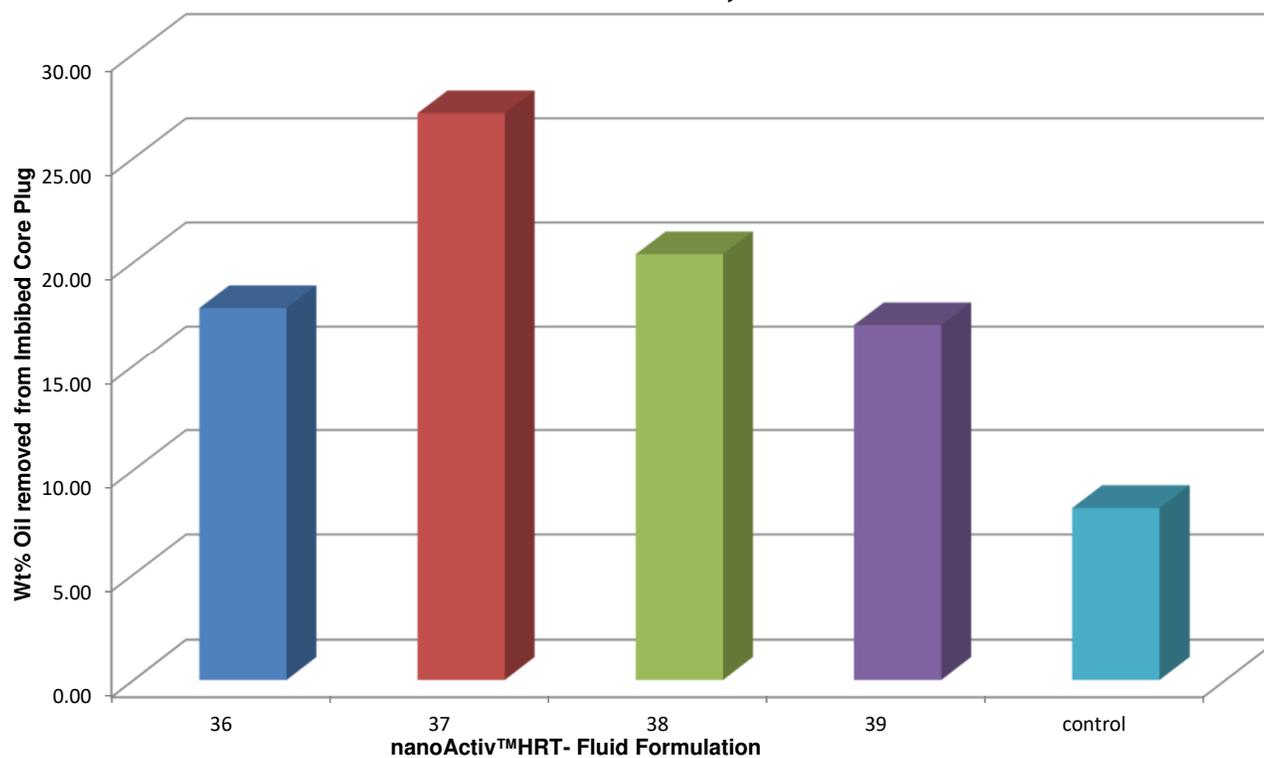
The apparent change in focus is the result of naturally occurring Brownian motion and diffusion driven wedge force causing the nanoparticles to move in and out of the focal plane.

Wasan & Nikolov,
Nature, Vol. 423, 2003.



Amott Cell Testing

**% Oil wt removed by nanoActiv™ Solution
Silurian Dolomite cores, Texas Crude Imbided**



How does it work?

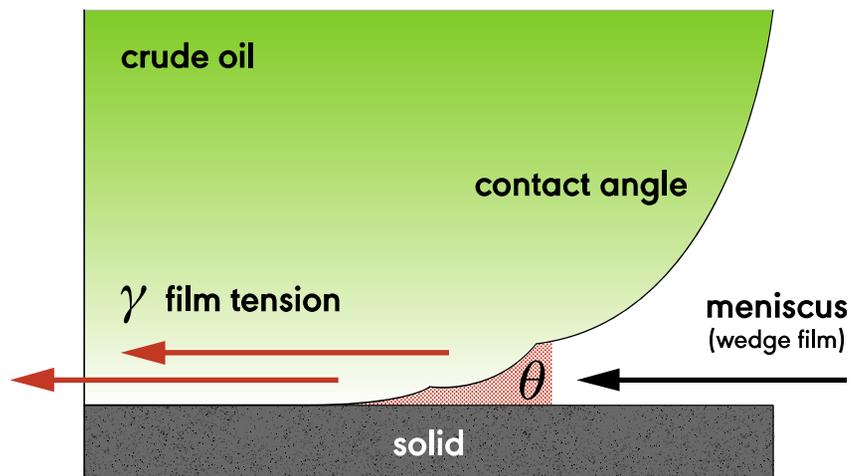
nanoActiv™ Wedge Effect Mechanism: Disjoining Pressure

nanoActiv™ solutions behave as a wedge film driven by **Brownian Motion** and **Diffusion** defined as **Disjoining Pressure** which can greatly facilitate and accelerate the mobility of gas, oil and water, or mixtures thereof within porous media, and/or natural or induced fracture networks that are contacted by a fluid containing a mixture of nanoActiv™ and water.

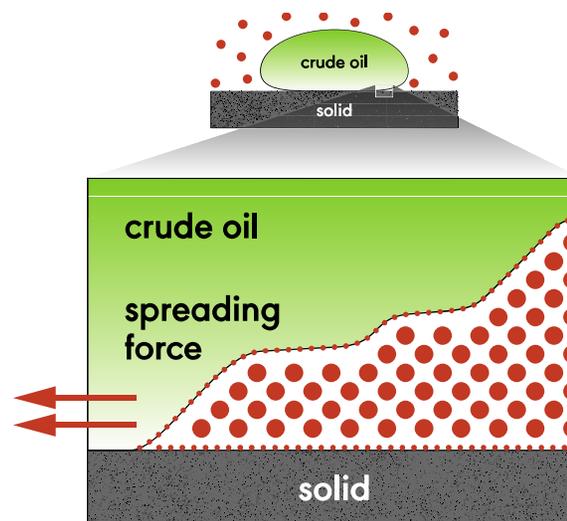


Brownian Motion/Diffusion = Spreading Force

Wedge Film



Film Tension



Wasan & Nikolov, *Nature*, Vol. 423, 2003.

nanoActiv™ HRT - Typical Applications

A highly effective product for:

- Hydrocarbon production rejuvenation
- Formation damage removal and/or prevention
- Production enhancement
- Paraffin, asphaltene, biofilm and scale mitigation and control
- Water block removal; drilling mud clean-up and removal
- Disposal well injection improvement
- Water flood sweep efficiency improvement
- Pipeline cleaning
- To regain and sustain enhanced hydrocarbon productivity rates



The background of the top section is a dark, high-contrast photograph of laboratory glassware, including several beakers and test tubes, arranged on a surface. The lighting is dramatic, highlighting the curved surfaces and reflections on the glass.

nanoActiv[®] EFT

Enhanced Flowback Technology

nanoActiv[®] EFT is a nanoparticle micellar dispersion, which uses a synergistic combination of silicon dioxide nanoparticles, a soybean extract solvent, and a blend of surfactants.

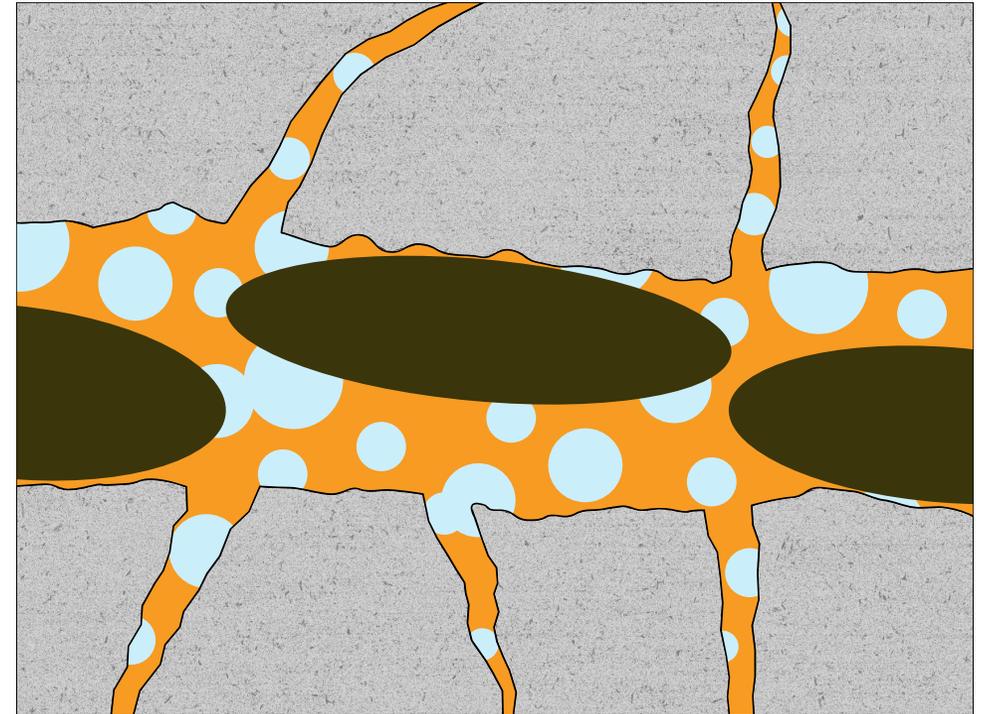
**nanoActiv[®] EFT exhibits an
extremely effective primary chemical
action, enhanced with the added mechanical
properties of nanotechnology—delivering
greater initial oil and gas production.**

The Solution • nanoActiv[®] EFT

nanoActiv[®] EFT is a three-part, synergistic combination of silicon dioxide nanoparticles, a soybean extract solvent, and a blend of surfactants, working together to bring more hydrocarbon to the well bore.

Surfactant

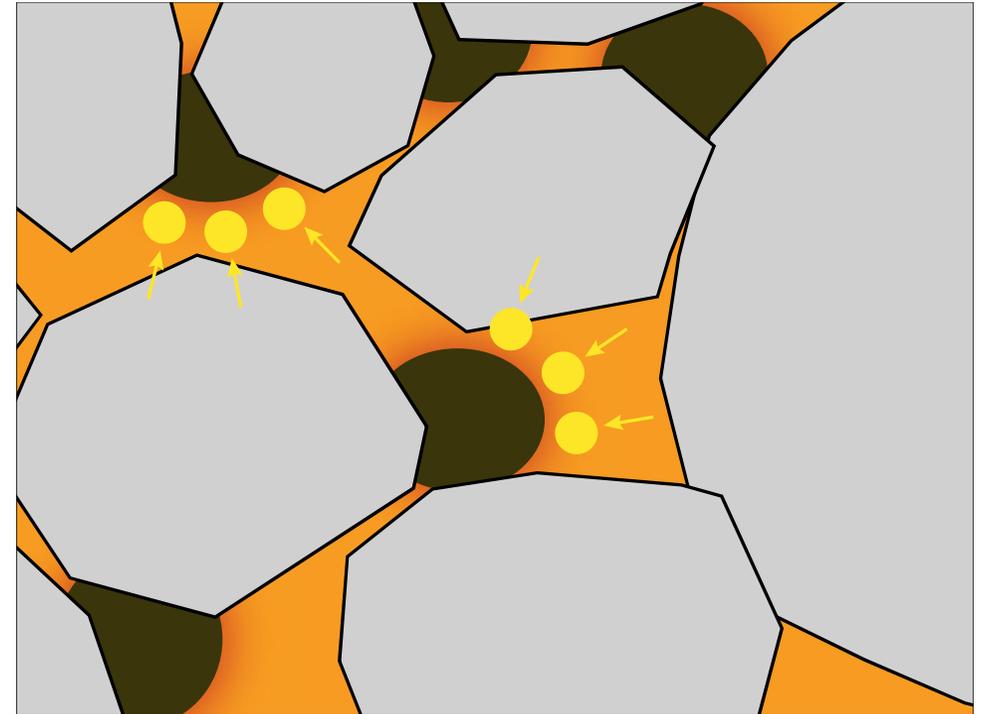
The surfactant in nanoActiv[®] EFT reduces the interfacial tension of fracturing fluids and mobilizes immobile water-block zones in pore spaces, increasing the capillary number, enabling more efficient fluid flow.



$$N_c = \mu * U / \sigma$$

Solvent

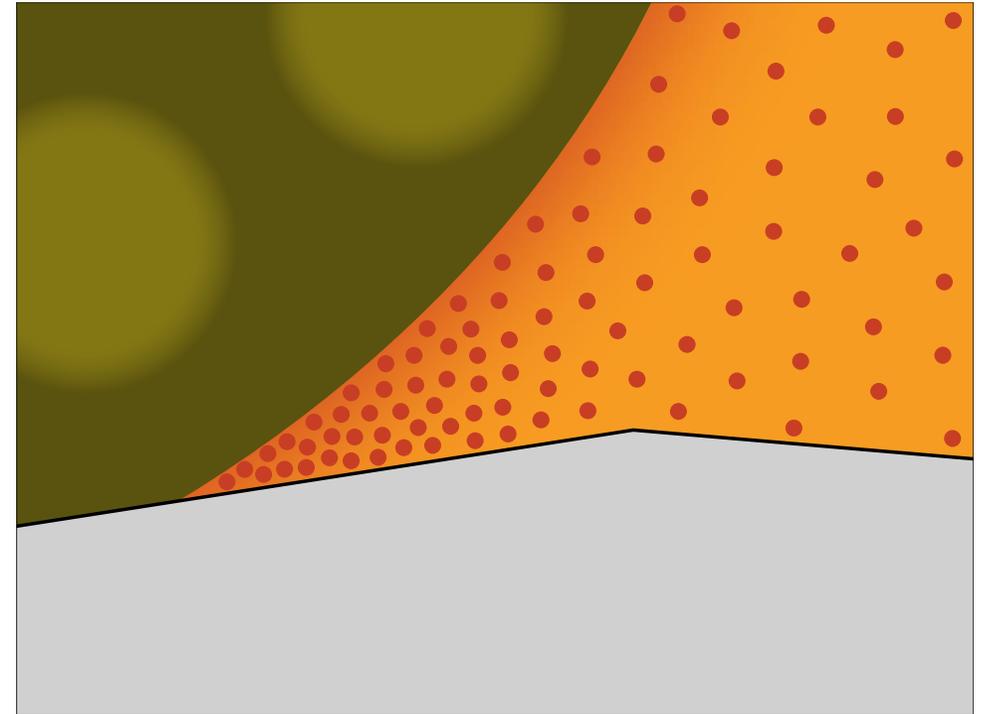
The soybean-extract solvent improves the mobility ratio by significantly reducing oil viscosity through solvent miscibility with the oil, improving primary flow.



$$M = K_{rd} * \mu_o / \mu_d * K_{ro}$$

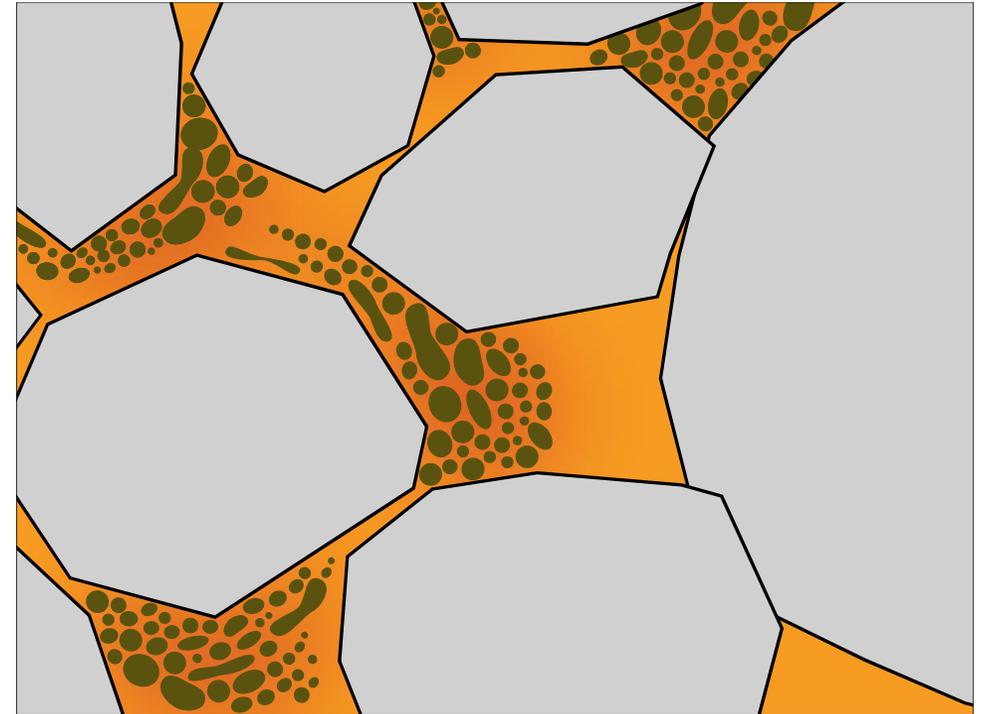
Nanoparticles

The nanoActiv[®] particles provide two primary functions. First, they stabilize and extend the life of the micellar dispersion—improving delivery to the oil in place.



Nanoparticles

Second, once the nanoparticles reach the oil, they employ a Brownian-motion, diffusion driven mechanism known as disjoining pressure to free oil from small pore spaces, fragmenting it into smaller droplets for increased initial production.



Contact Angle

Contact Angle	Wetting	Interaction
$\theta = 0^\circ$	 Perfect	Solid/Liquid: Strong Liquid/Liquid: Weak
$0 < \theta < 90^\circ$	 High	Solid/Liquid: Strong to Weak Liquid/Liquid: Strong to Weak
$90^\circ < \theta < 180^\circ$	 Low	Solid/Liquid: Weak Liquid/Liquid: Strong
$\theta = 180^\circ$	 	Solid/Liquid: Weak Liquid/Liquid: Strong

Key Benefits

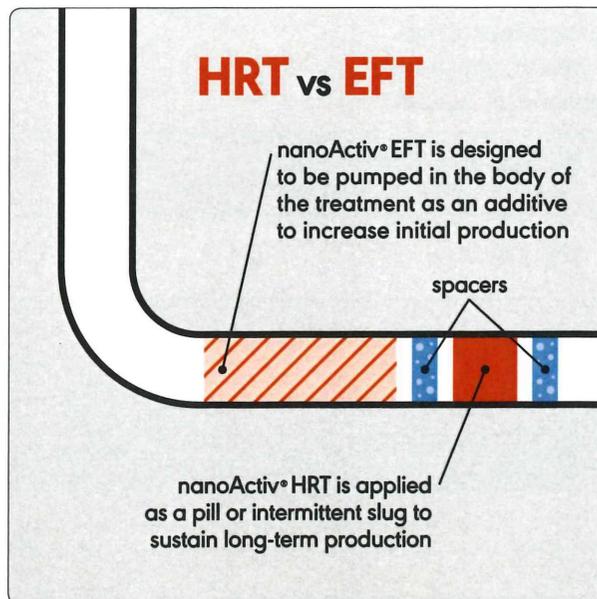
Benefit Attribute	Factors	nanoActiv® Technologies	Leading Microemulsion	Generic Surfactant
Speed of Oil Production	Production performance enhancement	✓	✓	✓
	Potential for early oil to surface	✓	✓	✓
	Longer lasting production with lower percentage decline rate	✓	✗	✗
Persistence	Duration effectiveness longer when compared to conventional treatments	✓	?	?
Effectiveness at Different Temperatures	90-175° F	✓	✓	✓
	175-275° F	✓	✓	✓
	275-350° F	✓	✓	?
Foaming	Ability to reduce foaming	✓	✓	✓
Paraffin Mitigation		✓	✗	✓
Mechanical vs. Chemical Approach	Wedge effect—disjoining pressure	✓	✗	✗

✓ Applicable ✗ Not Applicable ? Unknown

HRT vs EFT Relative Positioning

Potential Application Areas	nanoActiv® HRT	nanoActiv® EFT
Fracturing	✓	✓
EOR / IOR	✓	✗
Flowback Agent	✗	✓
Water Block	✓	✓
Stimulation	✓	✓
Remediation	✓	✓

✓ Applicable ✗ Not Applicable



Enhancing Hydrocarbon Recovery

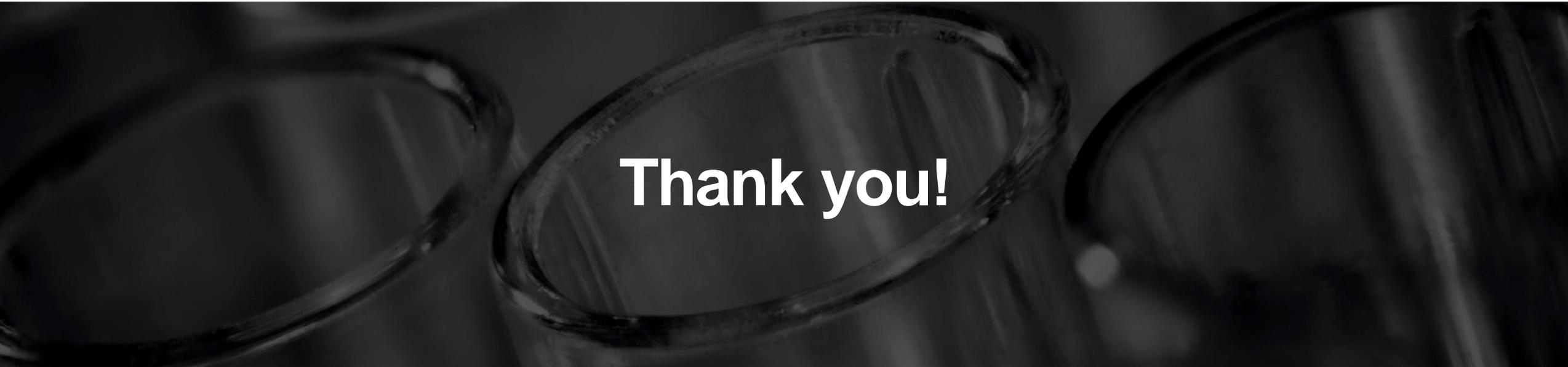
nanoActiv.com



**Nissan Chemical
America Corporation**

10333 Richmond Avenue, Suite 1100
Houston, Texas 77042 · 713.532.4745
nanoactiv@nissanchem-usa.com

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Thank you!

Start Getting Better Returns Today!

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