

## Cyclic Polarization Electrochemical Corrosion Testing of Silcosteel®-CR Treated 316L Stainless Steel and Bare 316L and Bare 304 Stainless Steel, by ASTM G 61

Samples were tested in accordance with ASTM G 61 in acidic and neutral aqueous solutions, at 23°C, at three chloride ion (Cl<sup>-</sup>) levels. Tables II and III summarize the test results: Silcosteel®-CR treated 316L stainless steel outperformed bare 316L stainless steel by a factor of approximately 30-50 in neutral chloride solutions, and by approximately 10-15 in acidic chloride solutions. At a chloride concentration of 3000ppm, Silcosteel®-CR treated 316L stainless steel outperformed 304 stainless steel by a factor of approximately 45 in neutral solutions and by approximately 17 in acidic solutions.

**Table II** Corrosion rate in mpy (mil per year) determined by electrochemical testing.

	Silcosteel®-CR	Bare Steel	Improvement
<b>Neutral Solution</b>			
100ppm chloride	0.0006	0.03	49x
3000ppm chloride	0.0009	0.03	32x
5000ppm chloride	0.001	0.03	29x
<b>Acidic Solution (1N H<sub>2</sub>SO<sub>4</sub>)</b>			
100ppm chloride	0.05	0.45	8x
3000ppm chloride	0.05	0.83	17x
5000ppm chloride	0.07	0.84	11x

**Table III** Comparison of Silcosteel®-CR treated 316L stainless steel versus bare 304 stainless steel at 3000ppm chloride.

	Silcosteel®-CR	Bare Steel	Improvement
<b>Neutral Solution</b>			
Corrosion Rate, mpy	0.0009	0.04	45x
Breakdown Potential, E <sub>b</sub>	1460	370	
<b>Acidic Solution (1N H<sub>2</sub>SO<sub>4</sub>)</b>			
Corrosion Rate, mpy	0.05	0.83	17x
Breakdown Potential, E <sub>b</sub>	927	370	



**Marty Higgins**  
Restek Performance  
Coatings Engineer  
10+ years of service!

## 4000 Hour Salt Spray Testing (ASTM B 117) of Silcosteel®-CR Treated 316L Stainless Steel and Bare Steel

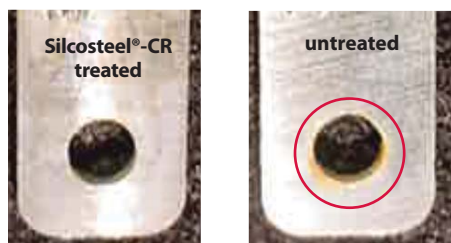
4000-hour salt spray testing shows Silcosteel®-CR treated stainless steel coupons exhibit no surface corrosion, while untreated coupons show surface corrosion and accelerated corrosion at the hole in the coupon (Figure 2). Neither coupon developed pitting over the test period.<sup>1</sup>

### Improve reliability while reducing costs by up to 65%!

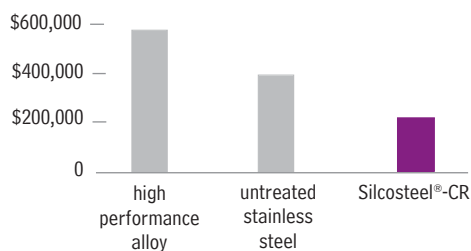
316L gas delivery systems exposed to corrosive environments typically are replaced within 5 years of installation. Substituting a high performance alloy for 316L stainless steel can increase the cost of the system by as much as 5-fold.<sup>2</sup>

By improving the corrosion resistance of 316L stainless steel by up to 10-fold, Silcosteel®-CR treatment reduces costly maintenance and field failures due to system corrosion. Figure 3 compares the cost of Silcosteel®-CR treatment versus Hastelloy® C22™ construction in a typical gas delivery system. Silcosteel®-CR treatment demonstrates significant life-cycle cost savings, compared to unprotected stainless steel or stainless steel alloys.

**Figure 2** Silcosteel®-CR treated 316L stainless steel shows no sign of attack after 4000-hour salt spray exposure, per ASTM B117.



**Figure 3** Silcosteel®-CR significantly lowers the life cycle cost of stainless steel or alloys (US dollars).



### References

- M. Zamanzadeh; G. Bayer; G. Rhodes; D. Smith; M. Higgins; *Laboratory Corrosion Testing of a Chemical Vapor Deposited Amorphous Silicon Coating*; Matco Associates, Inc. Pittsburgh, PA; Restek Corporation, Bellefonte, PA. 2005 Reference available on request.
- Vininski, Joseph; Lawrence, David; Torres, Robert; Diede, Ehrich; Daniels, Mia; "Corrosion Resistance of Cost Effective Alternative Materials for Semiconductor Gas Distribution Systems"; Matheson Tri-Gas, Longmont, CO; Diede Precision Welding, Longmont, CO; Sherwood, Harsco Corporation, Washington, PA. 2002

product guide



**Silcosteel®-CR tubing** (pages 394–396).

**Silcosteel®-CR fittings** (pages 392–393.)

Custom treatment is available for **your existing equipment**—see page 398.