

REMEDICATION

NORM TREATMENT & PREVENTION

Shotwell's NORM Remediation Program

NORM radiation can be found in three areas of oilfield storage and production. It is embedded in surfaces of tanks, pipes, and equipment, as well as in tank bottom sludge and scale deposits (typically barium and strontium sulfate). Solutions are tailored to each area of contamination.

In order to prevent recontamination, Shotwell offers a preventative maintenance program.

INTRODUCING SHOTWELL'S NORM REMEDIATION PROGRAM

NORM (Naturally Occurring Radioactive Materials) are radioactive elements found in the environment, such as uranium, thorium, and potassium, as well as their decay products, such as radium and radon.

It is present in very low concentrations in the earth's crust but are brought to the surface as a result of activities such as oil and gas exploration or mining. The NORM becomes embedded in BS&W and on surfaces such as tanks, piping, equipment, etc. At a certain level, the substance emits radiation high enough to have to be disposed of through a hazardous waste disposal facility.

SHRR-9500

SHRR-9500 is a liquid product that removes embedded NORM contamination from metal surfaces including tanks, piping, and equipment. It is a surface contact process so the surface to be decontaminated must be in contact with the product, whether by filling the material or via submerging it into a solution of the SHRR-9500. Contact duration is dependent on starting and desired ending levels. Additionally, the solution can be mixed with production oil for disposal.

SHPA-9850

SHPA-9850 is for asphaltene-based sludges. It is designed specifically for reliquefying or remediating petroleum (hydrocarbon) based sludges, sediment, and solids. The hydrocarbon chains are reliquefied, the viscosity reduced by 80% or more, and the API gravity increased. Typically, more than 95% of the available hydrocarbons are recovered without harm to the oil.

SHPD-3685

SHPD-3685 is for paraffin-based sludges. It is designed specifically for reliquefying or remediating petroleum (hydrocarbon) based sludges, sediment, and solids. The hydrocarbon chains are reliquefied, the viscosity reduced by 80% or more and the API gravity increased. Typically, more than 95% of the available hydrocarbons are recovered without harm to the oil.

SHGA-9400

SHGA-9400 is a high-performance NORM descaler designed to efficiently remove sulfate scale with the unique ability to dissolve extremely high amounts of barium sulfate. SHGA-9400 has additional chemistry that reduces the size of the sulfate particles and limits reprecipitation out of solution. Sulfate scale causes formation damage, which reduces production, hosts bacteria, fouls piping, tanks and process equipment, all greatly reducing the profitability of operations.

PRODUCT HIGHLIGHTS

SHRR-9500

NORM REMEDIATION

SHRR-9500 is a patent-pending technology that is designed to address NORM contaminated solids, solutions, and surfaces. SHRR-9500 combines a unique blend of surface-active compounds with several proprietary chemistries that are derived from an environmental waste stream.

SHRR-9500 is a contact-type product. In other words, for remediation to take place, it must contact the NORM contaminated surface, solid or solution. For treating BS&W or similar solids, mix a sufficient quantity of the product into the solids, mixing well to insure proper and complete contact (please note, a carrier such as produced oil, diesel, etc. may be needed). Allow to sit 24-48 hours depending on starting concentration. For contaminated surfaces, either submerge or fill surface in the product and allow to sit for 24-48 hours. The timeline depends on starting and desired ending NORM concentration desired.

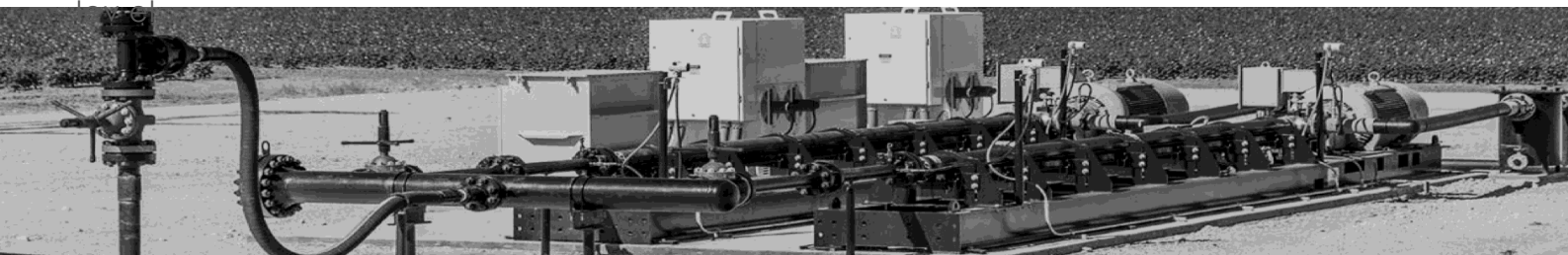
A preventative maintenance program can also be implemented with SHRR-9500. The product can also be fed continuously at low dosage to prevent re-adsorption into various metal surfaces as a secondary option.

PRODUCT BENEFITS AND FEATURES

- Easy-to-Feed liquid
- Effective on Surfaces & Sludge (BS&W)
- Eliminates hazardous waste disposal
- 100% compatible with produced oil
- Can be used in conjunction with sludge solubilization products
- Effective in remediating "soaked-in" surfaces such as tanks, piping, equipment, etc.

Tank Size	Sludge Depth	mRad 6"	mRad 12"	mRad 18"	mRad 24"	mRad 36"	mRad 48"
400 bbl.	14"	450	390	180	60	10	2
1000 bbl.	8"	5100	3300	800	120	6	6

*After an 18-hour soak, post testing revealed all levels below the targeted 8 mRad



PRODUCT HIGHLIGHTS.

SHPA-9850 AND SHPD-3685

ASPHALTENE-BASED AND PARAFFIN-BASED SLUDGES

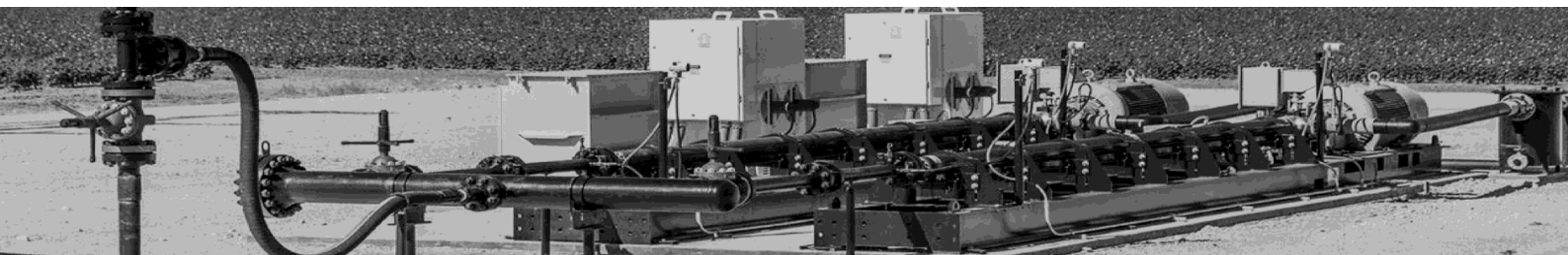
SHPA-9850 and SHPD-3685 combine a unique blend of surface-active compounds with several proprietary solubilization chemistries. Additionally, micro-surfactants provide penetration into even severely dehydrated deposits, allowing the solubilization chemistries to function quicker. Now deposits across a vast spectrum, even with minimal flow or agitation, can be addressed.

SHPA-9850 is for asphaltene-based sludges, whereas SHPD-3685 is for paraffin-based sludges. Both products are designed specifically for reliequifying or remediating petroleum (hydrocarbon) based sludges, sediment, and solids. The hydrocarbon chains are reliequified, the viscosity reduced by 80% or more, and the API gravity increased. Typically, more than 95% of the available hydrocarbons are recovered without harm to the oil.

For treating tank bottoms, it is recommended that 1-5% plus 1-4% carrier based on volume of crude/sludge should be spotted on the bottom to soak for 24-72hrs., depending on sludge depth. If possible, thin the tank solution thoroughly mixed by rolling the tank or using external circulation. Heating of the tank is not necessary, although helpful.

PRODUCT BENEFITS AND FEATURES

- Increased oil & gas production
- Does not require removal prior to refining
- Does not require heating
- Reduces pumping fees
- Reduces oil viscosity
- Provides demulsification
- Rapid clean-up
- Reduces under deposit corrosion
- Prevents redeposition



PRODUCT HIGHLIGHTS

SHGA-9400

SULFATE SCALE DISSOLVER

SHGA-9400 is a high-performance NORM descaler designed to efficiently remove sulfate scale with the unique ability to dissolve extremely high amounts of barium sulfate. SHGA-9400 has additional chemistry that reduces the size of the sulfate particles and limits reprecipitation out of solution. Sulfate scale causes formation damage which reduces production, hosts bacteria, fouls piping, tanks and process equipment, all greatly reducing the profitability of operations.

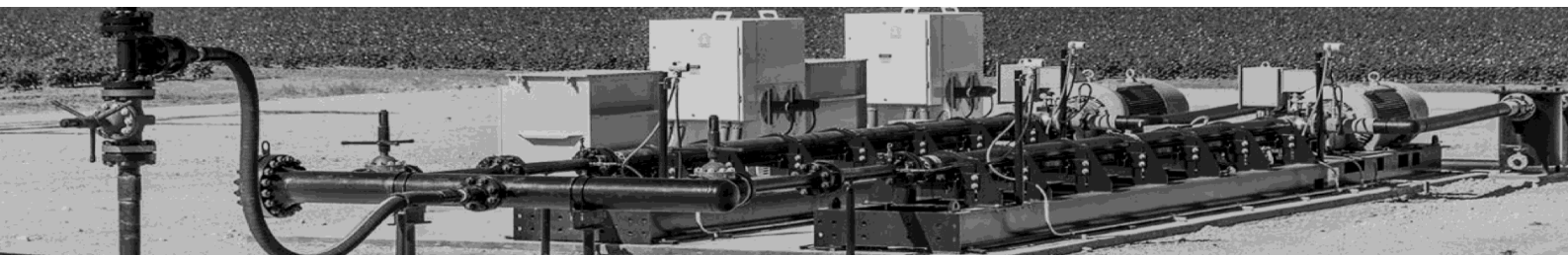
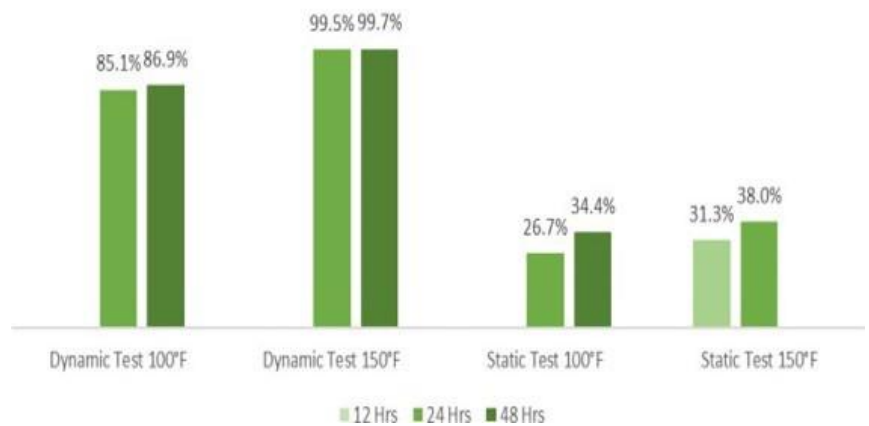
PRODUCT BENEFITS AND FEATURES

- Superior barium sulfate solubility
- High dissolution rate vs competition
- Lower pH than competitor products
- Reduces size of scale particles in solution
- Limits reprecipitation of scale
- Low activation temperature
- Dissolves strontium, barium, and calcium sulfate scale
- Concentrated options available

SOLUBILITY

- **BaSO₄**: 0.34 lb./gal, 41 kg/m³
- **SrSO₄**: 0.48 lb./gal, 57 kg/m³
- **CaSO₄**: 0.54 lb./gal, 65 kg/m³

Barium Sulfate % Weight Loss in SHGA-9400



PREVENTATIVE MAINTENANCE PROGRAM

SHSI-2718 AND SHSI-2786

Sulfate and Carbonate Scale Inhibitor

Shotwell's multi-purpose mineral scale inhibitors are water-based solutions of high temperature stable catalyzed copolymers. These products have found utility as an environmentally friendly and biodegradable replacement for phosphonates, phosphate esters and other polycarboxylates such as polyacrylates, polymaleates, their copolymers and terpolymers. Shotwell's copolymer products can be used alone or incorporated as ingredients in formulations used in oil and gas production where downhole temperatures routinely reach 120°C and above.

Shotwell's copolymers are unique. Unlike other polymeric scale inhibitors, they incorporate an amide unit in the backbone like nylon and most proteins. This unusual structure plays a critical role in allowing the backbone of the copolymer to easily adsorb onto and attach to crystalline surfaces and edges.

Shotwell's copolymer products were specifically designed to stop and prevent the formation of mineral precipitates and scales. The copolymer's amide backbone is geared toward preventing the surfaces of nucleate crystals from growing through a process known as nucleate threshold inhibition. They adsorb onto nucleate crystal surfaces by attachment of the amide unit, distorting their surfaces, preventing them from adhering to each other or to other surfaces.

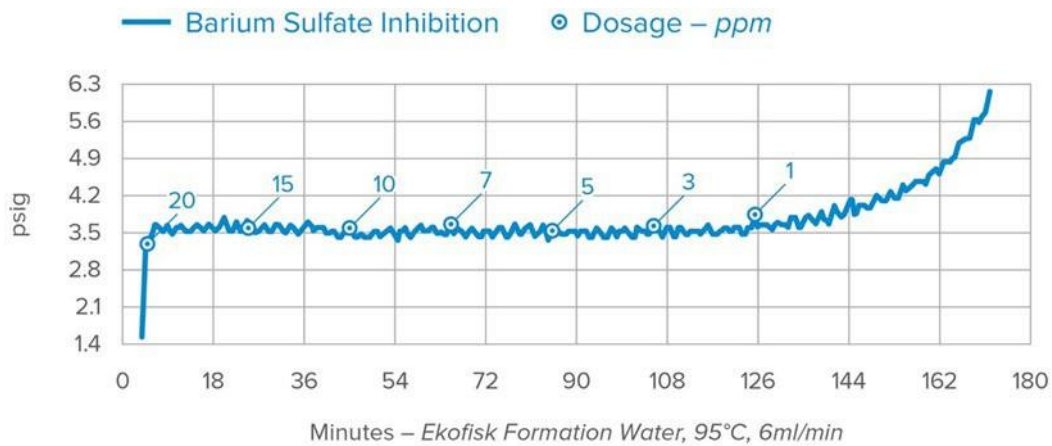
PRODUCT BENEFITS AND FEATURES

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|---|--|
| • Outstanding sulfate and carbonate inhibition. | • Best-in-class mineral scale inhibitor. |
| • Strong surface adsorption, superior dispersant. | • Easy to use polymer product is readily biodegradable (OECD 306). |
| • Phosphate free. | • Eco-friendly, non-toxic, non-hazardous. |
| • Polycarboxylate | • Stable to over 120°C (248°F). |
| • Calcium compatibility at pH 3. | |

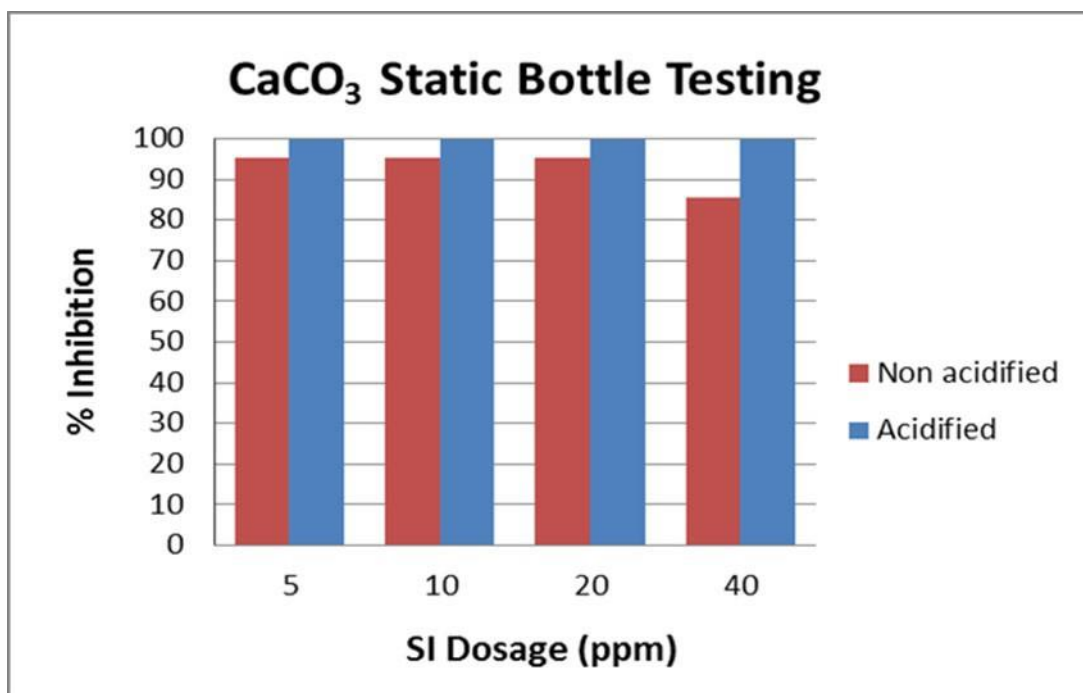
PREVENTATIVE MAINTENANCE PROGRAM

PERFORMANCE AND RESULTS

The ability of Shotwell's copolymer products to prevent and control various mineral scales including calcium carbonate, calcium sulfate, barium sulfate, strontium sulfate, iron-based scales and calcium oxalate is well known. In this DSL example for barium sulfate, the copolymer product MIC is determined from the stair-step reduction in product dosage.



Demonstrating good performance in formulated products, where both low and/or high pH requirements exist, a static bottle test for calcium carbonate shows minimum Shotwell copolymer product (SI) dosages.



CONTACT US



LEADING-EDGE FACILITY

- ▶ Fully Automated
- ▶ ISO9001:2015 certified
- ▶ NSF certified



LOCATION

- ▶ Heart of Permian Basin
- ▶ 35,000 square feet
- ▶ Midland, Texas

CONTACT US FOR MORE INFORMATION AT
SALESSUPPORT@SHOTWELLHYDROGENICS.COM
WWW.SHOTWELLHYDROGENICS.COM



QUALITY

- ▶ Blend capability up to 57.6M gallons/year
- ▶ Stringent Quality Control and Quality Assurance Standards



SERVICE

- ▶ Reliable technical and lab support
- ▶ Transport Bulk and Non-Bulk containers to field