Sulfur Compound Sampling, Storage, and Transfer using SilcoNert® 2000, The Ultimate Inert Coating

- **Accurate sulfur & H_2S sampling**
- **Faster cycle times**
- **Improve process yields, detect ppb levels of H_2S**
- **Improve productivity**
- **Achieve low parts per billion sulfur & H_2S sampling**

SilcoNert 2000 coating eliminates surface adsorption of active compounds like hydrogen sulfide (H_2S), methyl mercaptan or other sulfur containing compounds.

Accurate analysis of part-per-million and part-per-billion levels of sulfur containing compounds like H_2S and methyl mercaptan in petrochemical streams and down hole samplers are critical to meeting new regulations for low level sulfur. Many organo-sulfur compounds, like hydrogen sulfide (H_2S), methyl mercaptan, and ethyl mercaptan, adsorb to metal surfaces.

SilcoNert® 2000

Accurate sulfur sampling every time

* ***Detect costly process upsets*** in a fraction of the time

* ***Prevent catalyst contamination*** by eliminating reactor wall effects

* ***Assure regulatory compliance***
  - Rule 1118
  - Ultra-low sulfur diesel and gasoline standards

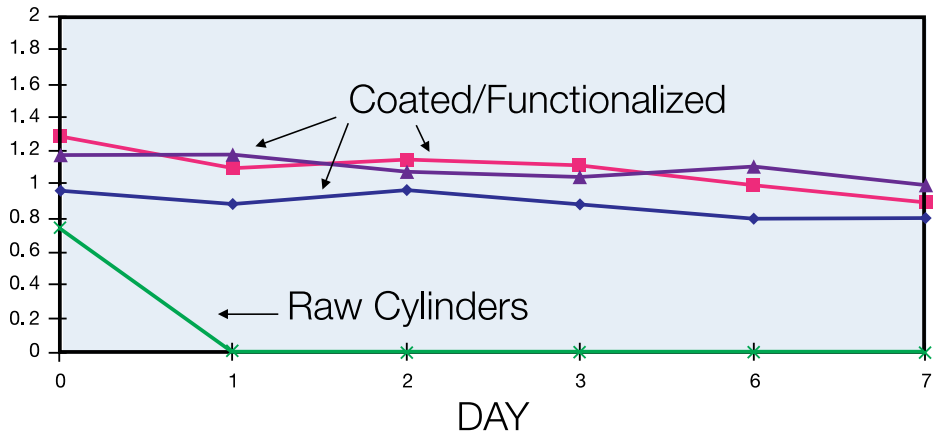

Figure 1: Sulfur compounds are stable in SilcoNert 2000 treated stainless steel systems- 17ppbv hydrogen sulfide in 500ml cylinders[1].

Ensure accurate feedstock or process sampling of sulfur, hydrogen sulfide (H_2S), methyl mercaptan or other sulfur containing compounds the first time, every time with SilcoNert 2000.

Figure 1 depicts performance results from a comparison of sample cylinders (typically used in refinery or down hole sampling) in which a gas containing 17 parts-per-billion (ppbv) hydrogen sulfide (H_2S) was stored for 7 days in untreated and SilcoNert 2000 treated stainless steel high pressure sample cylinders. The SilcoNert 2000 treated sample cylinder demonstrated superior sulfur/H_2S inertness and will reliably store low levels of active sulfur compounds for long periods of time. In contrast, H_2S degraded rapidly in the untreated cylinder, and was totally adsorbed within 24 hours.

SilcoTek®

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Lit Cat # SN-010

SilcoNert 2000 is a proprietary (U.S. Patent #6,444,326), silicon, chemical vapor-deposited (CVD) coating, specifically designed to improve the sulfur inertness and chemical inertness of steel, stainless steel, alloys, glass, and ceramics. The unique non line-of-site CVD process produces a flexible, high temperature capable, amorphous silicon layer that diffuses into the metal lattice. The coating will conform to the most intricate surfaces while maintaining high dimensional tolerances. SilcoNert 2000 will deform with tubing surfaces allowing for radius bends and will not interfere with threaded or compression joints; making SilcoNert 2000 the ideal coating for process sampling, refinery gas sampling, and down hole sampling applications.

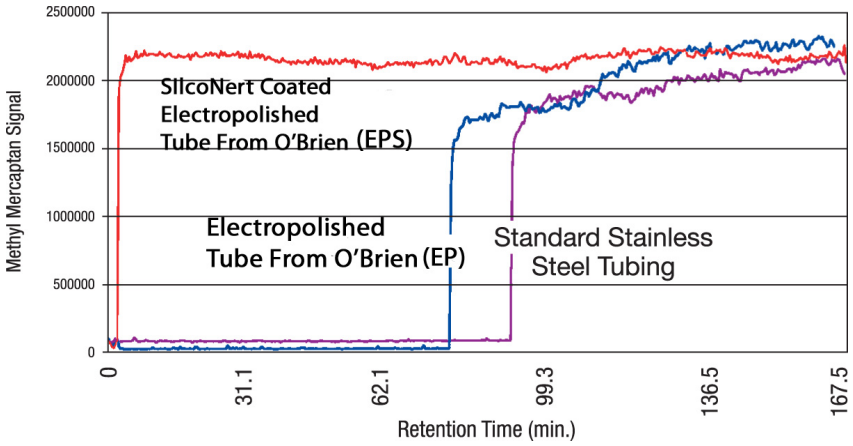
SilcoNert 2000 is an inert, chemically protective barrier of amorphous silicon material inter-diffused with the host substrate resulting in a 100-250 nm coating. The surface is further passivated with covalently bonded hydrocarbon molecules (as described in US Patent #6,444,326) as verified by an average surface contact angle value greater than 75° using deionized water on a process control coupon or GC inlet liner.

Sample Transfer: Adsorption of Hydrogen Sulfide (H_2S) and Other Sulfur Compounds to Tubing Surfaces

Figures 2 and 3 compare the sulfur transport properties of 100 foot (30.5 meter) lengths of SilcoNert 2000 treated, electropolished, and raw commercial grade 1/8in OD x 0.020" wall stainless steel tubing. Figure 2 demonstrates uptake of 500 ppmv methyl mercaptan sulfur compound by the 3 tube surfaces.

The SilcoNert 2000 treated electropolished tubing did not adsorb the methyl mercaptan to any measurable extent, delivering a representative sample with no delay. The untreated electropolished tubing totally adsorbed methyl mercaptan for more than 75 minutes, the sulfur gas level did not stabilize until 130 minutes. Conventional 316L seamless tubing totally adsorbed methyl mercaptan for more than 90 minutes; the sulfur gas level did not stabilize until 140 minutes.

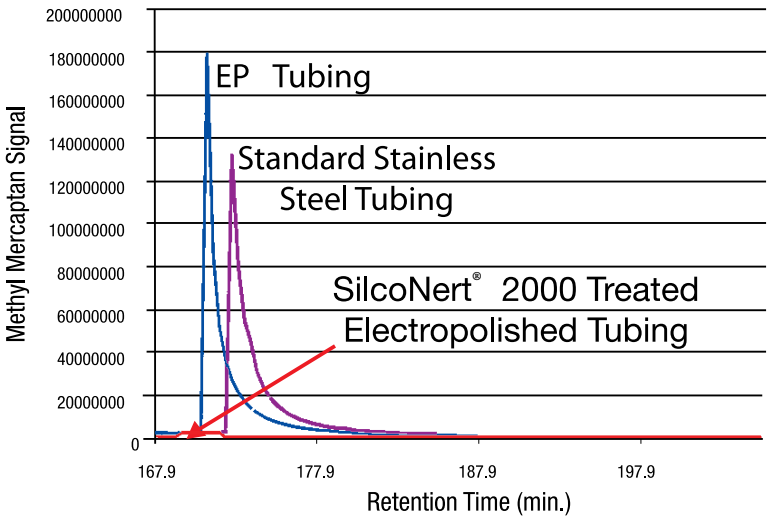
Figure 2: SilcoNert 2000 treated tubing does not adsorb methyl mercaptan (500ppbv) compared to electropolished and standard stainless steel tubing. (Data courtesy of Shell Corp. and O'Brien Corp.)[2]



SilcoNert 2000 eliminates memory effects in Sulfur Analysis

When adsorption of sulfur-containing compounds is prolonged, desorption from the surface can slowly cause disruptive false readings in process, refining and down-hole sampling applications. This "memory" of adsorbed sulfur compounds can cause long delays in equilibrating a sample stream. Figure 3 demonstrates the memory effects of the three types of tubing used to transfer streams containing sulfur compounds. The SilcoNert 2000 treated tubing shows less retention of sulfur compounds by several orders of magnitude, indicating very high sulfur inertness. SilcoNert 2000 treated sample pathways can eliminate costly refinery product losses due to false or delayed readings.

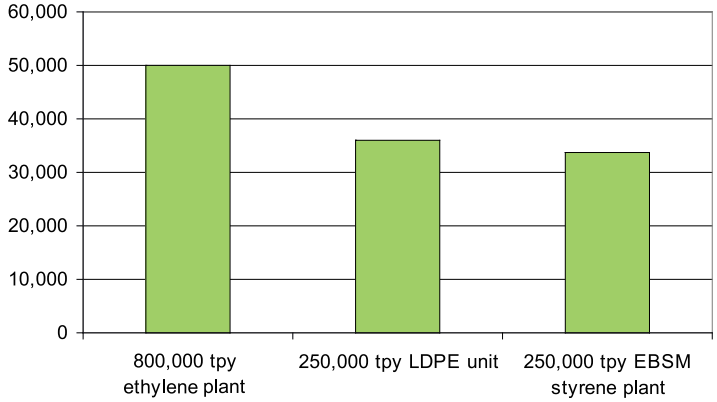
Figure 3: SilcoNert 2000 treated electropolished tubing shows no memory effects. Sulfur memory is prolonged in raw commercial grade stainless steel tubing. (500ppmv methyl mercaptan in helium). (Data courtesy of Shell Corp. and O'Brien Corp.)[2]



Value of an Inert Pathway

SilcoNert 2000 treated sampling and transfer equipment results in more accurate sampling and faster cycle times. Shorter sampling cycles translate directly into more samples collected and analyzed in a given period of time. Process upsets can be detected faster while false readings can be eliminated. Typical savings can be calculated by looking at average per-hour cost of operating a process that relies on accurate quantification of sulfur compounds. A 1 hour delay in operations can cost an 800,000 tpy ethylene plant $50,000. A 250,000 tpy LDPE unit will cost operations $36,000 for a 1 hour upset while an EBSM styrene plant will cost $33,000 (See Figure 4).

Figure 4: Estimates losses resulting from 1 hour delay in operations due to sulfur adsorption in sample and transfer systems.



Direct Line Partners

Interested in sourcing products that have benefited from SilcoTek coating? The following list of partners and OEM's supply SilcoTek coated products.

Fittings, Valves, Regulators and Sample Cylinders:

Swagelok Company www.swagelok.com
For SilcoNert 2000 (Siltek®/Sulfinert®) treated fittings, ask your local Swagelok distributor to add the following suffix to your part number: Fittings: add -JA Valves and sample cylinders: add -12457

Concoa www.concoa.com
Ask your Concoa representative for SilcoNert 2000 (Siltek®/Sulfinert®) treated regulators.

Emerson/Tescom www.tescom.com
Ask your Emerson/Tescom representative for SilcoNert 2000 (Siltek®/Sulfinert®) treated regulators.

Parker www.parker.com
Ask your Parker distributor for SilcoNert 2000 (Siltek®/Sulfinert®) treated fittings and valves.

Tubing and Heat Trace Tubing:

O'Brien Corporation www.obrien-analytical.com
Ask your O'Brien representative for EPS tubing

Thermon-The Heat Tracing Specialists® www.thermon.com
Ask your Thermon representative for SilcoNert 2000 (Sulfinert®) treated tubing.

Constant Pressure Sampling Cylinders:

Welker Engineering www.welkereng.com
Sampling natural gas streams or other pressure sensitive chemicals? Welker Engineering offers SilcoNert treated sample systems to insure complete inertness.

Chromatography Products:

Restek® Corporation www.restek.com
Find everything you need for your laboratory or life sciences application.

Summary

SilcoNert 2000 treated sampling and transfer systems allow oil and gas exploration, chemical, petrochemical and refineries to obtain accurate sulfur data the first time, every time with no delay, sample errors, or false readings. Analysts charged with monitoring sulfur levels in process streams can save thousands in improved yields, better test cycle times and improved system reliability. To learn more or to get a quotation for sending your parts to SilcoTek for coating services, visit our web site at www.SilcoTek.com or call us at 814-353-1778.

1. D. Smith, D. Shelow, G. Barone; "Instrument and Sampling Equipment Passivation Requirements to Meet Current Demands for Low-Level Sulfur Analysis"; Presented at Gulf Coast Conference, 2001; Restek Corporation, Bellefonte, PA 16823.
2. Application of TrueTube(tm) in Analytical Measurement Cardinal UHP, August 2004. The authors thank the staff at Shell Research and Technology Centre, Amsterdam, for data used in evaluating sulfur gas uptake and memory effects of tubing substrates.

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