Q-Matic, Model Q-55
Conveyor Oven Performance Test

Application of ASTM Standard Test Method F 1817-97

FSTC Report 5011.06.15

July 2006

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Acknowledgements

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Specific appreciation is extended to Q-Matic for supplying the Food Service Technology Q-55 conveyor oven for testing.

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Executive Summary

The Q-Matic Q-55 gas conveyor oven is a stackable unit capable of high-volume cooking. The oven is equipped with a 72-inch long by 24-inch wide, variable-speed conveyor which passes through a baking chamber. The oven uses a dual source heating system that combines natural gas infrared burners and electric elements. The oven is rated at 160,000 Btu/h and 6.6 kW.

The Q-55 oven was tested at the Food Service Technology Center Laboratory located in San Ramon, California. The objective of this testing was to examine the operation and performance of the Q-Matic gas conveyor oven, model Q-55, under controlled conditions. The oven was tested during idle and cooking conditions, using the American Society for Testing Materials (ASTM) Standard F1817-97 *Standard Test Method for the Performance of Conveyor Ovens.* Oven performance is characterized by preheat energy consumption and duration, idle energy rate, cooking-energy efficiency and production capacity

The ASTM test method specifies a 475°F cavity temperature for all tests. Due to the nature of the Q-Matic's infrared burner system, the temperature sensor installed in the center of the baking chamber indicated a stabilized operating temperature of 671°F. Since the object of the preheat test is to determine the time and energy required to reach a ready-to-cook condition, the oven was considered preheated when the cavity temperature reached 95% of its stabilized operating temperature (or 638°F). The oven reached this temperature in 9.5 minutes and used 13.3 cubic feet of gas. All testing was subsequently performed with the oven operating at 671°F. The oven was placed under a 10-foot by 5-foot wall-mounted canopy hood. The hood was 78 inches above the floor, centered left-to-right over the oven, with a 9-inch front overhang.

Executive Summary

Cooking-energy efficiency and production capacity results were obtained from the cooking of oversized 16″ test pizzas under heavy load testing scenarios. The Q-55 displayed a production capacity of 88.2 large pizzas per hour. The test setup is shown in Figure ES-1and the test data is summarized in Table ES-1.

Table ES-1. Summary of Performance: Q-Matic Q55 Gas Conveyor Oven.

Preheat and Idle Rate Tests	
Rated Energy Input Rate (Btu/h)	160,000
Measured Energy Input Rate (Btu/h)	176,045
Rated Energy Input Rate (kW)	6.6
Measured Energy Input Rate (kW)	6.67
Preheat Time (minutes)	9.5
Preheat Gas Energy (Btu)	12,963
Preheat Electric Energy (kWh)	4.93
Idle Energy Rate (Btu/h)	57,655
Idle Energy Rate (kW)	1.3
12-inch Pizza (Medium Load) Cooking Tests	
Gas Cooking Energy Rate (Btu/h)	73,801
Electric Cooking Energy Rate (kW)	4.6
Energy Efficiency (%)	23.9±1.5
Production Capacity (Pizzas/Hour)	120 ± 0
16-inch Pizza (Heavy Load) Cooking Tests	
Gas Cooking Energy Rate (Btu/h)	76,945
Electric Cooking Energy Rate (kW)	4.9
Energy Efficiency (%)	31.4±1.81
Production Capacity (Pizzas/Hour)	88.2 ± 3.1

The oven’s infrared burner system operated at a much higher temperature than the ASTM-specified 475°F. Researchers adjusted the oven controls and conveyor speed to achieve a cooked pizza temperature within the ASTM required range (195 ± 5°F). The oven’s 32 inch wide conveyor was optimized for 16-inch pizzas. When tested with the ASTM-specified 12-inch pizzas, the oven exhibited a 23.9% cooking efficiency. Researchers noted that this did not fully load the oven cavity and was not representative of the oven's maximum performance. When tested with the larger 16-inch pizzas, the Q-Matic's cooking efficiency improved to 31.3%. The 16-inch pizzas filled the baking chamber more completely, providing a test that was more representative of the oven's maximum performance.

Based on the experience of applying the ASTM test method, it is recommended that the test method be revised to accommodate different standard pizza sizes to best fill the baking chamber of the oven under test.

1 Introduction

Background

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 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. ASTM F1817, *Standard Test Method for the Performance of Conveyor Ovens,* was originally approved by ASTM in 1997. [1]

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.

Conveyor ovens allow for the rapid cooking of food products with consistency and ease of operator use. Beyond the initial capital cost, conveyor ovens can be evaluated with regards to long-term operational cost and performance as characterized by cooking-energy efficiency, idle energy consumption and production capacity.

Controlled testing of a Q-Matic conveyor oven was performed according to the ASTM conveyor oven test method. The test data provides key information to determine the cost of operation and the percentage of total kitchen productivity a single appliance can deliver. Better-informed decisions can then be made for equipment purchases, kitchen layout, energy demand of the kitchen, and appliance capacity during peak demand. Improved kitchen strategies can be implemented using the test information to reduce energy costs while still maintaining optimal cooking production. Information about preheat time can be used to schedule start up of an appliance when it is needed, which can reduce the amount of appliance idle time.

Other Food Service Technology Center reports document results of applying the ASTM test method for conveyor ovens to different models.[2,3] The glossary in Appendix A provides a quick reference to the terms used in this report

Objective

The objective of this report is to examine the operation and performance of the Q-Matic gas conveyor oven, model Q-55, under the controlled conditions of the ASTM Standard Test Methods. The scope of this testing is as follows:

- Energy input rate is determined to confirm that the oven is operating within 5% of the nameplate energy input rate.
- The amount of time and energy required to preheat the oven to a ready-to-bake state are determined.
- Idle energy rate is measured with the oven maintaining a ready-to-bake state while not baking.
- Cooking-energy efficiency and production rate are determined during heavy load cooking tests using standard cheese pizza as the food product.
- The maximum production capacity of the appliance is determined during heavy load cook testing.

Appliance Description

The Q-Matic Q-55 conveyor oven is a single deck oven that can be stacked with other Q-55 units in a multi-deck configuration. For the purposes of this testing, the Q-55 was tested in a single-deck configuration. The oven has a stainless steel exterior and includes solid-state electronic controls. As the pizza passes through the oven it is heated by infrared gas burners located below the conveyor belt and electric radiant heat from above. The oven comes with a set of metal cooking pans, which evenly distribute heat across the bottom of the food product.

The Q-55's gas input is rated at 160,000 Btu/h and electrical input is rated at 6.6 kW. Overall dimensions of the assembled oven are 91 inches wide, 47 inches deep, and 44 inches high. The baking zone measures 55 inches long by 32 inches wide. Appliance specifications are listed in Table 1-1, and the manufacturer's literature is included in Appendix B.

Figure 1-1.
The Q-55 conveyor oven.

Table 1-1. Appliance Specifications.

Manufacturer	Q-Matic, Inc.
Model	Q-55
Generic Appliance Type	Conveyor Oven
Rated Input	160,000 Btu/h, and 6.6 kW
Technology	Infrared
Construction	Stainless Steel Exterior
Controls	Solid state electronic
Belt Width	32"
Dimensions	91" Lx 47"W x 44"H

2 Methods

Setup and Instrumentation

The Q-55 conveyor oven was installed in accordance with the ASTM *Standard Test Method for Conveyor Ovens.*[1] The single-deck oven was positioned under a 10-foot by 5-foot wall mounted canopy hood, with the lower edge of the hood mounted at 78 inches above the floor. The oven was located nine inches inside the front edge of the hood, and was centered left to right. The exhaust ventilation operated at a nominal rate of 3,000 CFM, or 300 CFM per linear foot of hood.

Gas consumption was measured using a positive displacement gas meter and power and energy were measured with a watt/watt-hour transducer. Temperature measurement of the cooked pizzas as well as measurement of the oven cavity temperatures was accomplished using a data acquisition system that recorded data at 5-second intervals.

Energy Input Rate and Thermostat Calibration

The energy input rate was determined by measuring the energy consumed by the oven from the time it was first turned on until the time the oven's temperature reached 95% of its stabilized operating temperature. The energy consumed and the time elapsed were used to calculate the maximum energy input rate. Thermostat calibration was verified by installing a thermocouple in the center of the oven cavity, 4-inches above the conveyor. The oven was then turned on and the temperature setpoint and conveyor speed were adjusted until a 195°F average pizza temperature was obtained.

Preheat and Idle Rate Tests

Preheat tests recorded the time and energy required for the oven to warm the baking chamber from room temperature to a ready-to-bake condition. This was determined by allowing the oven to stabilize for one hour, then establishing the point when the center of the cavity reached 95% of the stabilized operating temperature. Although the ASTM test method specifies a 475°F operating temperature for all tests, the Q-Matic's infrared burner system achieves a much higher operating temperature (671°F). Therefore all tests were conducted with the oven operating at the manufacturer recommended 671°F settings.

After the oven was preheated, it was operated for one hour, which allowed the oven cavity, exhaust ventilation temperatures, appliance and hood surface temperatures to stabilize at steady state conditions. At the end of the stabilization, the idle energy consumption was monitored for a 2-hour period.

Heavy-Load Pizza Tests

The heavy load pizza tests were used to calculate cooking-energy efficiency and production capacity when the oven is under maximum loading conditions. The heavy load tests required preparation of 24 rows of 2 pizzas (48 total) for each test run, half of which were used to stabilize the oven. The pizzas used for the heavy load test were 16 -inch diameter, par-baked crusts, weighing 1.4 ± 0.2 pounds and having a moisture content of 36 ± 2% by weight. Pizza sauce was a simple, tomato-based sauce with a moisture content of 87 ± 3% by weight. Pizza cheese was part-skim, low moisture, shredded mozzarella cheese with a moisture content of 50 ± 2% by weight. The ingredients were tested for proper moisture content using gravimetric moisture analysis.

The pizzas were comprised of a pizza crust, sauce, and cheese according to the following: 0.44 lb of pizza sauce spread uniformly on top of a pizza crust to within 0.5 inch of the edge, and 0.67 lb of pizza cheese, spread uniformly over the pizza sauce. The pizzas were then placed on sheet pans and covered with plastic wrap. The pizzas were stabilized in a refrigerator for a minimum of 18 hours before testing to ensure temperature uniformity of 39 ± 1°F.

The pizzas were prepared, pre-weighed and stabilized. The pizza rows were placed one after the other on the oven conveyor such that the leading edge of the new row of pizzas was directly next to the trailing edge of the previous row. All pizzas were measured after cooking for final weight and temperature, for use in the energy efficiency calculations.

Medium-Load Pizza Tests

Medium-load pizza tests are used to calculate cooking-energy efficiency under partial loading conditions, such as when the oven is cooking pizzas intermittently or at a rate below its maximum capacity. The loading pattern and testing procedure for the medium load test was the same as the heavy load test, but the pizzas used were medium-sized 12-inch diameter, par-baked crusts, weighing 0.9 ± 0.2 pounds. The pizza sauce and cheese used for the medium load test was the same as that used for the heavy load test. The pizzas were comprised of a pizza crust, sauce, and cheese according to the following: 0.25 lb of pizza sauce spread uniformly on top of a pizza crust to within 0.5 inch of the edge, and 0.375 lb of pizza cheese, spread uniformly over the pizza sauce. All pizzas were measured for a final weight and temperature for use in the energy efficiency calculations.

Light-Load Pizza Tests

Light-load pizza tests are used to calculate cooking-energy efficiency under intermittent loading conditions, such as off-peak hours. The pizzas used for the light load test had the same ingredients and composition as the medium load test. Under the light load cooking scenario, 4 rows of 2 pizzas (8 total) were used for each run, half of which were used to stabilize the oven. The pizzas were removed from the refrigerator and loaded onto the oven conveyor belt so that no more than 1 minute elapsed before the cooking process began. Each row was placed on the conveyor with the pizzas equidistant from the center of the conveyor. All pizzas were measured for a final weight and temperature for use in the energy efficiency calculations.

The cooking tests were performed in triplicate to ensure 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. Appendix C contains the ASTM results reporting sheets for this oven.

3 Results

Energy Input Rate

The energy input rate was measured to ensure that the oven was operating according to manufacturer specifications during the subsequent testing. The peak input rate while the burners were on was 176,045 Btu/h; the peak input rate for the heating elements was 6.67 kW while energized.

Preheat and Idle Rate Tests

Time and energy were monitored starting from the time the oven was turned on. Any time that elapsed before the igniting of the burners is included in the test. Since the Q-Matic cycles the heaters continuously, the preheat was considered complete when the oven reached 95% of its stabilized operating temperature. The Q-Matic reached 630°F after 9.5 minutes while consuming 12,963 Btu. The oven's preheat curve is shown in Figure 3-1.

The oven was stabilized for one hour following the preheat test and then the energy consumption was monitored over a 2-hour period. The recorded idle energy rate was 57,655 Btu/h, which is 36.0% of the rated input for the oven. The rated energy input, preheat energy, and idle rate test results are summarized in Table 3-1.

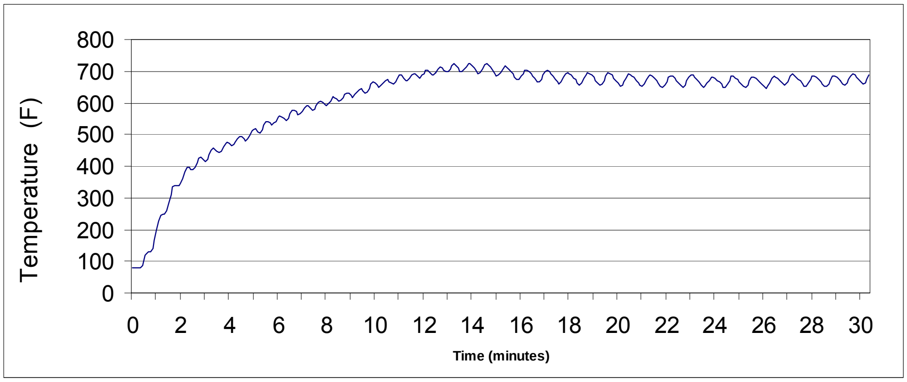

Figure 3-1.
Preheat characteristics.

Results

Table 3-1. Input, Preheat, and Idle Rate Test Results.

Rated Energy Input Rate (Btu/h)	160,000
Measured Energy Input Rate (Btu/h)	167,045
Rated Energy Input Rate (kW)	6.6
Measured Energy Input Rate (kW)	6.67
Preheat Time (minutes)	9.5
Preheat Gas Energy (Btu)	12,963
Preheat Electric Energy (kWh)	4.93
Idle Energy Rate (Btu/h)	57,655
Electric Energy Rate (kW)	1.28
Idle Duty Cycle (%)	36%

Cooking Tests

The oven was tested under light, medium and heavy load cooking scenarios. The gas consumption, electric energy consumption, elapsed cook time, oven cavity temperature, and ambient temperature were monitored during each test. Final pizza temperatures were recorded at five-second intervals. The ASTM test method specifies 12-inch diameter pizzas for the cooking-energy efficiency and production capacity tests. Since the Q-Matic Q-55 has a 32-inch wide belt, the ASTM-specified 12-inch pizzas did not completely fill the baking chamber. This testing scenario was more representative of a medium load test. The cooking-energy efficiency tests were repeated using 16-inch pizzas to provide a subsequently heavier load on the oven.

Light-Load Efficiency Tests

The light-load tests were used to determine the oven’s performance under low load conditions, typical of what may occur during off-peak hours. For light-load tests, researchers used eight 12-inch pizzas.

Medium-Load Efficiency Tests

The medium-load tests were used to determine the oven's performance under partial load conditions, typical of what may occur when the oven is not being used to full capacity. For the medium-load tests, researchers used twenty-four 12-inch pizzas.

Heavy-Load Efficiency and Production Capacity Tests

The heavy-load cooking tests were designed to reflect an oven's maximum performance. For the heavy-load tests, researchers used twenty-four 16-inch pizzas.

Test Results

Cooking-energy efficiency is defined as the quantity of energy consumed by the pizzas expressed as a percentage of energy consumed by the oven during the cooking test:

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

The energy transferred to the food was calculated using the measured values of initial and final pizza temperature, initial and final pizza weight, the specific heat of the pizza (based on the specified pizza composition), and the heat of vaporization of water. Energy consumed by the oven is the sum of the gas and electric energy consumed during the test. Table 3-2 summarizes the Q-55 oven's performance under the ASTM test method. Appendix D contains a synopsis of test data for each replicate of the cooking tests.

Table 3-2. Cooking-Energy Efficiency and Production Capacity Test Results.

	Light Load	Medium Load	Heavy Load
Number of pizzas	4	12	12
ASTM Measured Cook Time (mm:ss)	4.20	4.00	4.30
Test Time (minutes)	10.39	6.0	8.17
Gas Cooking Energy Rate (Btu/h)	56,572	73,801	76,945
Electric Cooking Energy Rate (kW)	2.46	4.6	4.9
Energy Efficiency (%)	7.1±3.2	23.9 ± 1.5	31.3 ± 1.8
Production Rate (pizzas/h)*	23.1±0.1	120 ± 0	88.2 ± 3.5
Production Rate (lb/h)			221.4 ± 7.75

*The production rate is dependent on the size of the pizza and the conveyor speed during the test.

Figure 3-2 illustrates the relationship between cooking-energy efficiency and production rate for the Q-Matic oven.

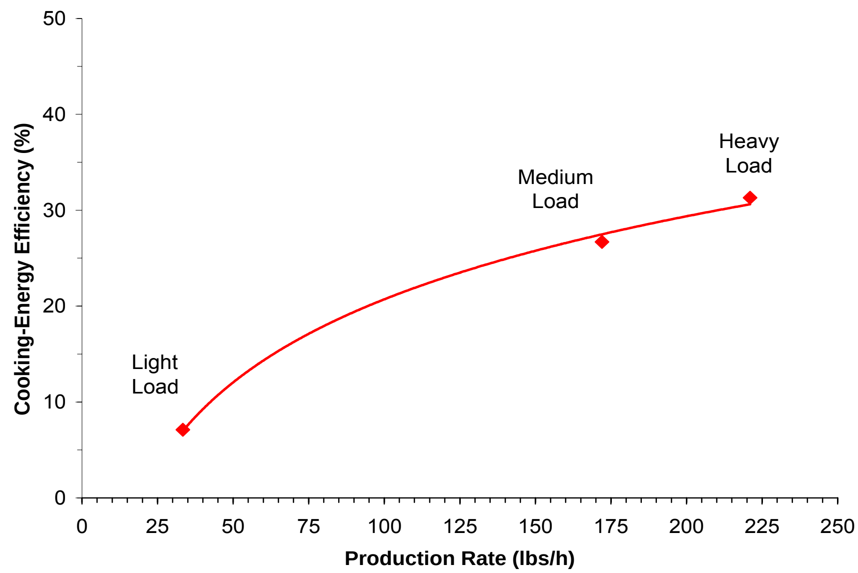

Figure 3-2.
Conveyor oven part load cooking energy efficiency.

Figure 3-3 illustrates the relationship between the conveyor oven's average energy consumption rate and the production rate. This graph can be used as a tool to estimate the daily energy consumption for the convection oven in a real-world operation. Average gas energy consumption rates at 50, 100, and

150 pounds per hour are 62 kBtu/h, 66 kBtu/h, and 70 kBtu/h, respectively. Similarly, Figure 3-4 can be used to estimate the electric use of the Q-Matic oven during operation. Average electric energy consumption rates at 50, 100, and 150 lb/h are 2.6 kW, 3.6 kW, and 4.8 kW, respectively.

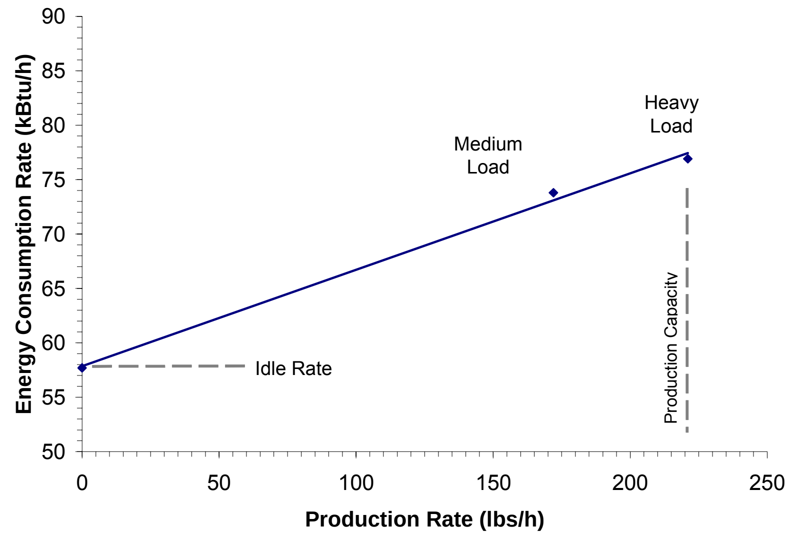

Figure 3-3.
Conveyor oven gas cooking energy consumption profile.

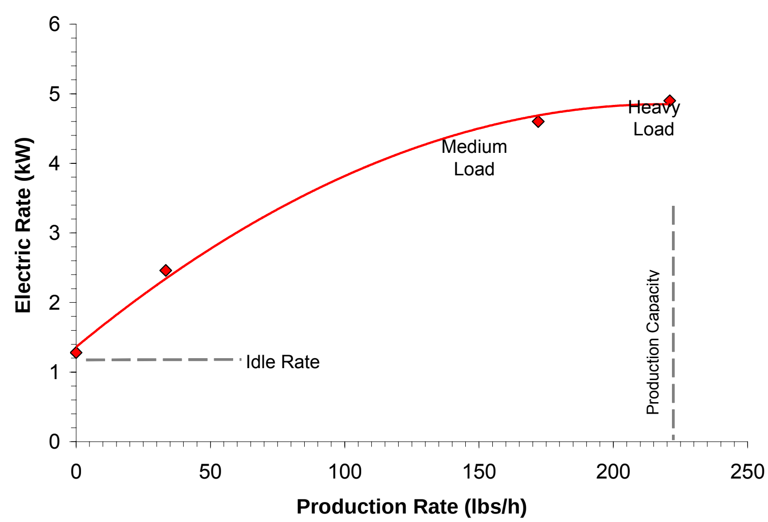

Figure 3-4.
Q-Matic 55 Electric energy profile.

4 Conclusions

The Q-55 was able to cook 88.2 large (16-inch) pizzas per hour while demonstrating a heavy-load cooking-energy efficiency of 31.3%. When tested with 12-inch pizzas under a medium load scenario, the oven produced 120 pizzas/h with an efficiency of 23.9%.

The oven's duty cycle—that is, the percentage of the oven's actual energy consumption rate compared to the 160,000 Btu/h measured energy input rate—was 36% during idle conditions and 48% during heavy load cooking operation. The low duty cycles calculated for idle and cooking conditions imply that the oven's burner has much more capacity than is being used during normal operation. In fact, the oven's cooking efficiency may benefit from using lower rated burners that operate at a higher duty cycle, as short-cycling of gas burners may cause inefficiencies.

The Q-Matic 55 oven presented a challenge to the current version of the ASTM test method. The oven's infrared burner system operated at a much higher temperature than the ASTM-specified 475°F. Furthermore, the oven's dimensions are optimized for larger 16-inch pizzas. When tested with the ASTM-specified 12-inch pizzas, the oven exhibited a 23.9% cooking efficiency. This is consistent with part-load efficiencies for other ovens,[2,3] and not representative of the oven's maximum performance. When tested with 16-inch pizzas, the Q-Matic's cooking efficiency improved to 31.3%. The 16-inch pizzas filled the baking chamber more completely, providing a heavier load on the oven.

Based on the experience of applying the ASTM test method, it is recommended that the test method be revised to accommodate different standard pizza sizes to best fill the baking chamber of the oven under test.

5 References / Bibliography

1. American Society for Testing and Materials, 1997. *Standard Test Method for Performance of Conveyor Ovens*. ASTM Designation F1817-97. In Annual Book of ASTM Standards, West Conshohocken, PA.
2. Sorensen, G., Young, R., 1998. *Middleby Marshall Conveyor Oven, PS 360WB Conveyor Oven Performance Test.* Food Service Technology Center Report 5011.98.63, December.
3. Sorensen, G., Young, R., 1998. *Blodgett Double Deck Conveyor Oven, MT3855G with In-Vent Ventilation System, AB2B Conveyor Oven Performance Test.* Food Service Technology Center Report 5011.98.62, December.

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Appendixes

A Glossary

Conveyor Oven

An appliance that carries the food product on a moving conveyor into and through a heated chamber. The chamber may be heated by gas or electric forced convection, radiants, or quartz tubes. Top and bottom heat may be independently controlled.

Conveyor Speed (min)

Time required for a single point on the conveyor belt to travel through the oven cavity.

Cook Time (min)

Time required for an entire pizza to travel through the oven cavity, measured from the time when the leading edge of the pizza enters the oven cavity, to the time when the trailing edge of the pizza exits the oven cavity.

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- 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.

Glossary

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

The rate of appliance energy consumption while it is holding or maintaining a stabilized operating condition or temperature at a specified control setting.

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.

Glossary

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 cooked food product from the appliance until the cooking cavity is within 10°F of the thermostat set point and the appliance is ready to be reloaded.

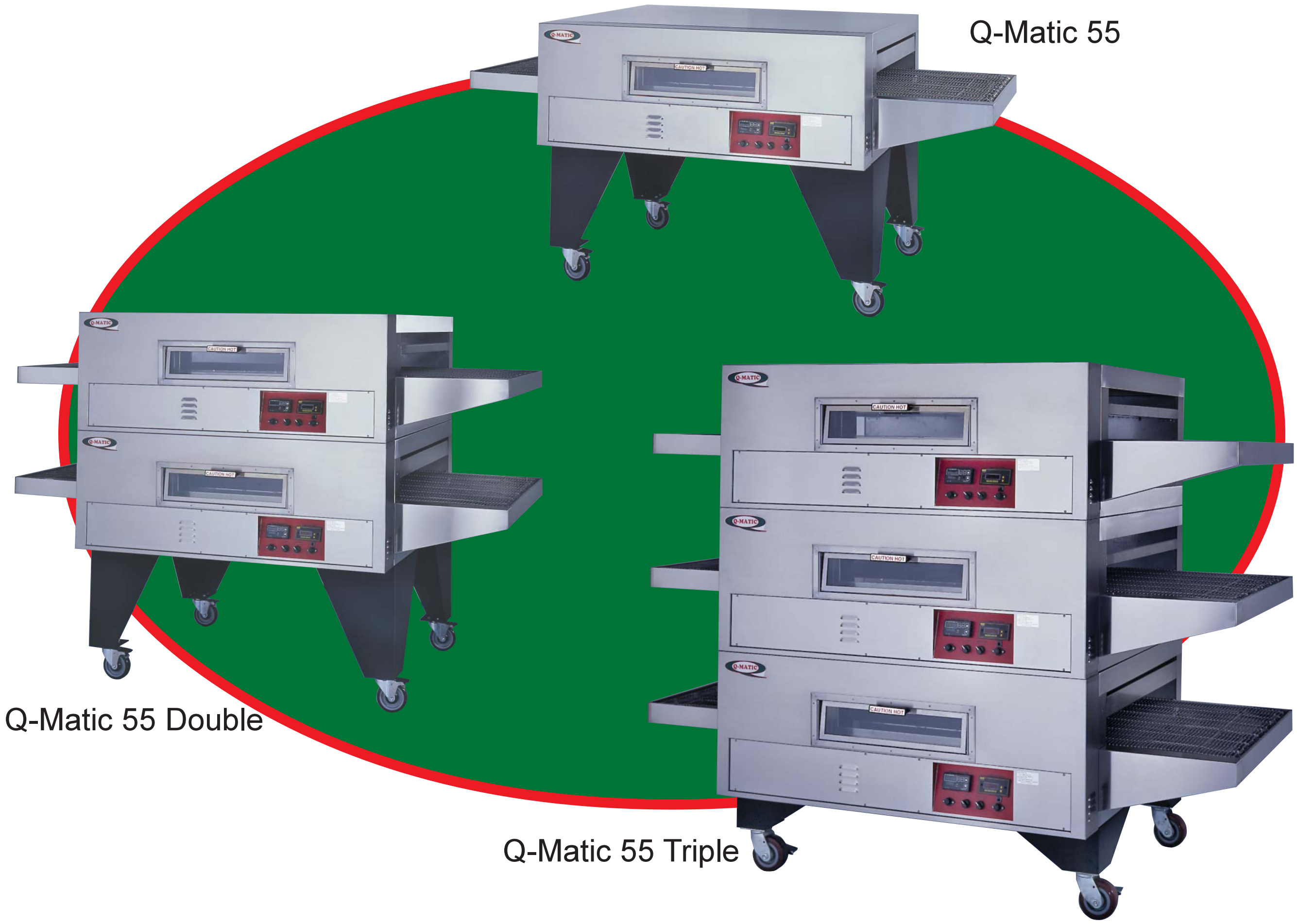
Test Method

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 Q-Matic, Model Q-55 Conveyor Oven

Q-Matic Ovens Combine the Speed and Consistency of a Conveyor and the Bake Quality of a Deck.



- Complete self-contained design makes oven simple to use, simple to clean.
- Front-mounted controls for easy set-up and service.
- Equipped with unique, specially-designed metal gas burners and state-of-the-art microprocessor controls.
- Fewer moving parts for quiet operation.
- Gas infrared and radiant heat for better energy and cost-effectiveness.
- Secured by an industry-best two-year parts and labor warranty.

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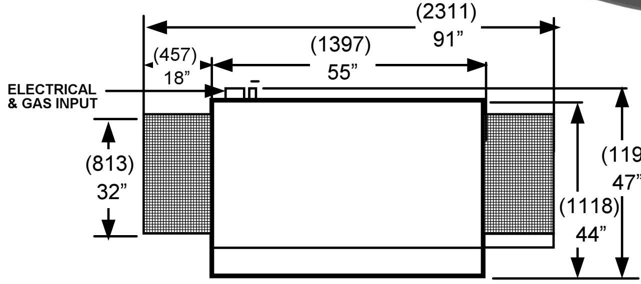
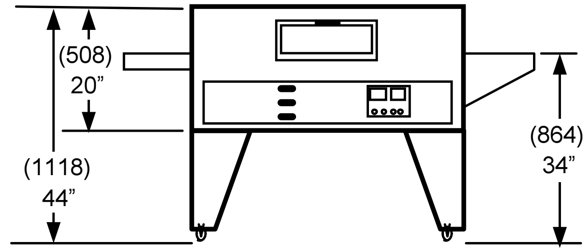
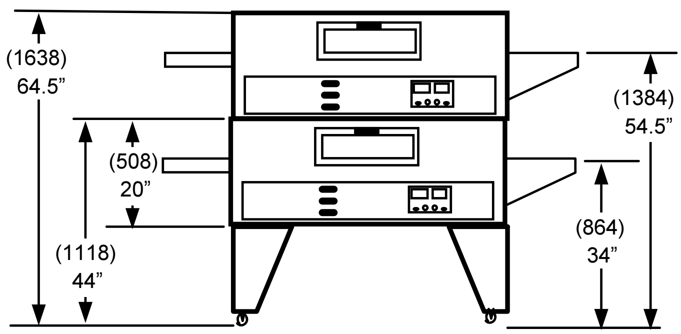
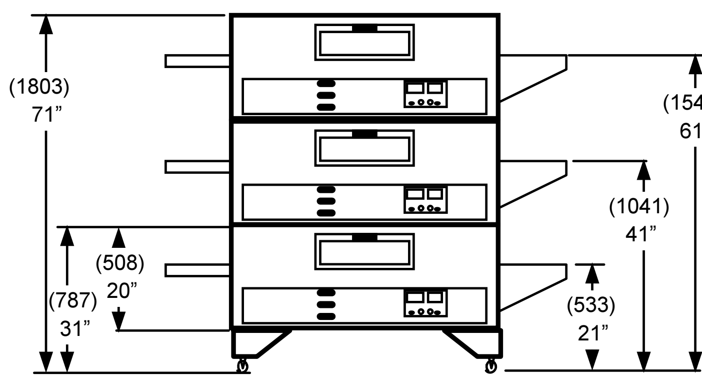
Q-Matic 55 Series

Q-MATIC TECHNOLOGIES









Q-MATIC 55 Series	
Overall Dimensions Single:	91” (2311)L x 47” (1194)W x 44” (1118)H
Overall Dimensions Double Stack:	91” (2311)L x 47” (1194)W x 64.5” (1638)H
Overall Dimensions Triple Stack:	91” (2311)L x 47” (1194)W x 71” (1803)H
Belt Width:	32” (813)
Cooking Zone:	55” (1397)
Maximum Operating Temperature:	550°F (288°C)
Maximum Input (each):	160,000 BTU/HR
Operating Range (each):	60,000 - 90,000 BTU/HR
Power Supply (each):	120/208 - 230/1/50 - 60hZ 3-Wire with Ground, 40 Amp
Gas Supply:	2” NPT LP or N.G.
Approx. Shipping Weight (crated each):	520 lbs. (206 kg)

Manufactured under U.S. patent# 5,145,160

1351 Estes Street • Gurnee, IL 60031 • Tel: (847) 263-7324; Toll-Free: (800) 880-OVEN (6836)
Fax: (847) 263-7367 • www.q-maticovens.com
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C Results Reporting Sheets

Manufacturer	Q-Matic, Inc.
Model	Q-55
Serial Number	200603929
Date:	6/22/06

Section 11.1 Test Oven

Description of operational characteristics: The oven is equipped with a 91-inch long by 32-inch wide, variable-speed conveyor which passes through a high-velocity impingement bake zone. The oven uses a dual source heating system that combines a natural gas burner and infrared panels. The oven is rated at 160,000 Btu/h. The oven has electronic dial operated controls for all operating functions.

Section 11.2 Apparatus

The oven was installed in accordance with the manufacturer's instruction on a tiled floor under a 4-foot-deep canopy hood, with the lower edge of the hood 6 feet, 6 inches above the floor and a minimum of 6 inches inside the vertical front edge of the hood. The exhaust ventilation operated at a nominal rate of 300 cfm per linear foot of hood.

The oven was instrumented using a positive displacement gas meter, a watt/watt-hour transducer, and a 24 gauge, type K fiberglass insulated thermocouple wire (for oven cavity temperature measurement). A voltage regulator maintained a constant voltage for all tests and data was recorded at five-second intervals by a computerized data acquisition unit. All test apparatus were installed in accordance with Section 9 of the ASTM test method.

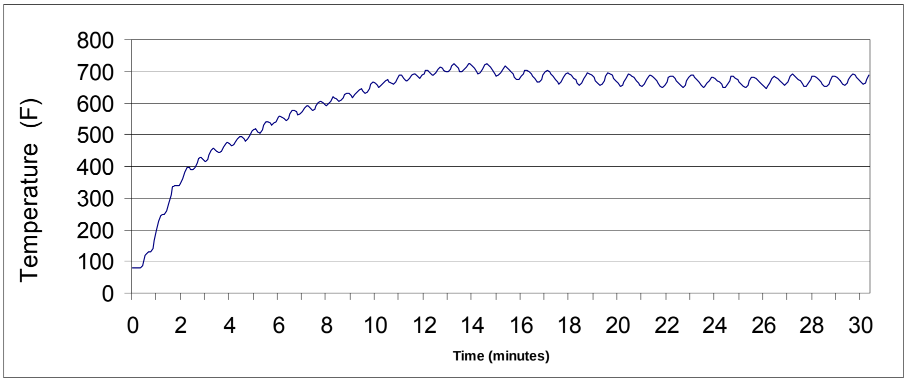
Section 11.4 Energy Input Rate

Test Voltage	208 V
Gas Heating Value	1019 Btu/ft^3
Rated	160,000 Btu/h
Measured	85,344 Btu/h
Percent Difference between Measured and Rated	46.6%
Fan/Control Energy Rate (Gas Ovens Only)	5.10 kW

Section 11.5 Preheat Energy and Time

Test Voltage	208 V
Gas Heating Value	1021 Btu/ft^3
Energy Consumption	12,963 Btu
Time from 75°F to 638°F	9.5 min

Preheat Characteristics



Section 11.6 Idle Energy Rate

Test Voltage	208 V
Gas Heating Value	1020 Btu/ft^3
Idle Energy Rate	57,655 Btu/h

Section 11.8 Cooking Energy Efficiency and Cooking Energy Rate

Light Load:

Test Voltage	208 V
Gas Heating Value	1020 Btu/ft^3
Cooking Energy Efficiency	7.1 ± 3.2%
Gas Cooking Energy Rate	56,572 Btu/h
Electric Cooking Energy Rate	2.46 kW

Medium Load:

Test Voltage	208 V
Gas Heating Value	1033 Btu/ft^3
Cooking Energy Efficiency	26.7 ± 6.6%
Gas Cooking Energy Rate	73,801 Btu/h
Electric Cooking Energy Rate	4.6 kW

Heavy Load:

Test Voltage	208 V
Gas Heating Value	1020 Btu/ft^3
Cooking Energy Efficiency	31.3 ± 5.7%
Gas Cooking Energy Rate	76,945 Btu/h
Electric Cooking Energy Rate	4.9 kW
Production Capacity	88.2 ± 1.8 Pizzas/h
Production Capacity	221.4 ± 7.75 lb/h

D Cooking-Energy Efficiency Data

Table D-1. Physical Properties.

Specific Heat (Btu/lb °F)	
Pizza	0.593
Latent Heat (Btu/lb)	
Vaporization, Water	970

Cooking-Energy Efficiency Data

Table D-2. Light Load Pizza Efficiency Test Data.

	Repetition #1	Repetition #2	Repetition #3
Measured Values			
Number of Pizzas	4	4	4
Conveyor Speed (min)	4.0	4.0	4.0
Initial Pizza Temperature (°F)	40.0	40.0	40.0
Final Average Pizza Temperature (°F)	196.0	197.3	196.4
Total Initial Pizza Weight (lb)	5.786	5.804	5.770
Total Final Pizza Weight (lb)	5.618	5.625	5.580
Test Time (min)	10.4	10.4	10.4
Gas Volume (ft^3)	10.0	9.9	10.1
Electric Energy (Wh)	420	440	420
Calculated Values			
Energy Consumed by Pizzas (Btu)	698	715	720
Energy Consumed by Pans (Btu)	86	87	86
Gas Energy Consumed by Oven (Btu)	9,797	9,710	9,883
Electric Energy Consumed by Oven (Btu)	1,433	1,502	1,433
Total Energy Consumed by Oven (Btu)	11,230	11,212	11,316
Cooking Energy Efficiency (%)	7.0	7.1	7.1
Gas Cooking Energy Rate (Btu/h)	56,467	56,181	57,070
Electric Cooking Energy Rate (kW)	2.4	2.6	2.4
Production Rate			

Cooking-Energy Efficiency Data

Table D-3. Medium Load Pizza Efficiency Test Data.

	Repetition #1	Repetition #2	Repetition #3
Measured Values			
Number of Pizzas	12	12	12
Conveyor Speed (min)	4.0	4.0	4.0
Initial Pizza Temperature (°F)	40.0	40.0	40.0
Final Average Pizza Temperature (°F)	195.7	196.0	197.9
Total Initial Pizza Weight (lb)	17.14	17.18	17.18
Total Final Pizza Weight (lb)	16.60	16.65	16.59
Test Time (min)	6.0	6.0	6.0
Gas Volume (ft^3)	7.5	7.2	7.2
Electric Energy (Wh)	460	440	480
Calculated Values			
Energy Consumed by Pizzas (Btu)	2,105	2,099	2,180
Energy Consumed by Pans (Btu)	256	257	261
Gas Energy Consumed by Oven (Btu)	7,508	7,091	7,541
Electric Energy Consumed by Oven (Btu)	1,570	1,502	1,638
Total Energy Consumed by Oven (Btu)	9,078	8,592	9,180
Cooking Energy Efficiency (%)	26.0	27.4	26.6
Gas Cooking Energy Rate (Btu/h)	75,083	70,907	75,414
Electric Cooking Energy Rate (kW)	4.6	4.4	4.8
Production Rate (pizzas/h)	120	120	120
Production Rate (lb/h)	171.4	171.8	171.8

Cooking-Energy Efficiency Data

Table D-4. Heavy Load Pizza Efficiency Test Data.

	Repetition #1	Repetition #2	Repetition #3
Measured Values			
Number of Pizzas	12	12	12
Conveyor Speed (min)	4.5	4.5	4.5
Initial Pizza Temperature (°F)	40.0	40.0	40.0
Final Average Pizza Temperature (°F)	195.5	197.4	197.1
Total Initial Pizza Weight (lb)	30.28	30.01	30.11
Total Final Pizza Weight (lb)	29.44	28.95	29.13
Test Time (min)	8.1	8.3	8.1
Gas Volume (ft^3)	10.8	10.8	10.7
Electric Energy (Wh)	640	680	680
Calculated Values			
Energy Consumed by Pizzas (Btu)	3,603	3,828	3,761
Energy Consumed by Pans (Btu)	256	260	259
Gas Energy Consumed by Oven (Btu)	10,456	10,472	10,487
Electric Energy Consumed by Oven (Btu)	640	680	680
Total Energy Consumed by Oven (Btu)	12,641	12,793	12,808
Cooking Energy Efficiency (%)	30.5	32.0	31.4
Gas Cooking Energy Rate (Btu/h)	77,455	75,699	77,681
Electric Cooking Energy Rate (kW)	4.7	4.9	5.0
Production Capacity (Pizzas/h)	89	87	89
Production Capacity (lb/h)	224.3	216.9	223.1

Cooking-Energy Efficiency Data

Table D-5. Cooking-Energy Efficiency and Production Capacity Statistics.

	Cooking-Energy Efficiency			Production Capacity
	Heavy Load	Medium Load	Light Load	(lb/h)
Replicate #1	30.5	26.0	7.0	224
Replicate #2	32.0	27.4	7.1	217
Replicate #3	31.4	26.6	7.1	223
Average	31.3	26.7	7.1	221
Standard Deviation	0.72	0.71	0.09	3.94
Absolute Uncertainty	1.79	1.75	0.22	13.68
Percent Uncertainty	5.9	6.6	3.2	6.18