

GammaFRac™

Breakthrough slick water fluid for shale fracturing



When stimulating a shale reservoir you want:

- Effectiveness
- Compatibility
- Simplicity
- Safety in handling
- Safety for equipment
- Cost control
- Thermal stability
- Freeze protection
- Flow back efficiency
- Environmentally responsible

With Superior Well Services' GammaFRac™ you get all you want.

- Superior Friction Reduction **WFR-3B**
- Superior Iron Control **ICP-1000**
- Superior Scale Control **Super TSC**
- Superior Biocide **KR-153SL**
- Superior Synergies **Work better together**
- Superior Time Savings **Fast prep; fast acting**
- Superior Cost Savings **Requires less chemicals**



Why GammaFRac™?

Superior Well Services understands that water is one of the most important considerations when gas extraction strategies are first implemented in shale basins. Water reuse is crucial to solving both the economic and environmental issues facing major shale challenges.

Superior Well Services developed solutions to address these concerns by introducing the GammaFRac System. GammaFRac is effective in the well stimulation process for the major fields being developed throughout all shale basins.

Laboratory and proven field data demonstrates that the constituents of GammaFRac are individually effective, collectively compatible, and ideally suited for a wide range of operating conditions.

GammaFRac proprietary technology provides the following benefits:

- Minimal environmental impact
- Enables frac water reuse
- Brine tolerance
- Sulfate tolerance
- Effective with all types of frac waters
- High chemical efficiencies
- Rapid hydration with complete dissolution
- Enhanced frac flow back
- Patented leak-off control
- Thermal stability
- Formation compatibility
- Non-damaging



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WFR-3B™

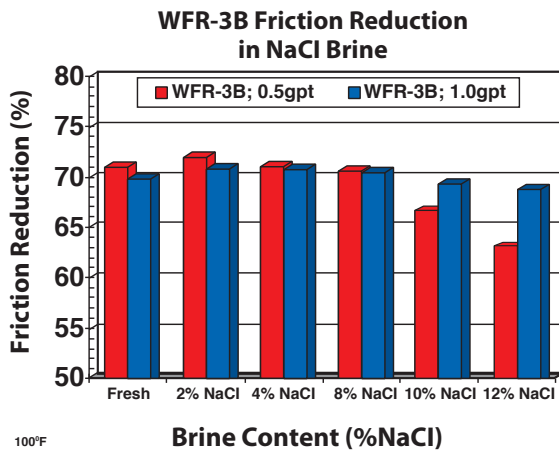
- High Friction Reduction (FR) Efficiency
- Brine Tolerant
- Sulfate Tolerant
- Excellent Leak-off Control Agent
- Maximize Fluid Efficiency Product
- Environmentally Safe

WFR-3B is a patented* innovative friction reducer designed to operate over a wide range of water, from fresh to highly saline. This technology is a polymer-microparticle composition formulated to optimize fracturing performance and maximize fluid efficiency. It is a multifunctional product, acting as a friction reducer and as an ultra-performance leak-off control additive.

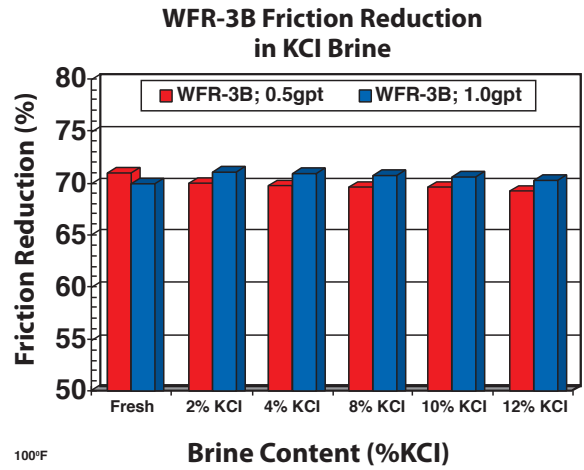
WFR-3B offers rapid hydration and yield for on-the-fly mixing. It reduces horsepower requirements and lowers friction pressure by 50% to 75%, and it improves fracture conductivity by eliminating residue. As a fluid-loss additive, WFR-3B works to control the leak-off process and avoid potential reservoir damage.

If higher concentrations of WFR-3B are needed to build viscosity to help carry sand, such as during a net pressure increase or during a planned "sweep", Breaker FR™, an innovative catalytic FR breaker, can be used to reduce viscosity and provide a residue-free cleanup.

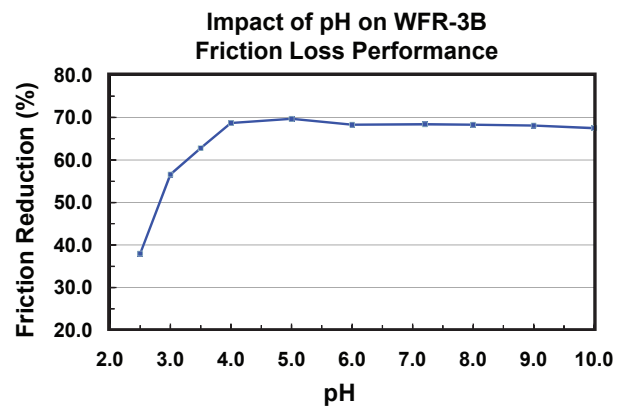
Friction reduction tests show that WFR-3B is an outstanding friction-reduction agent in fresh and brine solutions and is also highly stable in high sulfate waters.



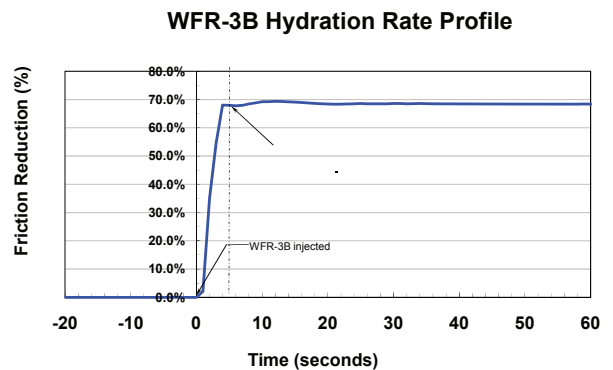
*U.S. Patent Number 07482310



WFR-3B is not impacted by pH levels above 3.5



WFR-3B is noted for rapid hydration rate and yield



WFR-3B, at application dosages, is environmentally acceptable: 4.5% of LC₅₀ of C. dubia and P. promelas

WFR-3B is compatible with a variety of clay controls, foamers, surfactants, non-emulsifiers, scale inhibitors, fluid-loss agents, and proppants.

ICP-1000™

- Innovative Iron-Control Agent
- Enhances Friction Reduction (FR)
- Environmentally Safe
- Highly Effective Chemical
- Negligible Effects on Frac Fluid pH
- Easy to Apply



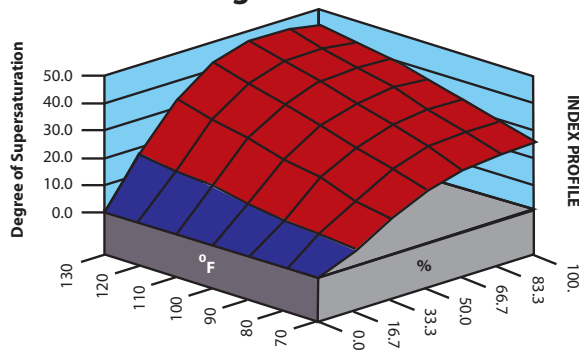
ICP-1000 is an innovative iron-control agent that chemically maintains the iron in formation fluids in the reduced-valence state and prevents precipitation of iron compounds. The iron-control polymer inhibits the iron from converting to insoluble particulates that can damage fracture conductivity and reduce the production potential of the formation.

The unique characteristic of this product is its capability to provide iron control at low chemical loading without the adverse side effect of reducing friction performance and system pH, an effect typically found in iron-control agents. This innovative chemical additive works synergistically with the scale-control additive to (1) prevent precipitation of difficult post-frac geochemical species such as siderite (which can form in hydraulic fractures) and (2) enhance FR chemistry performance.

Conventional iron-reducing and chelating agents consist of acidic chemicals such as citric acid, acetic acid, and EDTA (ethylenediaminetetraacetic acid) to keep the iron in formation in a soluble or reduced form (ferrous iron). These methods of iron control perform inconsistently, particularly when the formation tries to neutralize the acid and its capability to control iron and other metals. The acid approach also reduces the frac fluid pH and significantly affects FR and chemical performance.

ICP-1000 is added in proportion to the total iron in the water analysis as part of the GammaFRac design process. It does not affect the frac fluid pH because of its low effective addition rate.

FeCO₃ Saturation Level



Can be effectively controlled by ICP-1000

Extensive laboratory testing shows that ICP-1000 enhances the performance of anionic FR products.

Super TSC™

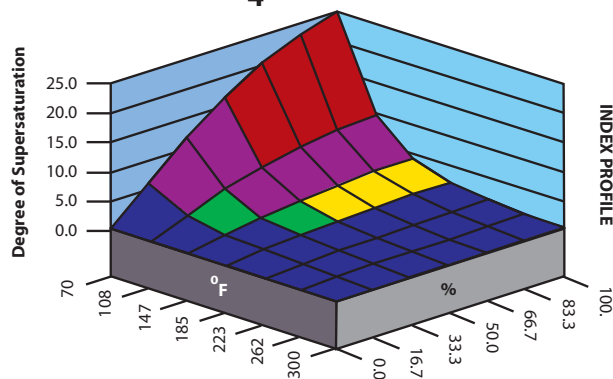
- Superior Scale Control Agent
- Environmentally Safe
- Highly Effective Chemical
- Easy to Apply

Super TSC simultaneously protects against three types of scale or precipitate. These include carbonate, sulfate, and iron-based scale depositions such as siderite as found in many shale completions. The frac water picks up significant levels of ions from the formation which have the potential to cause production impairment.

Recognition of this unique geochemical phenomenon led to the introduction of Super TSC. Unprotected, this unique geochemical environment can lead to geochemical precipitates within the created fracture network and potential scale to accumulate in perforations, piping, and surface equipment.

Super TSC has been engineered to address all scale situations predicted during post-frac flow back. It conforms to National Pollutant Discharge Elimination System (NPDES) standards and extensive laboratory testing has determined that Super TSC passes all aquatic toxicity standards with an LC₅₀ of less than 1% at its effective feed rates.

BaSO₄ Saturation Level



Can be effectively controlled by Super TSC

Superior Well Services can provide a Langelier Saturation Index (LSI) Calculator to determine the appropriate feed rate for Super TSC to prevent calcium carbonate scaling in the formation. LSI calculations predict the possibility of forming a calcium carbonate scale. Calcium, pH, total alkalinity, TDS, and temperature are factored into this equation. Contact Superior for more information.

KR-153SL™

- Broad Spectrum Microbiological Control
- Effective Quick Kill Biocide
- Rapid Decomposition to Innocuous By-Products
- Excellent Sulfate Reducing Bacteria Control
- Highly Effective Chemical
- Easy to Apply

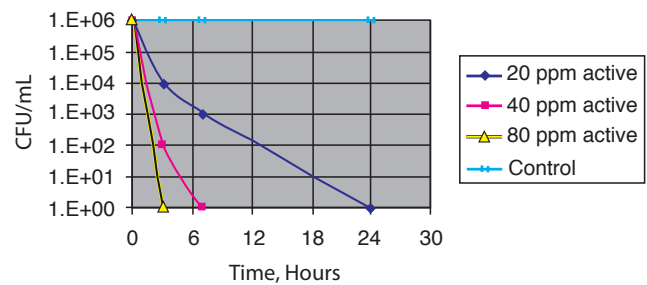
Superior Well Services uses KR-153SL (20% DBNPA) as the effective quick kill biocide in GammaFRac™. KR-153SL is very effective for controlling a broad spectrum of microorganisms. Twenty percent (20%) DBNPA is an industry standard used throughout the USA with no negative impact cited. Extensive laboratory testing shows that KR-153SL is fully compatible with the other components in GammaFRac™.

Sulfate-reducing bacteria (SRB) are anaerobic microorganisms often found under slime and other deposits. SRBs flourish where the oxygen content is low. These organisms are responsible for equipment corrosion and hydrogen sulfide (H₂S) reservoir “souring” problems.

Environmental fate studies show that KR-153SL undergoes hydrolytic, photolytic, chemical, and microbial activity for rapid decomposition to innocuous by-products. The breakdown constituent pathway does not lead to THM (chloroform) compounds, a major environmental concern with some popular biocides.

Experiments were performed in a system that contained high levels of the SRB *Desulfovibrio desulfuricans* to test the effectiveness of KR-153SL water treatment. The bacteria were exposed to the microbiocide for periods of 3, 7, and 24 hours. The graph below illustrates KR-153SL’s outstanding capability to reduce the level of SRBs present in the solutions at all contact times tested.

KR-153SL Efficacy vs. Sulfate-Reducing Bacteria



GammaFRac™ Component Traits

Trait	Product	WFR-3B	ICP-1000	Super TSC	KR-153SL
Tolerant					
Anion tolerant		✓	✓	✓	✓
Brine tolerant		✓	✓	✓	✓
pH tolerant		✓	✓	✓	✓
Environmental Acceptability					
EDC Accepted		✓	✓	✓	✓
Aquatic toxicity (less than 5% LC ₅₀)		✓	✓	✓	✓
Flow back reusable		✓	✓	✓	✓
Stable					
Thermal stability effectiveness to >300°F		✓	✓	✓	✓
Freeze protected to minus 20°F		✓	✓	✓	✓
Easy to Use					
No premixing or pre-gelling necessary		✓	✓	✓	✓
Liquid pump and metering dispenser		✓	✓	✓	✓
Mixes instantly with water		✓	✓	✓	✓
Fully functional in less than 10 seconds		✓	✓	✓	✓
Concentrations of 1/10 to 5 gallons per thousand		✓	✓	✓	✓
Safe to handle		✓	✓	✓	✓
Safe for equipment		✓	✓	✓	✓