Business Ethics AWARDS 2011 Finalist

Owned and operated by the Boyett family for over 46 years.

Softened Water Benefit Studies

The Water Quality Association (WQA) Research Foundation funded two important studies to quantify the benefits of softened water.

In 2010, the Battelle Memorial Institute in Columbus, Ohio, completed a study of the effects of hard water on; 1. water heaters and 2. plumbing fixtures such as low flow showerheads and faucets, and laundry, washers and dishwashers.

The results are summarized below:

1. Gas Storage Water Heaters

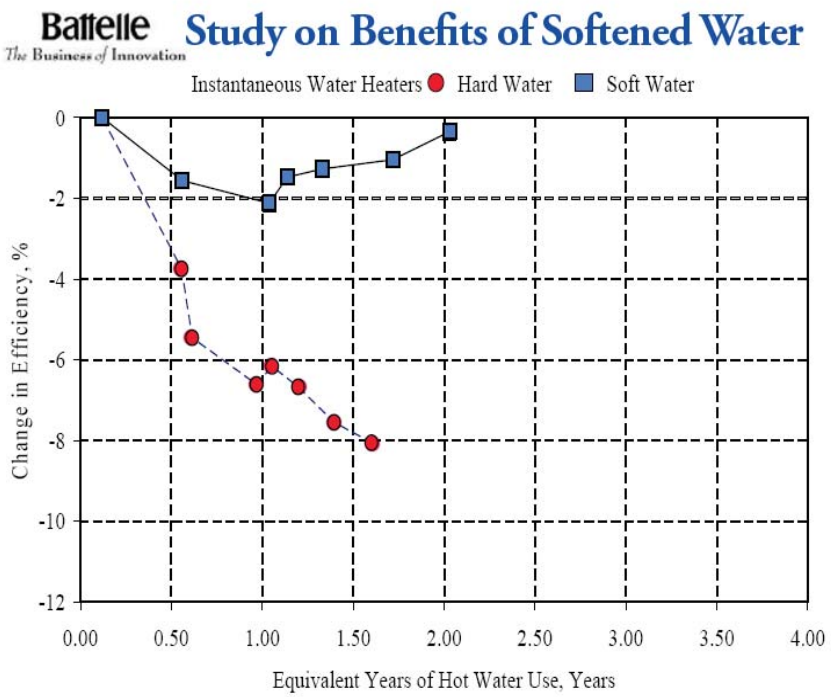
a. Hard water caused as much as a 24% loss of efficiency in water heaters
b. Water heaters operated on softened water maintained the original factory efficiency rating over a 15 year lifetime
c. The carbon footprint of a gas water heater increases 18% when operated on hard water

2. Electric Water Heaters

a. Each 5 grains per gallon of hardness causes 0.4 pounds of scale accumulation each year – that's 2 pounds per year on 25 grain water
b. The life of the heating element in an electric water heater can be expected to shorten due to scale buildup causing an increase in temperature in the element

3. Tankless Water Heaters

a. Tankless heaters completely failed to function because of scale plugging after only 1.6 years
b. Tankless heaters operated on softened water maintained the original factory efficiency rating over a 15 year lifetime
c. The economic savings of softened water with tankless heaters can lead to recovery of the cost of softening the water in a period as short as a year
d. The carbon footprint of a tankless heater increases 4% when operated on hard water



This table from the Battelle Study shows the change in efficiency from the start of the test for the instantaneous water heaters on hard and soft water. The equivalent years of field service was calculated assuming the average household uses 50 gallons of hot water per day.

4. Showerheads

a. Showerheads on hard water lost 75% of flow in less than 18 months

b. Showerheads on softened water maintained a brilliant luster and full flow

Showerhead with soft well water (<1 grain per gallon) showing spray pattern. Battelle testing for Water Quality Association.

Showerhead with hard well water showing spray pattern. Battelle testing for Water Quality Association.

5. Faucets

a. Faucets on hard water could not maintain the specified 1.25 gallon per minute flow rate because of scale

b. The strainers on faucets using hard water were almost completely plugged from scale after the equivalent of 19 days of testing

Results after 19 days of testing. The faucet strainer on the left is using softened water and the faucet strainer on the right is using hard water.

6. Laundry Washers & Dish Washers

a. Dish washers and laundry washers using softened water were free of any scale buildup

b. Units on hard water had noticeable scale buildup after only 30 days of testing

c. Although all appliances completed the same number of use cycles (240) the units on hard water showed the need to be "delimed" and cleaned due to scale deposits

The Battelle Institute study concluded that:

1. **Gas and instantaneous water heaters using softened water will:**
   a. Eliminate or minimize the scale forming compounds in the water and thus
   b. Result in more efficient water heating than using hard water and will
   c. Result in water heater efficiency remaining constant over the life of the water heater

2. **In contrast gas and instantaneous water heaters using hard water had a noticeable decrease in efficiency over the testing period resulting in higher natural gas usage**

3. **Because of the need to have the instantaneous water heater delimed and cleaned periodically to remove the scale, the economic savings can lead to recovery of the cost of softened water in as little as one year**

4. **The natural gas savings from using softened water will lead to DIRECT energy and economic savings of up to 57% over a 15 year tankless water heater life and 24% over the 15 year life of a gas water heater**

5. **The increase in total energy consumptions (as a result of a reduction in heat transfer efficiency) is related to water hardness and higher water hardness will lead to greater energy consumption**

6. **There are environmental benefits to the use of softened water as the lower use of natural gas leads to reductions in the carbon footprint related to the decrease in total energy consumption**

Table ES-2 – Estimated Savings for Gas-fired Water Heaters Using Softened Water Over 15 Years Life

Cost Elements	Water Hardness (grains per gallon)						
	0	5	10	15	20	25	30
Instantaneous Gas Water Heaters							
Percent Life Cycle Energy Cost Savings, %[1]	NA	5.4	5.4	5.4	5.4	5.4	5.4
Percent Total Life Cycle Cost Savings, %[1]	NA	14.0	22.5	31.2	39.6	48.4	57.0
Estimated Usage before Deliming Required, Years[2]	NA	8.4	4.1	2.7	2.0	1.6	1.4
Gas Storage Water Heaters							
Life Cycle Operating Efficiency Reduction From Baseline, %[3]	0.0	4.3	8.5	12.8	17.0	21.3	25.5
Percent Life Cycle Energy Cost Savings, %[4]	NA	3.1	6.6	10.3	14.5	19.0	24.2

Notes: [1] Derived from Table 5-2
[2] Derived from Table 5-1
[3] Derived from Table 5-3
[4] Derived from Table 5-4

In 2011, Scientific Services Laboratories near Middleton, New York, completed a study of the effects of hard water on;
1. the effect of hard water on clothes washer detergent dose and water temperature on stain removal performance and
2. the interaction of detergent dose and water hardness on the performance of automatic dishwashers.

The results are summarized below:

a. Stain removal performance increases dramatically when hardness is removed even when dose and temperature are lowered.
b. Softening water will allow use of less detergent and save energy by lowering water temperatures while still maintaining or improving performance.
c. When water of any hardness is softened prior to its use in washing, detergent use can be reduced by 50% and the washing can be carried out in 60ºF cold water instead of 100ºF hot water and achieve the same or better stain removal yielding whiter clothes.
d. This was true for all stains and all detergents tested.
e. This was verified for top loaded and high efficiency front loaded washers.
f. Softening water is SIGNIFICANTLY more effective on stain removal than either increasing the water temperature or detergent dose.

This graph shows the possible detergent savings.

2. The interaction of detergent dose and water hardness on the performance of automatic dishwashers and found:

a. Air drying as a way to save electrical energy was evaluated and is promising to provide better results when softened water is used rather than hard water
b. With tablet detergents tested, the beneficial effect of softening the wash water is much greater than the use of two tablets rather than one
c. Statistically significant improvements by softening water were observed in spotting and filming performance as well as in better soil removal in automatic dishwashing.

This graph shows the relationship between softened water, detergent dose, and wash water temperature.

PATTERN	Hardness in Grains	Dose %	Temperature F
Case 1	30	700	100
Case 2	15	75	80
Case 3	0	50	60

The shorter the bar the better the stain removal.