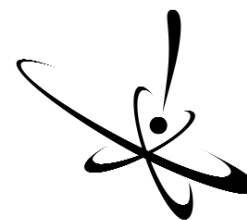


# Superior Storage and Transfer of Sulfur Compounds

## Sulfinert® Treated Systems Preserve ppb Levels of Active Compounds

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Restek  
Performance  
Coatings

- Improve analytical accuracy and reduce system cycle times, using Sulfinert® treated products.
- Increase analytical confidence for low parts-per-billion sulfur compounds, using Sulfinert® treated sample cylinders.
- Transfer sulfurs in gas streams, without loss, using Sulfinert® treated electropolished tubing.



Accurate analyses for parts-per-million to parts-per-billion levels of organosulfur compounds in petrochemical streams are critical to meeting new regulations for lower levels of sulfur in diesel fuel and gasoline. Many sulfur compounds, including hydrogen sulfide, methyl mercaptan, and ethyl mercaptan,

adsorb strongly to metal surfaces in sampling, storage, and transfer apparatus. In addition to causing inaccurate, falsely low values, adsorption can prolong analysis cycle times. To determine quantitative losses of active sulfur species, we sampled, stored, and transferred low ppmv to low ppbv concentrations of active sulfur gases, using control (untreated) and Sulfinert® treated system components.

### Preventing Sulfur Compound Losses During Storage

Figure 1a depicts results from a comparison in which a gas containing 17ppbv of hydrogen sulfide was stored for 7 days in untreated or in Sulfinert® treated stainless steel sample cylinders. The response ratio for hydrogen sulfide, relative to a stable reference material, dimethyl sulfide, is steady at approximately 1:1 for at least seven days in Sulfinert® treated cylinders. The data show a Sulfinert® treated system will reliably store ppb levels of the active sulfur-containing compound during transport from the sampling site to the analytical laboratory. In contrast, hydrogen sulfide degraded rapidly in the untreated cylinder, and was lost totally within 24 hours.

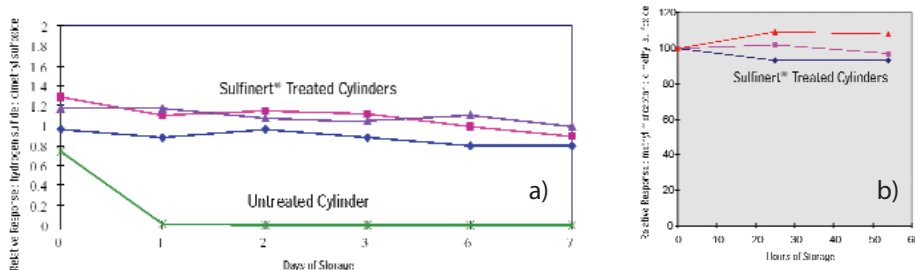
In a similar study in which gas containing 18.8ppbv methyl mercaptan was stored for 60 hours in Sulfinert® treated sample cylinders,

recovery of the active sulfur compound was equally high relative to the stable reference material, dimethyl mercaptan, as shown in Figure 1b.

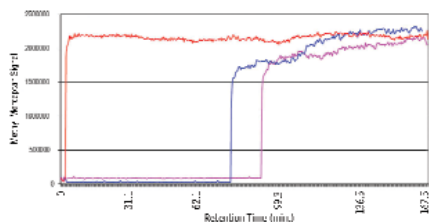
### Sample Transfer: Adsorption of Sulfur Compounds to Tubing

Comparison of Sulfinert® treated electropolished stainless steel tubing (TrueTube™ EPS tubing, surface roughness average (RA): 5-10, O'Brien Corporation, St. Louis, MO), untreated electropolished stainless steel tubing (TrueTube™ EP tubing, RA 5-10, O'Brien Corporation), and raw commercial grade stainless steel tubing (RA 23-27) showed only the Sulfinert® treated electropolished tubing has the inertness necessary for quantitatively transferring low ppmv to low ppbv concentrations of sulfur compounds. Figures 2 and 3 depict the results (seamless 316L stainless steel, 1/8" OD, 0.020" wall). Tests were performed at room temperature, using a gas flow rate of 40cc/minute.

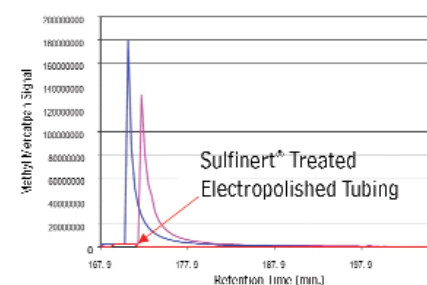
**Figure 1** Sulfur compounds are stable in Sulfinert® treated stainless steel systems  
a) 17ppbv hydrogen sulfide in 500mL cylinders  
b) 18.8ppbv methyl mercaptan in 300mL cylinders



**Figure 2** Sulfinert® treated electropolished seamless stainless steel tubing (red) does not adsorb methyl mercaptan (500ppbv). Blue-untreated electropolished tubing; violet-raw tubing.



**Figure 3** Sulfur memory is prolonged in raw commercial grade stainless steel tubing (violet). Red-Sulfinert® treated electropolished tubing; blue-untreated electropolished tubing. (500ppbv methyl mercaptan in helium)



To confirm whether an active sulfur-containing compound in a gas stream passing through 100-foot (30.5-meter) lengths of tubing would adsorb to active sites on the tubing surface, we measured the amount of time elapsed before values for the sulfur content exiting the tubing were stable and accurate, using helium containing 0.500ppmv methyl mercaptan. Figure 2 shows Sulfinert® treated electropolished tubing did not adsorb methyl mercaptan to any measurable extent, delivering a representative sample with no delay. Untreated electropolished tubing, in contrast, totally adsorbed methyl mercaptan for more than 75 minutes, and the sulfur gas level did not stabilize until approximately 130 minutes. Conventional 316L seamless tubing totally adsorbed methyl mercaptan for more than 90 minutes, and the sulfur gas level did not stabilize until approximately 140 minutes.

When adsorption of sulfur-containing compounds is prolonged, desorption from the surface also is slow. This "memory" of adsorbed compounds can cause long delays in equilibrating a sample stream. In Figure 3, Sulfinert® treated tubing shows the lowest retention of sulfur compounds, by several orders of magnitude. Samples can be evaluated, with accurate results, with no delay between them.

Reference  
1. Application of TrueTube™ in Analytical Measurement  
Cardinal UHP August 2004  
Available at [www.restekcoatings.com](http://www.restekcoatings.com) or by contacting us at 800-356-1688, ext. 4. Request lit. cat.# 59088.

Economic Value of an Inert Pathway  
Sulfinert® treated sampling and transfer systems offer more accurate results and faster cycle times. Improved accuracy and reliability of data for sulfur compounds allow improvements in downstream process control, with associated cost savings. Shorter cycles translate directly into more samples collected and analyzed in a given period of time. Savings accrued from shorter cycles can be calculated by looking at typical per-hour costs of operating processes that rely on accurate quantification of sulfur compounds: a one-hour delay in an 800,000 tons-per-year ethylene plant can cost \$50,000; a 250,000 tons-per-year EBSM styrene plant stands to lose \$33,000/hour; even for a

200,000 tons-per-year anti-freeze grade production process, the loss can be \$3,600/hour.<sup>1</sup>

In these studies, we obtained accurate data, with no delay between samples, by using Sulfinert® treated electropolished tubing in the sampling-storage-transport system. In contrast, we obtained significantly less accurate data, even with delays of more than two hours between samples, by using untreated tubing. Analysts charged with monitoring sulfur levels in process streams can significantly improve process control, and profitability, by using Sulfinert® treated system components and Sulfinert® treated electropolished tubing transport lines.

### Sulfinert®-Treated Electropolished Tubing

ID	OD	cat.#	5-24 ft.	25-99 ft.	100-299 ft.	> 300 ft.
0.085"	1/8"	22538				
0.180"	1/4"	22539				

### Coiled Sulfinert®-Treated Seamless 316 Grade Stainless Steel Tubing

ID	OD	cat.#	5-24 ft.	25-199 ft.	200-399 ft.	> 400 ft.
0.055" (1.40mm)	1/8" (3.18mm)**	22508				
0.180" (4.57mm)	1/4" (6.35mm)**	22509				

1/8" OD: 5 ft. to 100 ft. in one continuous coil; 1/4" OD: 5 ft. to 300 ft. in one continuous coil. Longer lengths will be more than one coil. Note: (required length in meters) x (3.2808) = length in feet. \*\* 0.035" wall thickness.

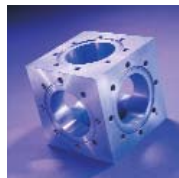
please **note** We can cut and finish tubing at nominal additional charge—please inquire.

### Sulfinert®-Treated Sample Cylinders

D.O.T. rated to 1800psi at room temperature.



Size	qty.	cat.#
75cc	ea.	24130
150cc	ea.	24131
300cc	ea.	24132
500cc	ea.	24133
1000cc	ea.	24134
2250cc	ea.	21394



### did you know?

Restek surface treatments have many uses, in addition to analytical chemistry.

#### Silcosteel®

A general-purpose passivation layer for steel and stainless steel. U.S. patent 6,511,760.

#### Silcosteel®-AC

Dramatically reduces carbon buildup on stainless steel components. U.S. patent 6,444,326.

#### Silcosteel®-CR

A corrosion resistant layer that increases the lifetime of system components in acidic environments containing hydrochloric acid, nitric acid, sulfuric acid, or seawater. Patent pending.

#### Silcosteel®-UHV

Greatly reduces outgassing from components of ultra-high vacuum systems. Patent pending.

#### Siltek®

The ultimate passivation for treated components, from glass to high nickel alloys of steel. U.S. patent 6,444,326.

#### Sulfinert®

A required treatment for metal components when analyzing for parts-per-billion levels of organo-sulfur compounds. U.S. patent 6,444,326.

award-winning **innovation!**



**Restek Surface Technology Earns R&D 100 Award**

Our newest surface treatment, Silcosteel®-UHV, has been recognized by a panel of independent judges and editors of R&D Magazine as one of the 100 most technologically significant products introduced in 2003. Silcosteel®-UHV treatment minimizes the migration of water and oxygen molecules from the surfaces of ultra high vacuum system components into the vacuum chamber, allowing the system to be evacuated much more quickly, with less costly pumping equipment.

### tech tip

#### Minimum Bend Radius

For tubing treated with Restek coatings

OD	Min. Bend Radius
≤ 1/32"	1" (2.5cm)
1/8"	2" (5.1cm)
1/4"	4" (10.2cm)

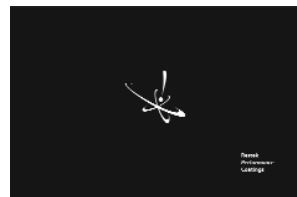


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