The Temperature Gradients are a major factor limiting the life of vitreous enamel lined mild steel water heaters when heated by gas. This is because the temperature gradient between the tank area under direct flame impingement and just a few millimetres away, is very high. The result is the failure of the lining due to its inability to accommodate this thermal stress as the burner cycles on and off; and the subsequent corrosion of the tank.
It can be demonstrated that this is why a conventional vitreous lined Electric Water Heater has a superior life to a conventional vitreous lined Gas Water Heater. *

The temperature gradient, or thermal gradient is also a major factor for stainless steel water heaters. # Research has shown that when water quality is poor due to chlorides, mineralisation or aggressive pH, that the effect of the extreme temperature in the flame zone is to assist high temperature corrosive attack of the stainless steel. This happens because the temperature at the immediate point where the flame heats the stainless steel is many hundreds of degrees.

Gas heated stainless steel water heaters have failed in areas of poor water quality.

When stainless steel water heaters are heated by an electric element, there is no flame zone or extreme temperature penetrating through to the water inside the cylinder. The hottest part of the stainless steel cylinder equals the thermostat setting of approx. 70 °C. As a result, electrically heated stainless steel water heaters are not affected by moderately poor water quality. In these cases however, the element may have a short life, which is an acceptable condition as it is a low cost service replacement component. Gas heating remote to the cylinder by an instantaneous Gas heater is also an ideal long life water heating solution as the flame heats a copper tube system which is designed for high temperature gradients and direct flame.

Water Heater manufacturers have therefore identified that the factor limiting the life of the unit is the integrity and corrosion resistance of the cylinder. The vitreous linings of conventional electric and gas water heaters contain many thousands of tiny fissures through the lining to the steel due to the effects of thermal cycling. The plain carbon steel cylinder is very reliant from early in its life on the protection of the sacrificial anode. If the water is high in calcium carbonate (known as water hardness), the anode will be coated in this material like a paint layer and cannot protect the steel cylinder from corrosion. The heater will rust through and fail.

The Everlast Stainless Steel water heaters contain no anode and require no sacrificial protection. Coating build-up of calcium carbonate or other deposits is of no consequence and the integrity of the stainless steel cylinder is not affected.
To resist pitting corrosion the stainless steel grade must be of the highest standard type AISI 316 marine grade stainless steel which contains molybdenum. (Type AISI 304 stainless steel does not contain this protection against pitting.)

Everlast Hydro Systems manufacture entirely in AISI 316 stainless steel, including welding consumables, fittings and connections. This practice, combined with the total surface cleaning and passivation of all welded areas, results in the highest possible chemical integrity. Highly saline waters such as bore water are not acceptable in any water heaters and void warranty.

Geoff C Grace

Geoff C Grace P Eng
Metallurgist (Past ESAA member for Victoria on SAA Water Heater Standards Committee EL 20, Solar Standards Committee CS 28; & former Residential Services Engineer, SECV)

Refs :
- **Stainless Steels Specifications - Atlas Steel Corporation Canada**
* **Ministry of Housing, Victoria statistics.**
\# **Stainless Steels in Chloride Media - Research by S. Price and G. Grace at Metallurgy Department, Royal Melbourne Institute of Technology.**