PRODUCT / APPLICATION INFORMATION

Tubing Finishes And Passivation

There is a growing popularity of electropolished (EP) and chemically passivated (CP) tubing for sampling and analyzing low concentrations of sulfur and sulfides in gas streams. Very sensitive sulfur analyzers (often measuring samples in ppb: parts per billion) are being installed to validate improved fuels and chemicals processing.

The preferred tubing for high purity analyzers is type 316L seamless stainless steel. However, one concern is how quickly a line can be purged, cleaned and dried before a new gas sample can be introduced and analyzed. Another concern is that molecules from one gas sample could adhere to the wall of a sample tube and be released at a later time into a future sample.

The first concern relates to the smoothness of the inside surface of a sample tube. Surface smoothness is measured in µ-in (micro-inches) as a "Roughness average" or Ra, where the lower the Ra, the smoother the tube. See Table 1 for relative performance of surface smoothness, and the impact of "passivation" which is introduced below.

Marketing efforts by one company over several years has created an increasing demand for EP (electropolished) tubing for process analyzer applications. EP finishes are being specified for refining and chemical industry sample lines for H2S, as an example, though the benefits are not always justified. So the growing "need" for the EP tubing and its value in many applications is being reconsidered by end customers and "systems integrators" that fabricate analyzer panels.

According to some experts, it's more important to ensure that the surfaces exposed to gas samples do not allow "adhesion" of the targeted molecules that could impact analyzer accuracy. This risk is reduced through "passivation" of tubing, fittings, and other types of equipment and vessels by creating a chromium enriched oxide layer on the surface of the stainless steel. This is common for companies needing to reduce or eliminate risks of contamination in biotech, pharmaceutical, semi-conductor, and similar industries.

Another interesting approach is to apply an amorphous silicon coating to ensure an inert surface that might contact the process stream. Examples include Silcosteel, Siltek, and Sulfinert, as developed and provided by Restek of Bellefonte, PA, USA.

Surface finishes vary widely from different mills that manufacture type 316 stainless steel tubing. Most process applications are insensitive to the inside surface smoothness of instrument impulse lines and sample tubing. But where smoothness is an issue, raw coiled seamless tubing can be produced as smooth as Ra 15 – 20 µin. This finish is produced for the semi-conductor industry without electropolishing or passivation. But because the EP process improves the surface finish of a material, it's generally important to start with a very smooth finish.

Passivation and/or silica lining of semi-conductor grade seamless 316L stainless steel tubing has shown positive results in analyzer applications, at a fraction of the cost of EP tubing. However, these processes are also being applied to electro-polished tubing that offers the smoothest possible finish.

Seamless 316 Stainless Steel Finish & Passivation Effects

Finish (all seamless 316 stainless)		Roughness Average Ra (micro-inches)	Impact on Performance During Lab Tests: Moisture Response Time	Impact on Performance During Lab Tests: Corrosion Resistance	Cost Increase
Base Commercial Grade		> 50	Baseline	Baseline	Baseline
Seamless "Silco"		> 20	-40%	< 10%	280%
Semi-Con Grade		15 to 20	N/A	0%	185%
Semi-Con "Silco"		~ 15	N/A	< 20%	369%
Electropolished Semi-Con		10 to 15	40%	< 10%	730%
Electropolished Semi-Con "Silco"		10	70%	> 100%	795%

"Silco" is "SilcoSteel", a tradename of Restek for an amorphous silicone coating, applied to seamless 316 stainless in these cases.

