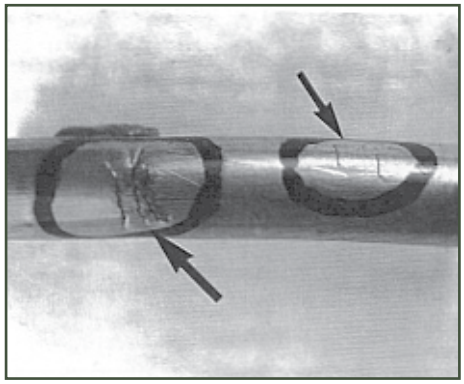
PRODUCT / APPLICATION INFORMATION

Stress Corrosion Cracking in Tubing Bundles

Our experience has been that SCC in tubing bundles has been a rare occurrence. We have only witnessed a few cases in over 20 years of manufacturing these products. Twenty years of tube bundle manufacturing represents millions of feet of tube bundle.

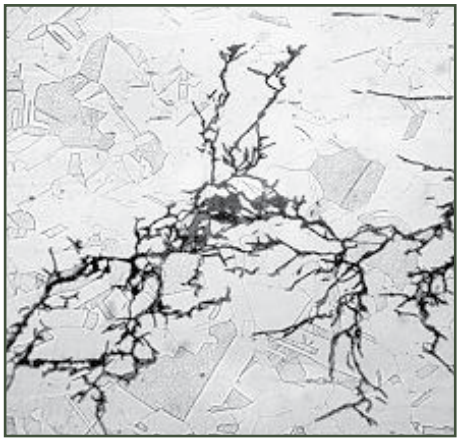
A recent laboratory summary from a failure of a tube in a tubing bundle concluded that there was a PVC coated wire in direct contact with the 316 stainless steel tubes. Heat from the steam tracer degraded the PVC resulting in chloride deposits on the tube which ultimately lead to tube rupture from chloride ion induced stress corrosion cracking (SCC).



Chloride ion induced stress corrosion cracking (SCC). Failure initiated from the inside of the tube.

In one case PVC tape (electricians tape) was used to seal the bundle ends. The tape melted and deposited a high concentration of chloride ions on the tube. In another case, after installation, seawater was used to flush the tubes. Again a high concentration of chloride deposit resulted in stress corrosion cracking.

The laboratory summaries from these few cases had similar conclusions.



Photograph showing the typical "lightning bolt" cracking pattern associated with SCC.

Corrosion in the Petrochemical Industry published by The Materials Information Society suggests that SCC require 4 ingredients.

1) An 18-8 austenitic stainless steel
2) The presence of residual or applied surface tensile stresses
3) The presence of chlorides; bromide (BR) and fluoride (F) ions may also be involved
4) The presence of an electrolyte

This list assumes there is heat. SCC usually takes place at elevated temperatures above 140°F (60°C) and below 300°F (149°C). Elevated temperatures cause rapid water evaporation, which concentrates chloride ions. Also, heat speeds up the corrosion reaction rate.

18-8 austenitic stainless steel is most susceptible to SCC. This includes the 300 series stainless steels and the commonly used 316, 316L, 304 and 304L grades. This suggests that other alloys like the 400 series and 800 series would be more resistant. Grades with lower nickel and higher chrome, duplex stainless steel, have been developed specifically to resist SCC. However, at this juncture, the 300 series stainless steels are the most widely used and as a result are chosen because they are readily available and relatively low cost.

"Most mill products, such as sheet, plate, pipe, and tubing contain enough residual tensile stresses from processing to develop cracks without external stresses."[1] Tubing received from the mill already contains enough tensile stress to develop cracks before processing into tubing bundles. Relieving tensile stress after processing is not practical or possible for tubing within tube bundles. Annealing and stress relieving require exposure to temperatures of 1750°F (955°C) or higher. And, stress relieved tubing could be subject to tensile stresses during installation and operation anyway.

Note . . .

1. I. Garverick Linda., Editor, Corrosion in the Petrochemical Industry, ASM International, p. 176, 1994

