technical brief

Electric and Gas Griddles: Energy and Ventilation Performance

Retail & Power Markets: Residential and Commercial Business Development

Summary—Energy

Applying standard test methods developed at its Food Service Technology Center, Pacific Gas and Electric Company (PG&E) evaluated the energy performance of nine griddle models—five electric and four gas. Laboratory tests and in-kitchen monitoring revealed the following:

- The electric griddles demonstrated average cooking efficiencies 90% to 172% higher than the gas models.
- Two of the electric griddles offer improved temperature uniformity, averaging only 12°F maximum temperature difference, while the four gas units averaged 76°F.
- In food production, the duty cycle averaged 24% for the electric griddles and 29% for the gas griddles.

Background—Performance

EPRI has supported an effort by PG&E's Food Service Technology Center to develop American Society for Testing and Materials (ASTM) protocols for evaluating cooking appliances. PG&E has applied these protocols to test many types of food service equipment under both laboratory and production kitchen settings. By developing consistent, standard verification of equipment energy use, these tests are providing restaurateurs, utility service representatives, equipment specifiers, and manufacturers data for optimum selection and operation of food service equipment.

One series of tests focused on griddles—a versatile appliance widely used in commercial kitchens. Typical items cooked on griddles include hamburgers, eggs, pancakes, and grilled sandwiches.

Griddle tests conducted by PG&E were instrumental in the 1990 adoption and 1996 revision of ASTM Standard Test Method F1275-95 for Performance of Griddles. This standard allows comparison of electric and gas commercial griddles based on such performance indicators as cooking energy efficiency and cooking rates under varying load conditions. Tables 1 and 2 list the models tested and the comparative criteria used in testing. The referenced PG&E reports provide additional data.

Approach

Using the standard test methods, PG&E staff compared energy consumption patterns of griddles under controlled laboratory conditions. Lab tests—conducted at heavy, medium, and light loads—focused on determining cooking energy efficiency, or the quantity of energy delivered to the food, expressed as a percentage of the total energy input to the griddle at a set temperature. The tests also measured preheat time and energy and idle energy consumption rates.

Due to the griddle's unique cooking surface, temperature uniformity is an important test measure. Evenly spread heat reduces the impacts of hot spots and minimizes temperature falloff around the edges, allowing improved product uniformity and worker productivity. To measure uniformity, researchers welded thermocouples to the cooking surface directly above the thermostat sensing probes. They then set the unit thermostat to 375°F, and monitored the thermocouples after the griddle temperature had stabilized at the set temperature for one hour.

PG&E also monitored griddle performance in an actual production kitchen setting. The Production Test Kitchen at PG&E's Learning Center is used for both routine menu production and appliance testing.

Results

As illustrated in Tables 1 and 2, the electric griddle models demonstrated cooking efficiency superior to the gas models. For the three load scenarios, the electric models averaged 90–172% higher efficiency than the gas models. A breakdown by equipment type showed that efficiency was 131–174% higher in the electric units than in standard efficiency gas units, and 61–168% higher in the electric units than in the high-efficiency gas units. The electric-gas efficiency gap was highest in low and medium loading.

Two of the electric griddles also offer superior temperature uniformity; their maximum temperature difference averaged 12°F while that of the four gas units averaged 76°F. Both electric and gas griddles operated with similar duty cycles (i.e., demand), averaging 24% and 29%, respectively.

Summary—Ventilation

Part of a larger effort to identify optimal designs for commercial kitchen appliances, researchers tested one electric griddle and one gas griddle in operation with two hood types: an exhaust-only, wall-mounted canopy hood and a custom-engineered backshelf hood. These tests are summarized in Figure 1 (last page) and revealed the following:

- The cooking capture and containment (C&C) flow rate under a canopy hood

Table 1 **Electric Griddle Comparison**						
		1	**2**	**3**[1]	**4**	**5**[2]
Product Information	**Efficiency Classification**	High	High	High	High	High
	Griddle Plate Size	36"Wx24"D	33"Wx24"D	36"Wx24"D	36"Wx24"D	24"Wx24"D
	Manufacturer's Rated Energy Input	16.2 kW (55.3 kBtu/hr)	8.4 kW (28.7 kBtu/hr)	9.3 kW (31.7 kBtu/hr)	14.0 kW 47.8 kBtu/hr	19.2 kW 65.5 kBtu/hr
	Heat Source	Tubular element	Tubular element	Heat panels	Steam thermal transfer	3 elements per side
	Controls	Thermostat control	3 zones each with a thermostat	3 zones each with a solid-state thermostat	Solid-state thermostat	3 zones solid-state programmable
ASTM Tests	**Measured Energy Input Rate**	14.9 kW (50.9 kBtu/hr)	7.9 kW (27.0 kBtu/hr)	9.3 kW (31.7 kBtu/hr)	14.0 kW (47.8 kBtu/hr)	19.8 kW (67.6 kBtu/hr)
	Preheat: Time to 375° Energy Consumed	19.3 min 4.39 kWh	19.8 min 2.5 kWh	11.6 min 1.72 kWh	19.6 min 4.56 kBtu	7.4 min 2.42 kBtu
	Cooking Efficiency[3] Heavy-Load Medium-Load Light-Load	64.6% 58.0% 42.7%	69.9% 61.5% 49.8%	71.9% 58.1% 42.2%	68.7% 51.9% 25.8%	75.4% 77.6% 68.3%
	Idle Energy Rate (@375°)	2.49 kW	1.64 kW	2.31 kW	2.80 kW	1.04 kW
	Pilot Energy Rate	n/a	n/a	n/a	n/a	n/a
	Maximum Temperature Difference	38°F	91°F	46°F	6°F	17°F
	Production Capacity[4]	46 lb/hr	29 lb/hr	34.8 lb/hr	43.7 lb/hr	62 lb/hr
In-Kitchen Tests	**Average Daily Energy Use**	21.9 kWh (74.8 kBtu)	14.9 kWh (51.0 kBtu)	n/a	n/a	n/a
	Average Energy Use Rate (demand)[5]	2.96 kW (10.1 kBtu/hr)	2.23 kW (7.6 kBtu/hr)	n/a	n/a	n/a
	Duty Cycle[6]	19.8%	28.2%	n/a	n/a	n/a

1 Double-sided griddle tested in single-sided mode.
2 Double-sided griddle tested in double-sided mode.
3 Defined as (energy to food) divided by (energy to griddle).
4 Based on the full-load cooking test.
5 For electric units this reflects the probable demand contribution for the best conditions.
6 Defined as (average energy use rate) divided by (measured energy input rate).

for the electric griddle is 241 scfm/lf, 13% lower than for the gas griddle, 40% lower than the 400 scfm/lf building code value, and 7% lower than the 260 scfm/lf Underwriters Laboratories (UL) listing.

- The cooking C&C flow rate under a custom-engineered backshelf hood for the electric griddle is 100 scfm/lf, 9% lower than for the gas griddle, 67% lower than the 304 scfm/lf building code value, and 26% lower than the 136 scfm/lf UL listing.
- The idle C&C flow rate under a canopy hood was 26% and 32% less, respectively, than the cooking C&C flow rate for gas and electric griddles, and was 0.5% and 22% less, respectively, under the backshelf hood.
- At the cooking C&C flow rate, the electric and gas griddles required about 60% lower flow under the backshelf hood than under the canopy hood.

These results indicate that custom-engineered backshelf hoods can operate with exhaust flows about 65% below code values, and that electric griddles with both hood types require about 10% less exhaust than gas units. Designers should apply site-specific data when evaluating equipment options.

Table 2 **Gas Griddle Comparison**					
		1	**2**	**3**	**4**
Product Information	**Efficiency Classification**	Standard	Standard	High	High
	Griddle Plate Size	36"Wx24"D	33"Wx22"D	36"Wx24"D	36"Wx24"D
	Manufacturer's Rated Energy Input	60 kBtu/hr	72 kBtu/hr	60 kBtu/hr	60 kBtu/hr
	Heat Source	Atmospheric burners	Three atmospheric burners	Infrared burners	Four gas infrared burners
	Controls	Thermostat control	Modulating thermostat with minimum flame	Thermostat control	2 zones each with a thermostat
ASTM Tests	**Measured Energy Input Rate**	59.0 kBtu/hr	69.5 kBtu/hr	60.0 kBtu/hr	83.9 kBtu/hr
	Preheat: Time to 375˚ Energy Consumed	 22.6 min 20.0 kBtu	 21.8 min 19.2 kBtu	 18.5 min 17.4 kBtu	 9.0 min 1.35 kBtu
	Cooking Efficiency[1] Heavy-Load Medium-Load Light-Load	 31.2% 21.2% 12.6%	 29.3% 21.2% 20.7%	 42.7% 31.2% 18.0%	 44.2% 36.6% 16.1%
	Idle Energy Rate (@375˚)	18.1 kBtu/hr	17.4 kBtu/hr	14.9 kBtu/hr	14.4 kBtu/hr
	Pilot Energy Rate	n/a	817 kBtuhr	n/a	3.2 kBtu/hr
	Maximum Temperature Difference	77˚F	73˚F	66˚F	89˚F
	Production Capacity[2]	34 lb/hr	25 lb/hr	43 lb/hr	48 lb/hr
In-Kitchen Tests	**Average Daily Energy Use**	1.45 therms (145 kBtu)	n/a	1.29 therms (129 kBtu)	2.24 therms (224 kBtu)
	Average Energy Use Rate (demand)[3]	0.218 th/hr (21.8 kBtu/hr)	n/a	0.177 th/hr (17.7 kBtu/hr)	0.177 th/hr (17.7 kBtu/hr)
	Duty Cycle[4]	36.9%	n/a	29.5%	21.1%

[1] Defined as (energy to food) divided by (energy to griddle).
[2] Based on the full-load cooking test.
[3] For electric units this reflects the probable demand contribution for the best conditions.
[4] Defined as (average energy use rate) divided by (measured energy input rate).

Background—Ventilation

To help electric utilities and the food service industry minimize commercial kitchen exhaust hood operating costs, EPRI is undertaking a series of tests to determine the exhaust requirement for a wide range of food service equipment and ventilation hoods. The exhaust requirement is the air flow needed to capture and contain cooking products and heat. Findings compare actual exhaust requirements with building code and UL levels. The ventilation tests described here examined electric and gas griddles operating under a wall-mounted canopy hood and under a custom-engineered backshelf hood using American Society for Testing and Materials (ASTM) standard method production conditions.

References—Performance

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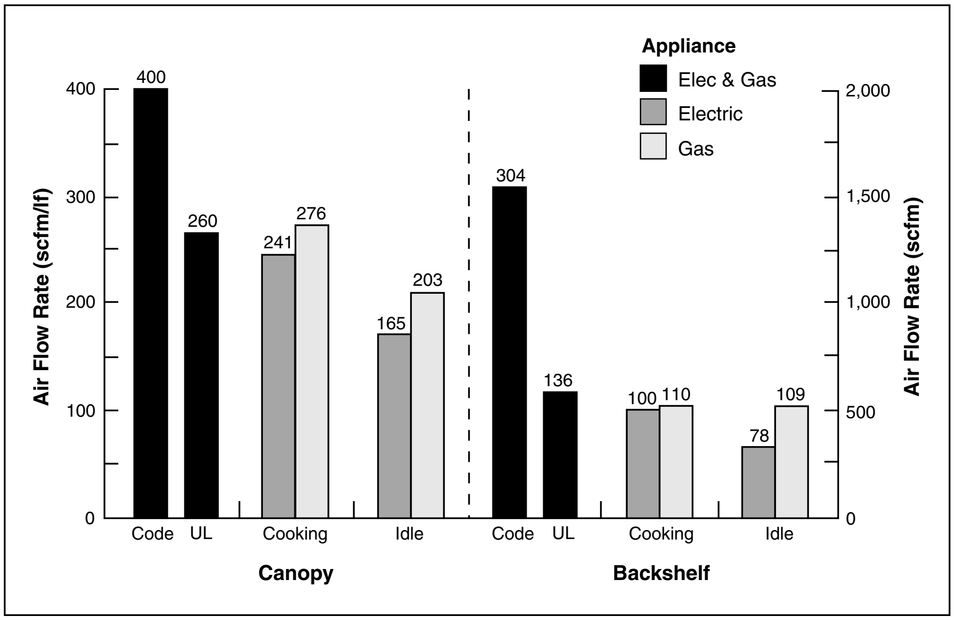

Figure 1. C&C Flow Rates for Electric and Gas Griddles

References—Ventilation

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