

# 9 Steam Kettles

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## Introduction

Steam kettles are an improved, self-contained version of the large stockpot used for range top cooking. And they are put to many of the same tasks. Steam kettles are often used to boil pasta, simmer sauces, stocks and stews. But, steam kettles offer a huge increase in productivity, convenience and energy efficiency. Steam-kettle cooking can be partially automated and closely controlled, far more so than cooking on a range top.

Steam kettles are enclosed by an outer wall, or jacket, containing raw steam. This steam jacket typically extends from the bottom of the kettle to between half and two-thirds of the distance to the rim. The circulation of steam inside the jacket provides even heating to the contents of the kettle. The pressure of the steam, which may be from 1 to 50 psig (7 to 345 kPa), determines the maximum temperature of the kettle.

## Cooking Process

Steam kettles cook by conduction: heat passes directly from the wall of the kettle into the food. This is the most common mode used for tasks like boiling and simmering large quantities of food product. Depending on the pressure of the steam in the jacket, the maximum temperature of the kettle may be 212-300°F (100-150°C). Some kettles have additional connections to the jacket for cold water, which allows the kettle to first cook the food and then chill the food.

Because kettles heat evenly, they need less supervision than a pot on the stove. A variety of controls allow the cooking process to be further simplified and automated. Manufacturers offer devices to measure the amount of water flowing into the kettle, timers to start cooking unattended and signal the end of the cook time, automatic valves to control cooking and chilling, and mixers to eliminate the need to check or stir the food.

Operators also use steam kettles for heating food up (e.g., rethermalizing precooked food and heating prepared sauces), boiling bagels and spaghetti, and for simmering long-cooking items such as chili. Cooking events may last

# Steam Kettles

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from a few minutes to several hours, and take place at temperatures from 150°F to 300°F (70 to 150°C). Reliance on steam kettles in institutional operations such as hotels and university kitchens is diminishing as menu preparation changes from batch cooking to accommodate the “fresh” concept so popular in today’s market. Many are moving towards cooking food items in other pieces of equipment such as combis and steamers, as batch cooking smaller quantities defines production. However, this trend is offset by the fact that the kettle is one of the primary appliances used within cook-chill systems for rethermalizing food received from a central commissary.

## Types of Kettles

Manufacturers offer a variety of steam kettles for commercial food service: direct steam and self-contained, tilting and stationary, floor-, wall- and countertop-mounted. All are available in gas and electric models. Many have a building service steam option for institutional facilities.

Capacity ranges from 1 quart to 200 gallons (1 to 760 liters). The source of steam may be a boiler built into the housing or base of a "self-contained" type kettle, or an external steam supply for "direct-steam connect" type kettles. Many smaller capacity (i.e. less than 60 gal (230 L)) steam kettles are mounted on pivots so that they may be tilted for pouring. Some manufacturers offer accessories such as timers and mixer attachments to automate steam kettle cooking. Kettles may be mounted on the wall, on a cabinet, pedestal or open-style base, or on a countertop.

### **Direct Steam Kettles**

In all kettles, steam enters the jacket and condenses on the kettle wall, transferring heat into the kettle and condensing back into water. The source of steam varies. Direct steam kettles are supplied with steam from an external boiler. While this makes the design of the kettle itself simpler, it incurs some additional maintenance. The kettle may need to be “blown down” once a day or more to eliminate condensate build-up in the steam supply line. This process is usually manual, although some kettles offer systems that take care of the condensate automatically.

## Self-Contained Kettles

Self-contained kettles have a closed steam system. The jacket is filled with distilled water and steam is supplied by a gas or electric boiler contained in a housing on the kettle's stand. This complicates design and increases the price of the kettle, but makes steam kettles available to kitchens of any size and with any configuration of gas and electrical plumbing. Maintenance of the steam jacket is simple. There is generally a sight glass to inspect water level, and the jacket occasionally requires manual venting or refilling.



*Figure 9-1.*  
*Floor-mounted tilting self-contained steam kettle.*

*Photo: Southbend*

## Tilting and Stationary Kettles

Tilting kettles simplify the task of decanting a large volume of food product. Tilting kettles range in size up to 100 gal (380 L), and are available in all configurations of steam source and mounting style. The kettle is generally tilted with a hand-operated wheel (Figure 9-1), but in some cases an electric motor is used. The kettle is counterbalanced so that it may stop and remain in any position as it tilts. Tilting kettles are also provided with a pouring lip to guide the food into steamer pans or other serving dishes. Additionally, larger units may have a tangent draw-off valve at the bottom of the kettle. This allows food such as spaghetti to be drained before decanting.

Stationary kettles do not tilt, but are usually equipped with a draw-off tangent valve at the bottom of the kettle. The largest steam kettles, those between 100 and 200 gal (380 and 760 L) capacity, are available only as stationary models.

## Mounting Style

Smaller steam kettles, generally less than 10 gal (40 L) capacity, may be available in countertop models. Countertop kettles are available in gas heated-, electric-heated and direct-steam configurations, and are generally tilting-type kettles.

Wall-mounted kettles may be stationary or mounted on trunnions for tilting. They are generally direct steam kettles, and often are installed as part of a

# Steam Kettles

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battery of appliances. Kettles of one-quart to 100-gallons (1-400 L) capacity are available in wall-mounted configurations.

Floor-mounted models may be from 10-200 gal (40-800 L), direct or self contained, tilting or stationary. The kettle may be mounted on a pedestal or on an open or cabinet-style base.

## Controls

Steam-kettle controls are generally simple, consisting typically of a power switch and a pressure dial. Smaller kettles may use thermostats to control cycling, while larger kettles use a pressure sensor in the jacket.

Some manufacturers offer optional lines of accessories including electronic controls that start and stop kettle cooking and/or chilling operations automatically. Systems are also available to automate boiler maintenance operations.

## Advanced Steam Kettle Technologies

### **Insulated Steam Kettles**

One manufacturer has introduced a line of insulated steam kettles. The insulated jacket will reduce heat losses from the bottom and sides of the kettle, which in turn increases efficiency, lowers energy consumption and reduces heat flow into the kitchen.

### **Thermal Fluid Kettles**

This type of kettle circulates a thermal fluid through the jacket instead of steam. This increases the temperature range of kettles significantly, with the manufacturer reporting cooking temperatures of up to 360°F (182°C) versus a more typical peak of 300°F (150°C) with high-pressure steam. This may make it possible to cook additional items such as braised meats in a steam kettle.

## Steam Kettle Performance

There is little published data for this category of appliances. An ASTM standard test method for steam kettles was developed by the Food Service Technology Center (F1785-97).<sup>1</sup> The ASTM method reports several parameters of steamer performance including maximum input rate, production capacity, cooking-energy efficiency and rate of energy use while simmering.

Other factors that affect the actual performance of the steamer include ergonomics, ease of use and maintenance, and quality of construction.

### **Maximum Energy Input Rate**

Maximum energy input rate is determined for kettles while the controls are set for maximum heating and the burners are on. Maximum input rate can be useful to food service operators for managing power demands and estimating a kettle's energy cost.

### **Production Capacity**

Production capacity is determined during a heat-up test that brings water from 70°F to 160°F (20°C to 70°C). It is a close indicator of how fast the kettle can bring soups, sauces, or other liquids up to temperature. Production capacity can be used by food service operators to choose a steam kettle to match their particular food output requirements.

### **Heat-up Energy Efficiency**

The heat-up test is used to determine both production capacity and efficiency of the steam kettle. Efficiency of the steam kettle during heat up enables the food service operator to consider energy performance when choosing a steam kettle.

### **Simmer Energy Rate**

The simmer test determines the energy rate while simmering foods. Simmer rate is an indicator of kettle performance while cooking foods that demand long cook times, such as soups and chili. This information also allows the

## Steam Kettles

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food service operator to consider energy performance when choosing a steam kettle. Table 9-1 presents performance characteristics for three different kettles based on data generated by the Food Service Technology Center from its development of the ASTM *Standard Test Method for the Performance of Steam Kettles*.

*Table 9-1. Steam Kettle Performance Comparison Based on Preliminary Data for Three Steam Kettles.<sup>2</sup>*

	Elec 10	Gas 10	Gas 40
Maximum Energy Input Rate (kBtu)	35	55	203
Heatup Energy Efficiency (%)	87	39	54
Production Capacity (gal/h)	41	29	131
Simmer Energy Rate (kBtu/h)	3	7	9

Note: Electric 10 and Gas 10 are a matched pair of 10-gal (40 L) tilting, tabletop kettles. Gas 40 is a tilting 40-gal (150 L) kettle.

The heat-up energy efficiencies in Table 9-1 are derived from a period when the burners or elements of the steam kettle boiler are at full input and have been running for several minutes. At this point, the kettle walls are stabilized and most of the available energy is being transferred into the water inside the boiler. Therefore, heat-up efficiency is a close indicator of boiler efficiency. Gas 10's lower efficiency, 39% vs. 54%, is probably not due to a smaller kettle or more surface area to volume, but to a less efficient boiler design. Operating within the manufacturer's specifications, Gas 10's exhaust temperature was over 800°F (425°C).

### Benchmark Energy Efficiency

Table 9-2 summarizes the range of efficiency for steam kettles. Benchmark energy efficiencies for steam kettles were based on the personal experience of the authors from work associated with test method development for steam kettles at Pacific Gas and Electric Company<sup>2</sup> and on data conducted by the University of Minnesota.<sup>3</sup>

# Steam Kettles

*Table 9-2. Benchmark Steam Kettle Cooking-Energy Efficiency.*

Gas Steam Kettles	40 – 60%
Electric Steam Kettles	80 – 95%

## Steam Kettle Energy Consumption

Projected energy consumption for gas and electric steam kettles is presented in Table 9-3 and Table 9-4. The information is based on test method development work for steam kettles at the Food Service Technology Center, on data from the University of Minnesota Study,<sup>3</sup> and from an unpublished proprietary end-use monitoring study. Daily energy consumption for kettles was calculated by multiplying the median rated energy input for each kettle type by the respective duty cycle and the hours of operation. The duty cycle for the gas kettle is based on data from proprietary end-use monitoring reports; the duty cycle for the electric kettle is based on an energy consumption ratio of 1.8 for tilting skillets and assumes that kettles and skillets have similar energy use patterns. The duty cycle is defined as the average rate of energy consumption expressed as a percentage of the rated energy input or the peak rate at which an appliance can use energy. Typical operating hours were gleaned from the PREP study.<sup>4</sup> The projected annual energy consumption was determined by assuming a 6-day per week, 52-week per year operation.

*Table 9-3. Projected Energy Consumption for Gas Steam Kettles.*

	Nominal Size	Rated Energy Input (kBtu/h)	Duty Cycle (%)	Avg. Energy Consumption (kBtu/h)	Typical Operating Hours (h/d) <sup>a</sup>	Annual Energy Consumption (kBtu) <sup>b</sup>
Steam Kettle	10-100 gal	50 - 125				
<b>(Median)</b>	<b>60</b>	<b>125</b>	<b>40<sup>c</sup></b>	<b>50</b>	<b>4</b>	<b>62,400</b>

<sup>a</sup> Operating hours or appliance "on time" is the total period of time that an appliance is operated from the time it is turned "on" to the time it is turned "off".

<sup>b</sup> The annual energy consumption calculation is based on the average energy consumption rate x the typical operating hours x 6 days per week x 52 weeks per year.

<sup>c</sup> The duty cycle of 40% is based on data from unpublished proprietary end-use monitoring studies. An associated average energy consumption rate of 50 kBtu/h was calculated.

# Steam Kettles

*Table 9-4. Projected Energy Consumption for Electric Steam Kettles.*

	Nominal Size	Rated Energy Input (kW)	Duty Cycle (%)	Avg. Energy Consumption (kW)	Typical Operating Hours (h/d) <sup>a</sup>	Annual Energy Consumption (kWh) <sup>b</sup>	(kBtu) <sup>c</sup>
Steam Kettle	10-100 gal	6 - 36					
<b>(Median)</b>	<b>60</b>	<b>21</b>	<b>40<sup>d</sup></b>	<b>8</b>	<b>4</b>	<b>9,980</b>	<b>34,000</b>

<sup>a</sup> Operating hours or appliance "on time" is the total period of time that an appliance is operated from the time it is turned "on" to the time it is turned "off".

<sup>b</sup> The annual energy consumption calculation is based on the average energy consumption rate x the typical operating hours x 6 days per week x 52 weeks per year.

<sup>c</sup> Conversion Factor: 1 kW = 3.413 kBtu/h.

<sup>d</sup> The duty cycle of 40% is based on an energy consumption ratio of 1.8 for tilting skillets with an assumption that energy usage is similar for the two appliance types. An associated average energy consumption rate of 8 kW was calculated.

## Ventilation Requirements

Steam kettles are classified as light-duty equipment from the perspective of exhaust ventilation. For a wall-mounted canopy hood, the design ventilation rate for steam equipment would range from 150 to 200cfm (75 to 100 L/s) per linear foot of hood.

## Research and Development

Consideration for R&D projects include:

- Evaluate the benefit of upgraded kettle insulation.
- Development/application of high-efficiency boilers.
- Evaluate thermal fluid kettle.

## Industry Market Focus

- Support benchmarking of steam kettle energy efficiency.
- Encourage the use of lids for steam kettles (60% simmer energy use reduction).



## References

1. American Society for Testing and Materials, 1997. *Standard Test Method for the Performance of Steam Kettles*. ASTM Designation F1785-97. In Annual Book of ASTM standards, West Conshohocken, PA.
2. Unpublished experience of FSTC from developing and applying the standard test method to three steam kettles.
3. Snyder, O.P., and J.F. Norwig., March 1983. *Comparative Gas/Electric Food Service Equipment Energy Consumption Ratio Study*. University of Minnesota.
4. Claar, C.N., Mazzucchi, R.P., Heidell, J.A., 1985. *The Project on Restaurant Energy Performance (PREP) –End-Use Monitoring and Analysis*. Prepared for the Office of Building Energy Research and Development, DOE, May.
5. Reed Business Information [Oak Brook, Illinois], 2002. *Foodservice Equipment and Supplies*, pp 86-87, May.

Information in this module also references Manufacturers Product Literature, catalogues, and appliance specification sheets.