nuvo h_2o ™

Study Findings and Executive Summaries

NuvoH$_2$O Efficacy and Consumer Benefits Study:

- Scale Prevention
- Scale Removal
- Energy Savings

An Independent Study by Battelle

Efficacy and Consumer Benefits Study

Introduction

The NuvoH$_2$O patented design and proprietary formulation was developed from almost thirty years of commercial experience. First designed for the food services industries, these products have helped solve complex water problems for some of the nation's largest businesses.

NuvoH$_2$O's residential product is a point-of-entry, cartridge-based water softening system containing a proprietary blend of ingredients including a citric acid media, which lowers the water's alkalinity and chelates the hardness-causing ions (See Figure 1). This prevents and removes scale formation in appliances and fixtures installed in the home. The cartridge inside the NuvoH$_2$O System is expended throughout the use cycle, typically 6 months of normal household usage.

Figure 1. NuvoH$_2$O Water Softening Systems and Cartridges

The Independent Consumer Benefits Study of nuvoH2O was conducted from 2011-2012 in conjunction with, but not endorsed by, the Battelle Memorial Institute and funded by nuvoH2O.

Efficacy and Consumer Benefits Study

An estimated 85% of the United States face hard water issues. Primary concerns of hard water for consumers are the decreased life of any appliance, fixtures and plumbing subjected to scale build-up and increased energy consumption to heat water for household use.

First, hard water build-up clogs and corrodes pipes, fixtures and appliances shortening their lifespan by as much as 25-30%. NuvoH_2O prevents scale, increasing the life of the appliance and decreasing the potential repair costs associated with scale. NuvoH_2O can also remove scale in many existing applications returning the appliances to an improved state of efficiency.

Second, heating water is the second largest energy expense in a typical household according to the U.S. Department of Energy (DOE); it can be directly translated that a scaled heating element can cause a higher energy bill than an un-scaled element. Every day, countless homes waste untold millions due to the inefficient heating of water caused by hard water buildup. NuvoH_2O prevents the scale from forming inside the water heater thereby decreasing the energy required to heat the water.

At the behest of the EPA, NuvoH_2O tasked Battelle with confirming and quantifying the benefits of the NuvoH_2O System. A primary component of the study was the longevity of appliances (instantaneous water heaters) and fixtures (showerheads) and the resulting energy savings for a typical U.S. household from use of the NuvoH_2O System (See Figure 2).

Figure 2. Battelle Lab

Study Findings

Scale Prevention. The results of the Battelle study are conclusive - the NuvoH_2O System prevents the formation of scale. The visual assessment of the heating elements after teardown analysis clearly shows that the NuvoH_2O systems prevented scale. The visual observation is supported by the detailed breakdown quantifying the exact scale amounts.

On average, untreated heaters exhibited more than 50x the scale mass than NuvoH_2O treated heaters with some untreated heaters exhibiting as much as 90x to 140x more scale formation. The average measure of scale (.87 g NuvoH_2O vs. 45.6 g untreated) indicates that the NuvoH_2O system effectively prevented over 98% of the scale formation over the simulated 2.2 year test period.

In addition, the NuvoH_2O-treated showerheads had less surface scaling than the untreated showerheads with the worst performing showerheads having more than 80% of their nozzles clogged.

Scale Removal. The NuvoH_2O systems are effective at improving energy efficiency and removing existing scale. When installed into existing homes, not only will the NuvoH_2O system prevent the scale build-up, but can also remove scale improving appliance efficiency in many applications.

Energy Savings. The more time required to achieve a steady operational state suggests that (1) additional energy is used to bring the water temperature to a desired level and (2) water is typically run longer resulting in increased water waste.

The NuvoH_2O-treated water heaters exhibited over a 25% shorter time to achieve a steady state of operation when compared to untreated water heaters. This decrease is achieved because the NuvoH_2O-treated elements were able to directly transfer the heat from the copper elements to the water whereas scale on the untreated heating elements acted as a barrier to the heat transfer.

Executive Summary

The NuvoH_2O Efficacy and Consumer Benefits Study tested tankless water heaters supplied with NuvoH_2O softened water and untreated hard water under controlled laboratory conditions designed to accelerate the waterside scaling and then quantify the scale growth and the performance efficiencies.

The independent study specifically focused on the effectiveness of the NuvoH_2O systems in (1) preventing scale and protecting the appliance from the corrosive and destructive power of scale, (2) preventing scale and producing an energy savings for the consumer, and (3) removing scale and returning appliances to a more efficient state of operation.

The study protocol was developed by Battelle, the world's largest nonprofit research and development organization. For this study, Battelle tested 15 Bosche RP17PT electric tankless water heaters and using treated municipal water with approximately 15 grains per gallon hardness (anything above 10.5 per gallon is considered to be very hard water) and a pH value of about 7.8 – 8.0.

The first phase simulated approximately 2.2 years of water heater use in approximately 4.5 months of testing. Five (5) NuvoH_2O-treated instantaneous electric water heaters (IEWHs) and ten (10) untreated IEWHs were set up for continuous testing. Battelle performed teardown analysis on five (5) NuvoH_2O-treated heaters and five (5) selected untreated heaters at the end of the first phase to assess scaling in the water heaters.

The treated and untreated water also flowed through corresponding Delta RP42578 showerheads that provide full spray at the identified test flow rates/pressure to further analyze scale growth.

For the second phase of testing, the remaining five (5) untreated water heaters were transitioned to installation with NuvoH_2O Systems. The intention of Phase II was to document NuvoH_2O System's ability to remove existing scale and improve appliance efficiency. The heaters selected for the second phase of study exhibited various degrees of scaling which served as the baseline heater condition.

Phase I Results

The objective of the first phase was to assess NuvoH$_2$O water softeners' ability to prevent scale, and to determine the longevity of the appliances and fixtures and resulting energy savings from use of the NuvoH$_2$O Systems. The accelerated life test protocol was developed to mimic household usage of the instantaneous water heaters and the downstream showerheads and then compare the performances of units fed with NuvoH$_2$O System treated water and those fed directly with the hard city water supply.

Phase I testing led to the following key observations:

1. Visual assessments showed NuvoH$_2$O Systems prevented scale formation in instantaneous electric water heaters.
2. On average, untreated heaters exhibited more than 50x the scale of NuvoH$_2$O-treated water heaters after 2.2 years simulated use.
3. Longer time to reach steady-state temperature for untreated vs. NuvoH$_2$O-treated water heaters.

Visual Assessment. A visual inspection of the water heaters and showerheads was performed at end of Phase I as part of the teardown analysis. No scaling was observed on all but one of the heating elements of the NuvoH$_2$O -treated instantaneous electric water heaters which only had minor visible scaling. On the other hand, all but one of the untreated water heaters showed very significant scaling (See Figures 3 and 4).

Figure 3. Untreated Element (Left) and Treated Elements (Right)

Figure 4. Untreated Canister (Left) and Treated Canister (Right)

Analytical Assessment. To quantify the visual assessment of the scale in the test heaters, the scale from the heating elements and canister for each respective heater was dissolved using 5% w/w Sulfamic acid (H3NSO3) solution. Calcium and magnesium concentrations for each sample were determined via atomic absorption spectroscopy (AA) and used to report mass of the scale deposited as CaCO3.

The average NuvoH_2O-treated water heater had an average of less than one gram of scale (.868) with the typical result being less than .25 grams of scale. The average non-treated water heater had an average of 45.6 grams of scale, but based on visual assessment of all of the water heaters the typical result suggest a range of 20 – 120 grams of scale (53 gram average) resulting in the NuvoH_2O system preventing over 99% of scale formation (See Figure 5).

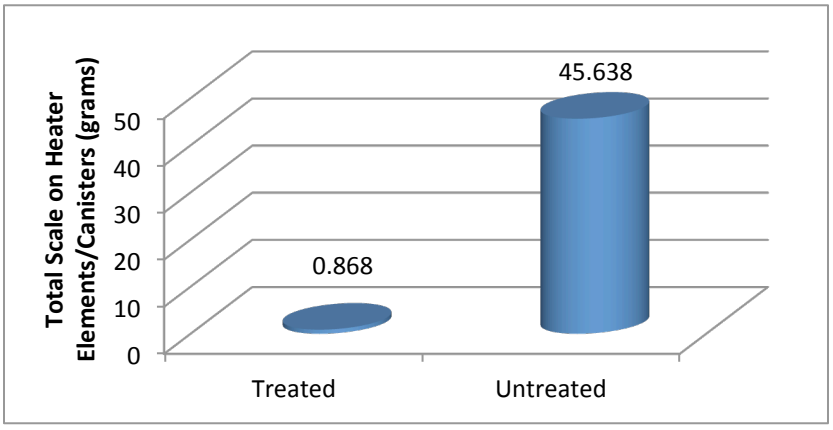


Figure 5. Scale dissolution results (Average for five treated and five untreated heaters)

Water Heater Efficiency: Steady-state Temperature. A key metric used to track water heater performance is time to steady state operational temperature. The time to steady state operational temperature is the amount of time it takes for the heater to consistently deliver the user-set temperature once the heater is active.

This metric is expressed in seconds per degree Fahrenheit (sec/°F). This represents the time taken by the water heater to heat the water by one degree and is directly proportional to the cost of energy. The NuvoH_2O-treated systems responded in an average of 8.34 (sec/°F) versus 10.6 (sec/°F) for non-treated heaters – over 27% less time on average to reach the steady state performance.

The scale on the untreated heating elements acted as a barrier to the heat transfer, whereas the Nuvo-treated elements were able to directly transfer the heat from the copper elements to the water.

As water heating is the second largest energy expense in a typical household according to the U.S. Department of Energy (DOE), it can be directly translated that a scaled heating element can cause a higher energy bill than an un-scaled element. For example, when a user is waiting for the tap water to heat to the desired temperature, the user will let the water run longer which in turn increases water as well as electricity consumption (See Figure 6).

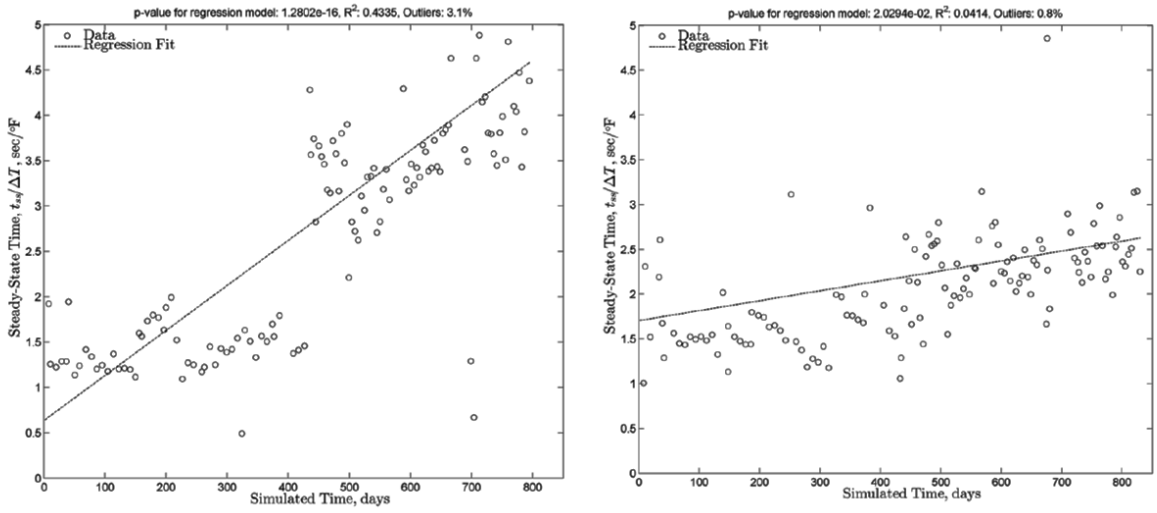


Figure 6.Regression Model Plots Time to steady state temperature for an untreated heater (Left) and NuvoH_2O-treated heater (Right).

Efficacy and Consumer Benefits Study

Phase II Results

The objective of Phase II was to determine the ability of the NuvoH_2O Systems to restore performance, efficiency, and aesthetics to scaled water heaters and showerheads. Untreated water heaters from the first phase were installed downstream of NuvoH_2O Systems to determine the efficacy of the NuvoH_2O systems to remove scale. The protocol from Phase I was continued through the Phase II testing which ran for a duration of approximately 10 weeks or one simulated year.

Phase II testing indicated that the NuvoH_2O system can effectively remove existing scale and improve energy efficiency.

Water Heater Efficiency: Steady-State Temperature. The metric used in the study to track water heater performance was time to steady state operational temperature. The time to steady state operational temperature is the amount of time it takes for the heater to consistently deliver the user-set temperature once the heater is active. All heaters in Phase I were dialed to an operational temperature of 130°F (+/- 3°F).

The metric is expressed in seconds per degree Fahrenheit (sec/°F). This represents the time taken by the water heater to heat the water one degree and is directly proportional to the cost of energy. In Phase I, the NuvoH_2O-treated systems responded in 27% less time on average to reach the steady state performance.

In Phase II the untreated water heaters from Phase I were installed downstream of Nuvo systems and ran for a duration of 2 cartridge changes (i.e. 1 year simulated life). A measured decrease in time to steady state temperature is an indicator of improved efficiency. Just as an increasing time to steady state temperature would indicate scale accumulation, a decreasing rate in the time to steady state temperature would indicate either a decrease in scale or scale density. After installation of the NuvoH_2O system, the water heaters in Phase II experienced a decline in the steady state temperature. While the heaters did not quite reach the rate of the initial measurements (See Figure 7), it is possible they would have if the test had continued past the 1 year simulated life.

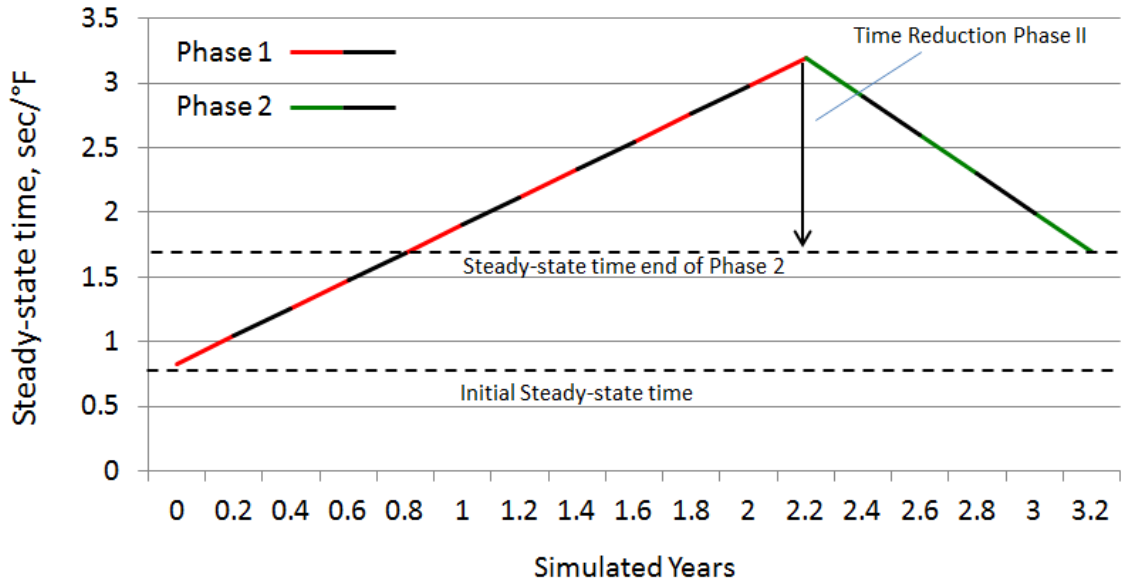
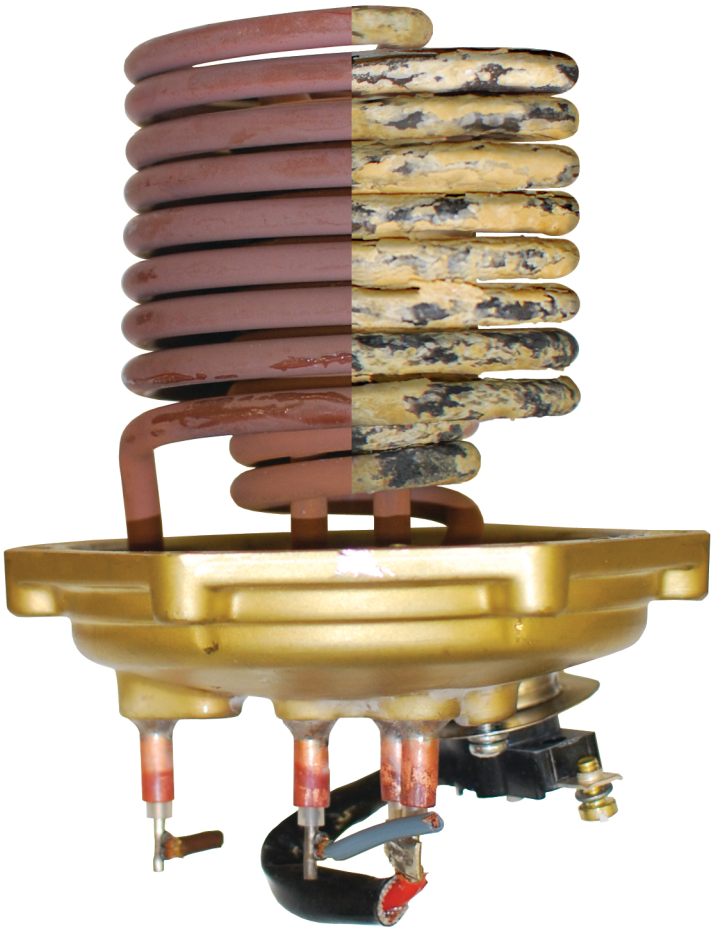


Figure 7. Phase II heaters displayed a decrease in time to steady state.

The study found that the NuvoH_2O system can remove scale and restore efficiency. Of the water heaters tested in Phase II, the majority displayed significant improvement, one showed little to no improvement and one actually failed. This led Battelle to conclude that while the NuvoH_2O system will and does remove scale, the removal process cannot fix corrosion caused by scale and there will be cases where the scale formation has progressed to a point where the NuvoH_2O system will not reverse or restore the appliance to pre-scale condition. A previous Battelle study indicated the point of failure for gas tankless water heaters to be approximately 1.6 years equivalent field service whereas Phase II of the NuvoH_2O Consumer Benefit Study started with electric tankless water heaters that had 2.2 years of equivalent field service. Certainly this study approached, if not surpassed in some cases, the point at which the de-scaling benefits of the NuvoH_2O System may no longer be effective.

Conclusion

The use of the NuvoH$_2$O System will (1) prevent scale and protect the appliance from the corrosive and destructive power of scale; (2) prevent scale and produce energy and potentially a water savings for the consumer, and (3) remove existing scale and in most cases return appliances to a more efficient state of operation.



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