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An American National Standard

# Standard Test Method for Performance of Open Vat Fryers[1]

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## 1. Scope

1.1 This test method covers the evaluation of the energy consumption and cooking performance of open vat fryers. The food service operator can use this evaluation to select a fryer and understand its energy efficiency and production capacity.

1.2 This test method is applicable to Types 1 (counter), 2 (drop-in), 3 (floor-mounted, portable), and 4 (floor-mounted, stationary), size A, B, and C, electric (Style A, B and C) and gas (Style D) open vat fryers as defined by Specification F1963, with nominal frying medium capacity up to 50 lb (23 kg) or a vat size less than 18 in. in width. For size C, D, E and F and large open vat fryers with a nominal frying medium capacity greater than 50 lb (23 kg), or a vat size of 18 in. in width or greater, refer to Test Method F2144.

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

1.3.1 Energy input rate (10.2),

1.3.2 Preheat energy and time (10.4),

1.3.3 Idle energy rate (10.5),

1.3.4 Pilot energy rate (10.6),

1.3.5 Cooking energy rate and efficiency (10.8), and

1.3.6 Production capacity and frying medium temperature recovery time (10.8).

1.4 This test method is not intended to answer all performance criteria in the evaluation and selection of a fryer, such as the significance of a high energy input design on maintenance of temperature within the cooking zone of the fryer.

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

1.6 *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.*

1.7 *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]

F1963 Specification for Deep-Fat Fryers, Gas or Electric, Open

F2144 Test Method for Performance of Large Open Vat Fryers

2.2 *ANSI Document:*[3]

ANSI Z83.11 American National Standard for Gas Food Service Equipment

2.3 *ASHRAE Document:*[4]

ASHRAE Guideline 2-1986 (RA90) Engineering Analysis of Experimental Data

## 3. Terminology

3.1 *Definitions:*

3.1.1 *open, deep fat fryer, n*—(hereafter referred to as fryer) an appliance, including a cooking vessel, in which oils are placed to such a depth that the cooking food is essentially supported by displacement of the cooking fluid rather than by the bottom of the vessel. Heat delivery to the cooking fluid varies with fryer models.

3.1.2 *test method, n*—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.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *cold zone, n*—the volume in the fryer below the heating element or heat exchanger surface designed to remain cooler than the cook zone.

[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.

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[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 National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036.

[4] Available from the American Society of Heating, Refrigeration, and Air Conditioning Engineers, Inc., 1791 Tullie Circle, NE, Atlanta, GA 30329.

3.2.2 *cook zone, n*—the volume of oil in which the fries are cooked. Typically, the entire volume from just above the heating element(s) or heat exchanger surface to the surface of the frying medium.

3.2.3 *cooking energy, n*—total energy consumed by the fryer as it is used to cook french fries under heavy- and light-load conditions.

3.2.4 *cooking-energy efficiency, n*—quantity of energy to the French fries during the cooking process expressed as a percentage of the quantity of energy input to the fryer during the heavy- and light-load tests.

3.2.5 *cooking energy rate, n*—average rate of energy consumed by the fryer while "cooking" a heavy- or light-load of French fries.

3.2.6 *idle energy rate, n*—average rate of energy consumed (Btu/h (kJ/h) or kW) by the fryer while "holding" or "idling" the frying medium at the thermostat(s) set point.

3.2.7 *measured energy input rate, n*—peak rate at which a fryer consumes energy, typically reflected during preheat.

3.2.8 *pilot energy rate, n*—average rate of energy consumption (Btu/h (kJ/h)) by a fryer's continuous pilot (if applicable).

3.2.9 *preheat energy, n*—amount of energy consumed (Btu (kJ) or kWh) by the fryer while preheating the frying medium from ambient room temperature to the calibrated thermostat(s) set point.

3.2.10 *preheat time, n*—time required for the frying medium to preheat from ambient room temperature to the calibrated thermostat(s) set point.

3.2.11 *production capacity, n*—maximum rate (lb/h (kg/h)) at which a fryer can bring the specified food product to a specified "cooked" condition.

3.2.12 *production rate, n*—average rate (lb/h (kg/h)) at which a fryer brings the specified food product to a specified "cooked" condition. Does not necessarily refer to maximum rate. Production rate varies with the amount of food being cooked.

3.2.13 *recovery time, n*—the time from the removal of the fry basket containing the French fries until the cooking medium is back up to within 10°F (5.56°C) of the set temperature and the fryer is ready to be reloaded.

3.2.14 *test, n*—a set of six loads of French fries cooked in a prescribed manner and sequential order.

3.2.15 *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

NOTE 1—All of the fryer tests shall be conducted with the fryer installed under a wall-mounted canopy exhaust ventilation hood that shall operate at an air flow rate based on 300 cfm per linear foot (460 L/s per linear metre) of hood length. Additionally, an energy supply meeting the manufacturer's specifications shall be provided for the gas or electric fryer under test.

4.1 The fryer under test is connected to the appropriate metered energy source. The measured energy input rate is determined and checked against the rated input before continuing with testing.

4.2 The frying-medium temperature in the cook zone of the fryer is monitored at a location chosen to represent the average temperature of the frying-medium while the fryer is "idled" at 350°F (177°C). Fryer temperature calibration to 350°F (177°C) is achieved at the location representing the average temperature of the frying medium.

4.3 The preheat energy and time, and idle-energy consumption rate are determined while the fryer is operating with the thermostat(s) set at a calibrated 350°F (177°C). The rate of pilot energy consumption also is determined when applicable to the fryer under test.

4.4 Energy consumption and time are monitored while the fryer is used to cook seven loads of frozen, ¼-in. (6-mm) shoestring potatoes to a condition of 30 ± 1 % weight loss with the thermostat set at a calibrated 350°F (177°C). Cooking-energy efficiency is determined for heavy-, (optional) extra-heavy, and (optional) and light-load test conditions. Production capacity is based on the heavy-load test.

## 5. Significance and Use

5.1 The measured energy input rate test is used to confirm that the fryer under test is operating in accordance with its nameplate rating.

5.2 Fryer temperature calibration is used to ensure that the fryer being tested is operating at the specified temperature. Temperature calibration also can be used to evaluate and calibrate the thermostat control dial.

5.3 Preheat-energy consumption and time can be used by food service operators to manage their restaurants' energy demands, and to estimate the amount of time required for preheating a fryer.

5.4 Idle energy and pilot energy rates can be used by food service operators to manage their energy demands.

5.5 Preheat energy consumption, idle energy, and pilot energy can be used to estimate the energy consumption of an actual food service operation.

5.6 Cooking-energy efficiency is a direct measurement of fryer efficiency at different loading scenarios. This data can be used by food service operators in the selection of fryers, as well as for the management of a restaurant's energy demands.

5.7 Production capacity can be used as a measure of fryer capacity by food service operators to choose a fryer to match their particular food output requirements.

## 6. Apparatus

6.1 *watt-hour meter,* for measuring the electrical energy consumption of a fryer, shall have a resolution value 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 value of at least 10 Wh and a maximum uncertainty no greater than 10 %.

6.2 *gas meter,* for measuring the gas consumption of a fryer, shall be a positive displacement type with a resolution value of at least 0.01 $ft^3$ (0.0003 $m^3$) and a maximum error no greater

than 1 % of the measured value for any demand greater than 2.2 $ft^3$ (0.06 $m^3$) per hour. If the meter is used for measuring the gas consumed by the pilot lights, it shall have a resolution value of at least 0.01 $ft^3$ (0.0003 $m^3$) and have a maximum error no greater than 2 % of the measured value.

6.3 *thermocouple probe(s),* industry standard thermocouples capable of immersion, with a range from 50° to 400°F and an uncertainty of ±2°F (1.1°C).

6.4 *analytical balance scale,* for measuring weights up to 10 lb (4.5 kg), with a resolution value of at least 0.01 lb (0.004 kg) and an uncertainty of 0.01 lb.

6.5 *convection drying oven,* with temperature controlled at 220 ± 5°F (104 ± 3°C), to be used to determine moisture content of both the raw and cooked fries.

6.6 *canopy exhaust hood,* 4 ft (1.2 m) in depth, wall-mounted with the lower edge of the hood 6 ft, 6 in. (1.98 m) from the floor and with the capacity to operate at a nominal net exhaust ventilation rate of 300 cfm per linear foot (460 L/s per linear metre) of active hood length. This hood shall extend a minimum of 6 in. (152 mm) past both sides and the front of the cooking appliance and shall not incorporate side curtains or partitions. Makeup air shall be delivered through face registers or from the space, or both.

6.7 *fry basket,* supplied by the manufacturer of the fryer under testing, shall be a nominal size of 6⅜ by 12 by 5⅜ in. (160 by 300 by 140 mm). A total of six baskets are required to test each fryer in accordance with these procedures.

6.8 *freezer,* with temperature controlled at –5 ± 5°F (–20 ± 3°C), with capacity to cool all fries used in a test.

6.9 *barometer,* for measuring absolute atmospheric pressure, to be used for adjustment of measured gas volume to standard conditions. Shall have a resolution value of at least 0.2 in. Hg (670 Pa) and an uncertainty of 0.2 in. Hg (670 Pa).

6.10 *data acquisition system,* for measuring energy and temperatures, capable of multiple temperature displays updating at least every 2 s.

6.11 *pressure gauge,* for monitoring gas pressure. Shall have a range from 0 to 15 in. $H_2O$ (0 to 3.7 kPa), a resolution value of at least 0.5 in. $H_2O$ (125 Pa), and a maximum uncertainty of 1 % of the measured value.

6.12 *stopwatch,* with a 1-s resolution.

6.13 *temperature sensor,* for measuring gas temperature in the range from 50 to 100°F (10 to 93°C) with an uncertainty of ±2°F (1.1°C).

## 7. Reagents and Materials

7.1 *French Fries (Shoestring Potatoes)*—Order a sufficient quantity of French fries to conduct both the French fry cook-time determination test and the heavy- and light-load cooking tests. All cooking tests are to be conducted using ¼-in. (6-mm) par-cooked, frozen, shoestring potatoes. Fat and moisture content of the French fries shall be 6 ± 1 % by weight and 68 ± 2 % by weight, respectively.

7.2 *frying medium,* shall be partially hydrogenated, 100 % pure vegetable oil. New frying medium shall be used for each fryer tested in accordance with this test method. The new frying medium that has been added to the fryer for the first time shall be heated to 350°F (177°C) at least once before any test is conducted.

NOTE 2—Generic partially hydrogenated all vegetable oil (soybean oil) has been shown to be an acceptable product for testing by PG&E.

## 8. Sampling, Test Specimens, and Test Units

8.1 *Fryer*—A representative production model shall be selected for performance testing.

## 9. Preparation of Apparatus

9.1 Install the appliance according to the manufacturer's instructions under a 4-ft (1.2-m) deep canopy exhaust hood mounted against the wall with the lower edge of the hood 6 ft, 6 in. (1.98 m) from the floor. Position the fryer with the front edge of frying medium inset 6 in. (152 mm) from the front edge of the hood at the manufacturer's recommended working height. The length of the exhaust hood and active filter area shall extend a minimum of 6 in. past the vertical plane of both sides of the fryer. In addition, both sides of the fryer shall be a minimum of 3 ft (0.9 m) from any side wall, side partition, or other operating appliance. A "drip" station positioned next to the fryer is recommended. Equipment configuration is shown in Fig. 1. The exhaust ventilation rate shall be based on 300 cfm per linear foot (460 L/s per linear metre) of hood length. 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 system is operating.

9.2 Connect the fryer to a calibrated energy test meter. For gas installations, a pressure regulator shall be installed downstream from the meter to maintain a constant pressure of gas for all tests. Both the pressure and temperature of the gas supplied to a fryer, as well as the barometric pressure, shall be recorded during each test so that the measured gas flow can be corrected to standard conditions. For electric installations, a voltage regulator may be required to maintain a constant "nameplate" voltage during tests if the voltage supply is not within ±2.5 % of the manufacturer's "nameplate" voltage (see 9.4).

9.3 For a gas fryer, adjust (during maximum energy input) the gas supply pressure downstream from the fryer's pressure regulator to within ±2.5 % of the operating manifold pressure specified by the manufacturer. Make adjustments to the fryer following the manufacturer's recommendations for optimizing combustion. Proper combustion may be verified by measuring air-free CO in accordance with ANSI Z83.11.

9.4 For an electric fryer, confirm (while the fryer 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 fryer at its rated gas pressure or electric voltage. If an electric fryer is rated dual voltage (that is, designed to operate at either 208