Comparison of Commercial Range Top Performance Test Methods

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Executive Summary

In 1995, the Food Service Technology Center (FSTC) developed a test method for quantifying the performance of commercial range tops. The results were published in the FSTC Development Report # 1022.95.20. The study also provided the foundation of the American Society for Testing and Materials' (ASTM) *Standard Test Methods for Performance of Range Tops* (Designation F1521-96), published the following year.

While an effective means of comparing the performance of different range top designs, the ASTM test method was not universally applied to gas-fired units due to an alternate efficiency test within an American National Standards Institute safety standard (ANSI Z83-11). Interesting enough, the test criteria between ASTM F1521-96 and ANSI Z83.11 are very similar. The basis of this report will be a comparison of the two test methods and the testing results.

Researchers at the FSTC conducted tests to further understand and derive a common standard test procedure that is comparable to the current ASTM and ANSI test requirements on range top testing.

In order to examine the differences between ASTM and ANSI, the researchers at FSTC had adopted the following test methodologies:

a. Characterization of the relationship between pot diameter and efficiency.

b. Review the sensitivity of water depth to efficiency.

c. Review the sensitivity of pot thickness to efficiency.

The ASTM test method was used as a basis for exploring the sensitivity of range top cooking-energy efficiency to pot size, water depth and pot thickness. ASTM required 20 lbs of water for the 12-inch diameter stockpot for the test. The methodologies required four different stockpot diameters (12, 13, 14, and 16 inches); because of these differences, the water weight specification

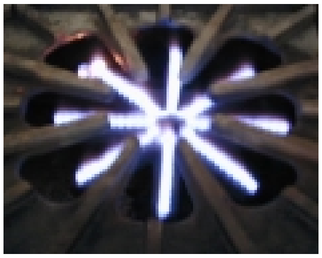

Figure ES-1.
Star burner – rated at 20,000 Btu/hr.

was changed to accommodate the increase in size/diameter. The new water weight specification varies proportionately to the cooking surface area of the stockpot.

The three range tops tested by FSTC engineers consist of a Star burner rated at 20,000 Btu/hr, a Ring burner rated at 30,000 Btu/hr, and a modified Star burner rated at 27,000 Btu/hr.

A Star burner emits flame in a traditional star pattern (Figure ES-1) and a Ring burner emits flame in a concentric circular pattern (Figure ES-2).

Figure ES-2.
Ring burner – rated at 30,000 Btu/hr.

Pot Size Characterization Curve

The test criteria for this test were as follows –

Water weight is proportional to the cooking surface diameter. The variable for this test was the stockpot size (diameter).

The Pot Size Characterization test revealed that the cooking efficiency increases with pot diameters. However, the researchers at the FSTC believe the efficiency will taper off once the maximum efficiency is achieved (maximum efficiency was not achieved in the FSTC's testing) and at that point an increase in pot diameter will decrease the efficiency.

The data from the 20,000 Btu/hr Star burner revealed a difference of 2.5% in cooking-energy efficiency. The ASTM test method resulted in a lower efficiency because of the smaller pot size used for the test. The 12-inch stockpot was too small for the grates, which allowed the flame to leak from around the outside of the pot (see Figure ES-3).

The 30,000 Btu/hr Ring burner exhibited cooking energy efficiencies of 31% for the ASTM test method and 38% for the ANSI test method. The results from these two test methods are quite different. The cooking-energy efficiency can be 2.5% – 7% higher depending on which test method was used during the test. Due to these efficiency discrepancies, it is evident that one standard pot size is needed to evaluate the performance of range tops.

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Figure ES-3.
A 12″ stockpot allowing flames to leak out from the bottom.

The results of the pot size characterization testing suggest that the 13-inch stockpot is the optimum pot size and should be the standard for determining rangetop cooking-energy efficiency. Table ES-1 shows as high as 13% discrepancy in cooking-energy efficiency for the two burners for a large (16-inch) stockpot. The 13-inch stockpot revealed 35% efficiency for both burners.

In order to compare range top cooking performance side by side to identify a benchmark, it is recommended that the 13-inch stockpot be used for all range tops with no distinction between burner size and energy source.

Table ES-1. Pot Size Characterization Results.

Stockpot Sizes	12-inch	13-inch	14-inch	16-inch
Star Burner Cooking Efficiency (%)	32	35	40	43
Ring Burner Cooking Efficiency (%)	31	35	37	38
Efficiency Discrepancy between burners	3%	0%	8%	13%

Water Depth Sensitivity Curve

The sensitivity curve for the 20,000 Btu/hr – Star burner with a 13-inch diameter stockpot is a straight line. The average efficiency over a range of water depths was 35%.

The sensitivity curves for the modified 27,000 Btu/hr – Star burner and the 30,000 Btu/hr – Ring burner with a 16-inch diameter stockpot have a maximum efficiency at an 8-inch water depth.

This test revealed that when a 16-inch diameter stockpot is used to evaluate the cooking efficiency, an 8-inch water depth is the minimum requirement necessary to obtain an accurate efficiency.

Executive Summary

Pot Thickness Sensitivity Curve

A $^{5}/_{16}$-inch thick steel plate was placed between the 13-inch diameter stockpot and the burner head on the range top equipped with a ring burner. The objective is to observe the changes in efficiency with an increase in pot thickness. The reason the researchers at the FSTC chose this method was that stockpots with different thicknesses were not available at the time of testing.

The increase in pot thickness resulted in a drop in cooking efficiency from 32% to 26%. This was a quick and simple test that needs to be refined to generate a sensitivity curve on pot thickness versus efficiency. However, this test does reveal that thickness is a variable in the cooking efficiency formula for range tops.

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 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.

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. By collaborating with the Electric Power Research Institute (EPRI) and the Gas Technology Institute (GTI) through matching funding agreements, the test methods have remained unbiased to fuel choice. End-use customers and commercial appliance manufacturers consider the FSTC to be the national leader in commercial food service equipment testing and standards, sparking alliances with several major chain customers to date.

In 1994, FSTC researchers developed a standard test method to quantify the performance of range tops. This test method allowed manufacturers and end users to compare performance indices such as energy efficiency, cooking uniformity, and production capacity for different burner/element designs. The draft test procedure was subsequently approved and ratified by ASTM as a standard test method (Designation F 1496-96).

The FSTC report, *Development and Validation of a Uniform Testing Procedure for Range Tops* documents the developmental procedures and preliminary test results for four (two gas and two electric) range tops.[2] Other FSTC reports document results of applying the ASTM test method to different range tops. [3,4,5,6,7,8,9]

Introduction

While an effective means of comparing the performance of different range top designs, the ASTM test method was not universally applied to gas-fired units due to an alternate efficiency test method within an American National Standards Institute (ANSI) safety standard (ANSI Z83-11). [10]

The test criteria between ASTM F1521-96 and ANSI Z83.11 are very similar except the for following:

ASTM F1521-96:

1. Requires the use of a 12-inch diameter pot for all commercial range tops, which included open and hot tops (there is no distinction in range top input rate).
2. Requires a specific water weight.
3. Applies to all fuel sources and technologies (including induction).

ANSI Z83.11:

1. Requires three different pot diameter sizes (9.5 inch, 13 inch, and 16 inches) for commercial range tops with input rate ranges from less than 15,000 Btu, between 15,000 – 25,999 Btu, and greater than 25,999 Btu.
2. Requires a specific water depth.
3. Applies to gas ranges only.

Interesting enough, the test criteria between ASTM F1521-96 and ANSI Z83.11 are very similar (refer to Table 1-1 for details). Due to these differences, the FSTC conducted testing to further understand and derive a common standard test procedure that is comparable for the current ASTM and ANSI test requirements on range top testing. From here on the ASTM F1521 will be referred to as ASTM and the ANSI Z83.11 will be referred to as ANSI.

Introduction

Table 1-1. ASTM F1521-96 Versus ANSI Z83.11.

	ASTM F1521-96	**ANSI Z83.11**		
Stabilization Time (minutes)	30	30		
Temperature Rise (°F)	130	130		
Control Setting	Maximum	Maximum		
Pot Diameter (inches)	12	<15,000 Btu 9.5	15,000 to 25,999 Btu 13	>26,000 Btu 16
Water Weight (lbs)	20	N/A (10)*	N/A (20)*	N/A (29)*
Water Depth (inches)	N/A	4		
Temperature Measurement Location	4 inches below bottom of lid	2 inches above bottom of pot		

* Measured water weight with respect to 4 inches of water depth. Note: Not a requirement for ANSI Z83.11

Objectives

In order to examine the differences between ASTM F1521-96 and ANSI Z83.11, FSTC researchers adopted the following methods:

a. Characterization of the relationship between pot diameter and efficiency.

b. Review the sensitivity curve of water depth to efficiency.

c. Review the sensitivity of pot thickness to efficiency.

Appliance Description

Two different range tops were tested during the course of this study:

A Star burner range top rated at 20,000 Btu/hr per burner and a Ring burner range top rated at 30,000 Btu/hr per burner. To provide a third unit, the Star burner was modified to operate at 27,000 Btu/hr per burner.

Introduction

A Star burner emits flame in a traditional star pattern (Figure 1-1) and a Ring burner emits flame in a concentric circular pattern (Figure 1-2). Table 1-2 summarizes the specifications for the three rangetop configurations.

Figure 1-1. Star burner – rated at 20,000 Btu/hr.

Figure 1-2. Ring burner – rated at 30,000 Btu/hr.

Table 1-2. Appliance Specifications.

Star Burner	
Rated Input	20,000 Btu/hr each
Dimensions	37 inchx36 inchx34 inch (LxWxH)
Burner Configuration	Six burners (3 open tops and 3 hot tops)
Star Burner*	
Rated Input	20,000 Btu/h each but modified to 27,000 Btu/hr
Dimensions	37 inchx36 inchx34 inch (LxWxH)
Burner Configuration	Six burners (3 open tops and 3 hot tops)
Ring Burner	
Rated Input	30,000 Btu/hr each
Dimensions	38 inchx36 inchx42 inch (LxWxH)
Burner Configuration	Six burners (open tops)

* The original Star burner was over-fired so that the effect of over firing could be studied during this test.

2 Methods

Setup and Instrumentation

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

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

0.1 ft^3.

Each appliance was set up according to the respective manufacturer's specifications. The exception was the 27,000 Btu modified Star burner. This modification was achieved by increasing the appliance manifold pressure.

Four aluminum stockpots were used for this test (the stock pots used were commercially available purchased through a commercial kitchen equipment vendor). Table 2-1 details the specifications for the four stockpots.

Table 2-1. Stockpot Specifications.

No.	Pot Diameter (inches)	Capacity (quarts)	Height (inches)	Pot Weight (lb)
1	12	20	10.5	6.24
2	13	20	9	6.68
3	14	40	16	10.47
4	15	60	18	13.49

The stockpot lid has a quarter inch hole drilled into the lid; this is to allow for thermocouple access to the water. A $^{1}/_{8}$-inch diameter close bead type K thermocouple was inserted through the top of the lid, reaches down to approximately 2 inches above the bottom of the stockpot, and was used to monitor water temperature during the test. This is illustrated in Figure 2-1.

Figure 2-1.
Lid with a ¼" thermocouple access hole drilled in place and a $^{1}/_{8}$" diameter close bead type K thermocouple inserted.

All instrumentation was connected to an automated data acquisition unit that recorded data every 5 seconds. A chemical laboratory used a gas chromatograph to determine the gas heating value on each day of testing. All gas measurements were corrected to standard conditions.

Pot Size Characterization

The 20,000 Btu/hr input Star burner and the 30,000 Btu/hr rated Ring burner were tested by using 12, 13, 14, and 16-inch aluminum stockpots. These pots were filled to a specified water weight to evaluate the efficiency of each burner.

The ASTM-specified 12-inch pot was used as the baseline for these tests. The amount of water used for the remaining pots was adjusted proportionally, based on the ratio of the pot's diameter to the 12-inch baseline. Table 2-2 summarizes the water weight specifications for all four pots.

Table 2-2. Water Weight Specifications.

No.	Pot Diameter (inches)	Water Weight (lbs)
1	12	20
2	13	24
3	14	27
4	16	36

The different diameter stockpots were filled with the specified amount of 70 ± 2°F water. All tests began with a 30-minute stabilization period using a 12-inch stockpot filled with 20 lbs of water. Immediately after the 30-minute stabilization run, the researcher placed the test pot on the preheated range top. The start time and input energy were recorded along with the time needed to raise the water temperature from 70°F to 200°F. Range top efficiency was determined as follows:

$$\eta_{cook} = \frac{E_{water} + E_{pot}}{E_{input}} \times 100\%$$

where E_{water} is the energy absorbed by the water (water weight × temperature rise), E_{pot} is the energy absorbed by the pot, and E_{input} is the energy consumed by the burner.

Water Depth Sensitivity

All three ranges were evaluated for this series of tests, which focused on the 13-inch and the 16-inch stockpots. By varying the water depth, a sensitivity curve was generated based on the appliance's performance. The two pots were filled with 70 ± 2°F water to the specified water height (Table 2-3).

Table 2-3. Water Depth Specifications.

Input Rate (Btu/hr)	Water Depth (inches)	Measured Water Weight (lbs)
20,000	3	19
Stockpot	4	23
(12 inch)	7	39
27,000	3	21
Stockpot	4	28
(16 inch)	5	36
	6	42
	8	58
	16	118
30,000	3	21
Stockpot	4	28
(16 inch)	5	36
	8	58
	12	88

Pot Thickness Sensitivity

The sensitivity of the efficiency test to pots with different thickness was evaluated by placing a $^{5}/_{16}$-inch thick steel plate between a 13-inch stockpot and the burner head (Figure 2-3). This approach was chosen because stock-pots with different thickness were not readily available at the time of testing. The test was conducted on the 30,000 Btu/hr ring burner range only.

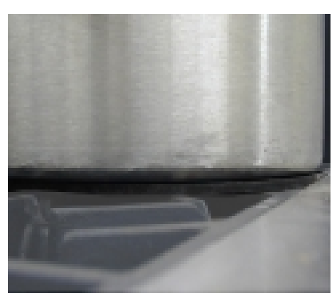

Figure 2-2.
$^{5}/_{16}$" steel plate placed between the stockpot and range top.

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 range tops were operating within their specified parameters. Table 3-1 summarizes the results of the energy input rate tests.

Table 3-1. Energy Input Rates.

Burner Type	Specified Input Rate (Btu/hr)	Measured Input Rate (Btu/hr)	% Difference
Star	20,000	20,905	4.5
Ring	30,000	28,250	5.9
Modified Star	N/A	27,000	N/A

Pot Size Characterization

The pot size characterization test revealed that an increase in pot diameter (size) increases the efficiency of the range top. Figure 3-1 shows characterization curves for the Ring burner and the 20,000 Btu/hr Star burner. It is interesting to note that the efficiencies of these two burners cross at the 13-inch diameter pot.

During the pot size characterization testing, the FSTC researchers observed the following, which supports the use of one stockpot size for all cooking efficiency test:

An oversized stockpot: A stockpot that is too big for the range top gives an inaccurate efficiency number because the cooking surface of the stockpot spills out to the adjacent cooking grids. This action causes a heat transfer

Results

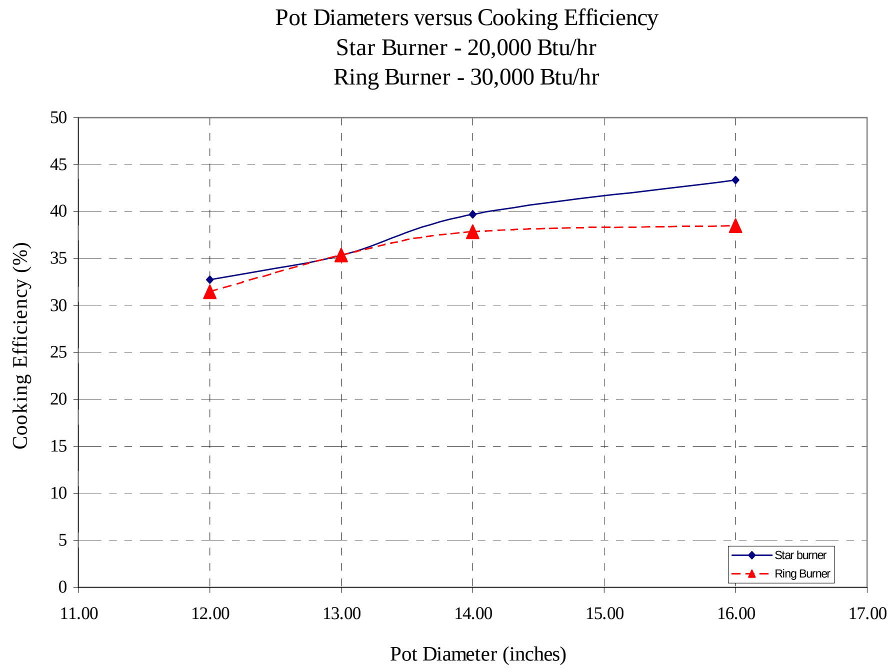

Figure 3-1. Pot size characterization curves.

from the cooking surface to a non-cooking surface and therefore reduces the energy added to the water. Figure 3-2 shows an oversized stockpot on a standard gas range.

Figure 3-2. A stockpot that is too big for the range top.

An undersized stockpot: A stockpot that is too small for the range top allows the flame to escape from the cooking surface resulting in a reduction in efficiency. The resulting flame leakage is illustrated in Figure 3-3.

An uneven cooking surface: The cooking surface of the stockpot must also be flat in order to evaluate the true cooking efficiency.

FSTC researchers noticed that the original 13-inch stockpot that was used for this investigation did not have a flat cooking surface. The bottom of the stockpot was rounded toward the burner (convex from the inside of the pot). The result was a higher cooking-energy efficiency (due to burner to pot height).

Results

A new 13-inch stockpot was purchased to further investigate and compare the efficiency between the disfigured pot and a flat pot. The test results showed that the rounded stockpot exhibited a higher efficiency than the flat stockpot. The rounded stockpot resulted in an increase of approximately 2 percentage points in cooking efficiency.

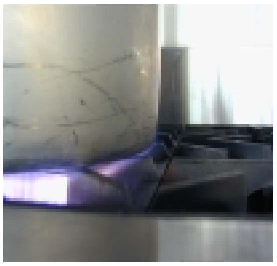

Figure 3-3.
A stockpot that is too small for the range top.

The rounded pot was then flattened and retested. The efficiency with the newly flattened pot was approximately 2 percentage points lower than the rounded configuration. Table 3-2 summarizes the results of these stockpot characteristic tests.

Table 3-2. Efficiency is a Function of Stockpot Characteristics.

Description	Water Weight (lbs)	Efficiency (%)*
Original 13-inch Stock Pot	23.5	35.4
Flattened 13-inch Stock Pot	23.5	33.8
New 13-inch Stock Pot	23.5	33.0

Water Depth Sensitivity

The sensitivity curve for the 20,000 Btu/hr – Star burner with a 13-inch diameter stockpot is a relatively straight line. The average efficiency over four different water depths is 35%. Figure 3-4 shows the water depth to efficiency curve for the 20,000 Btu/hr – Star burner.

The sensitivity curves for the modified 20,000 Btu/hr Star burner and the 30,000 Btu/hr Ring burner with a 16-inch diameter stockpot have a maximum efficiency at an 8-inch water depth. Figure 3-5 shows the water depth to efficiency sensitivity curves for the 27,000 Btu/hr Star burner and the 30,000 Btu/hr Ring burner.

Results

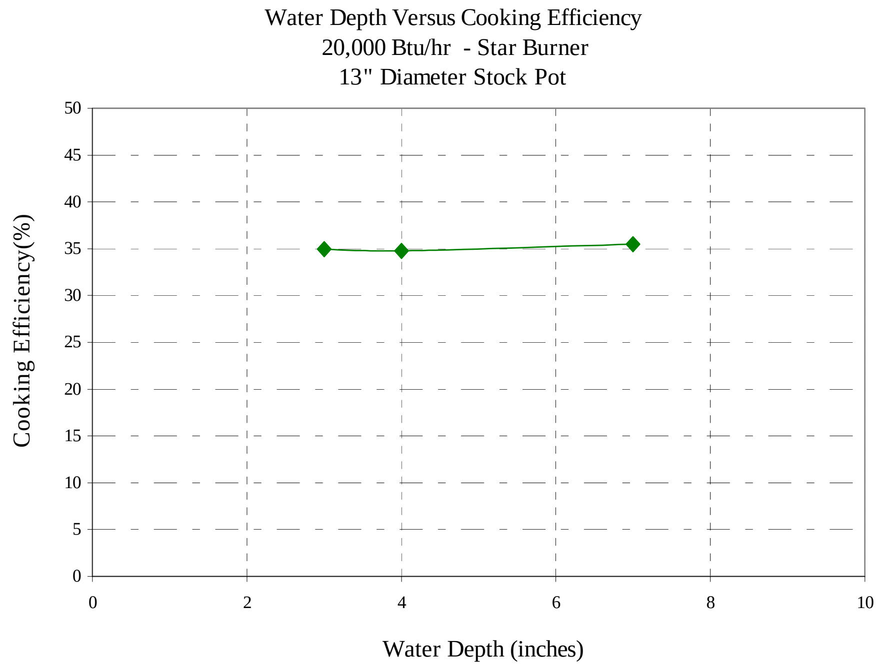

Figure 3-4.
Sensitivity curve – star burner.

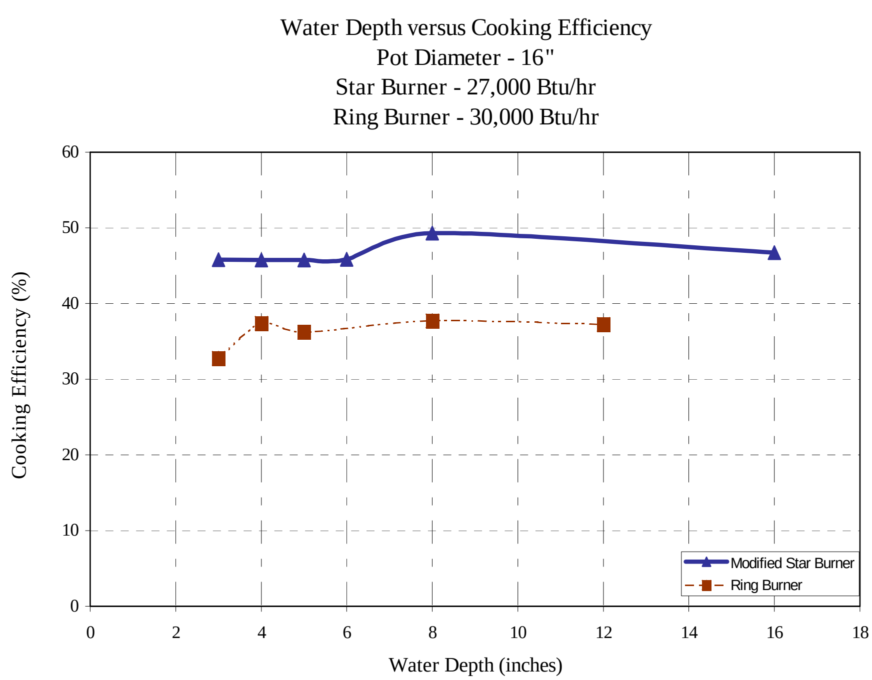

Figure 3-5.
Sensitivity curve – modified star burner and ring burner.

Results

Pot Thickness Sensitivity

A $^{5}/_{16}$-inch steel plate was placed between the 13-inch diameter stockpot and the burner head on the range top equipped with a ring burner. The objective is to increase the thickness of the stockpot. The reason the researchers at the FSTC chose this method was that stockpots with different thickness were not readily available at the time of testing.

The result of the increased thickness was a drop of approximately 6 percentage points in cooking-energy efficiency (from 32% to 26%).

4 Conclusions

Pot Size Characterization Test

One pot size should be specified for all range tops regardless of burner size and energy source.

The pot size characterization test revealed that range top cooking-energy efficiency increases with an increase in pot diameter. This test was performed with four different size stockpots with the water weight held constant according to water weight to cooking surface area ratio.

When analyzing the data from the Star burner (20,000 Btu/hr) and comparing the results from the ASTM and ANSI test methods, the resulting cooking-energy efficiencies are approximately 32.5% and 35%, respectively. The lower efficiencies using the ASTM test method were caused by flame leakage around the 12-inch stockpot, thereby reducing the amount of heat absorbed by the pot.

Analyzing the data from the Ring burner (30,000 Btu/hr) and comparing the results from ASTM, which required a 12-inch stockpot with 20 lbs of water, and ANSI, which required a 16-inch stockpot, the resulting cooking efficiencies were approximately 31% to 38%, respectively.

Further analysis of the data revealed the importance of having one pot size to evaluate the performance of a range top. Table 4-1 shows the cooking-energy efficiencies for the two different burners. There are significant increases in efficiency as the pot diameter increases. In order to compare range top cooking performance side by side, one pot size should be specified for all range tops regardless of burner size and energy source.

Furthermore, FSTC researchers had observed the following that supports the use of one stockpot size for all cooking efficiency test:

An oversized stockpot: A stockpot that is too big for the range top gives an inaccurate efficiency number because the cooking surface of the stockpot spills out to the adjacent cooking grids. This action causes a heat transfer

Conclusions

*Table 4-1. Pot Size Characterization Results.**

Stockpot Sizes	12-inch	13-inch	14-inch	16-inch
Star Burner Cooking Efficiency (%)	32	**35**	40	43
Ring Burner Cooking Efficiency (%)	31	**35**	37	38

* Water weight was held proportional to cooking surface area. Stockpot diameters were changed during the test.

The 13″ diameter stockpot should be used for all cooking-energy efficiency tests.

from the cooking surface to a non-cooking surface and therefore reduces the energy added to the water.

An undersized stockpot: A stockpot that is too small for the range top allows the flame to escape from the cooking surface resulting in a reduction in efficiency.

Availability of 13-inch stockpots: Finally, all restaurants have a 13-inch pot in their kitchen which allows the testing to reflect real world usage. Based on these observations, it is recommended that the 13-inch diameter stockpot be used for all range top cooking-energy efficiency tests.

Water Depth Sensitivity Test

The sensitivity curve for the 20,000 Btu/hr – Star burner with a 13-inch diameter stockpot is a relatively straight line. The average efficiency over four different water depths is 35%. In this case, the water depth is insignificant in cooking efficiency because the pot size is comparable with the range top.

The sensitivity curves for the modified 27,000 Btu/hr Star burner and the 30,000 Btu/hr Ring burner with a 16-inch diameter stockpot exhibited a maximum efficiency when tested with a water depth of approximately 8 inches.

Conclusions

This test revealed that when a 16-inch diameter stockpot was used to evaluate the cooking efficiency, an 8-inch water depth is the minimum requirement necessary to obtain an accurate result.

Pot Thickness Sensitivity Test

The test conducted with the $^{5}/_{16}$-inch steel plate is a crude test, however, it revealed that pot thickness is a variable in identifying cooking efficiency. Furthermore, the cooking surface of the stockpot must also be flat in order to evaluate the true cooking efficiency. From our research on the World Wide Web of major cooking equipment vendors, stockpot thickness is often not in their specifications. To further understand this issue, more testing with different pot thicknesses will need to be performed.

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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.

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

Glossary

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

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

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

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

Preheat Energy (kWh or Btu)
Preheat Energy Consumption

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

Preheat Rate (°F/min)

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

Preheat Time (minute)
Preheat Period

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

Production Capacity (lb/h)

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

Production Rate (lb/h)
Productivity

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

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

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

Test Method

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

B Cooking-Energy Efficiency Data

Table B-1. Pot Diameter Versus Efficiency (Star Burner).

Pot Diameter	12 inch	13 inch	14 inch	16 inch
$Efficiency_1$ (%)	31.06	35.25	39.08	43.12
$Efficiency_2$ (%)	33.30	36.79	39.64	42.65
$Efficiency_3$ (%)	33.20	35.64	39.51	44.08
Average Efficiency (%)	32.52	35.89	39.68	43.28
Standard Deviation	1.27	0.80	0.19	0.73

Table B-2. Pot Diameter Versus Efficiency (Ring Burner).

Pot Diameter	12 inch	13 inch	14 inch	16 inch
$Efficiency_1$ (%)	30.78	35.19	37.45	38.62
$Efficiency_2$ (%)	32.12	35.75	37.39	39.04
$Efficiency_3$ (%)	31.45	35.17	38.69	37.79
Average Efficiency (%)	31.45	35.37	37.84	38.48
Standard Deviation	0.67	0.33	0.73	0.64

Cooking-Energy Efficiency Data

Table B-3. Water Depth Versus Efficiency (Star Burner).

Water Depth	3 inch	4 inch	7 inch
$Efficiency_1$ (%)	34.96	35.25	35.49
$Efficiency_2$ (%)	34.06	36.79	35.57
$Efficiency_3$ (%)	35.32	35.64	34.95
Average Efficiency (%)	34.78	35.89	35.34
Standard Deviation	0.65	0.80	0.34

Table B-4. Water Depth Versus Efficiency (Ring Burner).

Water Depth	3 inch	4 inch	5 inch	6 inch	8 inch	16 inch
$Efficiency_1$ (%)	45.79	45.74	45.69	47.83	49.35	46.75
$Efficiency_2$ (%)	46.69	45.17	45.75	45.84	49.29	46.98
$Efficiency_3$ (%)	45.40	45.77	46.36	46.25	48.16	47.27
Average Efficiency (%)	45.96	45.56	45.93	46.64	48.93	47.00
Standard Deviation	0.66	0.34	0.37	1.05	0.67	0.26

Table B-5. Water Depth Versus Efficiency (Modified Star Burner).

Water Depth	3 inch	4 inch	5 inch	8 inch	12 inch
$Efficiency_1$ (%)	32.76	37.37	36.69	37.70	37.26
$Efficiency_2$ (%)	32.87	37.83	36.23	37.87	37.26
$Efficiency_3$ (%)	33.03	36.51	36.26	38.04	37.12
Average Efficiency (%)	33.40	37.24	36.39	37.87	37.21
Standard Deviation	1.01	0.67	0.26	0.17	0.08

Cooking-Energy Efficiency Data

Table B-6. Efficiency is a Function of Stockpot Characteristic.

Pot Configuration	New	Old with warpage	Old w/o warpage
$Efficiency_1$ (%)	33.13	34.90	36.74
$Efficiency_2$ (%)	33.42	33.12	34.3
$Efficiency_3$ (%)	32.46	33.65	35.12
Average Efficiency (%)	33.0	33.8	35.4
Standard Deviation	0.49	0.91	1.24