Vanguard Powermax 200 Gas-Fired Booster Heater Performance Tests

Application of ASTM Standard
Test Method F 2022-01

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The information in this report is based on data generated at the Food Service Technology Center.

Executive Summary

Vanguard's Powermax 200 gas-fired booster heater is powered by a 199,990 Btu/h input woven ceramic infrared burner housed in a welded stainless steel enclosure. The booster heater is controlled by an advanced microprocessor that regulates the pump and thermostat. Figure ES-1 illustrates the Vanguard's Powermax 200 gas-fired booster heater, as tested at the Food Service Technology Center (FSTC).

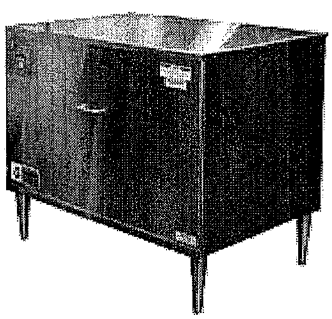

Figure ES-1.
Vanguard Powermax 200 Gas-fired booster heater.

FSTC engineers tested the booster heater under the tightly controlled conditions of the American Society for Testing and Materials' (ASTM) standard test method.[1] Booster heater performance is characterized by preheat time and energy consumption, idle energy rate, energy efficiency, and flow rate.

Booster heater performance was determined by testing the unit under four conditions (maximum flow capacity with inlet water temperatures of 140°F and 110°F and 50% flow capacity with inlet water temperatures of 140°F and 110°F). The Powermax 200 achieved 88% energy efficiency with a maximum flow capacity of 8.19 gal/min.

Energy efficiency is a measure of how much of the energy that a booster heater consumes is actually delivered to the water during the testing process. Booster heater energy efficiency is therefore defined by the following relationship:

$$Energy\ Efficiency = \frac{Energy\ to\ Water}{Burner\ Energy + Pump/Control\ Energy}$$

A summary of the test results is presented in Table ES-1.

[1] American Society for Testing and Materials. 2001. *Standard Test Method for the Performance of Booster Heaters.* ASTM Designation F 2022-01, in *Annual Book of ASTM Standards,* Philadelphia.

Table ES-1. Summary of Booster Heater Performance.

Rated Energy Input Rate (Btu/h)	199,990
Measured Energy Input Rate (Btu/h)	196,436
Storage Capacity (gal)	6.2
140°F Inlet Temperature [a]	
Preheat Time (min)	1.94
Preheat Energy (Btu)	4,854
Flow Rate (gal/h)	491.5 ± 14.0 [b]
Temperature Rise (°F)	43.7
Energy Efficiency (%)	88.1 ± 2.0 [b]
110°F Inlet Water Temperature [a]	
Preheat Time (min)	2.77
Preheat Energy (Btu)	7,854
Flow Rate (gal/h)	288.8 ± 8.9 [b]
Temperature Rise (°F)	73.5
Energy Efficiency (%)	87.0 ± 0.6 [b]
Idle Energy Rate (Btu/h)	3,313
Idle Electric Energy Rate (W)	69.4

[a] Efficiency and flow rate are from the maximum capacity tests.
[b] This range indicates the experimental uncertainty in the test result based on a minimum of three test runs.

A booster heater's job is to raise the temperature of the water from the primary water heater to a minimum of 180°F to provide the sanitizing rinse for the dishwasher. Since most primary building water heaters provide water at 140°F (restaurants) or 110°F (schools and institutions), the ASTM test method evaluates booster heater performance under both conditions. Figure ES-2 and ES-3 display the Powermax 200's ability to maintain a 180°F outlet temperature during the maximum flow capacity tests for both the inlet temperatures.

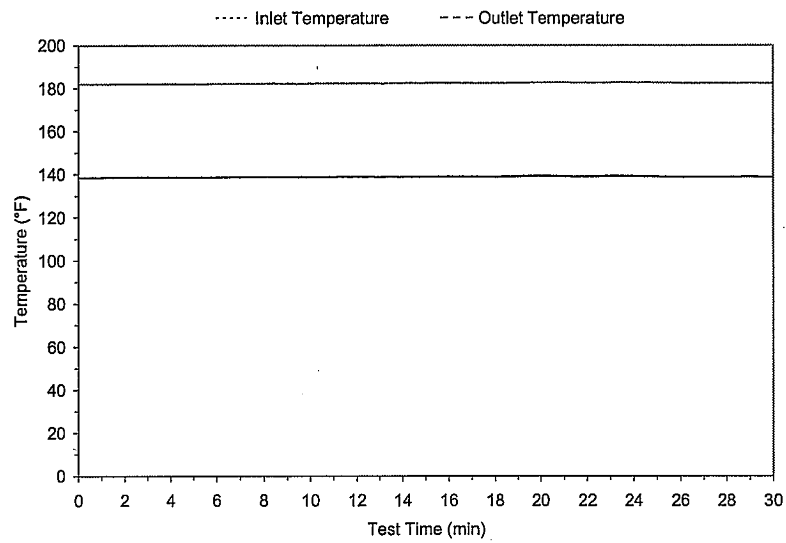

Figure ES-2.
140°F inlet water temperature during Max Capacity Test.

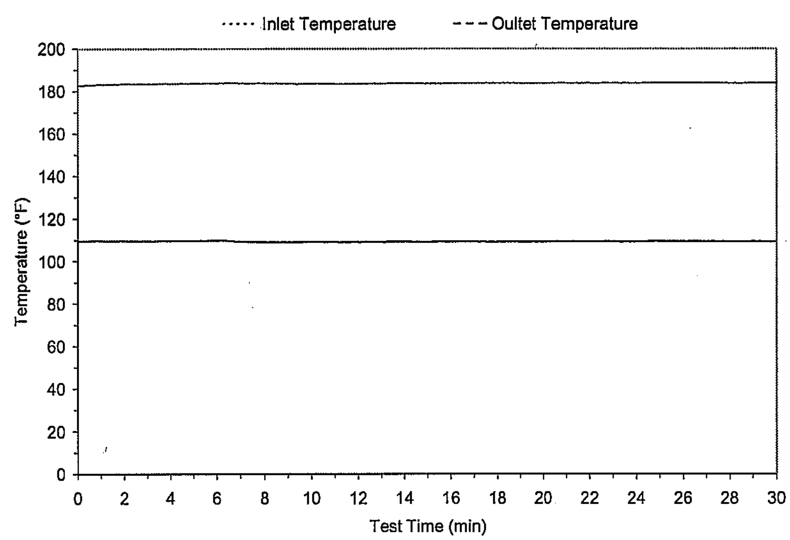

Figure ES-3.
110°F inlet water temperature during Max Capacity Test.

Executive Summary

Vanguard's Powermax 200 achieved excellent energy efficiency and flow capacity results during testing at the Food Service Technology Center. With 88% energy efficiency and a flow capacity approaching 500 gal/h, the Powermax 200 has established itself as a leader in gas-fired booster heaters. The Powermax's high efficiency was complimented by a fairly low idle rate. In fact, Vanguard's idle rate was among the lowest in its class.

The Powermax exhibited a short 1.9 minute preheat from 140°F, while requiring only slightly longer (2.8 minutes) to preheat from 110°F. With its high efficiency, low idle rate and quick preheat, Vanguard's Powermax 200 was an excellent all-around performer.

1 Introduction

Background

Dishrooms are one of the most energy-intensive segments of a food service operation, typically representing 18% of a restaurant's total energy bill.[1] The high energy costs associated with operating a large dishwasher are further exacerbated by the electric booster heater's costs, which provide the 180°F sanitizing rinse. A new generation of gas-fired booster heaters provides operators with a viable (and economic) alternative to the traditional electric booster heaters.

Dedicated to the advancement of the food service industry, the Food Service Technology Center (FSTC) has focused on the development of standard test methods for commercial food service equipment since 1987. The primary component of the FSTC is a 10,000 square-foot appliance laboratory equipped with energy monitoring and data acquisition hardware, 60 linear feet of canopy exhaust hoods integrated with utility distribution systems, appliance setup and storage areas, and a state-of-the-art demonstration and training facility.

The test methods, approved and ratified by the American Society for Testing and Materials (ASTM), allow benchmarking of equipment such that users can make meaningful comparisons among available equipment choices. By collaborating with the Electric Power Research Institute (EPRI) and the Gas Technology Institute (GTI) through matching funding agreements, the test methods have remained unbiased to fuel choice. End-use customers and commercial appliance manufacturers consider the FSTC to be the national leader in commercial food service equipment testing and standards, sparking alliances with several major chain customers to date.

FSTC engineers previously monitored the energy and water consumption of a dishroom utilizing a low-temperature dishwasher as a part of a whole-building monitoring project.[2,3] These studies reported that the dishroom accounted for 97% of a food service operation's total hot water consumption. Of that amount, the dishwasher consumed nearly half of the dishroom's hot water. The widespread usage of high-temperature dishwashers in the food service industry led the FSTC to develop test methods for quantifying the energy consumption and performance of these systems. These draft test methods were subsequently approved and ratified by ASTM. [4-6]

During the course of developing the test method for booster heaters (ASTM designation F2022-01), FSTC engineers tested several different units. [7] Booster heater performance is characterized by preheat time and energy consumption, idle energy consumption rate, pilot energy consumption rate, and energy efficiency and capacity at two supply temperatures (140°F and 110°F).

Vanguard's Powermax 200 gas-fired booster heater features a woven ceramic infrared burner in a welded stainless steel enclosure, with an advanced microprocessor to control ignition and thermostat response.

This report presents the results of applying the ASTM test method to the Vanguard's Powermax 200. The glossary in Appendix A is provided so that the reader has a quick reference to the terms used in this report.

Objectives

The objective of this report is to examine the operation and performance of Vanguard's Powermax 200, gas infrared booster heater under the controlled conditions of the ASTM standard test method. The scope of this testing is as follows:

1. Verify that the appliance is operating at the manufacturer's rated energy input.
2. Determine the time and energy required to preheat the appliance from an inlet supply water temperature of 140 $^{+0}/_{-3}$°F and 110 $^{+0}/_{-3}$°F to a thermostat setting of 183 ± 3°F.

3. Characterize the idle energy use with the booster heater tank stabilized with an inlet water supply temperature of 140 $^{+0}/_{-3}$°F and 110 $^{+0}/_{-3}$°F.
4. Document the flow capacity rate, energy rate, and energy efficiency with 140 $^{+0}/_{-3}$°F and 110 $^{+0}/_{-3}$°F inlet water supply temperature to the booster heater.
5. Document the energy rate and energy efficiency at 50% of flow capacity with 140 $^{+0}/_{-3}$°F and 110 $^{+0}/_{-3}$°F inlet water supply temperature to the booster heater.

Appliance Description

Vanguard's Powermax, gas-fired booster heater has an input rating of 199,990 Btu/h. The booster heater uses a microprocessor to control the temperature of a woven ceramic infrared burner housed in a welded stainless enclosure. A removable panel allows for easy access to booster heater internals for maintenance. See Figure 1-1.

Appliance specifications are listed in Table 1-1, and the manufacturer's literature is in Appendix B.

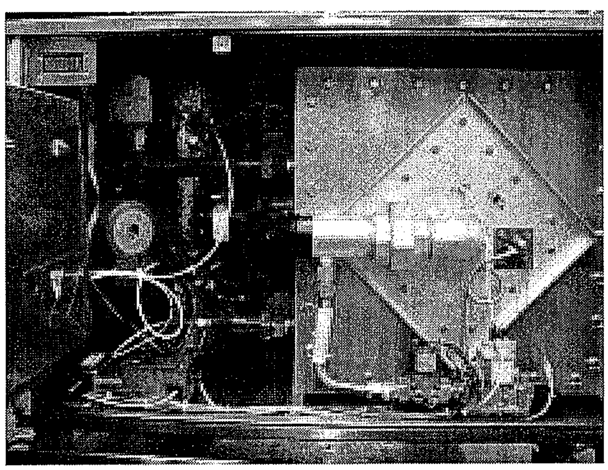

Figure 1-1. Powermax 200 heat exchanger.

4 Conclusions

Vanguard's Powermax 200 achieved excellent energy efficiency and flow capacity results during testing at the Food Service Technology Center. Gas-fired booster heaters have seen improvements in design and performance through collaboration between manufacturers and testing facilities such as the FSTC. The ASTM standardized test method for booster heaters can quantify design improvements, which have greatly impacted the acceptance of gas-fired booster heaters within the food service industry. During maximum flow capacity testing, Vanguard's Powermax 200 posted some of the highest energy efficiency results seen to date. With 88% energy efficiency and a flow capacity approaching 500 gal/h, the Powermax 200 has established itself as a leader in gas-fired booster heaters.

This Vanguard booster heater showed little drop-off in efficiency during the half-capacity tests, indicating that the unit will perform quite well with an intermittent load—such as a door-type dishwasher that washes one rack at a time. The 87% half-load energy efficiency was complimented by a fairly low idle rate. In fact, with a 1.7% idle duty cycle, Vanguard's idle rate was among the lowest for a gas-fired booster heater in its class.

Operators wanting to save energy by turning the booster heater off overnight will be pleased with the Powermax's short preheat. Preheat with a 140°F supply was a blazing 1.9 minutes, while a slightly longer 2.8 minute preheat was required for a 110°F supply. With its high efficiency, low idle rate and quick preheat, Vanguard's Powermax 200 was an excellent all-around performer.

5 References

1. Claar, C.N., R.P. Mazzucchi, J.A., Heidell. 1985. *The Project on Restaurant Energy Performance (PREP) – End-Use Monitoring and Analysis.* Prepared for the Office of Building Energy Research and Development, DOE, May.

2. Kaufman, D., Selden, M. 1990. *Learning Center Dining Building.* Prepared for the Department of Research and Development. Report No. 008.1-90.17. San Ramon, California: Pacific Gas and Electric Company.

3. Kaufman, D., Selden, M. 1990. *Dishroom and Warewasher Study Stero Single Rack, Low Temperature, Door Type Dishwasher.* Prepared for the Department of Research and Development. Report No. 008.1-91.1. San Ramon, California: Pacific Gas and Electric Company.

4. American Society for Testing and Materials. 1996. *Standard Test Method for Energy Performance of Single-Rack Hot Water Sanitizing, Commercial Dishwashing Machines.* ASTM Designation F1696-96, in *Annual Book of ASTM Standards,* Philadelphia.

5. American Society for Testing and Materials. 1998. *Standard Test Method for the Energy Performance of Rack-Conveyor, Hot Water Sanitizing, Door-Type Commercial Dishwashing Machines.* ASTM Designation F1920-98, in *Annual Book of ASTM Standards,* Philadelphia.

6. American Society for Testing and Materials. 2001. *Standard Test Method for the Performance of Booster Heaters.* ASTM Designation F2022-01, in *Annual Book of ASTM Standards,* Philadelphia.

7. Gil Ashton Publishing, LLC. *Gas-fired booster Heaters Take the Test,* Foodservice Equipment Reports, May, 2002.