Eneron, Inc. Prototype
Commercial Stock Pot Testing

FSTC Report 5011.08.12

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Executive Summary

Range tops are one of the most widely used pieces of cooking equipment in foodservice, but are notoriously inefficient. Typical energy efficiencies are 25 – 30% for standard models and 30 – 40% for high-efficiency models.[1]

Where previous efforts to improve energy-efficiency have focused on the range top, Eneron, Inc. has taken the approach of focusing on the cooking vessel. Their unique pot design uses aluminum fins to increase the surface area exposed to the burner flame, maximizing the amount of heat transferred to the bottom of the pot.

The objective of this report was to document the energy efficiency and production capacity of three range tops when using two prototype Eneron, Inc. stock pot designs[†]. The results were compared to baseline numbers obtained using a standard stock pot. The testing was performed under the controlled conditions of ASTM Designation F 1496-03, *Standard Test Method for Performance of Range Tops*.[2]

The cooking-energy efficiency and production capacity were determined by heating 20.0 lbs of water from 70°F to 200°F. An additional test determined if there was any reduction in energy use when the Eneron, Inc. pots were used to hold water at a steady simmer.

Tables ES-1 and ES-2 present the test results.

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[1] Fisher, D., 2002. *Commercial Cooking Appliance Technology Assessment.* Food Service Technology Center Report 5011.02.26.

[2] American Society for Testing and Materials. 1996. *Standard Test Method for Performance of Range Tops.* ASTM Designation F 1521-03, in *Annual Book of ASTM Standards,* West Conshohocken, PA.

[†] Note: Stock pot designs are Patent Pending. Contact: Lee Huang, Eneron, Inc. 550 Irven Court, Palo Alto, CA. 94306 (408) 568-3556

Executive Summary

Table ES-1. Energy Efficiency and Production Capacity Test Results.

	Standard Pot	Eneron, Inc. Design 1	Eneron, Inc. Design 2
Ring-Burner Range A			
Burner Energy Rate (Btu/h)	28,800	29,000	28,800
Heat-Up Time (min)	21.4	14.4	13.4
Production Capacity (lb/h)	56.0 ± 1.1	83.5 ± 2.3	89.8 ± 1.4
Cooking-Energy Efficiency (%)	27.0 ± 0.8	40.7 ± 1.2	44.0 ± 1.0
Ring-Burner Range B			
	Standard Pot	Eneron, Inc. Design 1	Eneron, Inc. Design 2
Burner Energy Rate (Btu/h)	31,600	31,500	31,700
Heat-Up Time (min)	15.8	10.9	10.4
Production Capacity (lb/h)	76.1 ± 1.9	109.8 ± 2.0	115.0 ± 4.4
Cooking-Energy Efficiency (%)	33.5 ± 0.5	49.6 ± 0.4	51.6 ± 0.6
Star-Burner Range Top			
	Standard Pot	Eneron, Inc. Design 1	Eneron, Inc. Design 2
Burner Energy Rate (Btu/h)	21,920	22,170	22,170
Heat-Up Time (min)	24.0	13.5	12.8
Production Capacity (lb/h)	50.1 ± 1.1	89.1 ± 4.8	93.5 ± 1.5
Cooking-Energy Efficiency (%)	31.7 ± 0.8	57.4 ± 2.6	59.8 ± 1.6

Table ES-2. Simmer Energy Rate Test Results on Star-Burner Range Top.

	Standard Pot	Eneron, Inc. Design 1	Eneron, Inc. Design 2
Test Time (min)	60.0	60.0	60.0
Average Water Temperature (°F)	204.2	204.2	205.6
Burner Energy Rate (Btu/h)	11,180	8,080	8,060

With improved performance and reduced energy use, the Eneron, Inc. pots appear to be an attractive proposition, especially when the replacement cost is that of a cooking utensil instead of an entire appliance.

1 Introduction

Background

Range tops are one of the most widely used pieces of cooking equipment in foodservice. They are indispensible for their versatility, but gas-fired models are notoriously inefficient when it comes to energy use. While the range top may be used for a variety of tasks, the cooking process is always the same—the appliance provides heat to a cooking vessel from below.

There has been an enormous effort to increase the efficiency of gas range tops, but a major obstacle is the simplicity of the appliance itself. Unlike a fryer or oven, one cannot simply add insulation or upgrade the control technology to improve energy-efficiency. Numerous designs have incorporated advanced burner types such as power, sealed combustion and infrared, but none have achieved widespread success. These technologies and the industry efforts behind them are detailed in the Food Service Technology Center publication *Commercial Cooking Appliance Technology Assessment*.[1]

Range top energy performance is determined by applying ASTM Standard F 1521-03 *Standard Test Method for Performance of Range Tops*.[2] Application of the Standard Test Method has shown energy efficiencies of 25 – 30% for standard gas range tops and 30 – 40% for high efficiency gas range tops.[1,3-5]

Where previous efforts to improve energy-efficiency have focused on the range top, Eneron, Inc. has taken the approach of improving the cooking vessel. Their unique pot design uses aluminum fin exchange channels to increase effective surface area exposed to the burner flame, maximizing the amount of heat transferred to the bottom of the pot.

There has been research on the effect of different cooking vessels on range top performance, but the focus was on pot size and thickness, rather than advanced design.[6]

Introduction

Objective

The objective of this report was to document the energy efficiency and production capacity of three range tops when using two prototype Eneron, Inc. stock pot designs. The results were compared to baseline numbers obtained using a standard stock pot. The testing was performed under the controlled conditions of ASTM Designation F 1496-03, *Standard Test Method for Performance of Range Tops*. The scope of this testing was as follows:

1. Using a standard pot, determine the cooking-energy efficiency and production capacity of three different range tops.
2. Determine the cooking-energy efficiency and production capacity of the three range tops using two unique Eneron, Inc. pot designs.
3. Determine the energy consumption rate of a star-burner range when simmering water in each of the three pots at a steady 205°F.

Cooking Pot Description†

The standard pot used for baseline testing was a 12-inch diameter, aluminum stock pot with a capacity of 24 quarts (Figure 1-1). It was purchased off the shelf from a restaurant supply house and represented a typical cooking vessel designed for use on a commercial range top. The first Eneron, Inc. stock pot was the same model as the standard pot, with the bottom modified to include 1/16-inch wide aluminum fins. The fins were 5/8-inch high and spaced 1/8-inch apart. The first stock pot design is shown in Figure 1-2. The second Eneron, Inc. stock pot added 1/8-inch wide perpendicular grooves in the fins, producing a bottom of small rectangular fins. The second stock pot design is shown in Figure 1-3.

† Note: Stock pot designs are Patent Pending. Contact: Lee Huang, Eneron, Inc. 550 Irven Court, Palo Alto, CA 94306 (408) 568-3556.

Figure 1-1.
Standard pot.

Figure 1-2.
Prototype Design 1.

Figure 1-3.
Prototype Design 2.

Appliance Description

Each pot was tested on three range tops for this study:

Two Ring-burner range tops rated at 30,000 Btu/hr per burner and a Star-burner range top rated at 20,000 Btu/hr per burner. A Ring burner emits flame in a concentric circular pattern, and a Star burner emits flame in a traditional star pattern. While both Ring burners were rated at 30,000 Btu/h, they were slightly differing in design and produced unique flame patterns.

2 Methods

Setup and Instrumentation

The range tops were installed under a 4-foot-deep canopy hood that was 6 feet, 6 inches above the floor. The hood operated at a nominal exhaust rate of 300 cfm per linear foot of hood. There was a minimum of 6 inches of clearance between the vertical plane of the front of the range and the edge of the hood. During testing the room was maintained at 75 ± 5°F.

Thermocouples were used to monitor the ambient temperature of the lab and the inlet temperature of the natural gas. A pressure gauge was used to monitor the gas pressure. A barometric pressure gauge was used to monitor the barometric pressure in the laboratory. Natural gas consumption was measured using a positive displacement-type gas meter that generated a pulse every 0.1 ft^3.

The stockpot lid had a quarter inch hole drilled near its center to allow a thermocouple to pass through. A $^1/_8$-inch diameter, beaded, type K thermocouple was inserted from the top of the lid, and reached down to approximately 2 inches above the bottom of the stockpot. This probe monitored the temperature of the water during the tests. The lid and thermocouple are shown in Figure 2-1

Figure 2-1.
Lid and thermocouple.

All instrumentation was connected to an automated data acquisition system that recorded data every 5 seconds. A Cutler-Hammer gas calorimeter was used to determine the gas heating value during each test. All gas measurements were corrected to standard conditions.

Energy Efficiency and Production Capacity

The cooking-energy efficiency and production capacity were determined by heating 20.0 lbs of water from 70°F to 200°F. Testing began with the standard pot on Ring-Burner Range A. The front-right burner was first stabilized with a 14-inch standard pot containing 20lbs of 70°F water and the burner operating at 50% input. After 30 minutes the stabilization pot was removed, the burner was increased to full input, and the test pot containing the 70°F water was placed on the range top. The test began just as the pot was placed on the burner, with the lid in place and the pot centered on the burner grate. No other burner operated during the test, and the pot was not disturbed at any time. The test ended when the thermocouple indicated the water temperature reached 200°F.

This test was repeated two additional times for a total of three test runs. After the third test on the standard pot, testing progressed to the first and second Eneron, Inc. pots.

After completing three tests using each pot on Ring-Burner Range A, the sequence was repeated on Ring-Burner Range B and the Star-Burner Range. Three tests were performed for each scenario as required by the ASTM test method to ensure the reported cooking-energy efficiency and production capacity results had an experimental uncertainty of less than ± 10.0 %. The results from the individual test runs were averaged, and the absolute uncertainty was calculated based on the standard deviation of the results.

Simmer Energy Rate

The simmer energy rate test determined if there was a reduction in energy use when the Eneron, Inc. pots were used to hold water at a steady simmer.

Methods

To conduct the test, the standard pot was filled with 20.0 lbs of water and placed on the Star-Burner Range Top. After raising the water temperature to 205°F, the lid was removed from the pot and the burner was adjusted to hold the water temperature at 205 ± 1°F. Time and energy was monitored for 1 hour to allow calculation of the simmer energy rate.

After testing the standard pot, the test was repeated using the first and second Eneron, Inc. pot designs.

3 Results

Energy Efficiency and Production Capacity

Three test runs were performed for each stock pot on each of the three range tops to determine energy efficiency and production capacity. The results from Ring-Burner Range A are reported in Table 3-1.

Table 3-1. Results from Ring-Burner Range A.

	Standard Pot	Eneron, Inc. Design 1	Eneron, Inc. Design 2
Burner Energy Rate (Btu/h)	28,800	29,000	28,800
Heat-Up Time (min)	21.4	14.4	13.4
Production Capacity (lb/h)	56.0 ± 1.1	83.5 ± 2.3	89.8 ± 1.4
Cooking-Energy Efficiency (%)	27.0 ± 0.8	40.7 ± 1.2	44.0 ± 1.0

The results for the Eneron, Inc. stock pots showed a substantial improvement over the standard stock pot. Test time was shortened by 7.0 minutes for the first design and 8.0 minutes for the second design. This resulted in production capacity increases of 27.5 lbs/h and 33.8 lbs/h, respectively. Cooking-energy efficiency was increased over the standard pot by 50.7% for the first design, and 63.0% for the second design.

Figure 3-1 plots the temperature rise of the water in each pot on Ring-Burner Range A. Each line represents the average result from three test runs.

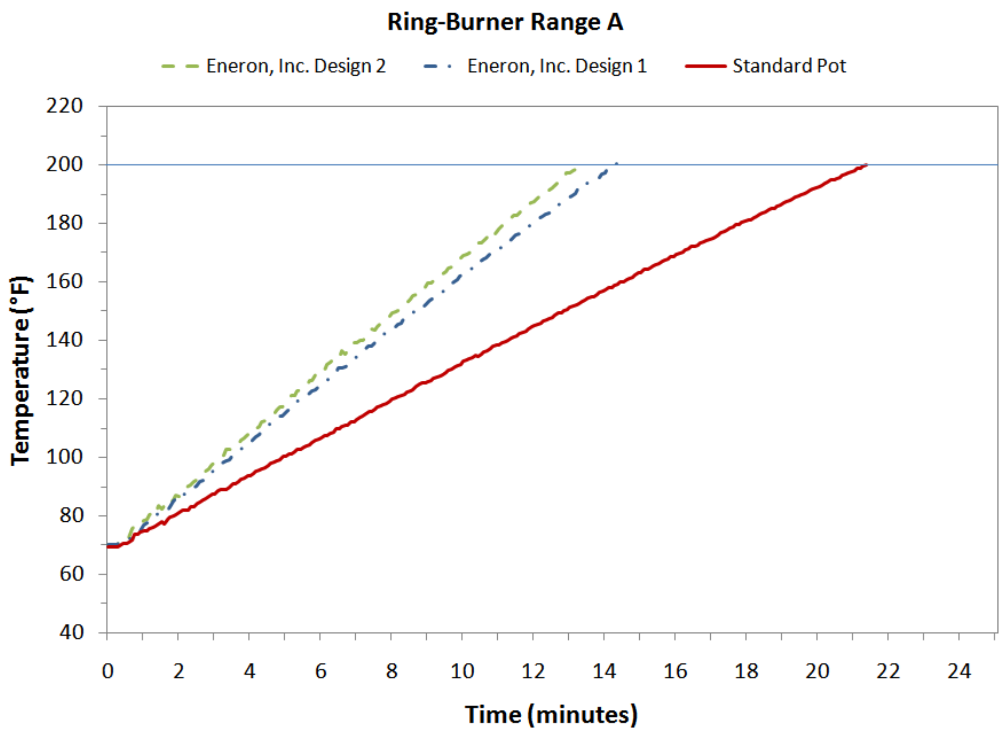

Figure 3-1.
Temperature vs. Time-Ring-Burner Range A.

Test results for the three pots on Ring-Burner Range B are shown in Table 3-2.

Table 3-2. Results from Ring-Burner Range B.

	Standard Pot	Eneron, Inc. Design 1	Eneron, Inc. Design 2
Burner Energy Rate (Btu/h)	31,600	31,500	31,700
Heat-Up Time (min)	15.8	10.9	10.4
Production Capacity (lb/h)	76.1 ± 1.9	109.8 ± 2.0	115.0 ± 4.5
Cooking-Energy Efficiency (%)	33.5 ± 0.5	49.6 ± 0.4	51.6 ± 0.6

Ring-Burner Range B saw even larger improvements than the previous unit. Production capacity jumped 33.7 lbs/h with the first Eneron Inc. design and 38.9 lbs/h with the second. Efficiencies increased by 48.5% and 54.0% for the two new designs.

Figure 3-2 plots the temperature rise of the water in each pot on Ring-Burner Range B. Each line represents the average result from three test runs.

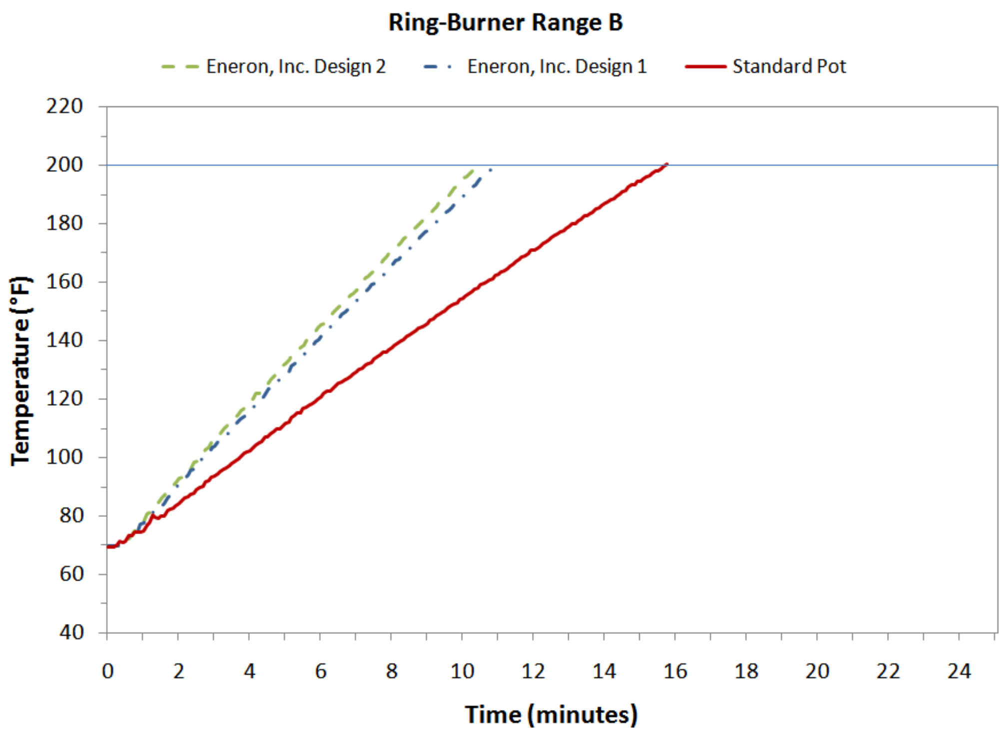

Figure 3-2. Temperature vs. Time-Ring-Burner Range B.

The Star Burner Range was rated at 20,000 Btu/h per burner, and therefore was expected to have longer heat-up times than the 30,000 Btu/h burners. The results from the Star-Burner Range tests are shown in Table 3-3.

Table 3-3. Results from Star-Burner Range Top.

	Standard Pot	Eneron, Inc. Design 1	Eneron, Inc. Design 2
Burner Energy Rate (Btu/h)	21,920	22,170	22,170
Heat-Up Time (min)	24.0	13.5	12.8
Production Capacity (lb/h)	50.1 ± 1.1	89.1 ± 4.8	93.5 ± 1.5
Cooking-Energy Efficiency (%)	31.7 ± 0.8	57.4 ± 2.6	59.8 ± 1.6

The results from the Star-Burner Range Top were the most impressive out of the three appliances, easily showing the largest improvements over the baseline levels. Test times were reduced by 10.5 and 11.2 minutes. Production capacities increased by 39.1 lbs/h and 43.5 lbs/h. Cooking efficiencies increased by an amazing 81.1% and 88.6%.

Figure 3-3 plots the temperature rise of the water in each pot on the Star-Burner Range Top. Each line represents the average result from three test runs.

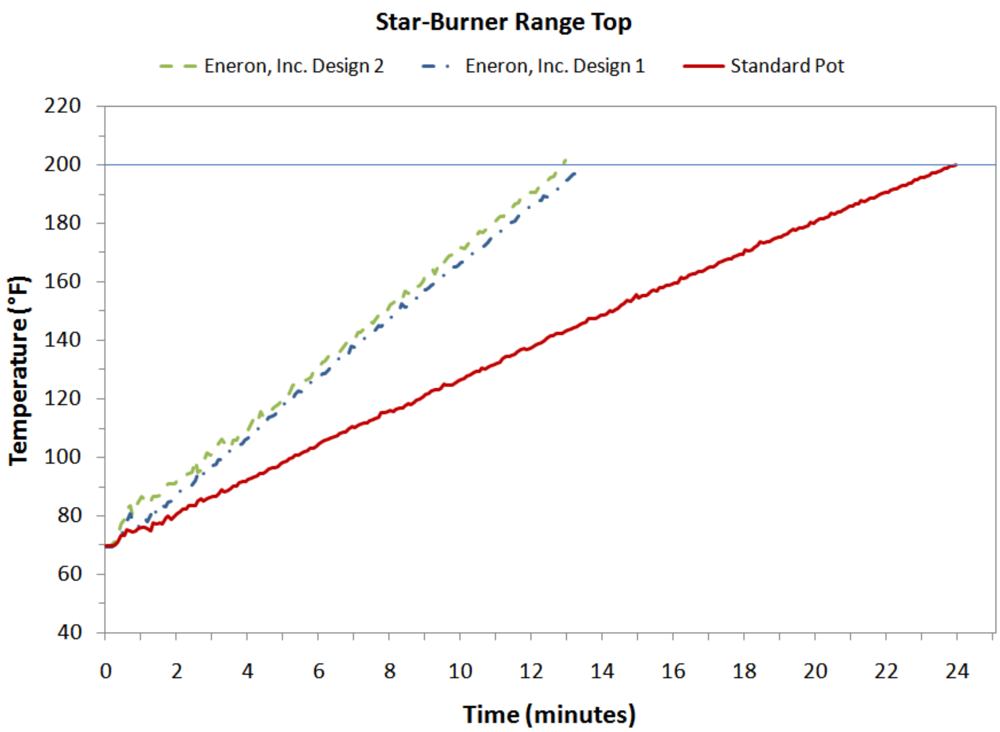

Figure 3-3. Temperature vs. Time-Star-Burner Range Top.

Focusing on the Eneron, Inc. pot designs, the test times were slightly longer on the Star-Burner Range Top than on Ring-Burner Range B, but when compared to Ring-Burner Range A they were actually faster. This is an outstanding achievement, considering the star-burner range is operating at a much lower energy rate.

Simmer Energy Rate

Table 3-4 shows the results of the simmer energy rate testing on the star-burner range top.

Table 3-4. Simmer Energy Rate Results.

	Standard Pot	Eneron, Inc. Design 1	Eneron, Inc. Design 2
Test Time (min)	60.0	60.0	60.0
Average Water Temperature (°F)	204.2	204.2	205.6
Burner Energy Rate (Btu/h)	11,180	8,080	8,060

Each of the Eneron, Inc. pots allowed the star burner to operate about 3,100 Btu/h lower than the standard pot while holding a steady simmer. As opposed to the energy-efficiency tests, the results from the two prototype pot designs were nearly identical, presumably because of the much lower flame level on the burner.

4 Conclusions

Using the Eneron, Inc. prototype stock pots proved to be a remarkably effective method of increasing range-top performance. Heat-up times were substantially reduced and production capacities increased. Energy performance was also significantly improved. By simply using an advanced pot design, the 25 – 30% energy efficiency of a standard, gas-fired range top was raised to over 40%. When used on a range top with an energy efficiency in the low 30's, the number approached 60%.

The benefits were not limited to full-input operation, as shown by the simmer tests. Less energy was required to maintain temperature, meaning a further increase in savings.

With improved cooking performance and reduced energy use, the Eneron, Inc. pots appear to be an attractive proposition, especially when the replacement cost is that of a cooking utensil instead of an entire appliance.

5 References

1. Fisher, D., 2002. *Commercial Cooking Appliance Technology Assessment.* Food Service Technology Center Report 5011.02.26.

2. American Society for Testing and Materials. 1996. *Standard Test Methods for Performance of Range Tops.* ASTM Designation F 1521-03, in *Annual Book of ASTM Standards*, West Conshohocken, PA.

3. Blessant, J.,1995. *Development and Validation of a Uniform Testing Procedure for Range Tops*. Pacific Gas and Electric Company Department of Research and Development Report 1022.95.20, October.

4. Young, R., Cesio, C., 1995. *Montague Model V-136-5 Heavy Duty 30,000 Btu/hr Open Top Range: Application of ASTM Standard Test Method F1521-94.* Food Service Technology Center Report 5011.94.6, October.

5. Young, R., Cesio, C., 1995. *Montague Model V136-5 Heavy-Duty Open Top Gas Range: Application of ASTM Standard Test Method F1521-94*. Food Service Technology Center Report 5011.94.4, October.

6. Wong, F., 2002. *Comparison of Commercial Range Top Test Methods*. Food Service Technology Center Report 5011.02.16-2nd Edition, June.

Appendices

A Glossary

Cooking Energy (kWh or kBtu)

The total energy consumed by an appliance as it is used to cook a specified food product.

Cooking Energy Consumption Rate (kW or kBtu/h)

The average rate of energy consumption during the cooking period.

Cooking-Energy Efficiency (%)

The quantity of energy input to the food products; expressed as a percentage of the quantity of energy input to the appliance during the heavy-, medium-, and light-load tests.

Duty Cycle (%)
Load Factor

The average energy consumption rate (based on a specified operating period for the appliance) expressed as a percentage of the measured energy input rate.

$$\text{Duty Cycle} = \frac{\text{Average Energy Consumption Rate}}{\text{Measured Energy Input Rate}} \times 100$$

Energy Input Rate (kW or kBtu/h)
Energy Consumption Rate
Energy Rate

The peak rate at which an appliance will consume energy, typically reflected during preheat.

Heating Value (Btu/ft^3)
Heating Content

The quantity of heat (energy) generated by the combustion of fuel. For natural gas, this quantity varies depending on the constituents of the gas.

Idle Energy Rate (kW or Btu/h)
Idle Energy Input Rate
Idle Rate

The rate of appliance energy consumption while it is "idling" or "holding" at a stabilized operating condition or temperature.

Idle Temperature (°F, Setting)

The temperature of the cooking cavity/surface (selected by the appliance operator or specified for a controlled test) that is maintained by the appliance under an idle condition.

Idle Duty Cycle (%)
Idle Energy Factor

The idle energy consumption rate expressed as a percentage of the measured energy input rate.

$$\text{Idle Duty Cycle} = \frac{\text{Idle Energy Consumption Rate}}{\text{Measured Energy Input Rate}} \times 100$$

Glossary

Measured Input Rate (kW or Btu/h)
Measured Energy Input Rate
Measured Peak Energy Input Rate

The maximum or peak rate at which an appliance consumes energy, typically reflected during appliance preheat (i.e., the period of operation when all burners or elements are on inch).

Pilot Energy Rate (kBtu/h)
Pilot Energy Consumption Rate

The rate of energy consumption by the standing or constant pilot while the appliance is not being operated (i.e., when the thermostats or control knobs have been turned off by the food service operator).

Preheat Energy (kWh or Btu)
Preheat Energy Consumption

The total amount of energy consumed by an appliance during the preheat period.

Preheat Rate (°F/min)

The rate at which the cook zone heats during a preheat.

Preheat Time (minute)
Preheat Period

The time required for an appliance to "preheat" from the ambient room temperature (75 ± 5°F) to a specified (and calibrated) operating temperature or thermostat set point.

Production Capacity (lb/h)

The maximum production rate of an appliance while cooking a specified food product in accordance with the heavy-load cooking test.

Production Rate (lb/h)
Productivity

The average rate at which an appliance brings a specified food product to a specified cooked inch condition.

Rated Energy Input Rate
(kW, W or Btu/h, Btu/h)
Input Rating (ANSI definition)
Nameplate Energy Input Rate
Rated Input

The maximum or peak rate at which an appliance consumes energy as rated by the manufacturer and specified on the name.

Simmer Energy Rate (Btu/h)

The rate of appliance energy consumption while maintaining a specified volume of liquid at 205 ± 1ºF.

Test Method

A definitive procedure for the identification, measurement, and evaluation of one or more qualities, characteristics, or properties of a material, product, system, or service that produces a test result.

B Cooking-Energy Efficiency Data

Table B-1. Specific Heat and Latent Heat.

Specific Heat (Btu/lb, °F)	
Water	1.0
Aluminum	0.22

Table B-2. Standard Pot on Ring Burner A.

	Test #1	Test #2	Test #3
Measured Values			
Gas Consumed (ft^3)	10.5	10.3	10.4
Test Time (min)	21.5	21.5	21.3
Weight of Water (lb)	20.00	20.00	20.00
Weight of Cooking Container (lb)	5.490	5.490	5.490
Initial Temperature of Water (°F)	69.7	69.4	68.8
Final Temperature of Water (°F)	200.2	200.1	200.3
Calculated Values			
Energy to Water (Btu)	2610	2614	2630
Energy to Cooking Container (Btu)	158	158	159
Energy to Burner (Btu)	10,402	10,195	10,279
Cooking-Energy Efficiency (%)	26.6	27.2	27.1
Burner Energy Rate (Btu/h)	29,029	28,452	28,954
Production Capacity (lb/h)	55.8	55.8	56.3

Cooking-Energy Efficiency Data

Table B-3. Eneron, Inc. Design 1 on Ring Burner A.

	Test #1	Test #2	Test #3
Measured Values			
Gas Consumed (ft³)	7.0	6.9	7.1
Test Time (min)	14.3	14.3	14.5
Weight of Water (lb)	20.00	20.00	20.00
Weight of Cooking Container (lb)	7.740	7.740	7.740
Initial Temperature of Water (°F)	70.3	70.1	70.3
Final Temperature of Water (°F)	200.7	200.1	200.9
Calculated Values			
Energy to Water (Btu)	2608	2600	2612
Energy to Cooking Container (Btu)	222	221	222
Energy to Burner (Btu)	6,941	6,846	7,042
Cooking-Energy Efficiency (%)	40.8	41.2	40.3
Burner Energy Rate (Btu/h)	29,122	28,743	29,139
Production Capacity (lb/h)	83.9	83.9	82.8

Table B-4. Eneron, Inc. Design 2 on Ring Burner A.

	Test #1	Test #2	Test #3
Measured Values			
Gas Consumed (ft³)	6.5	6.5	6.5
Test Time (min)	13.3	13.4	13.4
Weight of Water (lb)	20.00	20.00	20.00
Weight of Cooking Container (lb)	7.340	7.340	7.340
Initial Temperature of Water (°F)	70.8	70.3	69.3
Final Temperature of Water (°F)	200.4	200.4	200.9
Calculated Values			
Energy to Water (Btu)	2592	2602	2632
Energy to Cooking Container (Btu)	209	210	213
Energy to Burner (Btu)	6,418	6,416	6,409
Cooking-Energy Efficiency (%)	43.6	43.8	44.4
Burner Energy Rate (Btu/h)	28,952	28,731	28,698
Production Capacity (lb/h)	90.2	89.6	89.6

Cooking-Energy Efficiency Data

Table B-5. Standard Pot on Ring Burner B.

	Test #1	Test #2	Test #3
Measured Values			
Gas Consumed (ft³)	8.4	8.3	8.4
Test Time (min)	15.7	15.7	15.9
Weight of Water (lb)	20.00	20.00	20.00
Weight of Cooking Container (lb)	5.490	5.490	5.490
Initial Temperature of Water (°F)	68.8	69.2	70.0
Final Temperature of Water (°F)	200.4	200.3	201.0
Calculated Values			
Energy to Water (Btu)	2632	2622	2620
Energy to Cooking Container (Btu)	159	158	158
Energy to Burner (Btu)	8,348	8,242	8,324
Cooking-Energy Efficiency (%)	33.4	33.7	33.4
Burner Energy Rate (Btu/h)	31,902	31,499	31,410
Production Capacity (lb/h)	76.4	76.4	75.5

Table B-6. Eneron, Inc. Design 1 on Ring Burner B.

	Test #1	Test #2	Test #3
Measured Values			
Gas Consumed (ft³)	5.8	5.8	5.8
Test Time (min)	10.9	10.9	11.0
Weight of Water (lb)	20.00	20.00	20.00
Weight of Cooking Container (lb)	7.735	7.735	7.735
Initial Temperature of Water (°F)	69.8	69.6	69.4
Final Temperature of Water (°F)	201.5	200.7	200.2
Calculated Values			
Energy to Water (Btu)	2634	2622	2616
Energy to Cooking Container (Btu)	224	223	223
Energy to Burner (Btu)	5,740	5,741	5,740
Cooking-Energy Efficiency (%)	49.8	49.6	49.5
Burner Energy Rate (Btu/h)	31,598	31,604	31,310
Production Capacity (lb/h)	110.1	110.1	109.1

Cooking-Energy Efficiency Data

Table B-7. Eneron, Inc. Design 2 on Ring Burner B.

	Test #1	Test #2	Test #3
Measured Values			
Gas Consumed (ft^3)	5.6	5.9	5.5
Test Time (min)	10.5	10.5	10.3
Weight of Water (lb)	20.00	20.00	20.00
Weight of Cooking Container (lb)	7.345	7.345	7.345
Initial Temperature of Water (°F)	69.3	69.6	69.8
Final Temperature of Water (°F)	202.0	201.2	200.1
Calculated Values			
Energy to Water (Btu)	2654	2632	2606
Energy to Cooking Container (Btu)	214	213	211
Energy to Burner (Btu)	5,543	5,546	5,449
Cooking-Energy Efficiency (%)	51.7	51.3	51.7
Burner Energy Rate (Btu/h)	31,676	31,690	31,739
Production Capacity (lb/h)	114.3	114.3	116.5

Table B-8. Standard Pot on Star Burner.

	Test #1	Test #2	Test #3
Measured Values			
Gas Consumed (ft^3)	8.8	8.8	8.8
Test Time (min)	23.8	24.1	24.0
Weight of Water (lb)	20.00	20.00	20.00
Weight of Cooking Container (lb)	5.485	5.485	5.485
Initial Temperature of Water (°F)	70.7	68.7	70.2
Final Temperature of Water (°F)	200.5	200.4	201.2
Calculated Values			
Energy to Water (Btu)	2596	2634	2620
Energy to Cooking Container (Btu)	157	159	158
Energy to Burner (Btu)	8,788	8,782	8,697
Cooking-Energy Efficiency (%)	31.3	31.8	31.9
Burner Energy Rate (Btu/h)	22,154	21,863	21,743
Production Capacity (lb/h)	50.4	49.8	50.0

Cooking-Energy Efficiency Data

Table B-9. Eneron, Inc. Design 1 on Star Burner.

	Test #1	Test #2	Test #3
Measured Values			
Gas Consumed (ft^3)	4.9	5.1	5.0
Test Time (min)	13.3	13.7	13.4
Weight of Water (lb)	20.00	20.00	20.00
Weight of Cooking Container (lb)	7.735	7.735	7.735
Initial Temperature of Water (°F)	69.8	68.4	69.3
Final Temperature of Water (°F)	201.3	200.4	200.4
Calculated Values			
Energy to Water (Btu)	2630	2640	2622
Energy to Cooking Container (Btu)	224	225	223
Energy to Burner (Btu)	4,878	5,076	4,975
Cooking-Energy Efficiency (%)	58.5	56.4	57.2
Burner Energy Rate (Btu/h)	22,005	22,232	22,278
Production Capacity (lb/h)	90.2	87.6	89.6

Table B-10. Eneron, Inc. Design 2 on Star Burner.

	Test #1	Test #2	Test #3
Measured Values			
Gas Consumed (ft^3)	4.7	4.8	4.8
Test Time (min)	12.8	12.8	12.9
Weight of Water (lb)	20.00	20.00	20.00
Weight of Cooking Container (lb)	7.345	7.345	7.345
Initial Temperature of Water (°F)	70.5	69.0	69.7
Final Temperature of Water (°F)	201.4	200.9	200.5
Calculated Values			
Energy to Water (Btu)	2618	2638	2616
Energy to Cooking Container (Btu)	212	213	211
Energy to Burner (Btu)	4,676	4,775	4,774
Cooking-Energy Efficiency (%)	60.5	59.7	59.2
Burner Energy Rate (Btu/h)	21,918	22,382	22,204
Production Capacity (lb/h)	93.8	93.8	93.0

Cooking-Energy Efficiency Data

Table B-11. Cooking-Energy Efficiency Statistics for Ring Burner A.

	Cooking-Energy Efficiency		
	Standard Pot	Eneron, Inc. Design 1	Eneron, Inc. Design 2
Replicate #1	26.6	40.8	43.6
Replicate #2	27.2	41.2	43.8
Replicate #3	27.1	40.3	44.4
Average	27.0	40.7	44.0
Standard Deviation	0.32	0.48	0.38
Absolute Uncertainty	0.80	1.20	0.95
Percent Uncertainty	2.9	2.9	2.2

Table B-12. Cooking-Energy Efficiency Statistics for Ring Burner B.

	Cooking-Energy Efficiency		
	Standard Pot	Eneron, Inc. Design 1	Eneron, Inc. Design 2
Replicate #1	33.4	49.8	51.7
Replicate #2	33.7	49.6	51.3
Replicate #3	33.4	49.5	51.7
Average	33.5	49.6	51.6
Standard Deviation	0.19	0.17	0.25
Absolute Uncertainty	0.47	0.43	0.61
Percent Uncertainty	1.4	0.9	1.2

Cooking-Energy Efficiency Data

Table B-13. Cooking-Energy Efficiency Statistics for Star Burner.

	Cooking-Energy Efficiency		
	Standard Pot	Eneron, Inc. Design 1	Eneron, Inc. Design 2
Replicate #1	31.3	58.5	60.5
Replicate #2	31.8	56.4	59.7
Replicate #3	31.9	57.2	59.2
Average	31.7	57.4	59.8
Standard Deviation	0.32	1.05	0.65
Absolute Uncertainty	0.81	2.6	1.61
Percent Uncertainty	2.5	4.5	2.7

Table B-14. Production Capacity Statistics for Ring Burner A.

	Production Capacity		
	Standard Pot	Eneron, Inc. Design 1	Eneron, Inc. Design 2
Replicate #1	55.8	83.9	90.2
Replicate #2	55.8	83.9	89.6
Replicate #3	56.3	82.8	89.6
Average	56.0	83.5	89.8
Standard Deviation	0.30	0.67	0.39
Absolute Uncertainty	1.05	2.33	1.35
Percent Uncertainty	1.9	2.8	1.5

Table B-15. Production Capacity Statistics for Ring Burner B.

	Production Capacity		
	Standard Pot	Eneron, Inc. Design 1	Eneron, Inc. Design 2
Replicate #1	76.4	110.1	114.3
Replicate #2	76.4	110.1	114.3
Replicate #3	75.5	109.1	116.5
Average	76.1	109.8	115.0
Standard Deviation	0.56	0.58	1.28
Absolute Uncertainty	1.93	2.01	4.46
Percent Uncertainty	2.5	1.8	3.9

Table B-16. Production Capacity Statistics for Star Burner.

	Production Capacity		
	Standard Pot	Eneron, Inc. Design 1	Eneron, Inc. Design 2
Replicate #1	50.4	90.2	93.8
Replicate #2	49.8	87.6	93.8
Replicate #3	50.0	89.6	93.0
Average	50.1	89.1	93.5
Standard Deviation	0.32	1.37	0.42
Absolute Uncertainty	1.11	4.7	1.46
Percent Uncertainty	2.2	5.3	1.6