Integrated Solutions Improving Process Accuracy

O'BRIEN analytical

Tube Selection

Tube Selection for Analyzer Sample Systems

Selecting the optimum process tube for use in analyzer sample transport systems requires critical consideration of process conditions. There are a wide variety of metallic and non-metallic tube types available: welded and seamless 304 and 316 series stainless steel, other metallurgies used are Monel®, Hastelloy®, Inconnel®, Incoloy®, zirconium, Super-Duplex, titanium, and even copper. Common non-metallic tube materials are Teflon® (PFA, PFE, and PTFE fluoropolymer), polyethylene and Halar (ECTFE). Some bundles may also contain coaxial tubing (tube-in-tube) or unheated tubes for calibration gas and blowback lines.

O'Brien Analytical provides a wide variety of in-house services including chemical passivation, thermocouple cleaning and cleaning for oxygen service. We also furnish fused silica lined commercial tubing.

TrueTube™ identifies an O'Brien family of process transport tubes with enhanced performance. TrueTube CP is a chemically polished and cleanded 316L SS tube with limited surface roughness. TrueTube FS adds a layer of SilcoNert 2000 to the inner surface of the CP base. TrueTube EP steps up to an electropolished inner surface which improves general chemical resistance and reduces adsorption. TrueTube EPS adds a SilcoNert 2000 barrier over the electropolished surface for the ultimate in corrosion and chemical resistance.

Improper tube selection may lead to failure of the analyzer system caused by adsorption, contaminants, corrosion stress cracking or gas permeation in the sample transport line. Restricted sample flow, long sample lag times, and kinking are also problems often related to tube selection.

Selecting Tube Material

Consider the porosity, corrosion, and adsorption as well as the size and metallurgy (or composition) of the tubing.

Porosity

Fluoropolymer tubes are common for many analyzer applications particularly stack gas measurement. For all of its positive characteristics fluoropolymer is "porous" and has a limited working pressure, which deteriorates rapidly as temperature increases. Consider using only thick wall (0.062" / 1.5mm) tubing.

If the porosity and / or pressure rating is not acceptable then consider using electropolished or fused silica lined stainless steel tube. While resistant to most chemicals fused silica coatings have limited resistance to acids so caution should be exercised.

Corrosion

When determining corrosion resistance it is imperative that the material selection considers failure conditions. Just because the process stream does not contain acids under normal conditions the component concentrations and byproducts created if an upset occurs must also be considered. The creation of acids is common in stack gas applications when inadequate heating allows water vapor to condense and combine with sulfur or nitrogen compounds.

Adsorption

When utilizing stainless steel tubing adsorption and desorption will exhibit itself as a delay in detecting changes of trace amounts of component (especially moisture and sulfur compounds, H2S and SO2.) The structure of commercial stainless steel tubing is such that compounds may be caught up in the "crevices" and not reach the analyzer. Once the tube is saturated the levels will equalize relative to the process as long as the process composition, temperature and pressure remain constant. Any change in composition, temperature or pressure will cause compounds to be adsorbed at a different rate by the tube or released at different rates from the tube surface and "spike" the sample to the analyzer. As a result adsorption and desorption create inconsistent and unpredictable results. This is sometimes referred to as the "memory effect". This problem can often be solved by the use of electropolished or fused silica lined tubing.

O'Brien Analytical is the recognized leader in best practices for process and stack gas sample transport bundles.

Sample conditioning cabinets, bundle entry fittings, explosion proof heaters, as well as engineering, design and installation support services are all areas where O'Brien Analytical provides the total solution.

AMETEK®

Tube Selection

Tube	General Uses	Characteristics
Commercial 316L Seamless SS	Standard instrument tubing. Free Fe will react with most acids.	Average Surface Roughness: +80 µ inch Limitations: Limited by chemical reactivity and oxygen levels. Subject to stress corrosion cracking. High Ra values of internal surface contribute to adsorption / desorption problems. Advantages: Inexpensive and readily available.
Commercial 316L Welded SS	Standard low pressure / temperature instrument tubing. Free iron will react with most acids. Weld containments may contribute to reduced corrosion protection compared to seamless tubing.	Average Surface Roughness: ± 40 µ inch Limitations: Limited by chemical reactivity and oxygen levels. Subject to stress corrosion cracking. Pressure rating less than seamless products. May be more susceptible to corrosion than seamless products. Advantages: Inexpensive and readily available.
Fluoropolymer (Teflon®)	Low pressure sample and chemical lines where 316 SS is not acceptable. Used for applications requiring cleanliness.	Average Surface Roughness: NA Limitations: Limited by chemical reactivity and oxygen levels. Temperature and pressure limits vary by variety of fluoropolymer. Very permeable. Used for manufacture of permeable membranes. Advantages: Excellent chemical resistance. Flexible.
TrueTube CP	Analyzer sample lines where sample cleanliness is important	An O'Brien Analytical TrueTube Product Chemically Polished and Cleaned 316L Seamless SS Average Surface Roughness: less than 40 µ inch Limitations: Limited by chemical reactivity and oxygen levels. Subject to stress corrosion cracking Advantages: Improved surface finish and cleanliness. Free Fe contaminants eliminated
TrueTube FS	Moderate acid samples and sulfur.	An O'Brien Analytical TrueTube Product A secondary SilcoNert 2000 coating applied to chemically polished 316L SS tubing. Average Surface Roughness: NA Limitations: Very poor resistance to bases. Reacts adversely with fluorides. Advantages: Has improved chemical resistance over substrate alone. Can be used at higher temperatures than polymer coatings. Covalently bonded matrix which reduces surface tension. Has found wide acceptance for transporting sulfur samples.
TrueTube EP	Critical sample systems where adsorption / desorption is a problem.	An O'Brien Analytical TrueTube Product Electropolished and chemically treated 316L SS seamless tubing. Maximum Surface Roughness: 10 µ inch Limitations: Limited by chemical reactivity and oxygen levels. Advantages: Cr/Fe ratio better than 1.5:1 and CrO/FeO ratio better than 3:1 improve chemical resistance. Improved adsorption / desorption characteristics compared to commercial tubing.
TrueTube EPS	Critical sample measurements in the ppb range. Critical sample systems where adsorption / desorption and corrosion is a problem.	An O'Brien Analytical TrueTube Product Electropolished and SilcoNert 2000 coated 316L seamless tubing Average Surface Roughness: NA Advantages: Cr/Fe ratio better than 1/5:1 and CrO/FeO ratio better than 3:1. Covalently bonded elemental silica matrix reduces surface tension. Improved adsorption/desorption for moisture and sulfur species. Wide acceptance for transporting sulfur samples in ppb rang. Fastest response rate of any TrueTube product