Nanoparticle Sealing Agent for Water-Based Fluids

BaraFLC® Nano-1

ADVANCED WELLBORE SEALANT

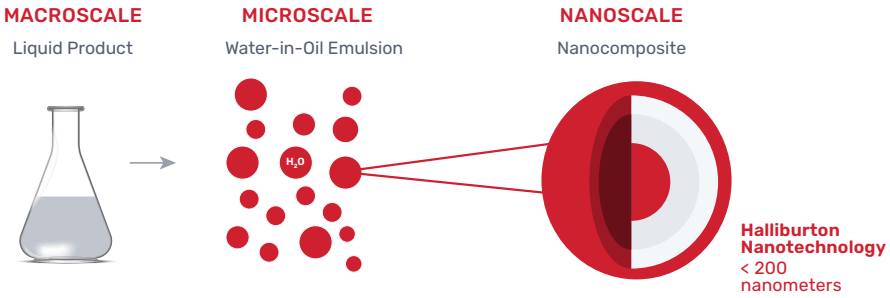
CHALLENGE

Most drilling applications intersect shale formations, which are prone to instability when drilled with water-based fluids (WBFs). Chemical inhibition only addresses the wellbore surface and drilled cuttings. Mechanical issues can occur within days as the filtrate slowly penetrates into the shale matrix, increasing pore pressure in the near wellbore. As time goes on, this pressure may buildup to the point where shale breakout or sloughing occurs. Deteriorating hole conditions like these often lead to high costs. Efficient sealing additives are needed to help WBFs block off microfractures and unsealed pores to prevent this transmission of pressure.

OVERVIEW

Halliburton Baroid's BaraFLC® Nano-1 wellbore sealant provides enhanced sealing capacity to WBFs to prevent pore pressure transmission and stabilize troublesome shales. It contains polymer-coated particles with an average size of 150 nanometers. These combine with conventional filtration control polymers and particulate solids to rapidly seal microfractures and pores in shales, shutting off pressure at the well face. WBF treated with BaraFLC Nano-1 can achieve particle plugging test (PPT) spurt loss results of less than 0.5-1.0 ml. High concentrations of traditional filtration control additives could achieve similar filtration results, but most combinations of starches and synthetic polymers would contribute excessive viscosity to the fluid. BaraFLC Nano-1 imparts tight filtration control with only minor effects on the fluid's rheological profile.

BaraFLC® Nano-1 wellbore sealant is a nanocomposite suspension that provides enhanced sealing capacity to water-based drilling fluids. The individual nanoparticles fill voids in formations and filter cakes.



FEATURES

Innovative Product Design

- Nanocomposite particles with water-soluble polymer coating
- Liquid dispersion eliminates dust hazards and bag waste

Filtration Control Performance

- Lower spurt loss and total filtrate than latex-treated WBF
- Reduces the amount of standard filtration control additives needed

Compatible with a Range of WBF Designs

- Freshwater to near-saturated brines
- Stable to 325-350°F

BENEFITS

Reduces Pore Pressure Transmission

- Independent laboratory testing showed a similar delay factor to NAF on reactive shales
- Drastic improvement to WBF performance

Improves Shale Stability

- Minimized fluid invasion protects the mechanical strength of the shale, extending the amount of trouble-free open hole time
- Enhances inhibitive WBF designs

Protects the Reservoir

- Forms a tight seal to prevent filtrate invasion into producing zones
- Reduces external filter cake
- Allows for high return permeability
- Removable with breaker systems

SOLUTION TESTING

Baroid's BaraFLC® Nano-1 sealant was tested versus a latex-based sealant for PPT filtration (see Figure 1). At a treatment level of 5 lb/bbl in a high-performance WBF (HPWBF), the nanocomposite solution provided much lower initial spurt and total filtrate than a 10.5 lb/bbl treatment with BaraSealTM W-1040 in the same fluid. The rheological properties were similar for both treated fluids. In two separate independent laboratories in USA, specialized pore pressure transmission tests were carried out on reactive shale samples from two different plays. Inhibitive HPWBF and non-aqueous drilling fluid systems were also tested for comparison. HPWBF containing BaraFLC Nano-1 achieved superior results for reducing pressure transmission, with performance nearly matching the NAF sample. Standard HPWBF formulations did not provide a significant reduction in pressure transmission rates (see Figure 2).

120°F	Base HPWBF	BaraSeal W-1040	BaraFLC Nano-1
Rheology	–	10.5 lb/bbl	5.0 lb/bbl
600	67	89	88
300	45	62	61
200	36	49	49
100	25	34	34
6	8	10	10
3	6	8	8
PV	22	27	27
YP	23	35	34
Gels	7/9	9/10	10/12

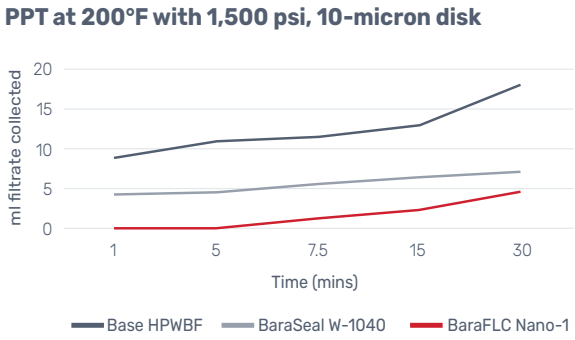


Figure 1: Test series using 10.4 lb/gal HYDRO-GUARD® fluids. Rheology measurements were made after hot rolling the samples overnight at 200 degrees F. The sample treated with BaraFLC® Nano-1 shows a significant reduction in spurt and PPT filtrate with only minor increases in the plastic viscosity and yield point. Formulation contained NaCl/KCl, 3 lb/bbl premium starch and 2 lb/bbl low-viscosity polyanionic celluslose for filtration control. Sized calcium carbonate was added at 15 lb/bbl to aid in bridging the disks.

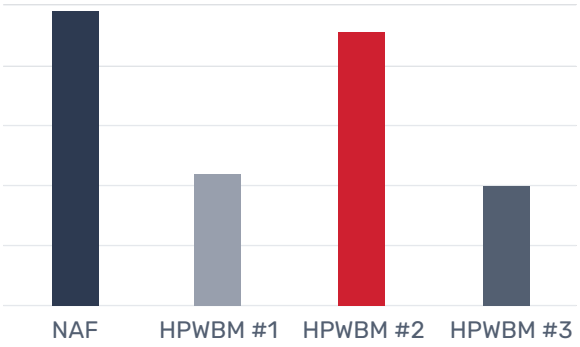


Figure 2: Pressure transmission testing results for several fluid types. Equipment measures the amount of overbalance pressure maintained over time when shale samples are exposed to pore fluid and then drilling fluids. The transmission rate is evident when plotting this pressure response curve over time. Fluids which seal off the shale effectively will provide a significant rate reduction.

Baroid supplied four drilling fluid samples to an independent laboratory for shale studies. Simulated pore fluid was used to saturate the shale core material, then drilling fluid was placed in contact with the shale. Overbalance pressure was applied and the downstream pressure was monitored to gauge penetration/transmission. The non-aqueous fluid (NAF) sample was made from mineral oil with a water phase salinity of 15% weight CaCl2. The HPWBF fluids all contained 5% by weight KCl, along with an encapsulating polymer and polyamine hydration suppressant. HPWBF #2 contained 10.5 lb/bbl BaraFLC Nano-1 while HPWBF #3 contained 2% volume glycol and a silicate inhibitor. HPWBF #2 achieved a similar reduction in pore pressure transmission to the NAF sample, with more than two times the delay factor of the competing HPWBF formulations.

For more information, contact your local Halliburton representative or visit us at www.halliburton.com