Designation: F2380 – 18

An American National Standard

Standard Test Method for Performance of Conveyor Toasters[1]

This standard is issued under the fixed designation F2380; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This test method evaluates the energy consumption and cooking performance of conveyor toasters including radiant and contact toasters. The food service operator can use this evaluation to select a conveyor toaster and understand its energy consumption.

1.2 This test method is applicable to gas and electric conveyor toasters.

1.3 The conveyor toaster can be evaluated with respect to the following (where applicable):

1.3.1 Energy input rate and preheat temperature profile (10.2),

1.3.2 Preheat energy consumption and time (10.3),

1.3.3 Idle energy rate (10.4),

1.3.4 Pilot energy rate (if applicable, 10.5),

1.3.5 Cooking energy rate (10.8), and

1.3.6 Production capacity (10.8).

1.4 The values stated in inch-pound units are to be regarded as standard. The SI units given in parentheses are for information only.

1.5 *This test method may involve hazardous materials, operations, and equipment. This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.6 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D3588 Practice for Calculating Heat Value, Compressibility Factor, and Relative Density of Gaseous Fuels

2.2 *ASHRAE Document:*

ASHRAE Guideline 2 (RA90) Engineering Analysis of Experimental Data[3]

2.3 *UL Document:*

UL 1026 Electric Household Cooking and Food Service Appliances[4]

3. Terminology

3.1 *Definitions:*

3.1.1 *contact toaster, n*—toaster that cooks product primarily by conduction via contact with a heated surface.

3.1.2 *conveyor toaster, n*—an appliance for caramelizing bread products that carries the bread product on a belt or chain 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.

3.1.3 *cooking energy rate, n*—average rate of energy consumption (Btu/h or kW) during the production capacity tests.

3.1.4 *energy input rate, n*—peak rate at which a conveyor toaster consumes energy (Btu/h or kW).

3.1.5 *idle energy rate, n*—the conveyor toaster's rate of energy consumption (kW or Btu/h), when empty, required to maintain its cavity temperature at the predetermined temperature set point.

3.1.6 *pilot energy rate, n*—rate of energy consumption (Btu/h) by a conveyor toaster's continuous pilot (if applicable).

3.1.7 *preheat energy, n*—amount of energy consumed (Btu or kWh), by the conveyor toaster while preheating its cavity from ambient temperature to the determined steady state temperature.

[1] This test method is under the jurisdiction of ASTM Committee F26 on Food Service Equipment and is the direct responsibility of Subcommittee F26.06 on Productivity and Energy Protocol.

Current edition approved March 1, 2018. Published April 2018. Originally approved in 2004. Last previous edition approved in 2016 as F2380 – 04 (2016). DOI: 10.1520/F2380-18.

[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] Available from American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc. (ASHRAE), 1791 Tullie Circle, NE, Atlanta, GA 30329, http://www.ashrae.org.

[4] Available from Underwriters Laboratories (UL), 333 Pfingsten Rd., Northbrook, IL 60062-2096, http://www.ul.com.

3.1.8 *preheat time, n*—time (min) required for the conveyor toaster cavity to preheat from ambient temperature to the specified set point.

3.1.9 *production capacity, n*—maximum rate (slices/h) at which a conveyor toaster can bring the specified bread product to a specified "toasted" condition.

3.1.10 *production rate, n*—rate (slices/h) at which a conveyor toaster brings the specified food product to a specified "toasted" condition. This does not necessarily refer to maximum rate. Production rate varies with the amount of food being toasted.

3.1.11 *radiant toaster, n*—toaster that cooks product primarily by radiation.

3.1.12 *toaster cavity, n*—that portion of the conveyor toaster in which bread products are heated or toasted.

3.1.13 *uncertainty, n*—measure of systematic and precision errors in specified instrumentation or measure of repeatability of a reported test result.

4. Summary of Test Method

4.1 Energy input rate is determined to confirm that the conveyor toaster is operating within 5 % of the nameplate energy input rate. For gas conveyor toaster, the pilot energy rate and the fan and control energy rates are also determined.

4.2 Preheat energy and time are determined.

4.3 Idle energy rate is determined.

4.4 Production rate is determined using sliced bread as a food product.

5. Significance and Use

5.1 The energy input rate test is used to confirm that the conveyor toaster is operating properly prior to further testing.

5.2 Preheat energy and time can be useful to food service operators to manage power demands and to know how quickly the conveyor toaster can be ready for operation.

5.3 Idle energy rate and pilot energy rate can be used to estimate energy consumption during non-cooking periods. In addition, a power saving mode (if applicable) will demonstrate energy savings during idle periods.

5.4 Production capacity information can help an end user to better understand the production capabilities of a conveyor toaster as it is used to cook a typical food product and this could help in specifying the proper size and quantity of equipment. If production information is desired using a food product other than the specified test food, the test method could be adapted and applied.

6. Apparatus

6.1 *Analytical Balance Scale,* for measuring weights up to 20 lb, with a resolution of 0.01 lb and an uncertainty of 0.01 lb.

6.2 *Barometer,* for measuring absolute atmospheric pressure, to be used for adjustment of measured natural gas volume to standard conditions. It shall have a resolution of 0.2 in. Hg and an uncertainty of 0.2 in. Hg.

6.3 *Gas Meter,* for measuring the gas consumption of a conveyor toaster, shall be a positive displacement type with a resolution of at least 0.1 ft^3 and a maximum uncertainty no greater than 1 % of the measured value for any demand greater than 2.2 ft^3/h. If the meter is used for measuring the gas consumed by the pilot lights, it shall have a resolution of at least 0.1 ft^3 and a maximum uncertainty no greater than 2 % of the measured value.

6.4 *Pressure Gage,* for monitoring natural gas pressure. It shall have a range of zero to 10 in. water, a resolution of 0.5 in. water, and a maximum uncertainty of 3 % of the measured value.

6.5 *Stop Watch,* with a 1-s resolution.

6.6 *Temperature Sensor,* for measuring natural gas temperature in the range of 50 to 100°F with an uncertainty of ±1°F.

6.7 *Thermocouple,* high temperature glass insulated, 24 gage, type K thermocouple wire, connected at the exposed ends by tightly twisting or soldering the two wires together.

6.8 *Watt-Hour Meter,* for measuring the electrical energy consumption of a conveyor toaster, shall have a resolution of at least 10 Wh and a maximum uncertainty no greater than 1.5 % of the measured value for any demand greater than 100 W. For any demand less than 100 W, the meter shall have a resolution of at least 10 Wh and a maximum uncertainty no greater than 10 %.

7. Reagents and Materials

7.1 *Bread for Toasting* shall be a generic grocery store brand, 1.5 ± 0.1 lb white loaf with a crown, consisting of 20 slices (not including the ends) measuring approximately 4.5 by 4.5 by 0.5 in. per slice. Each slice must weigh 0.065 ± 0.01 lb. The bread shall be stored at room temperature 75 ± 5°F.

7.2 *Buns for Toasting* shall be 5 in. in diameter consisting of a crown and a heel without sesame seeds and weigh 0.125 ± 0.02 lb for both crown and heel. Toasters that have the capability for toasting clubs (center piece of the bun) shall be toasted with a three-piece bun consisting of a crown, club and a heel and weigh 0.16 ± 0.02 lb for all three pieces. The buns shall be stored at room temperature 75 ± 5°F.

NOTE 1—The bread is not to have any type of topping such as a butter top, flour top, or any seed/nut topping. Sandwich type bread is not to be used because it does not have a crown. In addition, loaves of bread that only have 19 slices (not including the heals) typically have too high of individual slice weight. The 1.5 lb of generic store brand white bread that has 20 slices (not including the heals) more often than not consists of individual slices that weigh approximately 0.065 lb which is specified for this test method.

8. Sampling and Test Units

8.1 *Conveyor Toaster*—Select a representative production model for performance testing.

9. Preparation of Apparatus

9.1 Install the appliance according to the manufacturer's instructions. The associated heating or cooling system shall be capable of maintaining an ambient temperature of 75 ± 5°F (24 ± 3°C) within the testing environment when the exhaust ventilation system is operating.

NOTE 2—The ambient temperature requirements are designed to simulate real world kitchen temperatures and are meant to provide a reasonable guideline for the temperature requirements during testing. If a facility is not able to maintain the required temperatures, then it is reasonable to expect that the application of the procedure may deviate from the specified requirements (if it cannot be avoided) as long as those deviations are noted on the Results Reporting Sheets.

9.2 Connect the conveyor toaster to a calibrated energy test meter. For gas installations, install a pressure regulator downstream from the meter to maintain a constant pressure of gas for all tests. Install instrumentation to record both the pressure and temperature of the gas supplied to the conveyor toaster and the barometric pressure during each test so that the measured gas flow can be corrected to standard conditions. For electric installations, a voltage regulator may be required during tests if the voltage supply is not within ±2.5 % of the manufacturer's nameplate voltage.

9.3 For an electric conveyor toaster, confirm (while the conveyor toaster elements are energized) that the supply voltage is within ±2.5 % of the operating voltage specified by the manufacturer. Record the test voltage for each test.

NOTE 3—It is the intent of the testing procedure herein to evaluate the performance of a conveyor toaster at its rated gas pressure or electric voltage. If an electric unit is rated dual voltage (that is, designed to operate at either 240 or 480 V with no change in components), the voltage selected by the manufacturer or tester, or both, shall be reported. If a conveyor toaster is designed to operate at two voltages without a change in the resistance of the heating elements, the performance of the unit (for example, preheat time) may differ at the two voltages.

9.4 For a gas conveyor toaster, adjust (during maximum energy input) the gas supply pressure downstream from the appliance's pressure regulator to within ±2.5 % of the operating manifold pressure specified by the manufacturer. Make adjustments to the appliance following the manufacturer's recommendations for optimizing combustion.

10. Procedure

10.1 *General:*

10.1.1 For gas appliances, record the following for each test run:

10.1.1.1 Higher heating value,

10.1.1.2 Standard gas pressure and temperature used to correct measured gas volume to standard conditions,

10.1.1.3 Measured gas temperature,

10.1.1.4 Measured gas pressure,

10.1.1.5 Barometric pressure,

10.1.1.6 Energy input rate during or immediately prior to test (for example, during the preheat for that day's testing), and

10.1.1.7 Ambient temperature.

NOTE 4—Using a calorimeter or gas chromatograph in accordance with accepted laboratory procedures is the preferred method for determining the higher heating value of gas supplied to the conveyor toaster under test. It is recommended that all testing be performed with gas having a higher heating value of 1000 to 1075 Btu/ft^3.

10.1.2 For gas conveyor toasters, add electric energy consumption to gas energy for all tests, with the exception of the energy input rate test (see 10.3).

10.1.3 For electric conveyor toasters, record the following for each test run:

10.1.3.1 Voltage while elements are energized,

10.1.3.2 Energy input rate during or immediately prior to test (for example, during the preheat for that day's testing), and

10.1.3.3 Ambient temperature.

10.1.4 For each test run, confirm that the peak input rate is within ±5 % of the rated nameplate input. If the difference is greater than 5 %, terminate testing and contact the manufacturer. The manufacturer may make appropriate changes or adjustments to the conveyor toaster.

10.2 *Energy Input Rate and Preheat Temperature Profile:*

10.2.1 For radiant toasters, install a thermocouple ¼ in. above the conveyor, at the center of the toaster cavity (side to side and front to back).

NOTE 5—When placing the thermocouple wire in the toaster cavity above the conveyor belt, it is highly suggested to feed the thermocouple wire in from the front of the unit, in the same direction as the belt travels. This will prevent the toast from fouling the thermocouple wire, which could get tangled in the conveyor belt. In addition, having the thermocouple wire visible will serve as a reminder as not to place the bread over the thermocouple when loading the toaster during the testing.

10.2.1.1 For contact toasters, install a thermocouple in contact with heating plate underneath the non stick sheets. The thermocouple shall not interfere with the toasting capability of the unit. The thermocouple can be either welded to the contact plate or adhered with high temperature tape. Attach a separate thermocouple for each heated plate.

10.2.2 Turn the conveyor toaster on, and set the temperature controls to their maximum settings (if applicable). Record the time, temperature, and energy consumption for one hour. At this time the conveyor toaster should have reached a steady state temperature as described in Section 10.2.3.

10.2.3 At the end of that hour, create a temperature plot (see Fig. 1). On that plot, when the temperature reaches a steady state (a steady state temperature is when the cavity temperature is neither rising nor falling, but instead holding a consistent temperature). This consistent temperature or "steady state" temperature idle will be used to determine when the unit is preheated. The toaster is considered preheated when the temperature reaches 95 % of its steady state temperature. If the unit has not reached a steady state temperature within an hour, repeat 10.2.2 and increase the monitoring time from 1 h to 2 h, or until a steady state temperature is reached.

NOTE 6—Research at the Food Service Technology Center indicates that a conveyor toaster is sufficiently preheated and ready to cook/toast when the toaster's cavity temperature reaches 95 % of the toaster's steady state temperature. In Fig. 1, the steady state temperature is 730°F, and 95 % of that steady state temperature is 693°F. The unit then can be considered preheated when it reaches 693°F and ready to toast.

10.2.4 In accordance with 11.4, calculate and record the conveyor toaster's energy input rate and compare the result to the rated nameplate input. For gas conveyor toasters, only the burner energy consumption is used to compare the calculated energy input rate with the rated gas input. Any electrical energy use shall be calculated and recorded separately as the control energy rate.

10.3 *Preheat Energy Consumption and Time:*

10.3.1 Verify that the conveyor toaster cavity temperature is 75 ± 5°F (24 ± 3°C) and turn the conveyor toaster on.