

Why PVI does not use 300 series stainless steel for direct-fired, potable water heat exchangers.

The 300 series or austenitic stainless steels are susceptible to failure from stress corrosion cracking in an aqueous environment where residual stress, heat and dissolved chlorides (salts) are present. The failure is characterized by micro granular cracking within the material resulting in an irreparable leak and requiring replacement with a new heat exchanger.

While 300 series stainless steel has been used for storage tanks and indirect-fired (steam or boiler water) heat exchangers in potable water heating for decades without much incident, this application differs significantly in one regard when compared to direct-fired water heating. The difference is heat.

A direct-fired water heater is one where the flame from a natural gas burner is in the direct vicinity of the heat exchanger; exposing the exchanger to temperatures in excess of 1800°F or 8 to 10 times the temperatures experienced in indirect heat exchangers and storage tanks. This is an important distinction because elevated temperature is a main contributor to an increased incidence of stress corrosion cracking.

Similarly, while 300 series stainless steel has been used as direct-fired heat exchangers in closed-loop boilers, this application differs in another critical regard compared to direct-fired water heaters. This difference is the continuous supply of fresh water containing some level of dissolved chlorides. In a closed boiler system, the introduction of dissolved chlorides is greatly limited. In a potable water heater, the introduction of fresh water containing dissolved chlorides is unlimited.

The level of dissolved chlorides in the water supply is a key issue in predicting the likelihood of stress corrosion cracking. However, a chlorides level that is considered benign at a low temperature can become aggressive in regards to stress corrosion cracking at a higher temperature. Also, as the precipitants build up on heat exchanger surfaces, the dissolved chlorides can become concentrated at these points. Therefore, a certain level of dissolved chlorides in the water supply is only a marginal predictor of the probability of stress corrosion cracking.

The final issue is residual stress in the heat exchanger. It is simply impossible to eliminate or relieve all the residual stress created during the manufacturing process.

The bottom line is that the variables of residual stress, heat and dissolved chloride salts in the supply water, combine to render predictions of longevity unreliable in regards to employing direct fired heat exchangers fabricated from austenitic stainless steel in potable water heating applications. While these heat exchangers have ASME stamps for boilers (“H”) or water heaters (“HLW”), this does not brush aside the stress corrosion cracking issue. ASME emphasizes safety and does not evaluate materials on the basis of longevity in a particular application.

