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Product Application

Water heater study reveals significant fuel savings from new Programmable Setback Control

When Bradford White Water Heaters introduced its new intelligent gas control, The Bradford White ICON System™, the control's computer processing technologies ushered in a new realm of possibilities in tank type water heating. One such possibility, a Programmable Setback Control, would enable a user to program their water heater to automatically "set back" or lower the temperature of water stored within the tank for periods of time when hot water demand was low, and raise the temperature for periods of time when hot water demand was high. The theoretical advantage of such a feature would be significant savings in fuel usage.

Possibility turned to reality with Bradford White's introduction of a fully Programmable Setback Control. The new control works with the ICON gas control, and together the two devices "communicate" with each other through an Accessory Module to automatically adjust the set point temperature up or down in accordance with the user's programmed usage patterns (4-period/day, 7-day/week). As previously mentioned, such a feature would result in significant fuel savings due to the fact that the water heater would be doing most of its work during periods when hot water demand was high.

Prior to bringing the Programmable Setback Control to market, Bradford White conducted rigorous testing at the company's state of the art research and development facility in Middleville, Mich. to determine just how much fuel savings would result from the Programmable Setback Control.

Over the course of several months, engineers conducted several side-by-side comparative analyses of water heaters. Each analysis paired two water heaters on adjacent test stations, one equipped with only the ICON gas control (the control group), the other equipped with both the ICON control and the Programmable Setback Control (the experimental group).

The results of each study were consistent — water heaters equipped with a Programmable Setback Control significantly reduced fuel usage. The following are the test procedures and results of one such analysis that was indicative of the study overall.

(Figure A: Typical Family Programming Schedule)

	Wake	Leave	Return	Sleep
Monday				
Time	5:15 AM	7:00 AM	3:15 PM	11:00 PM
Temperature	130°F	85°F	130°F	85°F
Tuesday				
Time	5:15 AM	8:00 AM	3:15 PM	11:00 PM
Temperature	130°F	85°F	130°F	85°F
Wednesday				
Time	5:15 AM	7:00 AM	3:15 PM	11:00 PM
Temperature	130°F	85°F	130°F	85°F
Thursday				
Time	5:15 AM	7:00 AM	3:15 PM	11:00 PM
Temperature	130°F	85°F	130°F	85°F
Friday				
Time	5:15 AM	7:00 AM	2:45 PM	11:45 PM
Temperature	130°F	85°F	130°F	85°F
Saturday				
Time	6:45 AM	--	--	11:45 PM
Temperature	130°F	130°F	130°F	85°F
Sunday				
Time	6:45 AM	--	--	11:00 PM
Temperature	130°F	130°F	130°F	85°F

Background

Bradford White engineers designed a test based upon information in ASHRAE Project Report #1172. A side-by-side comparative

(Figure B: Low Demand Family Programming Schedule)

	Wake	Leave	Return	Sleep
Monday				
Time	6:00 AM	7:00 AM	6:00 PM	8:00 PM
Temperature	130°F	85°F	130°F	85°F
Tuesday				
Time	6:00 AM	7:00 AM	6:00 PM	8:00 PM
Temperature	130°F	85°F	130°F	85°F
Wednesday				
Time	6:00 AM	7:00 AM	6:00 PM	8:00 PM
Temperature	130°F	85°F	130°F	85°F
Thursday				
Time	6:00 AM	7:00 AM	6:00 PM	8:00 PM
Temperature	130°F	85°F	130°F	85°F
Friday				
Time	6:00 AM	7:00 AM	6:00 PM	8:00 PM
Temperature	130°F	85°F	130°F	85°F
Saturday				
Time	7:00 AM	8:00 AM	10:00 PM	12:00 AM
Temperature	130°F	85°F	130°F	85°F
Sunday				
Time	7:00 AM	8:00 AM	10:00 PM	12:00 AM
Temperature	130°F	85°F	130°F	85°F

Table 1. Programmable Setback Control Fuel Usage Test Results

Savings Test	Water Heater	Fuel Usage (ft^3) Test Station #1	Test station#2	Average	Average Fuel Savings
Typical Family	ICON	1647.1	1483.3	1565.2	7.6%
	ICON + PSC	1509.8	1382.1	1446.0	
Low Demand Family	ICON	1738.6	1763.2	1750.9	36.8%
	ICON + PSC	1052.8	1160.1	1106.4	

(PSC = Programmable Setback Control)
Some factors vary during testing (i.e. inlet water temperature, input of water heater, gas pressure and temperature ambient temperature, etc.).

analysis was conducted on two Bradford White water heaters, each equipped with the Bradford White ICON System™ gas control. To test the probability of potential fuel savings, one of the units was equipped with the new Programmable Setback Control, the other was not.

The products selected for the test were two Bradford White M-I-40T6FBN (Residential Upright Energy Saver Natural Gas) with an input rating of 40,000 BTU/hr. Both water heaters were vented atmospherically and were operated on the same draw schedule over a two week time period. The draw patterns, both duration and frequency, varied on a day-to-day basis.

Two test groups were set up to analyze potential fuel savings based on varying demand.

Test group #1, "Typical Family" household, simulated hot water usage for a typical family of four with two working adults and two teenage children. Test group #2, "Low Demand Family" household, simulated the hot water used by one, single adult person.

Test set-up

The two water heaters were set up on adjacent test stations. The cold water supplied to each water heater was approximately 58°F. The cold water supply was from the local water supply system and was hard, with more than 20 grains of hardness. The control groups (water heaters not equipped with the Programmable Setback Control), were set to maintain approximately 130°F tank temperatures. The experimental groups (water heaters equipped with the Programmable Setback Control) were programmed to raise and lower temperatures in accordance with programmed time periods. (See Figures A and B.)

Throughout each test, measurements were taken on both test stations, similar to that done in the Department of Energy's Simulated Use Test. The following measurements were taken: inlet water temperature, outlet water temperature, gallons of water used, cubic feet of gas used, barometric pressure, heating value of natural gas, and ambient temperature. The readings were taken 15 seconds after the start of each draw and every 5 seconds thereafter. The water and gas usage were measured with calibrated water and gas meters, respectively.

After a two week interval, the water heater's switched test stations and the tests were repeated. This was done to account for any differences in the test stations and their instrumentation. Once the second two week test was finished, the results of the two tests were averaged for the final result.

Test results

The "Typical Family" test results revealed that the water heater equipped with the Programmable Setback Control consumed an average 1446.0 $ft.^3$ of gas over the course of testing. The water heater without the Programmable Setback Control consumed an average of 1565.2 $ft.^3$ over the course of testing. The resulting fuel savings of the Programmable Setback Control equipped water heater was approximately 7.6%. This savings was attributed to the fact that the water heater with the Programmable Setback Control automatically dropped its setpoint temperature down to 85°F during standby periods when a user was away from home or asleep. In contrast, the unit without the Programmable Setback Control was constantly maintaining the 130°F water temperature in the tank regardless of demand and usage patterns.

The side-by-side comparative analyses of the "Low Demand Family" test group revealed more pronounced fuel savings. The water heater equipped with the Programmable Setback Control consumed an average of 1106.4 $ft.^3$ of gas, in comparison to 1750.9 $ft.^3$ of gas consumed by the water heater not equipped with the Programmable Setback Control — an approximate average fuel savings of 36.8%. As was the case with the "Typical Family" test group, the programming of lower temperature during standby periods was the reason for the fuel savings. However the "Single Person" or "Low Demand Family" test group savings were amplified due to the longer standby periods during which the unit's temperature was programmed at 85°F.

General summary

The testing showed that the use of the Programmable Setback Control can result in fuel savings for the customer. Homeowners that don't use a lot of hot water, or own vacation homes, can see considerable fuel savings of up to 36%. Even in a "Typical Family" installation, homeowners can see fuel savings of 7% or greater, and my maximizing the efficiency of the Programmable Setback Controller, average families can reduce energy usage even further. ■