

Water Heaters/Boilers/Booster Heaters/Snow Melt

Summary¹

The heating of water is an energy intensive process and used in a wide variety of residential, commercial and industrial segments. Water is the basis for the definition of a BTU. 1 BTU = the amount of energy it takes to raise 1 pound of water by 1 degree Fahrenheit. Since water weighs about 8.34 lbs/gallon, and we like to use it at above 100F, we put a lot of BTUs into our water.

Codes dictate the temperature of water in commercial facilities. For example, hot water for showers may be limited by code to about 110F, where water used for dish washing must be at least 180F or use chemical sanitation. Most facilities operate their water temperature in the 140F range.

Water heating can be categorized in the following general classes:

- Residential water heaters - tank units typically 30 or 40,000 BTUs/Hour in gas
- Commercial tank water heaters 199,000 BTUs to about 250,000 BTUs/Hour
- Instantaneous, tank-less, steam convertors
- Direct Contact water heaters (submerged combustion)
- Water Heating Boilers (essentially the same as space heating boilers)
- Booster Heaters
- Snow melt systems

Water Heaters (Direct-Fired)

Summary/Principles of Operation²

Water heaters are rated according to their recovery rate, or the number of gallons of hot water they can produce in one hour after their storage tank has been drawn down. This varies with the inlet and outlet water temperatures. The larger the burner, the higher the recovery rate. The larger the storage tank, the more hot water they can provide in the first hour.

Residential water heaters are common in small commercial and industrial office buildings. They are typically 30 or 40 gallons and have BTU ratings that match their size (30,000 BTUs/Hr and 40,000 BTUs/Hr). These units are very low cost and can produce water up to about 150F in volumes of about 20 to 30 gallons per hour.

Commercial basic tank water heaters are simply heartier versions of the residential units. Typically are 250,000 Btu's or less. They have a storage tank of about 100 gallons and can heat water to about 180F.

¹ Technology Profiles by DTE Energy

² Technology Profiles by DTE Energy, Inside Sales-Fundamentals of Heating Systems by GTI and Northeast Gas Association, 2003

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- Units consist of a storage tank and gas burner with the combustion gases venting through the middle of the tank
- They are controlled by a thermostatic gas valve
- Completely non-electric
- Pilot light ignition

Strengths/Opportunities³

- Cost less to operate than electric water heaters and can heat water twice as fast as electric⁴
- Heats and stores water until ready to use
- Can provide entire tank of hot water immediately on demand
- Lowest cost water heater
- Requires no electrical connection
- Gas heaters resist hard water better than electric heaters (hard water burns out electric elements quickly)

Weaknesses/Barriers⁵

- Less efficient than electric units
- Cannot provide maximum water flow indefinitely
- Stand-by losses – Storage tank continually loses heat when not in use, Consumes gas even when not in use

Market Niches

- Residential homes
- Small restaurants
- Small hotels
- Large office buildings

Competition

- Electric Units/Heat Pump
- Propane Units
- Oil Units

³ Technology Profiles by DTE Energy, Inside Sales-Fundamentals of Heating Systems by GTI and Northeast Gas Association, 2003

⁴ AGA Residential Marketing Fact Sheet

⁵ Inside Sales-Fundamentals of Heating Systems by GTI and Northeast Gas Association, 2003

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Typical Costs (not installed)

Residential⁶

30,000 Btu (Energy Factor 0.61) = \$208
 40,000 Btu (Energy Factor 0.59) = \$228-\$435
 50,000 Btu (Energy Factor 0.58) = \$278-\$474

Commercial⁷

100,000-200,000 Btu (95% AFUE) = \$2,100-\$2,900
 199,000 Btu (85% AFUE) = \$2,150

Manufacturers

Manufacturer	Representative	Phone Number	Website
American Standard	Various distributors statewide	(800) 442-1902	www.americanstandard.com
A.O. Smith			www.hotwater.com
Bradford White	A.K.R. Associates	(860) 882-0213	www.bradfordwhite.com
Lochinvar Corporation	Elliot Shyer	(860) 413-9453	www.lochinvar.com
Raypak	Ed Lynch	(805) 278-5300	www.raypak.com
State	Plimpton & Hills Corp.	(860) 229-2076 (860) 522-4233	www.stateind.com
Weil-McLain	Metro	(201) 797-8550	www.weil-mclain.com

Instantaneous or Tankless

Summary/Principles of Operation⁸

Instantaneous water heaters are also known as tankless, because they heat the water in one pass through the heat exchanger. The heat exchanger may be gas fired or it may be a steam convertor. If gas fired, the applications tend to be very small volumes. Steam convertors on the other hand, tend to be large loads where there is a central boiler - such as institutional and hospitals.

These compact units have a gas burner that ignites when a hot water faucet is turned on. The burner heats the water instantaneously as it is being used, and turns off when the faucet is turned off⁹.

These units are typically used in the residential and small commercial markets.

⁶ Lowes www.lowes.com 9/8/04 Whirlpool models

⁷ A.O. Smith per Bill 9/10/04

⁸ Technology Profiles by DTE Energy

⁹ AGA Residential Marketing Fact Sheet

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Strengths/Opportunities¹⁰

- No standby heat loss because heats water as it's used and the units do not store water
- Efficient-no gas used to maintain a large volume of water during periods of low usage
- Extremely compact-saves space
- Heater delivers a constant supply of hot water indefinitely

Weaknesses/Barriers¹¹

- Output of burner limits rate of heated water flow which may fall short during periods of high demand
- Expensive

Market Niches

- Residential hot water applications where space is at a premium i.e. urban condos, etc.
- Sometimes used to provide hot water for hydronic or in-floor heating systems

Competition

- Steam Converters (Electric)
- Propane Units
- Oil Units

Typical Costs (Not installed)¹²

125,000 Btu unit = \$599

240,000 Btu unit = \$929

Manufacturers

Manufacturer	Representative	Phone Number	Website
AquaStar	Home Depot		www.homedepot.com

¹⁰ Inside Sales-Fundamentals of Heating Systems by GTI and Northeast Gas Association, 2003

¹¹ Inside Sales-Fundamentals of Heating Systems by GTI and Northeast Gas Association, 2003

¹² Home Depot www.homedepot.com 9/7/04 for AquaStar units

Direct Contact

Summary/Principles of Operation¹³

Direct contact water heaters claim near 100% efficiency as they squeeze nearly every BTU out of the combustion process, including the latent heat of vaporization. The flue gasses are passed directly through the water being heated, and even the water vapor in the combustion air is condensed. These units have been around since the early 1980's, but there are still only a handful of manufacturers. Although some units now carry potable (human consumption) ratings, they were slow to be accepted in most potable water applications.

Direct contact water heaters are available in a wide range of sizes, from about 500,000 BTUs to several million BTUs. They have powered gas burners which require elevated gas pressure (0.5 to 2 psi) to operate.

Direct contact water heating using a pre-mix burner to mix gas and air, ignite it and pass the gas flame directly through the water. Some systems use tanks where the flame is virtually flooded in the water and other systems use a 'mist' or 'spray' of water into the combustion chamber. These systems are highly efficient, but not all are approved for all applications, because the products of combustion enter into the hot water stream.

Strengths/Opportunities¹⁴

- Nearly 100% efficient
- Reduces water heating costs by 35-40%
- Instant and continuous hot water

Weaknesses/Barriers¹⁵

- Limited number of manufacturers in the market
- Slow to be accepted
- Requires elevated gas pressures to operate
- Not approved for all applications
- 2-3 times more expensive than indirect or conventional boilers¹⁶

Market Niches

- Commercial laundries
- Industrial process
- Food processing
- Food Service
- High rise apartments

¹³ Technology Profiles by DTE Energy

¹⁴ www.kemco.com

¹⁵ Technology Profiles by DTE Energy

¹⁶ http://www.advancedbuildings.org/_frames/fr_t_heat_direct_contact.htm

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Competition

- Propane
- Oil

Typical Costs (Not installed)¹⁷

600,000 Btu/hr - 12 gpm with 100 F temp rise = \$18,376
1.75mmBtu/hr – 35 gpm with 100 F temp rise = \$25,900
3.5mmBtu/hr – 70 gpm with 100 F temp rise = \$34,398
6.0mmBtu/hr – 120 gpm with 100 F temp rise = \$47,261
10.0mmBtu/hr – 200 gpm with 100 F temp rise = \$65,700

Manufacturers

Manufacturer	Representative	Phone Number	Website
Kemco Systems		(800) 633-7055	www.kemcosystems.com
QuikWater		(918) 241-8880	www.quikwater.com
Sofame		(514) 523-6545	www.sofame.com

Boilers

Summary/Principles of Operation¹⁸

Conventional water heating boilers are different than space heating boilers. They tend to have atmospheric gas burners, where boilers generally have powered burners, and operate at lower temperatures. Newer high-efficiency units have power burners, condensing heat exchangers, and operate at temperatures just as high as space heating boilers. Other differences are that water heater boilers are built to take more 'thermal shock' due to colder inlet water temperatures and must raise the water to a higher 'delta T' (change in temperature), operate without boiler water treatment chemicals, and use external water storage tanks.

A thermostat controls the water temperature in the storage tank, with a circulation pump used to circulate the water between the storage tank and the boiler. A second pump circulates water to the point of use. These systems are generally rated up to 5 Million BTU/hour range. Storage tanks are large, highly insulated cylinders, and the boilers resemble smaller boxes with gas burners.

¹⁷ QuikWater per Tammy Collins 9/10/04

¹⁸ Technology Profiles by DTE Energy

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Strengths/Opportunities¹⁹

- Less operating costs than electric resistance or heat pumps
- Immediate operating cost savings by replacing oil and electric boilers
- No need to fill oil tanks
- No oil tank fire hazard
- No concerns about on-time truck delivery
- No oil spills
- Lower maintenance

Weaknesses/Barriers

- Cannot be used with air conditioning
- Less efficient than electric heat pumps

Market Niches

- Residential
- Schools
- Hospitals
- Large hotels

By varying the size of the storage tank and the boiler size, a large variety of capacities and demands can be met. For example, a hotel with a high demand in the morning, but little demand the rest of the day, could have a small boiler and a large storage tank. A laundry may have a large boiler and a small storage tank.

Competition

- Electric Resistance Heat/Heat Pumps
- Steam Boiler
- Propane Units
- Oil Units

¹⁹ Inside Sales-Fundamentals of Heating Systems by GTI and Northeast Gas Association, 2003

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Typical Costs (Not installed)²⁰

Refer to Supplier/Contractor for exact pricing

- 37,500 Btu - Series 2 (high efficiency) standing pilot and vent damper ~ \$1,143
- 50,000 Btu - Series 2 (high efficiency) standing pilot and vent damper ~ \$1,230
- 96,000 Btu - Series 2 (high efficiency) standing pilot and vent damper ~ \$1,511
- 232,000 Btu - Series 2 (high efficiency) standing pilot and vent damper ~ \$2,460
- 299, 000 Btu - Series 2 (high efficiency) standing pilot and vent damper ~ \$3,046
- 330,000 Btu – Series 8B ~ \$3,597
- 594,000 Btu – Series 8B ~ \$4,821
- 1,014,000 Btu – Series 5B (water) ~ \$9,063 (steam) ~ \$9,074
- 1,950,000 Btu – Series 5B (water) ~ \$15,737 (steam) ~\$15,761

Manufacturers

Manufacturer	Representative	Phone Number	Website
Burnham	Mike Morrissey	(860) 575-0182	www.burnham.com
Raypak/Rheem			www.raypak.com
Lochinvar Corporation	Elliot Shyer	(860) 413-9453	www.lochinvar.com
Weil-McLain			www.weilmclain.com
Carrier	Bob Curran	(860) 894-3361	www.carrier.com

Booster Heaters

Summary/Principles of Operation²¹

Commercial food service operations must use one of two approved methods to sanitize dishes in the dish washing process: water temps above 180F or chemical (chlorine) additives.

There are pros and cons of both methods, but for those who choose the hot water method, most use electric booster heaters to get up to 180F. Standard natural gas water heaters are not designed for that high of temperature, so they either cannot get that hot, or are very inefficient at those temperatures. It is also not safe (or legal in many cases) to have water that hot be distributed to the entire facility for other use, such as hand washing.

Typically a gas water heater will be used to get the water to about 140F and then boosted electrically. Even a small electric booster heater can be 30kW, which substantially increases cost, especially if on a high demand charge tariff. (Large operations could use commercial boilers, but this is rare in average restaurants.)

²⁰ Burnham Trade Pricebook #180 effective 8/20/04

²¹ Technology Profiles by DTE Energy

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Strengths/Opportunities²²

- Gas operating costs lower than electric
- Helps customers to balance load
- Uses less detergent and wetting agent than standard dishwashing
- More environmentally friendly than its chemical rinse competition
- No need to stock chemical rinse additives
- Uses less water than fill and dump style, resulting in lower operating costs
- Stackable units available to save valuable floor space

Weaknesses/Barriers²³

- Higher initial costs
- Require venting
- Generally needs a location in the piping system near where the very hot water is needed

Market Niches

- Restaurants
- Institutional Food Service
- Catering, Banquette Halls
- Laundry services
- Bed pan washers
- Cage washers

Competition

- Electric units
- Chemical additives to sanitize dishes

Typical Costs (Not installed)²⁴

46,000 Btu = \$4,300
84,000 Btu = \$5,300
156,000 Btu = \$6,300

Manufacturers

Manufacturer	Representative	Phone Number	Website
Hatco Corporation		(800) 558-0607	www.hatcocorp.com
PrecisionTemp			http://66.161.146.46/index.htm
Voyager		(800) 323-9651	www.htproducts.com

²² Inside Sales-Fundamentals of Heating Systems by GTI and Northeast Gas Association, 2003

²³ Technology Profiles by DTE Energy, Inside Sales-Fundamentals of Heating Systems by GTI and Northeast Gas Association, 2003

²⁴ Hatco www.hatcocorp.com 9/7/04 per Bill Citti

Snow Melt

Summary/Principles of Operation²⁵

Today, snow melting systems are helping to push the season in northern climates for outdoor activities, and helping to keep all sorts of large walks and parking areas safer during winter months.

From horse race tracks to tennis courts, it makes financial sense to include a snow melt system and extend the season of use to year round. Facilities are expensive to build; adding a snow melt system that can extend the revenue season can be a very sound economic decision.

A series of hydronic pipes are buried just under the surface or poured into the cement. The pipes are connected to headers and controls that are connected to gas boilers. If melting snow only, water temperature is generally lower (90 - 100F), but if also using for heating, such as airport hangers or outdoor maintenance areas, the temperature can be turned up.

Very heavy plastic or rubber tubing is buried beneath brick and asphalt or into concrete surfaces. The system is generally designed so that there are no joints in the pipe in inaccessible areas. Each pipe loop is feed from and returned to a header in a common area. This way, most leaks could be repaired at the header, or leaking loops disconnected.

Some systems are installed with insulation below the piping; either rigid foam or roll-out reflective insulation consisting of a layer of aluminum foil sandwiched between two layers of polyethylene bubbles are used to form a thermal break. This can make the systems respond a little quicker, but don't save much in annual operation costs, as most of the heat goes to the surface anyway. Systems should have some sort of ground temperature control, and may also have a surface moisture detector to turn up/on during periods of heavy snow fall.

Traditional boilers and water heaters are used on snow melt systems. Water temperature is typically only about 90F for systems that are always circulating, a little higher for systems that turn on and off. Small snow melt systems may have heaters of only 200,000 BTUs, where large installations could be several million BTUs with redundant boilers.

Strengths/Opportunities²⁶

- Can be economical if snow must be hauled away, such as in a downtown setting
- Reduces damage repair from snow handling equipment and melting compounds like salt
- Improves safety from falls from ice covered sidewalks

Weaknesses/Barriers

- High costs for small areas

²⁵ Technology Profiles by DTE Energy

²⁶ Technology Profiles by DTE Energy

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Market Niches

- Public sidewalks, Parks, Outdoor Malls
- Hospital and Elderly care facility entries, Heliports
- Airport Public areas, Hangers, and Tarmac
- Driveways and parking areas
- Sports Parks, Stadiums and Race Tracks
- Car washes
- Auto Dealerships

Competition

- Electric radiant heaters

Typical Costs²⁷

Installed costs can easily be \$5 to \$10 per square foot, plus the cost of a boiler.

Manufacturers

Manufacturer	Representative	Phone Number	Website
Wirsbo			www.wirsbo.com
Rehau		(914) 763-3200	www.northeastradiant.com
Watts Radiant		(800) 276-2419	www.wattsradiant.com

²⁷ Technology Profiles by DTE Energy