Nitro-Lift Technologies Tech Tips:

Friction Reducers & Pore Throat Plugging

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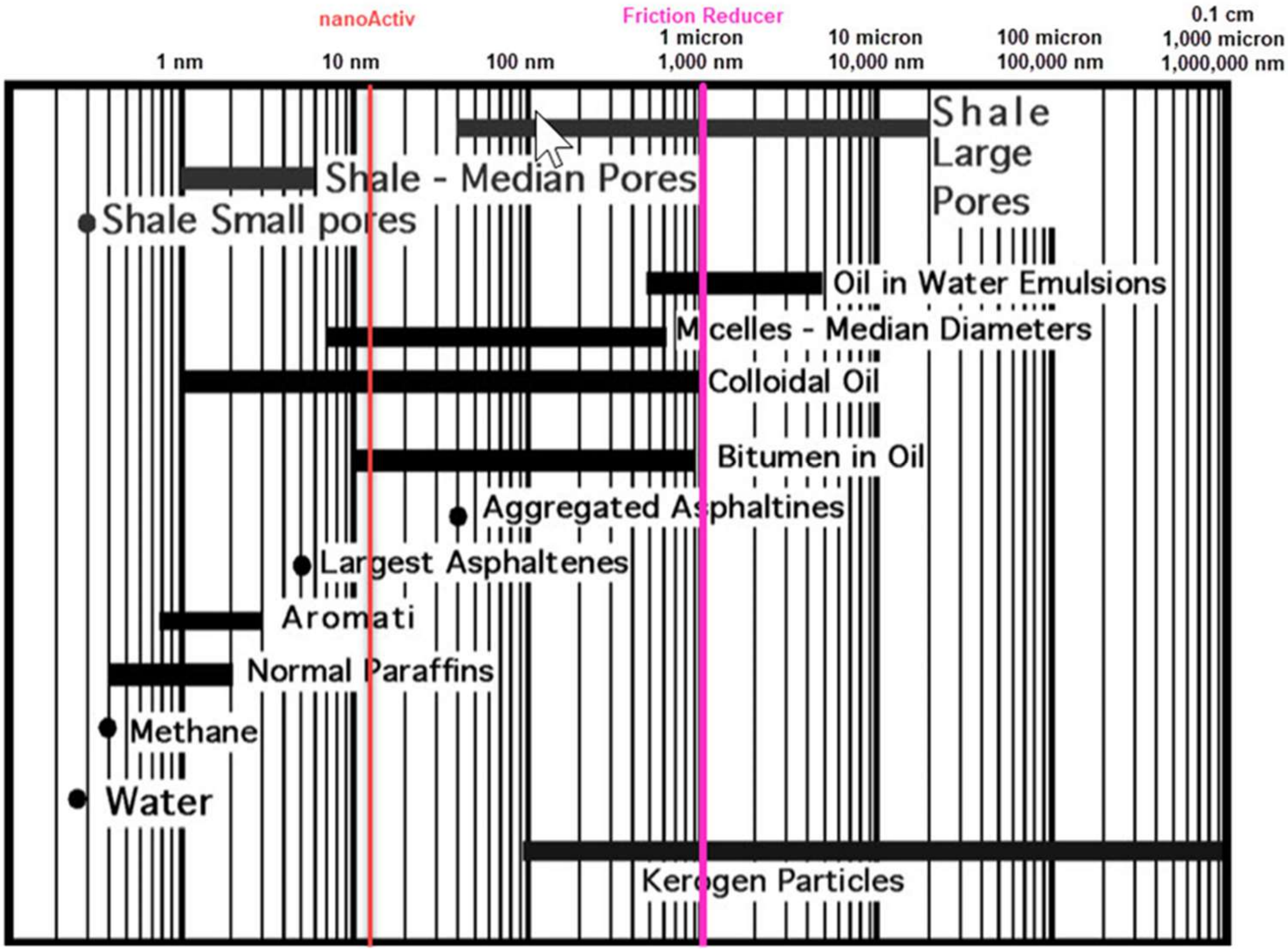
Our Partners:

The Problem

A friction reducer (FR) is a high-molecular-weight, anionic, and water-soluble copolymer approximately 1,000 nanometers in size (1 micrometer). A 1,000 nm product in micropores less than 1,000 nm presents a microscopic problem with major ramifications.



An additional problem with FRs is *"At low flow rates, the drag reducer forms a liquid layer against the pipeline surface, which decreases the interface drag. In contrast, at high flow rates, since the intensity of internal turbulence increases, the energy consumed within the slick-water constitutes the main drag of the pipeline"*.

Friction reducers may precipitate in the formation causing damage. See example.

Pore Throat Distribution

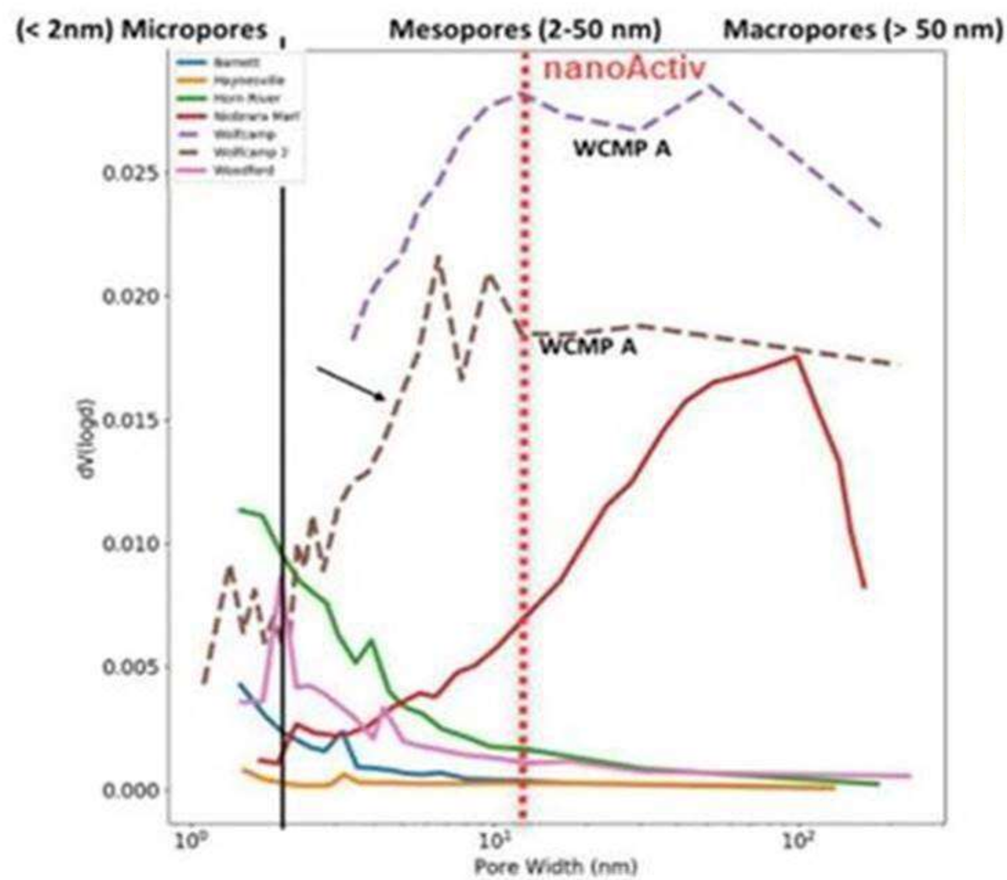
If pore throat distribution is smaller than the 1,000 nm, the FRs will plug the pore throats and pores. As a result, production rate will suffer and ultimate recovery lowered.

“Shale media possesses a complex pore architecture [20]. Thus, the uniform capillary model does not adequately account for the heterogeneity of shale. Civan [21] **indicated that the apparent permeability of tight rock is directly related to pore size distribution (PSD)**. But limited work has studied the effect of PSD on gas transport in shale. Villazon et al. [22] employed a log-normal density function to characterize the PSD of shale and proposed an apparent permeability model. The model is developed based on the Hagen–Poiseuille equation and the general slip boundary condition [23].Thus, the model only considers viscous flow and slip flow. But, at low pore pressure, Knudsen diffusion dominates gas transport.“ (Ref. #1 with sub-references).

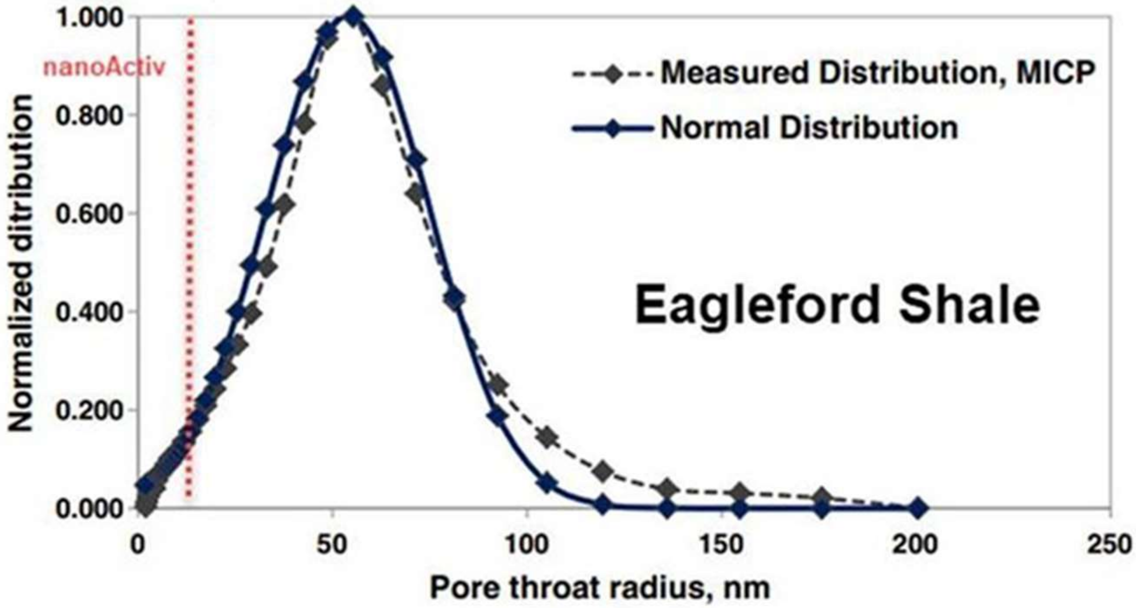
As stated, **“apparent permeability of tight rock is directly related to pore size distribution**”. Permeability is the property of the porous medium that measures the capacity and ability of the formation to transmit fluids. The rock permeability, k, is a very important rock property because it controls the directional movement and the flow rate of the reservoir fluids in the formation.

Wolfcamp A and B – Permian Basin

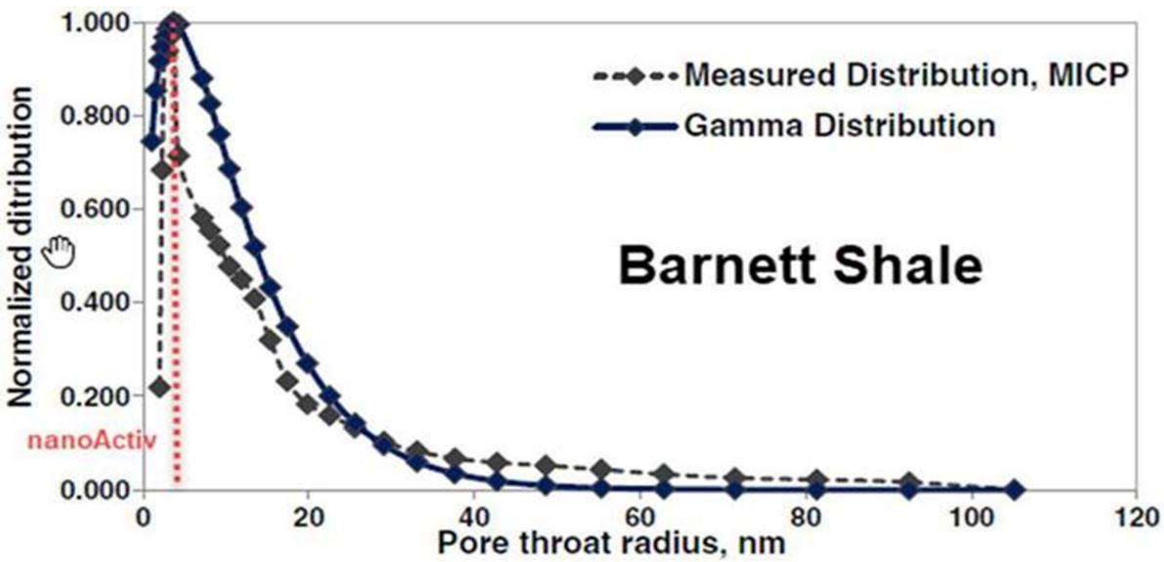
Figure 4 – Pore Size Distribution in Wolfcamp A and Wolfcamp B.



Eagle Ford Shale (Ref. 4)



Barnett Shale (Ref. 4)

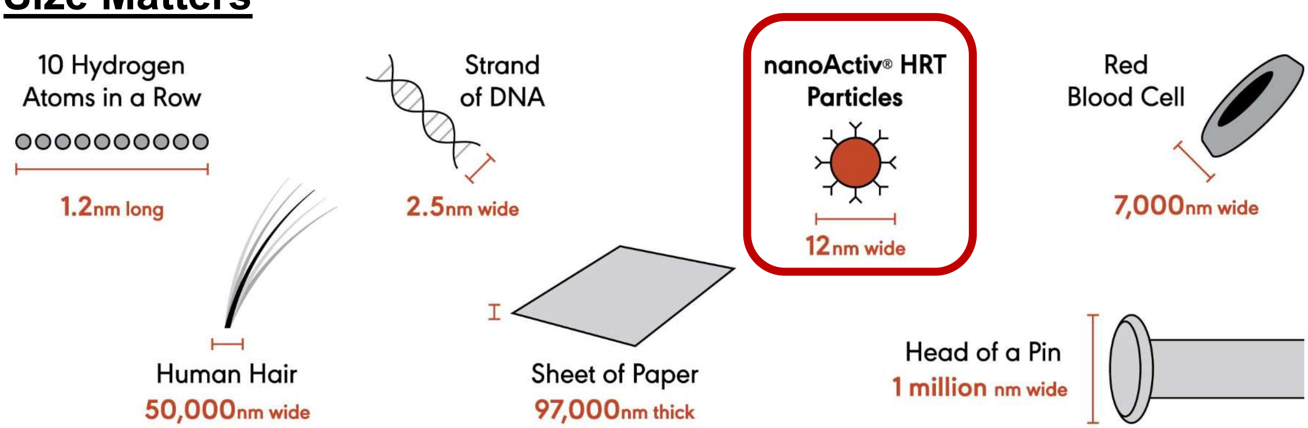


*"More and more attention has been paid to the oil and gas flow mechanisms in shale reservoirs. __**The solid–fluid interaction becomes significant when the pores are in the nanoscale**__. The interaction changes the fluid's physical properties and leads to different flow mechanisms in shale reservoirs from those in conventional reservoirs………__**The results show that both gas and oil exhibit enhanced flow rates in nanopores**__. Gas-phase flow in nanopores is dominated by the density-changing effect (adsorption), while the oil-phase flow is mainly controlled by the viscosity-changing effect. Both gas and oil permeability quickly decrease to the Darcy permeability when the slit aperture becomes large." (Ref. 5)*

The Solution:

nanoActiv® is a nanoparticle, developed by Nissan Chemical, that is pumped into existing wellbores. **nanoActiv®** enters microscopic pore throats and fragments hydrocarbon molecules that were previously unrecoverable using current technology. **nanoActiv®** is proven to increase recoveries in existing wells, remediate skin damage, and protect wells from frac hits.

Size Matters



nanoActiv® particles are 83x smaller than Friction Reducers and ~20,000x smaller than a grain of sand.

nanoActiv's Brownian motion driven particles have proven the ability to remediate fines migration and to break through clogged pores.

See the customer testimonial on the next page.

Customer Testimony

To confirm these results, we contacted an operator drilling horizontal wells in the Woodford Shale. Their response was:

"You are right on the money with the reaction to FR. If you do not want to read the rest of the novel I am writing, the long story shortened is that I believe the nanoActiv® does scour formation, skin, and pore blockage.

Below is a slide from old presentation we were giving to our capital source following 6 wells completed by (Vendor 1). All 6 used a FR that was making an iron scale downhole and on surface. (Operator 1) had an issue they called producing gummy bears, and (Operator 2) and (Operator 3) have had a similar gummy substance and high iron scale issue on wells in the (Name Hidden) Field especially. We diagnosed it is as a reaction of Anionic FR and poor organic kill on our treatment water. The results were really poor performances and high scale, needing to be remedied. (Vendor 2) offers a blended citric acid pump down remediation that was really popular for a few years, and they had a crew working nonstop for (Operator 2) and (Operator 3). I think the bloom has come off the rose a little, but they still have a nice business. We did a few jobs, think it worked, but was not permanent. A lot of companies for a while went to a high-performance FR instead of gel, and had great results with pressure and treating, but were unhappy with well results. Most likely from the downhole scale and pore clogging.

(Vendor 1) claimed that the chemicals they used were good, compatible, and that Iron scale would have come from our pipe. I believe it was formation reaction combined with the H2S we were creating by not doing a sufficient bug kill. Either way, the wells were not as good as they could have been.

Our last two pads we went to as little chemical as we needed and used a lot of breaker and acids at the tail of the stages to eliminate whatever we could. We can do that because our treatment pressures are not really high.

I have no doubt that your product removes the iron sulfite and scours free other skin damage as it mechanically frees up pores*.*

Not sure I believe it, but I heard one presenter at a frac conference claim that poor recoveries in semi permeable formations was attributable to frac chemical interactions downhole."

Conclusions

- Selection of fluid additives in hydraulic fracturing fluids play a significant role in the production rate and ultimate recovery of hydrocarbons from unconventional reservoirs.
- Repair methods can be costly when cleaning up damage from hydraulic stimulation.
- Formation damage is repaired using nanoActiv® nanoparticles that are able to penetrate the nanoscale pores.
- Chemical repair of formation damage may not be enough. Mechanical action through Brownian Motion of nanoActiv® nanoparticles provides the physical mechanism in addition to chemical treatment.

References

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