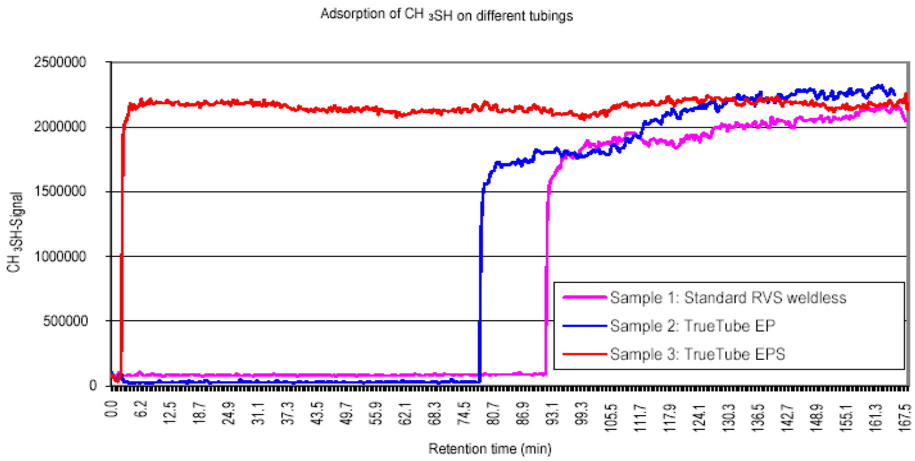
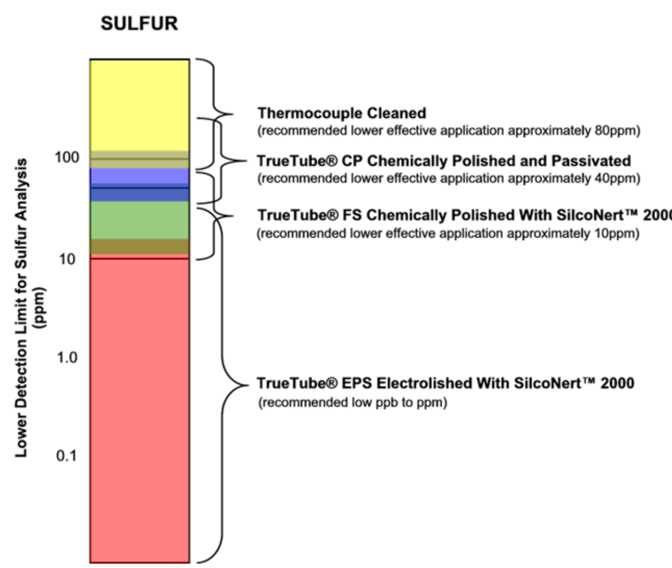
The transport of flare gas to process analytical systems for the analysis of sulfur species is a complex issue. It has been well established that sulfur species can be especially reactive with surfaces present in the system, and will potentially adsorb and desorb from metal surfaces.



O'Brien Corporation has published Test Reports on sample transport and this data is commonly used in industry as a guide for specification of tubing material in low level analysis. This is a graph from testing performed by Shell on sulfur species and included in these published Test Reports. Reports are available upon request.

This data as well as real world experience exists which demonstrates that the combination of producing a smooth, oxide rich surface through either chemical passivation or electropolishing and the deposition of an amorphous silicon coating such as SilcoNert 2000™ is extremely effective in reducing surface adsorption. The common material used in such applications is electropolished 316L tubing with Sulfinert ™ coating, such as O'Brien TrueTube EPS™.



In some flare gas applications, most notably those at a refinery where an HF alkylation unit is present, there exists the possibility that there will be hydrofluoric acid (HF) present in the sample gas stream. In such cases, the sample system must be designed to not only reliably transport the sulfur species but also resist corrosion by the hydrofluoric acid. This latter requirement places some constraints on the materials used and must be considered carefully. HF is highly corrosive to most metals, elastomers and silica-containing materials.

Teflon tubing is certainly an option, but one which is not viewed favorably in many installations due to the risk of diffusion through the Teflon, limited strength and risk of rupture, as well as the limited temperature range. Of particular concern is that during a major flaring event, temperatures around the flare can be very high.

Stainless steel, most notably 316L, is one of the favored materials in flare gas applications in cases where there is little or no risk of HF being present. However, studies at Oak Ridge National Laboratories[1] have clearly shown that 316L is readily attacked by both aqueous and gas phase HF, especially in the presence of oxygen. Alloy 600 (Inconel) performed better than SS-316L but still experienced moderate corrosion rates. Monel 400 performed better than Alloy 600. The Hastelloy alloy C-276 outperformed all the other alloys.

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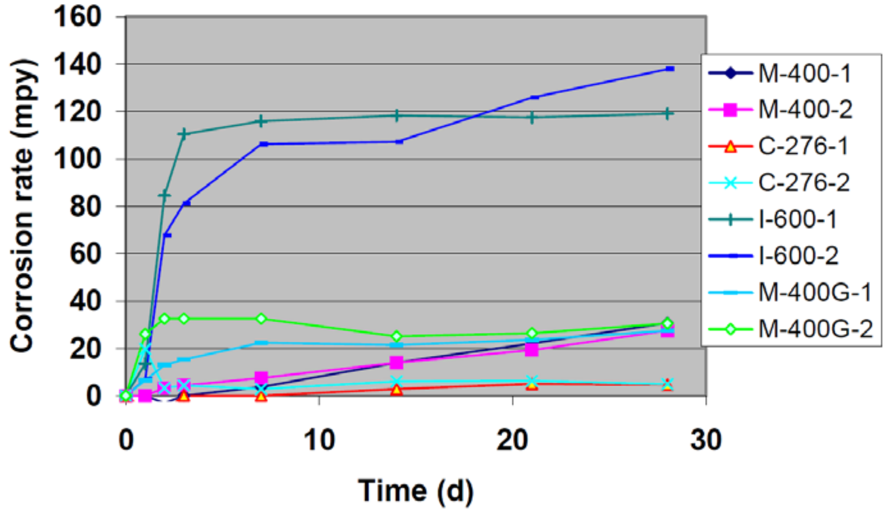
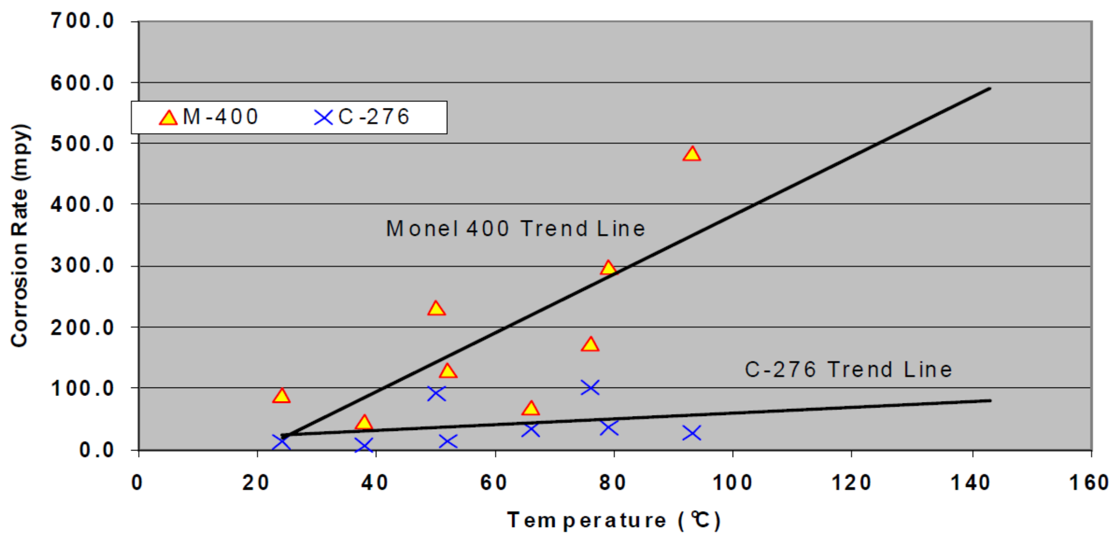
[1] Osborne, P.E.,Isenhour, A. S. and Del Cul,G.D. "Hydrofluoric Acid Corrosion Study of High Alloy Materials", Oak Ridge National Laboratories Report ORNL/TM-2002/165



Studies have shown that the presence of oxygen in the HF vapor dramatically increased the corrosion rate of alloy 400. Alloy C-276 is also adversely by temperature and oxygen but not as adversely as alloy 400. Additional data from Haynes International Inc. also strongly supports the use of Ni-Cr-Mo alloys[2] like alloy C-276 for HF service in the presence of oxidizers for temperatures up 80°C.



The data clearly indicates that both Monel 400 and Alloy C-276 are suitable for HF service, with some benefit shown to C-276. We must also consider the use of these materials for sample lines for sulfur species analysis. Monel 400 is a high copper alloy and the copper tends to be reactive towards sulfur species forming copper sulfides. Monel 400 also does not accept a SilcoNert 2000 coating very well, resulting in poor coating uniformity. By contrast, alloy C-276 is naturally more resistant to sulfur species, can be chemically polished and will accept a uniform SilcoNert 2000™ coating.

Given the above information, the recommended product for flare gas applications is SilcoNert 2000™ coated Alloy C-276.

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[2] Guide to Corrosion Resistant Nickel Alloys, Haynes International Inc H2114B, 2001