How lime-scale is killing heating efficiency

1. Introduction

The most common cause of failure in traditional gas and electric water heaters is limescale build-up. During normal operation, especially in hard water areas, minerals in water will accumulate on the hottest parts of the water heater. In electric water heaters this would be the heating coil, and in traditional gas water heaters this would be the tank area near the burner.

Fig 1. Heating element with scale deposits

2. Reduced efficiency

Over time scale deposits act as an insulator, causing the water heater to work harder and harder to heat the water. This reduces the energy efficiency of the water heater by up to 50% (iv). According to the Battelle Study (i), each five grains per gallon of water hardness will cause a 4% loss in efficiency. This loss of efficiency in the heat transfer directly affects heaters ability to heat water to high temperatures in short amounts of time. Studies show the water temperature decreases 5°C with a limescale thickness of 2mm after 480 seconds (ii). The water heater will eventually fail due to this excessive heat caused by the insulative properties of scale. A water heater‘s useful life can be reduced by as much as 50% through scale build-up (iv).

3. Increased running costs

Scale deposits on water heaters and heat exchangers will lead to increased running costs, as the heater will now require more energy in order to heat the water. According to the Battelle Study (i), scale deposits will cause a 4% increase in cost for gas storage tank water heaters when using 50 gallons of hot water per day. The Ministry of Health Water Report - UK also found similar results. Their study concluded that 0.5 mm of hard scale increases fuel costs by 9.4% (iii).

Key findings

- Scale reduces energy efficiency of the water heater by up to 50%
- Each five grains per gallon of water hardness will cause a 4% loss in efficiency
- Water temperature decreases 5°C with a limescale thickness of 2mm after 480 seconds
- A water heater‘s useful life can be reduced by as much as 50% through scale build-up
- Scale deposits will cause a 4% increase in cost for gas storage tank water heaters when using 50 gallons of hot water per day.
- 0.5 mm of hard scale increases fuel costs by 9.4%

References

i) Battelle Memorial Institute, Columbus, OH, Study on Benefits of Removing Hardness (calcium & magnesium ions) from a water supply, 2009

ii) Influence of Limescale on Heating Elements Efficiency http://www.comsol.it/conference2013/europe/abstract/id/15419/pezzin_abstract.pdf

iii) Ministry of Health UK, Report of the Sub-committee of the Central Advisory Water Committee, 1949

iv) The Office of Saline Water, U S Department of the Interior