Taylor, Model QS24-23
Electric Double-Sided Griddle Performance Test

Application of ASTM Standard
Test Method F 1605-95

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Specific appreciation is extended to Taylor, for supplying the Food Service Technology Center with an electric double-sided griddle for controlled testing in the appliance laboratory.

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Executive Summary

Taylor's new double-sided griddle incorporates the latest in two-sided cooking technology including programmable thermostats, independently-controlled heating zones, and removable non-stick sheaths for the upper platens. Heat is delivered to the cooking surfaces by six individually-controlled elements per cooking zone—three in the lower cooking surface and three in the upper cooking surface—for tighter temperature control. Each cooking zone is outfitted with a separate programmable solid-state thermostat for the upper and lower sections, allowing users to select different operating temperatures for greater versatility.

Food Service Technology Center (FSTC) engineers tested the 2-foot double-sided griddle under the tightly controlled conditions of the American Society for Testing and Materials' (ASTM) standard test method.[1] Double-sided griddle performance is characterized by temperature uniformity, preheat time and energy consumption, idle energy consumption rate, cooking energy efficiency, and production capacity.

Cooking performance was determined by cooking frozen hamburgers under three different loading scenarios (heavy—16 hamburgers, medium—8 hamburgers, and light—4 hamburgers). The cook times for the three loading scenarios were 2.86 minutes for the heavy-load test, 2.90 minutes for the medium-load test, and 2.92 minutes for the light-load test. Production

[1] American Society for Testing and Materials. 1995. *Standard Test Method for the Performance of Double-sided griddles.* ASTM Designation F 1275-95, in *Annual Book of ASTM Standards,* Philadelphia.

capacity includes the cooking time and the time required to remove the cooked hamburger patties and to scrape the cooking surfaces (reload time). Reload time varies with the quantity of food being cooked.

Cooking energy efficiency is a measure of how much of the energy that an appliance consumes is actually delivered to the food product during the cooking process. Cooking energy efficiency is therefore defined by the following relationship:

$$\text{Cooking Energy Efficiency} = \frac{\text{Energy to Food}}{\text{Energy to Appliance}}$$

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

Table ES-1. Summary of Double-sided Griddle Performance.

Rated Energy Input Rate (kW)	19.20
Measured Energy Input Rate (kW)	19.79
Temperature Uniformity (°F)	± 8.5
Preheat Time to 350°F (min)[a]	7.40
Preheat Energy to 350°F (kWh) [a]	2.42
Idle Energy Rate @ 350°F (kW) [a]	1.04
Heavy-Load Cooking Energy Efficiency (%)	75.4 ± 2.0
Medium-Load Cooking Energy Efficiency (%)	77.6 ± 1.0
Light-Load Cooking Energy Efficiency (%)	68.3 ± 4.2
Production Capacity[b] (lb/h)	62.0 ± 3.1
Cooking Surface Recovery Time[b] (min)	< 0.5

[a]Conducted with the top sides in the lowered position.
[b]Based on the heavy-load cooking test with a minimum 30-second preparation time between loads.

Taylor recommends setting the upper platens to 400°F and the bottom cooking surface to 325°F for multipurpose cooking. According to the manufacturer, these settings provide the greatest flexibility, while reducing cook times. Since the ASTM test method calls for setting the unit to 350°F on the top and bottom, researchers repeated the heavy-load test at the manufacturer's recommended settings.

The manufacturer's recommended settings showed improved performance over the ASTM-specified 350°F settings. Adjusting the temperatures resulted in a somewhat shorter cook time and a higher cooking energy efficiency (77.2% vs. 75.4%). Table ES-2 summarizes the test results for the heavy-load tests.

Table ES-2. Heavy-Load Test Results.

	ASTM-Specified Settings	Manufacturer-Specified Settings
Temperature Settings (upper/lower–°F)	350/350	400/325
Hamburger Patty Cook Time (min)	2.86	2.83
Average Recovery Time (sec)	< 30	< 30
Production Rate (lb/h)	62.0 ± 3.1	63.0 ± 2.8
Energy Consumption (Wh/lb)	167	169
Cooking Energy Rate (kW)	10.36	10.65
Cooking Energy Efficiency (%)	75.4 ± 2.0	77.2 ± 6.7

Figure ES-1 illustrates the relationship between cooking energy efficiency and production rate for this double-sided griddle. Double-sided griddle production rate is a function of both the hamburger patty cook time and the reloading time.

Figure ES-2 illustrates the relationship between the double-sided griddle's average energy consumption rate and the production rate. This graph can be

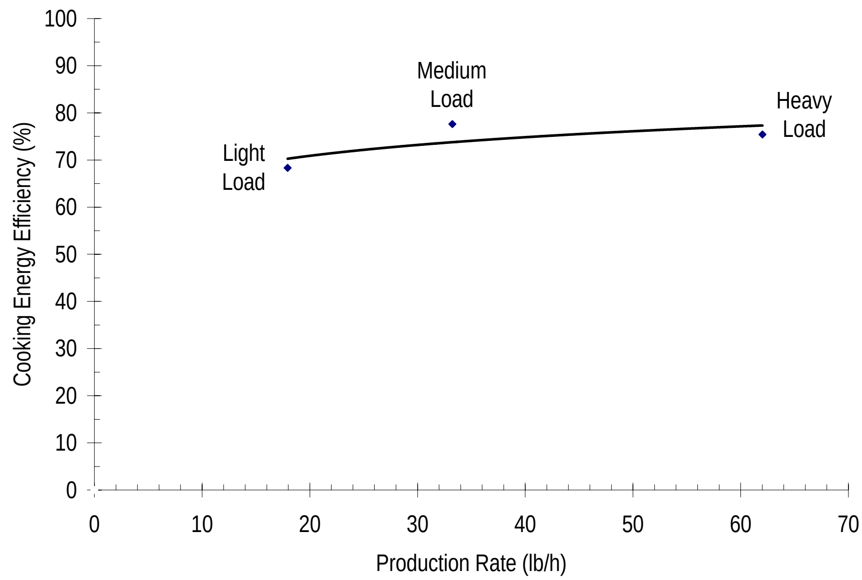

Figure ES-1. Double-sided griddle part-load cooking energy efficiency.

used as a tool to estimate the daily energy consumption and probable demand for the double-sided griddle in a real-world operation.[2] Average energy consumption rates at 15, 30, and 60 pounds per hour are 3.08 kW, 5.39 kW, and 8.47 kW, respectively. For an operation cooking an average of 15 pounds of food per hour over the course of the day (e.g., 150 lb of food over a ten-hour day), the probable demand for this double-sided griddle is 3.08 kW.

This 2-foot Taylor QS24 will do all the work of a standard 3-foot flat griddle and then some. The double-sided griddle exhibited the highest cooking energy efficiency (75.4%) of any electric griddle—single- or double-sided—

[2] Research has shown that the probable demand for a cooking appliance is the average demand over the course of the day.

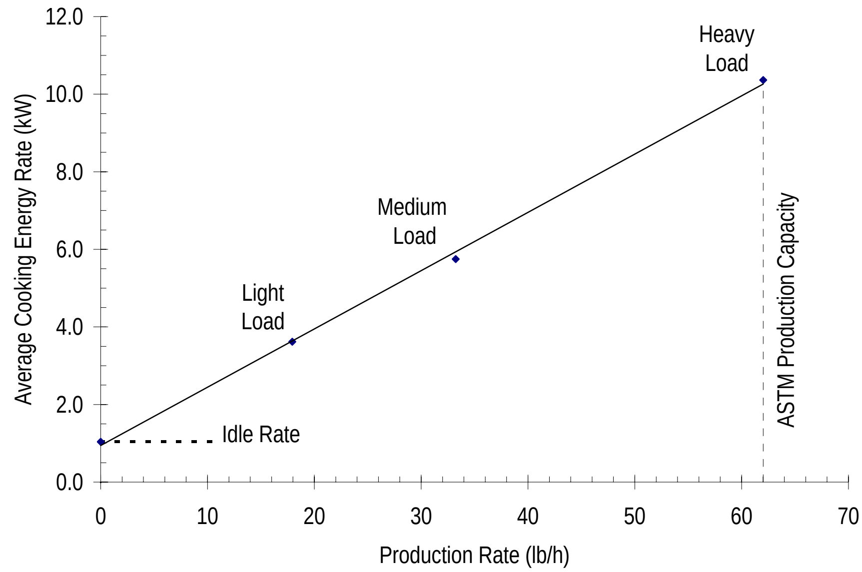

Figure ES-2. Double-sided griddle cooking energy consumption profile.

Note: The heavy-load and idle tests were conducted with all sections heated to 350°F, the medium- and light-load tests were conducted with only one section heated. Light-load = 4 hamburgers/load; medium-load = 8 hamburgers/load; heavy-load = 16 hamburgers/load.

tested at the Food Service Technology Center and its production capacity is nearly twice that of most 3-foot flat griddles.[3]

Add in a tight ± 8½°F temperature uniformity, a quick preheat and a low stand-by idle rate and this grill easily outperforms its competitors. The grill's high cooking energy efficiency, quick preheat, and uniform cooking surface make this an ideal choice for short-order applications. Throw in its high productivity and this grill will work well in most quick service and other high volume restaurants.

[3] Pacific Gas and Electric Company. 1989. *Development and Application of a Uniform Testing Procedure for Double-sided griddles.* Report 008.1-89.2 prepared for Research and Development. San Ramon, California: Pacific Gas and Electric Company.

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1 Introduction

Background

Griddles are used throughout the hospitality industry to prepare a variety of menu items such as pancakes and hamburgers. Double-sided griddles offer a greater diversity of use and cook food more quickly than their single-sided counterparts. An operator shopping for a new double-sided griddle looks for energy usage, uniformity of cooking surface temperature, and amount of food that can be cooked in a given period of time.

Taylor's new double-sided griddle employs six individually-controlled elements per cooking zone.

With support from the Electric Power Research Institute (EPRI), the Gas Research Institute (GRI), and the National Restaurant Association, PG&E's Food Service Technology Center (FSTC) developed a uniform testing procedure to evaluate the performance of gas and electric griddles. This test procedure was submitted to the American Society for Testing and Materials (ASTM), and it was accepted as a standard test method (Designation F 1275-90) in January 1990.[1] PG&E's *Development and Application of a Uniform Testing Procedure for Griddles* documents the developmental procedures and test results of several gas and electric griddles, including preliminary test results on a double-sided griddle.[2] Other PG&E reports document results of applying the revised version of the ASTM test method and discuss the scope of these revisions.[3,4,5,6]

In 1995, ASTM approved and ratified a similar test method for double-sided griddles (Designation F 1605-95). This test method retained many similarities to the griddle test method, with the individual procedures adapted specifically for use with two-sided cookers.

Taylor's new double-sided griddle employs six individually-controlled elements per cooking zone—three in the lower cooking surface and three in the upper cooking surface. Each cooking zone is outfitted with a programmable solid-state thermostat for the upper and lower sections, allowing users to select different operating upper and lower cooking surface temperatures.

Introduction

Non-stick sheaths were provided for the upper platens to prevent product from sticking.

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 the Taylor electric double-sided griddle, model QS24-23, 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. Document the temperature uniformity of the lower cooking surface and the accuracy of the thermostats.
3. Determine the time and energy required to preheat the appliance from room temperature to 350°F.
4. Characterize the idle energy use with the thermostats set at a calibrated 350°F.
5. Document the cooking energy consumption and efficiency under three hamburger loading scenarios: heavy (16 patties), medium (8 patties), and light (4 patties).
6. Determine the production capacity and cooking surface temperature recovery time during the heavy-load test.

Appliance Description

The 24 × 24-inch cooking surface is complimented by two 11 × 21½-inch heated upper platens, rated at 4200 watts each. Removable non-stick sheaths prevent sticking product on the upper platens. Each half of the double-sided griddle is independently controlled by a programmable microprocessor, which maintains six elements (three for the upper platen and three for the lower cooking surface), each with its own solid-state thermostat.

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

Table 1-1. Appliance Specifications.

Manufacturer	Taylor
Model	QS24-23
Generic Appliance Type	Thermostatically Controlled Double-Sided Griddle
Rated Input	19.20 kW
Dimensions	24" x 35½" x 15¼"
Construction	Stainless Steel
Controls	Two programmable solid state thermostats controlling six elements (three upper and three lower) per 1-foot section.

2 Methods

Setup and Instrumentation

FSTC researchers installed the double-sided griddle on a tiled floor 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 at least 6 inches of clearance between the vertical plane of the double-sided griddle and the edge of the hood. All test apparatus were installed in accordance with Section 9 of the ASTM test method.[1]

Researchers instrumented the double-sided griddle with thermocouples to measure cooking surface temperatures. For the temperature uniformity test, 30 thermocouples were welded to the cooking surface in a grid pattern (see Figure 2-1). Two thermocouples (one at the center of each cooking zone) were used for the remainder of the tests (see Figure 2-2).

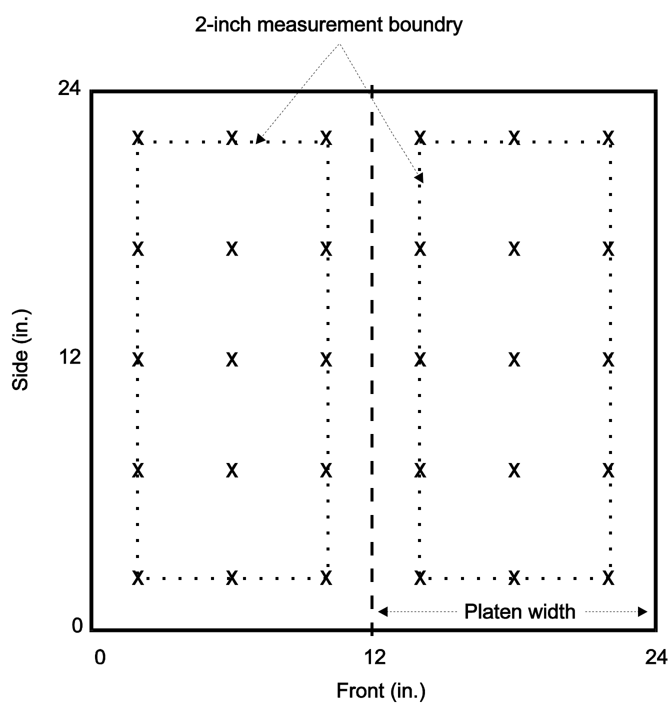


Figure 2-1.
Thermocouple grid for temperature uniformity test.

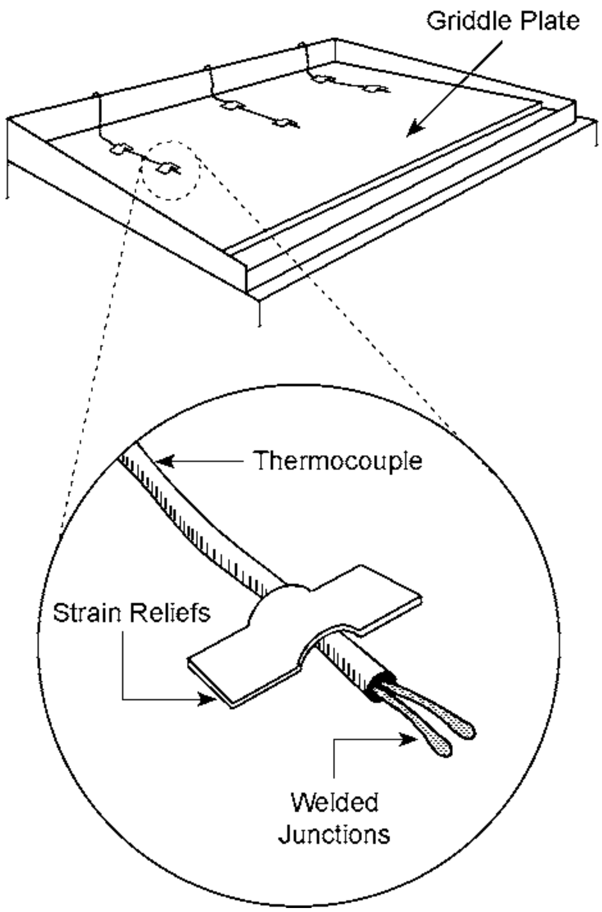


Figure 2-2.
Thermocouple placement for testing.

Power and energy were measured with a Watt/Watt-hour transducer that generated an analog signal for instantaneous power and a pulse for every 10 Wh. The transducer and thermocouples were connected to an automated data acquisition unit that recorded data every 5 seconds. A voltage regulator was connected to the double-sided griddle to maintain a constant voltage for all tests.

Methods

Measured Energy Input Rate

Researchers determined the energy input rate by measuring the energy consumption during a preheat from room temperature. The maximum power draw during this period was reported as the measured energy input rate.

Cooking Tests

Researchers specified frozen, 20% fat, quarter-pound hamburger patties for all cooking tests. Each load of hamburgers was cooked to a 35% weight loss. The cooking tests involved “barreling” six loads of frozen hamburger patties; cooking surface temperature was used as a basis for recovery (see Figure 2-2). Each test was followed by a 1-hour wait period and was then repeated two more times. Researchers tested the double-sided griddle using 16 patties (heavy load), 8 patties (medium load), and 4 patties (light load).

Due to the logistics involved in removing one load of cooked hamburgers and placing another load onto the double-sided griddle, a minimum preparation time of 30 seconds (based on 15 seconds per linear foot) was incorporated into the cooking procedure. This ensures that the cooking tests are uniformly applied from laboratory to laboratory. Double-sided griddle recovery was then based on the cooking surface’s reaching a threshold temperature of 340°F (measured at the center of each linear foot of the bottom cooking surface). Reloading within 10°F of the 350°F thermostat set point does not significantly lower the average cooking surface over the cooking cycle, nor does it extend the cook time. The double-sided griddle was reloaded either after both thermocouples reached the threshold temperature, or 30 seconds after removing the previous load from the double-sided griddle, whichever was longer.

Prior to the six-load test, one to two loads of hamburgers were cooked to stabilize the double-sided griddle thermostat response. Energy consumption, elapsed time, and the average weight loss of the hamburger patties were recorded during the final six loads of the cooking test. After removing the last load and allowing the double-sided griddle to recover, researchers terminated the test.

Cooking tests were run in the following sequence: three replicates of the heavy-load test, three replicates of the medium-load test, and three replicates of the light-load test. This procedure ensured that the reported cooking energy efficiency and production capacity results had an uncertainty of less than ±10%. The results from each test run were averaged, and the absolute uncertainty was calculated based on the standard deviation of the results.

The ASTM results reporting sheets appear in Appendix C.

3 Results

Energy Input Rate

Prior to testing, the energy input rate was measured and compared with the manufacturer's nameplate value. This procedure ensured that the double-sided griddle was operating within its specified parameters. The energy input rate was 19.79 kW (a difference of 3.1% from the nameplate rating).

Temperature Uniformity

Thermocouples were welded to the cooking surface at the center of each linear foot to facilitate temperature calibration. The thermostat control was turned to a ~ 350°F setting. The thermocouples were then monitored after the double-sided griddle had stabilized at the set temperature for one hour. Researchers adjusted the calibration for each thermostat zone to maintain an average of 350 ± 5°F on upper and lower cooking surfaces at the center of each control zone.

To characterize the temperature profile of the cooking surface at 350°F, researchers welded additional thermocouples to the cooking surface in a 30-point grid with approximately 4½ inches between adjacent points. Double-sided griddle temperatures were monitored for one hour after the cooking surfaces had stabilized at a calibrated 350°F. The temperature sensing points and resulting profile are illustrated in Figures 3-1 and 3-2, respectively. The results from the temperature uniformity and thermostat accuracy test is summarized in Table 3-1.

Results

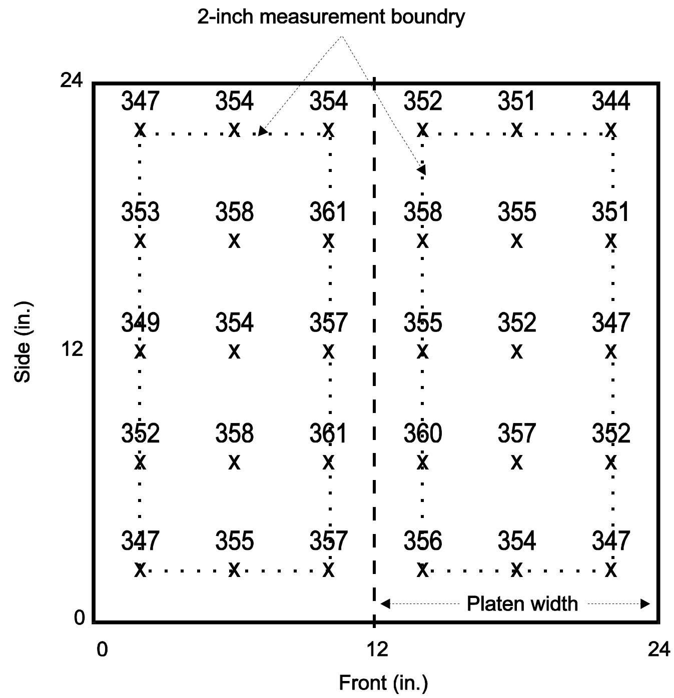


Figure 3-1.

Temperature sensing points on the bottom cooking surface.

Legend

- 360-370°F
- 350-360°F
- 340-350°F
- 330-340°F

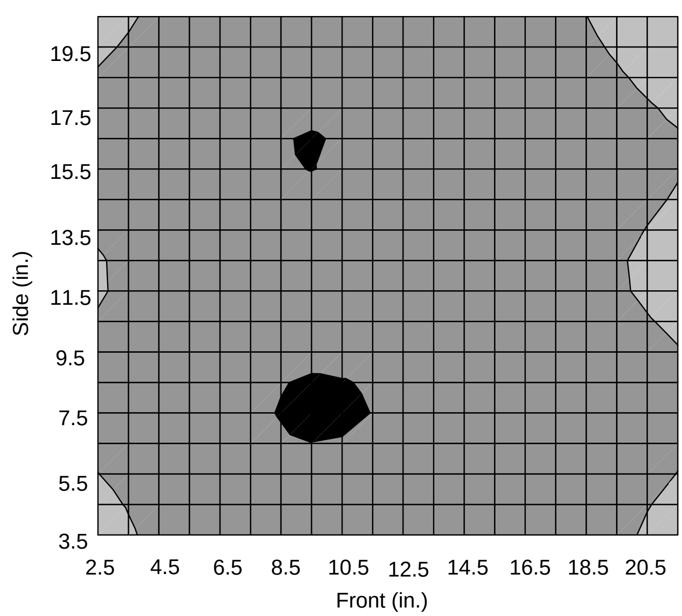


Figure 3-2.

Temperature map of the bottom cooking surface.

Table 3-1. Temperature Uniformity and Thermostat Accuracy.

Thermostat Settings[a]:	
Bottom, Left (°F)	350
Bottom, Right (°F)	350
Top, Left (°F)	350
Top, Right (°F)	350
Average Surface Temperature (°F)	354
Maximum Temperature Difference Across Bottom Cooking Surface (°F)	17
Standard Deviation of Surface Temperatures (°F)	4

[a]Thermostat accuracy is the thermostat setting required to maintain 350 ± 5°F on the cooking surface.

Preheat and Idle Tests

Preheat Energy and Time

Researchers removed the additional thermocouples, leaving only the points at the center of each linear foot. The cooking surfaces were an average of 74°F at the outset of the preheat test. With the upper platens in the lowered position, researchers measured the energy consumption and time required to preheat the cooking surfaces to a calibrated 350°F. The double-sided griddle's preheat required 2.42 kWh and 7.40 minutes. Figure 3-3 shows the energy consumption rate in conjunction with the cooking surface temperature during this preheat test.

After the double-sided griddle had cooled down and stabilized at room temperature for at least 8 hours, the preheat test was repeated. This second preheat was conducted with the upper platens in the raised position. At the beginning of preheat, the cooking surfaces averaged 72°F. With the tops raised, the preheat required 2.50 kWh and 7.58 minutes.

Idle Energy Rate

With the top sides in the lowered position, the double-sided griddle was allowed to stabilize at 350°F for one hour. Researchers then monitored the energy consumption over a 2-hour period. The idle energy rate during this period was 1.04 kW.

This 3-hour test was repeated with the top sides in the raised position. The idle energy rate with the tops raised increased about 2½ times to 2.55 kW.

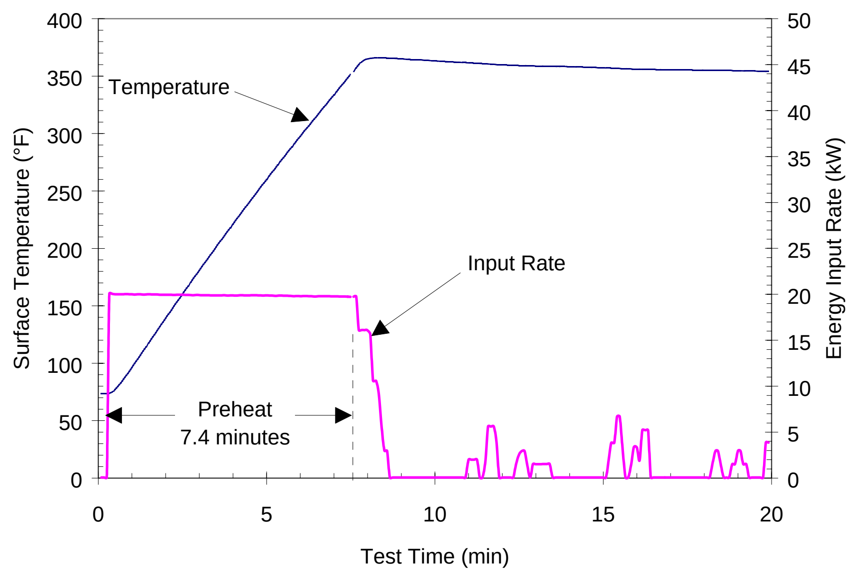


Figure 3-3.
Preheat characteristics with the top sides down.

Test Results

Input, preheat, and idle test results are summarized in Table 3-2.

Table 3-2. Input, Preheat, and Idle Test Results.

Condition	Top Sides Up	Top Sides Down
Rated Energy Input Rate (kW)	19.20	19.20
Measured Energy Input Rate (kW)	19.79	19.79
Preheat		
Time to 350°F (min)	7.58	7.40
Energy (kWh)	2.50	2.42
Rate to 350°F (°F/min)	36	36
Idle Energy Rate @ 350°F (kW)	2.55	1.04

Cooking Tests

The double-sided griddle was tested under three loading scenarios: heavy (16 hamburger patties), medium (8 hamburger patties), and light (4 hamburger patties). The hamburgers used for the cooking tests consisted of 20% fat and approximately 60% moisture, as specified by the ASTM procedure. Researchers monitored hamburger patty cook time and weight loss, cooking surface recovery time, and double-sided griddle energy consumption during these tests.

Heavy-Load Tests

The heavy-load cooking tests were designed to reflect a double-sided griddle's maximum performance. The double-sided griddle is used to cook six loads of 16 frozen hamburger patties—one load after the other, similar to a batch-cooking procedure. Figure 3-4 shows the average temperature of the bottom cooking surface during a heavy-load test. One load was used to stabilize the double-sided griddle, and six loads were used to calculate cooking energy efficiency and production capacity.

Taylor recommends setting the top to 400°F and the bottom to 325°F for multipurpose cooking. According to the manufacturer, these settings

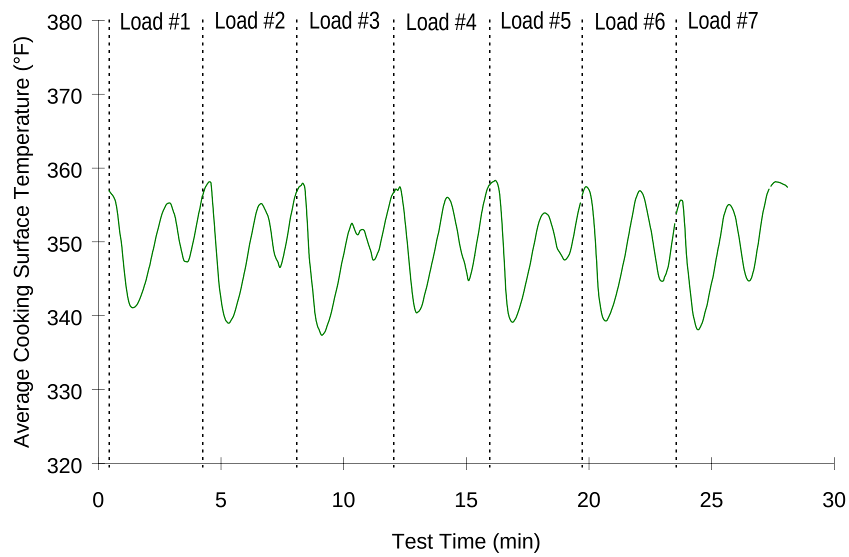


Figure 3-4.
Average cooking surface temperature during a heavy-load test.

provide the greatest flexibility, while reducing cook times. Since the ASTM test method calls for setting the unit to 350°F on the top and bottom, researchers repeated the heavy-load test at the manufacturer's recommended settings.

The manufacturer's recommended settings showed improved performance over the ASTM-specified 350°F settings. Adjusting the temperatures resulted in a somewhat shorter cook time and a higher cooking energy efficiency (77.2% vs. 75.4%). Table 3-3 summarizes the test results for the heavy-load tests.

Figure 3-5 illustrates the double-sided griddle's temperature response while a heavy load of frozen hamburger patties was cooked. Since the cooking surface temperature had recovered to 340°F before the end of the cooking cycle, the effective recovery time was zero. Production capacity includes the time required to remove the cooked hamburger patties and scrape the cooking surfaces (reload time). Reload time varies with the amount of food being cooked at one time.

Table 3-3. Heavy-Load Test Results.

	ASTM-Specified Settings	Manufacturer Settings
Temperature Settings (upper/lower–°F)	350/350	400/325
Hamburger Patty Cook Time (min)	2.86	2.83
Average Recovery Time (sec)	< 30	< 30
Production Rate (lb/h)	62.0 ± 3.1	63.0 ± 2.8
Energy Consumption (Wh/lb)	167	169
Cooking Energy Rate (kW)	10.36	10.65
Cooking Energy Efficiency (%)	75.4 ± 2.0	77.2 ± 6.7

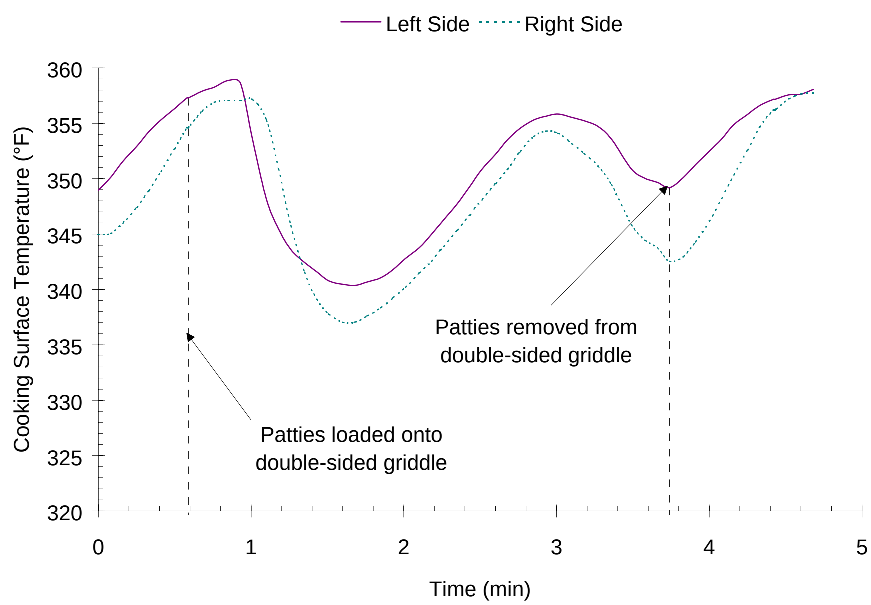


Figure 3-5.
Average cooking surface temperatures while cooking a heavy load.

Medium- and Light-Load Tests

Medium- and light-load tests represent a more typical usage pattern for a double-sided griddle in cook-to-order applications. Since a double-sided griddle may not be fully loaded in many food service establishments, these part-load efficiencies can be used to estimate double-sided griddle performance in an actual operation.

Both the medium- and light-load tests were conducted on the left half of the appliance. The right half was turned off with upper platen in the lowered position during the testing. Cooking energy efficiencies at 33.2 (medium) and 17.9 (light) pounds per hour were 77.6% and 68.3%, respectively.

Test Results

Energy imparted to the hamburger patties was calculated by separating the various components of the patties (water, fat, and solids) and determining the amount of heat gained by each component (Appendix D). The double-sided griddle's cooking energy efficiency for a given loading scenario is the amount of energy imparted to the hamburger patties, expressed as a percentage of the amount of energy consumed by the double-sided griddle during the cooking process.

Cooking energy efficiency results for the ASTM heavy-load tests were 75.9%, 74.5%, and 75.8%, yielding a maximum uncertainty of 2.66% in the test results. Table 3-4 summarizes the results of the ASTM cooking energy efficiency and production capacity tests.

Figure 3-6 illustrates the relationship between cooking energy efficiency and production rate for this double-sided griddle. Double-sided griddle production rate is a function of both the hamburger patty cook time and the reloading time. Appendix D contains a synopsis of test data for each replicate of the cooking tests.

Table 3-4. Cooking Energy Efficiency and Production Capacity Test Results.

	Heavy Load	Medium Load	Light Load
Temperature Settings (upper/lower–°F)	350/350	350/350	350/350
Hamburger Patty Cook Time (min)	2.86	2.90	2.92
Average Recovery Time (sec)	< 30	< 15	< 15
Production Rate (lb/h)	62.0 ± 3.1	33.2 ± 1.3	17.9 ± 0.3
Energy Consumption (Wh/lb)	167	173	202
Cooking Energy Rate (kW)	10.36	5.75	3.62
Cooking Energy Efficiency (%)	75.4± 2.0	77.6 ± 1.0	68.3 ± 4.2

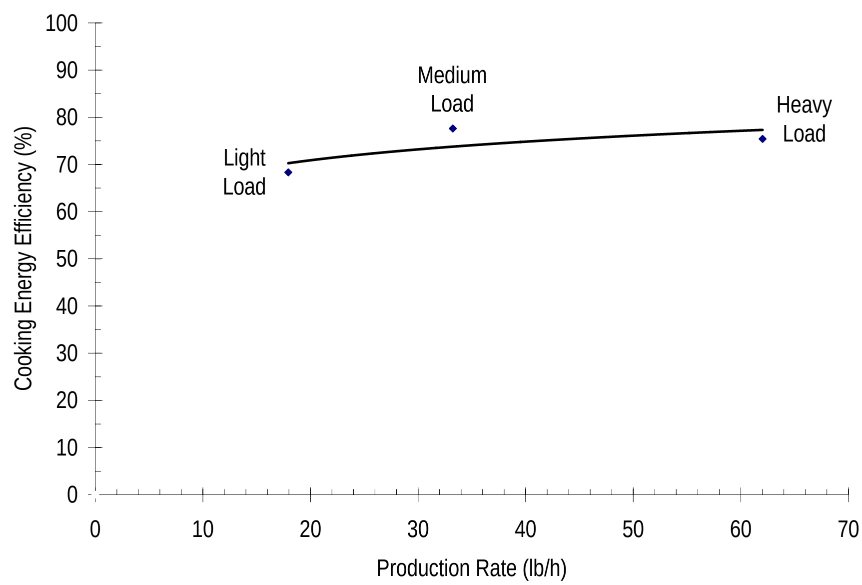
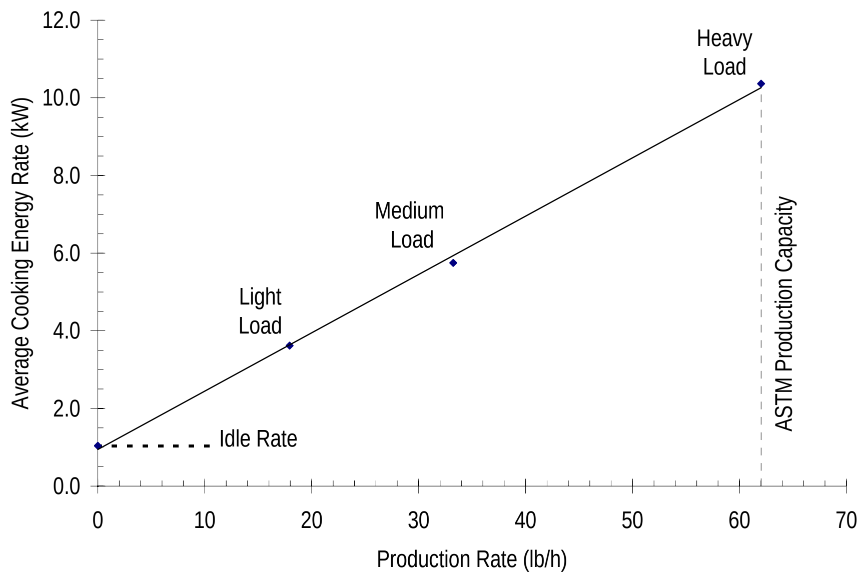


Figure 3-6.
Double-sided griddle part-load cooking energy efficiency.

Figure 3-7 illustrates the relationship between the double-sided griddle's average energy consumption rate and the production rate. This graph can be used as a tool to estimate the daily energy consumption and probable demand for the double-sided griddle in a real-world operation.[a] Average energy consumption rates at 15, 30, and 60 pounds per hour are 3.08 kW, 5.39 kW, and 8.47 kW, respectively. For an operation cooking an average of 15 pounds of food per hour over the course of the day (e.g., 150 lb of food over a ten hour day), the probable demand for this double-sided griddle is 3.08 kW.



Note: The heavy-load and idle tests were conducted with all sections heated to 350°F, the medium- and light-load tests were conducted with only one section heated. Light-load = 4 hamburgers/load; medium-load = 8 hamburgers/load; heavy-load = 16 hamburgers/load.

Figure 3-7.
Double-sided griddle cooking energy consumption profile.

[a] Research has shown that the probable demand for a cooking appliance is the average demand over the course of the day.

4 Conclusions

This 2-foot grill does all the work of a 3-foot flat grill and then some.

The Taylor, model QS24-23 electric double-sided griddle performed well under the rigorous conditions of the ASTM standard test method, particularly with respect to the cooking tests. The unit exhibited the highest cooking energy efficiency (75.4%) of any electric griddle—single- or double-sided—tested at the Food Service Technology Center. More so, this Taylor grill maintained its high cooking energy efficiency under part-load. In fact, its 68.3% light-load efficiency compares favorably with the 70% average heavy-load efficiency recorded for other electric grills.[2,5,6]

The double-sided griddle's part-load efficiency is enhanced by a remarkably low idle rate. With the upper platens lowered, the grill consumes a meager 500 watts/foot width, compared to 700 watts/foot or more for other electric griddles.[2,5,6] However, with the upper platens in the raised position, the idle rate more than doubles to 1,280 watts per foot width, making it all important for end users to lower the platens when the grill is in standby mode.

This 2-foot grill does all the work of a 3-foot flat grill and then some. The griddle's 62 pound per hour production rate is nearly twice that of most 3-foot flat grills, while requiring a third less space under the hood.[2,3,4,5,6]

Another highlight is the tight temperature uniformity. The grill maintained the cooking surfaces to within ± 8½°F anywhere from the edge to the center of each section. Combined with its 62 pound/hour production capacity, this translates to more even cooking and quicker turn around times for food orders.

The grill's high cooking energy efficiency, quick preheat, and uniform cooking surface make this an ideal choice for short-order applications. Throw in its high productivity and this grill will work well in most quick service and other high volume restaurants.

5 References

1. American Society for Testing and Materials. 1995. *Standard Test Method for the Performance of Double-sided griddles.* ASTM Designation F 1605-95, in *Annual Book of ASTM Standards,* Philadelphia.

2. Pacific Gas and Electric Company. 1989. *Development and Application of a Uniform Testing Procedure for Griddles.* Report 008.1-89.2 prepared for Research and Development. San Ramon, California: Pacific Gas and Electric Company.

3. Food Service Technology Center. 1993. *U.S. Range Model RGTA-2436-1 Gas Griddle Application of ASTM Standard Test Method.* Report 5017.93.1 prepared for Products and Services Department. San Francisco: Pacific Gas and Electric Company.

4. Food Service Technology Center. 1993. *Keating MIRACLEAN Model 36 x 30 IBLD Gas Griddle: Application of ASTM Standard Test Method F 1275-90.* Report 5017.93.3 prepared for Products and Services Department. San Francisco: Pacific Gas and Electric Company

5. Food Service Technology Center. 1996. *Toastmaster Accu-Miser, Model AM36SS Electric Griddle Performance Test.* Report 5011.96.34 prepared for Customer Energy Management. San Francisco: Pacific Gas and Electric Company.

6. Food Service Technology Center. 1998. *AccuTemp, Model 2-3-14-208 Electric Griddle Performance Test.* Report 5011.98.55 prepared for Customer Energy Management. San Francisco: Pacific Gas and Electric Company.

Appendixes

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.

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

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").

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" 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 nameplate.

Recovery Time (minute, second)

The average time from the removal of the fry baskets from the fryer until the frying medium is within 10°F of the thermostat set point and the fryer is ready to be reloaded.

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 Appliance Specifications

Appendix B includes the product literature for the Taylor double-sided griddle.

C Results Reporting Sheets

Manufacturer:	Taylor Company
Model:	QS24-23
Date:	September 1998

Section 11.1 Test Double-Sided Griddle

Description of operational characteristics: The 24 × 24-inch cooking surface is complimented by two 11 × 21½-inch heated upper platens, rated at 1400 watts each. Removable non-stick sheaths prevent sticking product on the upper platens. Each half of the double-sided griddle is independently controlled by a programmable microprocessor, which maintains six elements (three for the upper platen and three for the lower cooking surface), each with its own solid-state thermostat.

Section 11.2 Apparatus

√ Check if testing apparatus conformed to specifications in section 6.

Deviations: None.

Section 11.4 Energy Input Rate

Test Voltage	208 V
Measured	19.79 kW
Rated	19.20 kW
Percent Difference Between Measured and Rated	3.1%

Section 11.5 Temperature Uniformity and Thermostat Accuracy

Thermostat settings required to maintain 350°F cooking surface temperature (from left):

Bottom Thermostat #1	350°F
Bottom Thermostat #2	350°F
Top Thermostat #1	350°F
Top Thermostat #2	350°F
Maximum Temperature Difference	17°F

See Figure C-1 for average cooking surface temperatures.

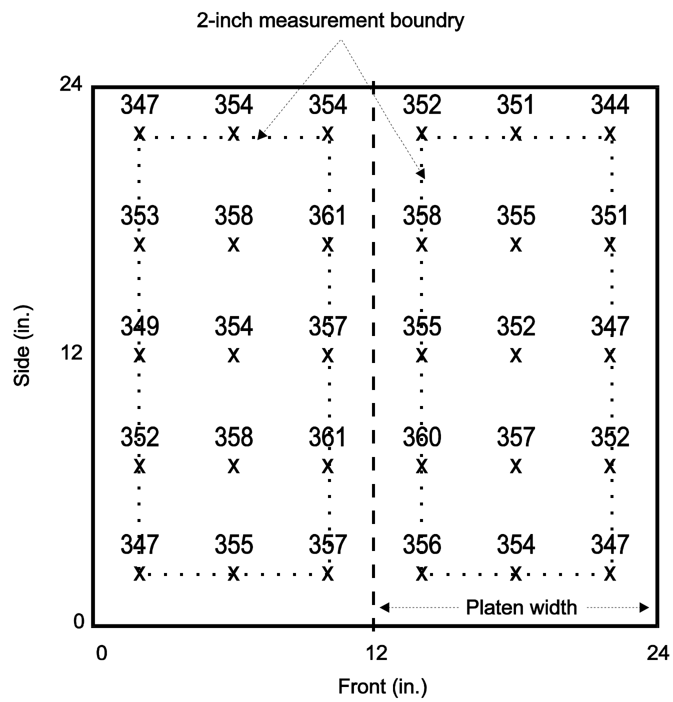


Figure C-1 Average cooking surface temperatures

Section 11.6 Preheat Energy and Time

Top Sides Lowered:

Test Voltage	208 V
Starting Temperature	74°F
Energy Consumption	2.42 kWh
Duration	7.40 min
Preheat Rate	36°F/min

Top Sides Raised:

Test Voltage	208 V
Starting Temperature	74°F
Energy Consumption	2.42 kWh
Duration	7.40 min
Preheat Rate	36°F/min

Section 11.7 Idle Energy Rate

Top Sides Lowered:

Test Voltage	208 V
Idle Energy Rate @ 350°F	2.55 kW

Top Sides Raised:

Test Voltage	208 V
Idle Energy Rate @ 350°F	1.04 kW

Section 11.9 Cooking Energy Efficiency and Cooking Energy Rate

Heavy Load:

Test Voltage	208 V
Cooking Time	2.86 min
Average Cooking Surface Recovery Time	< 0.5 min
Production Capacity	62.0 ± 3.1 lb/h
Energy to Food	430 Btu/lb
Cooking Energy Rate	10.36 kW
Energy per Pound of Food Cooked	570 Btu/lb
Cooking Energy Efficiency	75.4 ± 2.0%

Medium Load:

Test Voltage	208 V
Cooking Time	2.90 min
Average Cooking Surface Recovery Time	< 0.25 min
Production Rate	33.2 ± 1.3 lb/h
Energy to Food	459 Btu/lb
Cooking Energy Rate	5.75 kW
Energy per Pound of Food Cooked	591 Btu/lb
Cooking Energy Efficiency	77.6 ± 1.0%

Light Load:

Test Voltage	208 V
Cooking Time	2.92 min
Average Cooking Surface Recovery Time	< 0.25 min
Production Capacity	17.9 ± 0.3 lb/h
Energy to Food	471 Btu/lb
Cooking Energy Rate	3.62 kW
Energy per Pound of Food Cooked	689 Btu/lb
Cooking Energy Efficiency	68.3 ± 4.2%

D Cooking Energy Efficiency Data

Table D-1. Specific Heat and Latent Heat.

Specific Heat (Btu/lb, °F)	
Ice	0.50
Fat	0.40
Solids	0.20
Latent Heat (Btu/lb)	
Fusion, Water	144
Fusion, Fat	44
Vaporization, Water	970

Cooking Energy Efficiency Data

Table D-2. Heavy-Load Test Data.

	Repetition #1	Repetition #2	Repetition #3
Measured Values			
Total Energy (kWh)	4.10	4.06	3.92
Cook Time (min)	2.92	2.83	2.83
Total Test Time (min)	23.9	23.0	23.1
Weight Loss (%)	36.1	34.5	33.4
Initial Weight (lb)	24.09	24.09	24.09
Final Weight (lb)	15.38	15.77	16.04
Initial Fat Content (%)	21.2	21.2	21.2
Initial Moisture Content (%)	58.8	58.8	58.8
Final Moisture Content (%)	53.8	54.0	53.9
Initial Temperature (°F)	0	0	0
Final Temperature (°F)	166	162	159
Calculated Values			
Initial Weight of Water (lb)	14.2	14.2	14.2
Final Weight of Water (lb)	8.3	8.5	8.6
Weight of Fat (lb)	5.1	5.1	5.1
Weight of Solids (lb)	4.8	4.8	4.8
Sensible to Ice (Btu)	227	227	227
Sensible to Water (Btu)	1,895	1,836	1,794
Sensible to Fat (Btu)	339	330	324
Sensible to Solids (Btu)	160	156	153
Latent - Water Fusion (Btu)	2,040	2,040	2,040
Latent - Fat Fusion (Btu)	255	255	254
Latent - Water Vaporization (Btu)	5,712	5,479	5,351
Total Energy to Food (Btu)	10,627	10,321	10,143
Energy to Food (Btu/lb)	441	428	421
Total Energy to Double-sided griddle	13,993	13,857	13,379
Energy to Double-sided griddle (Btu/lb)	581	575	555
Cooking Energy Efficiency (%)	75.9	74.5	75.8
Cooking Energy Rate (kW)	10.31	10.60	10.19
Production Rate (lb/h)	60.6	62.9	62.6
Average Recovery Time (min)	< 0.5	< 0.5	< 0.5

Cooking Energy Efficiency Data

Table D-3. Manufacturer-Specified Settings Heavy-Load Test Data.

	Repetition #1	Repetition #2	Repetition #3
Measured Values			
Total Energy (kWh)	4.10	4.08	4.02
Cook Time (min)	2.83	2.83	2.83
Total Test Time (min)	23.4	22.6	22.8
Weight Loss (%)	34.9	35.1	35.1
Initial Weight (lb)	24.09	24.09	24.04
Final Weight (lb)	15.68	15.64	15.60
Initial Fat Content (%)	21.2	21.2	19.8
Initial Moisture Content (%)	58.8	58.8	60.2
Final Moisture Content (%)	53.2	52.6	52.4
Initial Temperature (°F)	0	0	0
Final Temperature (°F)	163	163	163
Calculated Values			
Initial Weight of Water (lb)	14.2	14.2	14.5
Final Weight of Water (lb)	8.3	8.2	8.2
Weight of Fat (lb)	5.1	5.1	4.8
Weight of Solids (lb)	4.8	4.8	4.8
Sensible to Ice (Btu)	227	227	232
Sensible to Water (Btu)	1,850	1,855	1,896
Sensible to Fat (Btu)	332	333	310
Sensible to Solids (Btu)	157	157	157
Latent - Water Fusion (Btu)	2,040	2,040	2,084
Latent - Fat Fusion (Btu)	255	255	227
Latent - Water Vaporization (Btu)	5,650	5,759	6,104
Total Energy to Food (Btu)	10,510	10,625	11,009
Energy to Food (Btu/lb)	436	441	458
Total Energy to Double-sided griddle	13,993	13,925	13,720
Energy to Double-sided griddle (Btu/lb)	581	578	571
Cooking Energy Efficiency (%)	75.1	76.3	80.2
Cooking Energy Rate (kW)	10.52	10.83	10.60
Production Rate (lb/h)	61.8	63.9	63.4
Average Recovery Time (min)	< 0.5	< 0.5	< 0.5

Table D-4. Medium-Load Test Data.

	Repetition #1	Repetition #2	Repetition #3
Measured Values			
Total Energy (kWh)	2.04	2.14	2.06
Cook Time (min)	2.83	2.95	2.92
Total Test Time (min)	21.3	21.8	22.0
Weight Loss (%)	33.6	36.6	33.7
Initial Weight (lb)	12.02	12.02	12.02
Final Weight (lb)	7.98	7.62	7.96
Initial Fat Content (%)	19.4	19.4	19.4
Initial Moisture Content (%)	60.6	60.6	60.6
Final Moisture Content (%)	53.0	52.2	52.4
Initial Temperature (°F)	0	0	0
Final Temperature (°F)	159	167	160
Calculated Values			
Initial Weight of Water (lb)	7.3	7.3	7.3
Final Weight of Water (lb)	4.2	4.0	4.2
Weight of Fat (lb)	2.3	2.3	2.3
Weight of Solids (lb)	2.4	2.4	2.4
Sensible to Ice (Btu)	117	117	117
Sensible to Water (Btu)	926	983	929
Sensible to Fat (Btu)	148	156	149
Sensible to Solids (Btu)	76	80	77
Latent - Water Fusion (Btu)	1,049	1,049	1,049
Latent - Fat Fusion (Btu)	110	109	110
Latent - Water Vaporization (Btu)	2,960	3,208	3,017
Total Energy to Food (Btu)	5,386	5,703	5,446
Energy to Food (Btu/lb)	448	474	453
Total Energy to Double-sided griddle	6,963	7,304	7,031
Energy to Double-sided griddle (Btu/lb)	579	608	585
Cooking Energy Efficiency (%)	77.4	78.1	77.5
Cooking Energy Rate (kW)	5.74	5.90	5.62
Production Rate (lb/h)	33.8	33.1	32.8
Average Recovery Time (min)	< 0.25	< 0.25	< 0.25

Table D-5. Light-Load Test Data.

	Repetition #1	Repetition #2	Repetition #3
Measured Values			
Total Energy (kWh)	1.20	1.22	1.22
Cook Time (min)	2.92	2.92	2.92
Total Test Time (min)	20.1	20.0	20.2
Weight Loss (%)	36.7	35.5	35.9
Initial Weight (lb)	6.01	6.01	6.01
Final Weight (lb)	3.81	3.88	3.86
Initial Fat Content (%)	19.8	19.8	19.8
Initial Moisture Content (%)	60.2	60.2	60.2
Final Moisture Content (%)	50.9	51.9	51.4
Initial Temperature (°F)	0	0	0
Final Temperature (°F)	167	164	165
Calculated Values			
Initial Weight of Water (lb)	3.6	3.6	3.6
Final Weight of Water (lb)	1.9	2.0	2.0
Weight of Fat (lb)	1.2	1.2	1.2
Weight of Solids (lb)	1.2	1.2	1.2
Sensible to Ice (Btu)	58	58	58
Sensible to Water (Btu)	489	478	482
Sensible to Fat (Btu)	80	78	79
Sensible to Solids (Btu)	40	39	40
Latent - Water Fusion (Btu)	521	521	521
Latent - Fat Fusion (Btu)	57	57	57
Latent - Water Vaporization (Btu)	1,631	1,557	1,588
Total Energy to Food (Btu)	2,876	2,788	2,824
Energy to Food (Btu/lb)	478	464	470
Total Energy to Double-sided griddle	4,096	4,164	4,164
Energy to Double-sided griddle (Btu/lb)	681	693	693
Cooking Energy Efficiency (%)	70.2	67.0	67.8
Cooking Energy Rate (kW)	3.59	3.65	3.62
Production Rate (lb/h)	18.0	18.0	17.8
Average Recovery Time (min)	< 0.25	< 0.25	< 0.25

Cooking Energy Efficiency Data

Table D-6. Cooking Energy Efficiency and Production Capacity Statistics.

	Cooking Energy Efficiency			Production Capacity
	Heavy Load	Medium Load	Light Load	
Replicate #1	75.9	77.4	70.2	60.6
Replicate #2	74.5	78.1	67.0	62.9
Replicate #3	75.8	77.5	67.8	62.6
Average	75.4	77.6	68.3	62.0
Standard Deviation	0.81	0.39	1.68	1.25
Absolute Uncertainty	2.00	0.97	4.18	3.11
Percent Uncertainty	2.66	1.25	6.11	5.01