Tankless Water Heaters
How a Tankless operates

When a hot water fixture opens, the flow of water causes the flow sensor impeller to spin. The larger the flow rate, the faster the impeller spins.

The computer board reads how fast the impeller is spinning to determine the flow rate.

Once the activation point (0.5 gpm on most current models) is met, the computer board moves on to the next step.
How a Tankless begins ignition

In preparation for combustion, the computer tells the fan motor to initiate. The fan sends a signal back to the computer board to signal that it is operating at the correct RPM, without blockage.
Next, the computer gives power to the igniter, which starts a spark in the combustion chamber. The main gas valve and solenoid valves open to let gas into the combustion chamber.
Tankless ignition process

With the precise amount of combustion air and gas for a clean burning flame, combustion occurs. The flame sensor, located within the combustion chamber, verifies that combustion has occurred.
After combustion has started, the computer board constantly utilizes information from a number of sensors in order to determine how much air and gas is needed for the desired set temperature, and modulates accordingly. These sensors include three thermistors (reading the inlet, outlet, and heat exchanger temperatures) and the flow sensor. The AFR (air fuel ratio) rod is another sensor inside the combustion chamber that measures the quality of the combustion, ensuring that it is a strong, blue, low CO\textsubscript{x} producing flame.
Using all the sensors, the computer controls the components that manage the air, gas, and water flow amounts to meet the varying levels of demand it encounters from the hot water fixtures. The bypass valve (BV) mixes cold water into the outgoing hot line to reduce pressure loss, and increase speed of modulation. A proportional gas valve (not pictured, but between main valve and solenoids), manages the amount of gas delivered to the different sections.
Burner Assembly

- Facilitates combustion: 4 stages
- The burner assembly is comprised of two types of burners: *rich* and *lean*
- The assembly facilitates proper air/fuel ratios for proper combustion

Twenty T-M32 Burners
Burner Assembly

**General modes of failure:**
- Dust or soot deposits either on the burner surface or inside the burner assembly
- Gas leaks due to compromised gaskets

**Possible effects of failure:**
- Unstable flame conditions and/or flame loss
- Ignition failure
- Improper combustion / high emissions

**Basic diagnostics:**
- Remove assembly from combustion chamber and perform a visual inspection of the burner.
Gas Manifold

**Distributes gas into the combustion chamber**

**Two sets of gas nozzles: one set provides to the lean burners and the other set provides to the rich burners**

**Manifold is divided into 3 zones, creating 4-stage combustion**

10-3/4" (276.4mm)

7-7/8" (202.6mm)
Gas Manifold

General modes of failure:
- Dust deposits on the manifold
- Gas leakage from failed gaskets

Possible effects of failure:
- Unstable flame conditions and/or flame loss
- Ignition failure
- Improper combustion / high emissions

Basic diagnostics:
- Remove gas manifold perform a visual inspection for excessive dust deposits around the nozzles.
Fan Motor

Provides combustion air into the burner chamber

Exhausts flue gases

Provides combustion air into the burner chamber

Exhausts flue gases
Fan Motor

**General modes of failure:**
- Improper fan motor speed
- Moisture on the electrical connections of the fan

**Possible effects of failure:**
- Inability for water heater to function
- Ignition failure
- Improper combustion / high emissions
- Abnormal sounds prior to, during, and after combustion

**Basic diagnostics:**
- Visual inspection of electrical connections to fan motor: moisture, dust, connection/breakage of wires
- Visual inspection of fan motor housing for moisture
- Voltage check (Service Manual)
- Fan speed check (Service Manual)
Gas Valve Assembly

- Opens and closes the gas pathways going into the manifold and combustion chambers (main and solenoid valves)
- Modulates the amount of gas going into those chambers (proportional valve)

Dimensions:
- 4-1/2" (114mm)
- 4-1/2 (119mm)
Gas Valve Assembly

General modes of failure:
- Damaged housing or O-rings causing gas leaks
- Inability to open/close (main and solenoid valves)
- Inability to properly modulate (proportional valve)

Possible effects of failure:
- Inability for water heater to function
- Ignition failure
- Improper combustion / high emissions
- Abnormal sounds during combustion
- Lack of water temperature control

Basic diagnostics:
- Visual inspection of electrical connections: moisture, dust, connection/breakage of wires
- Listen for the double “clunk” sounds from the gas valves right after fan motor initiates during start of operation.
- Voltage & resistance check (Service Manual)
Flame Sensor

Detecst whether combustion has occurred during operation

Ensures that combustion is not occurring when the water heater should be off

Assembled with the AFR sensor (some models)

Sensing elements (AFR & flame sensors)

Connection leads to the PCB
Flame Sensor

General modes of failure:
- No detection of flame when combustion has occurred.
- False detection of flame when no combustion has actually occurred.

Possible effects of failure:
- Water heater will stop operating

Basic diagnostics:
- Visual inspection of electrical connections: moisture, dust, connection/breakage of wires
- Electrical current check (Service Manual)
AFR Sensor

- **Air-Fuel Ratio sensor**
- Monitors combustion conditions within the chamber

When combustion conditions are less than ideal, computer adjusts fan motor speed to compensate.

Also functions as a secondary flame sensor (verification).

Assembled with the flame sensor.

Connection leads to the PCB.

Sensing elements (AFR & flame sensors)
AFR Sensor

General modes of failure:

• No detection of flame when combustion has occurred.
• False detection of flame when no combustion has actually occurred.

Possible effects of failure:

• Water heater will stop operating
• Fan motor cannot adjust properly in response to abnormal combustion conditions.
• Improper combustion / high emissions

Basic diagnostics:

• Visual inspection of electrical connections: moisture, dust, connection/breakage of wires
• Electrical current check (Service Manual)
Primary Heat Exchanger

Absorbs heat from combustion

Transfers this heat into the water
Heat Exchanger

General modes of failure:
- Exhaust gas leakage
- Clogged heat exchanger fins
- Breach in drum walls
- Hard-water scale
- Heat stress
- Corrosion

Possible effects of failure:
- Copper damage due to heat stress
- Water leakage
- Poor heat transfer
- Abnormal combustion noise

Basic diagnostics:
- Visual inspection: soot, debris, cracks, water leakage, scale buildup, etc.
Secondary Heat Exchanger

Absorbs heat/exhaust from combustion

Transfers this heat into the water

Basic diagnostics:

- Visual inspection: soot, debris, cracks, water leakage, scale buildup, etc.
Flow Sensor

Detects and measures the water flow rate

Contains a spinning impeller and magnetic pickup
Flow sensor

General modes of failure:
- Impeller does not spin or spin freely: unable to detect or measure water flow.

Possible effects of failure:
- Startup ignition sequence will not initiate. Water heater will not operate.

Basic diagnostics:
- Visual inspection of electrical connections: moisture, dust, connection/breakage of wires
- Visual inspection of impeller for debris (any cause of restriction)
- Voltage check (Service Manual)
Water Control Valves

Provides 3 functions within the water heater: flow adjustment, bypass, and two-way functions (540)

Controls water flow to maintain proper output water temperatures (flow adjustment function)

Mixes hot and cold water for proper output water temperatures (bypass function, 540 only)

Prevents low-temperature corrosion from condensation in the heat exchanger (bypass function)

Prevents water flow through the heat exchanger when water heater is not in operation (two-way function)
Water Control Valves

General modes of failure:
- Breach in valve housing, causing water leakage
- Inability to modulate flow or make fully opened/closed positions

Possible effects of failure:
- Water leakage can damage other components of the water heater
- Fluctuation in hot water output temperatures

Basic diagnostics:
- Visual inspection of electrical connections: moisture, dust, connection/breakage of wires
- Visual inspection of valves: motor drive locked due to scale buildup, breach in housing, etc.
- Voltage check (Service Manual)
Water Thermistors

Thermistors measure and help monitor water temperatures throughout the water heater.

There are 3 (540) 240, 340 have 2 water thermistors: one for the incoming cold water, one for the heat exchanger, and one for the output.

240/340 Thermistors

540 Thermistors
Thermistors

General modes of failure:
- Open circuit failure (no current) or electrical short (no resistance)
- Resistance values are off the calibrated values

Possible effects of failure:
- Water heater will not operate
- Fluctuation in hot water output temperatures

Basic diagnostics:
- Visual inspection of electrical connections: moisture, dust, connection/breakage of wires
- Visual inspection of thermistor: damage, buildup of debris or scale, etc.
- Resistance check (Service Manual)
Hi-limit switch

- Detects excessively high water temperatures within the heat exchanger.
- Upon detection, immediately cuts off all power to the gas valves.
- Utilizes bimetal thermal expansion
- Manual reset switch

Reset button
Hi-limit switch

General modes of failure:
- Open-circuit or closed-circuit failures

Possible effects of failure:
- In a closed-circuit failure, switch cannot detect high water temperatures. The thermistors will then act as backup hi-limit detectors until operation ends.
- If an open-circuit failure, water heater will not operate.

Basic diagnostics:
- Visual inspection of electrical connections: moisture, dust, connection/breakage of wires
- Visual inspection of the switch: position of the reset button (pressed or depressed)
- Possible buildup of scale within the heat exchanger.
- Voltage/resistance check (Service Manual)
Exhaust Safety Features

- **1 Thermistor**, can get temp read out on controller 140°
- 1 Flat plate high limit, automatic reset 151°
- Protects temps for getting over 140°
- If one fails, system will read an error, and unit will shut down
Overheat Cutoff Fuse

- Detects excessive temperatures around the heat exchanger and combustion chamber.
- Upon detection, immediately cuts off all power to the gas valves.
- Fuse contains solder, with a melting point of 430°F.
Overheat Cutoff Fuse

General modes of failure: • Open-circuit or closed-circuit failures

Possible effects of failure: • In a closed-circuit failure, excessive heat can cause a breach in the walls of the heat exchanger or combustion chamber.
• In an open-circuit failure, water heater will not operate.

Basic diagnostics: • Visual inspection of electrical connections: moisture, dust, connection/breakage of wires
• Voltage/resistance check (Service Manual)
Freeze-Protection Thermostat

Senses ambient air temperatures and activates the freeze-protection ceramic heaters when necessary.

Ceramic heaters activate when the thermostat senses temperatures below 36.5°F.
Freeze-Protection Ceramic Heaters

The ceramic heaters prevent water within the water heater from freezing during non-operation. Freezing causes water to expand and can rupture the heat exchanger and other components.

The ceramic heaters are located throughout the water heater along the water pathways.
Freeze-Protection Ceramic Heaters

**General modes of failure:**
- Open-circuit failures: ceramic heaters do not receive the voltage needed to heat up

**Possible effects of failure:**
- Freezing cannot be prevented, heat exchanger may burst from excessive pressure.

**Basic diagnostics:**
- Visual inspection of electrical connections: moisture, dust, connection/breakage of wires
- Voltage/resistance check (Service Manual)
Computer Board

Controls most of the functions of the water heater
## Computer Board

### General modes of failure:
- Computer board malfunction

### Possible effects of failure:
- Lack of proper combustion control during operation
- Inability to detect signals from numerous sensors
- Lack of water temperature control
- Error in self-diagnostics
- No communication between heaters or with the controller in a multiple-unit manifold system.
- General abnormal responses

### Basic diagnostics:
- Visual inspection of electrical connections: moisture, dust, connection/breakage of wires
- Visual inspection of PCB e.g. burn marks or brown spots
Igniter

Creates a spark to ignite the air/fuel mixture within the combustion chamber during activation.

The output voltage of the igniter exceeds 14 kV.
Igniter

General modes of failure:
- Unable to create a spark (or adequately strong spark) during activation
- Continually creates sparks i.e. before, during, and after operation.

Possible effects of failure:
- Without ignition, water heater will not operate
- Durability of igniter will decrease

Basic diagnostics:
- Visual inspection of electrical connections: moisture, dust, connection/breakage of wires
- Observe spark condition: strong, blue, & solid vs. weak.
- Voltage check (Service Manual)
Freeze-Protection Thermostat

General modes of failure:
- Closed-circuit failure
- Open-circuit failure

Possible effects of failure:
- In a closed-circuit failure, ceramic heaters will always remain on, providing excessive heat in the long term.
- In an open-circuit failure, the water heater’s freeze-protection system will never activate, causing damages associated with freezing water

Basic diagnostics:
- Visual inspection of electrical connections: moisture, dust, connection/breakage of wires
- Visual inspection of thermostat body
- Voltage check (Service Manual)

Possible effects of failure:
- Excessive heat in the long term due to a closed-circuit failure
- Deactivation of freeze-protection system in an open-circuit failure, leading to freezing water
Fuse Box

Protects water heater from high voltage and/or current caused by lightning or other electrical spikes or surges.

Fuse box contains two surge absorbers: Absorber A activates when voltages exceed 220 volts. Absorber B activates when voltages exceed 680 volts.

Surge absorber B: 680V
Fuse: 10A
Fuse Box

General modes of failure:
- Short-circuit failure of absorber
- Open-circuit failure of absorber and/or fuse

Possible effects of failure:
- In a short-circuit failure of the absorber, the fuse will blow out and the water heater will not operate.
- Inability to protect the computer board in the event of high-voltage surges. A damaged board will stop all water heater operations.

Basic diagnostics:
- Visual inspection of electrical connections: moisture, dust, connection/breakage of wires
- Visual inspection: burn marks on the components
- Voltage check (Service Manual)
Installation Requirements
**BASIC INSTALLATION REQUIREMENTS**

- **Specifications:** Always size gas line for maximum BTU rating for your heater or heaters.

- **Gas:** \( \frac{3}{4}'' - 1'' \) ID Gas Line Minimum, Use BTU Chart

- **Water:** Treated water to extend the lifespan of heat exchanger

- **Water connections:** \( \frac{3}{4}'' - 1'' \) recommended with isolation valves. Recommended 30 ~ 80 psi water pressure

- **Electrical:** 120VAC Electrical Supply, No dedicated or GFI circuit needed (check with local codes)

- **Make Up Air:** Clean combustible air supply recommended

- **Cat. III Stainless Steel Only:** Exhaust Vent Pipe on Non-Condensing Units
Gas

-Natural Gas Supply Piping-

Maximum Delivery Capacity of Cubic Feet of Gas per Hour of IPS Pipe Carrying Natural Gas of 0.60 Specific Gravity Based on Pressure Drop of 0.5” WC

Based on Energy Content of 1,000 BTU/Cubic Ft.: The water heater requires 140 Cubic Ft./hr for the 110 models, 190 Cubic Ft./hr for the 310 models, and 199 Cubic Ft./hr for the 510 models.

<table>
<thead>
<tr>
<th>Pipe Size</th>
<th>10’</th>
<th>20’</th>
<th>30’</th>
<th>40’</th>
<th>50’</th>
<th>60’</th>
<th>70’</th>
<th>80’</th>
<th>90’</th>
<th>100’</th>
<th>125’</th>
<th>150’</th>
<th>200’</th>
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<tbody>
<tr>
<td>Inches</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>¾”</td>
<td>363</td>
<td>249</td>
<td>200</td>
<td>171</td>
<td>152</td>
<td>138</td>
<td>127</td>
<td>118</td>
<td>111</td>
<td>104</td>
<td>93</td>
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<td>1”</td>
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<td>470</td>
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<td>323</td>
<td>286</td>
<td>259</td>
<td>239</td>
<td>222</td>
<td>208</td>
<td>197</td>
<td>174</td>
<td>158</td>
<td>135</td>
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<tr>
<td>1 ¼”</td>
<td>1,404</td>
<td>965</td>
<td>775</td>
<td>663</td>
<td>588</td>
<td>532</td>
<td>490</td>
<td>456</td>
<td>428</td>
<td>404</td>
<td>358</td>
<td>324</td>
<td>278</td>
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<tr>
<td>1 ½”</td>
<td>2,103</td>
<td>1,445</td>
<td>1,161</td>
<td>993</td>
<td>880</td>
<td>798</td>
<td>734</td>
<td>683</td>
<td>641</td>
<td>605</td>
<td>536</td>
<td>486</td>
<td>416</td>
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<tr>
<td>2”</td>
<td>4,050</td>
<td>2,784</td>
<td>2,235</td>
<td>1,913</td>
<td>1,696</td>
<td>1,536</td>
<td>1,413</td>
<td>1,315</td>
<td>1,234</td>
<td>1,165</td>
<td>1,033</td>
<td>936</td>
<td>801</td>
</tr>
</tbody>
</table>

-Propane (LP) Supply Piping-

Maximum Capacity of Propane (LP) Based on 11” WC supply pressure at a 0.5” WC pressure drop

<table>
<thead>
<tr>
<th>Pipe Size</th>
<th>10’</th>
<th>20’</th>
<th>30’</th>
<th>40’</th>
<th>50’</th>
<th>60’</th>
<th>70’</th>
<th>80’</th>
<th>90’</th>
<th>100’</th>
<th>125’</th>
<th>150’</th>
<th>200’</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inches</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>¾”</td>
<td>567</td>
<td>393</td>
<td>315</td>
<td>267</td>
<td>237</td>
<td>217</td>
<td>196</td>
<td>185</td>
<td>173</td>
<td>162</td>
<td>146</td>
<td>132</td>
<td>112</td>
</tr>
<tr>
<td>1”</td>
<td>1,071</td>
<td>732</td>
<td>590</td>
<td>504</td>
<td>448</td>
<td>409</td>
<td>378</td>
<td>346</td>
<td>322</td>
<td>307</td>
<td>275</td>
<td>252</td>
<td>213</td>
</tr>
<tr>
<td>1 ¼”</td>
<td>2,205</td>
<td>1,496</td>
<td>1,212</td>
<td>1,039</td>
<td>913</td>
<td>834</td>
<td>771</td>
<td>724</td>
<td>677</td>
<td>630</td>
<td>567</td>
<td>511</td>
<td>440</td>
</tr>
<tr>
<td>1 ½”</td>
<td>3,307</td>
<td>2,299</td>
<td>1,858</td>
<td>1,559</td>
<td>1,417</td>
<td>1,275</td>
<td>1,181</td>
<td>1,086</td>
<td>1,023</td>
<td>976</td>
<td>866</td>
<td>787</td>
<td>675</td>
</tr>
<tr>
<td>2”</td>
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<td>4,331</td>
<td>3,465</td>
<td>2,992</td>
<td>2,646</td>
<td>2,394</td>
<td>2,205</td>
<td>2,047</td>
<td>1,921</td>
<td>1,811</td>
<td>1,606</td>
<td>1,496</td>
<td>1,260</td>
</tr>
</tbody>
</table>

For more information, please see the below.

Use National Fuel Gas code chart for pipe capacities (NG and LP WC)
Water Quality
Water Quality

• Hard water will shorten the life of the heater
  – Residential: 7 grains/gal (120 ppm) max
  – Commercial: 4 grains/gal (70 ppm) max

• Isolation Valves are recommended

• Flushing/Descaling
  – Not the answer to hard water, but does help to extend the heat exchanger life
Used heat exchangers on soft water; no signs of hard water scaling.

- No signs of copper turning black from heat stress
- Minimal signs of exterior corrosion. Blue-green color from condensation not a concern
Normal Heat Exchanger Fins

Used heat exchangers: Bottom view. Both are considered relatively clean. Right photo has low levels of dust accumulated in the center.

• No signs of copper turning black from heat stress
• Dust on fins can cause performance and reliability problems, but would not be a factor in causing leaks.
Under normal conditions, fins and pipes are kept in a suitable temperature. If poor quality water or hard water enters, scale buildup occurs, leading to temperature reaching an unacceptable level. Scale disrupts proper heat transferring, leading to leakage and deterioration of copper.
Water Quality

Hard Water Damage

Recirculation System on Hard Water
Used heat exchanger with signs of hard water scaling definitely evident from scale formation of the tubes on the fins.

- Signs of copper turning black from heat damage in the left photo is probably severe hard water scaling; on the right photo, it is probably moderate hard water scaling.
- The black discoloring of the fins is severe. This black discoloring can be seen on the bottom and top of the heat exchanger (external).
Severe Scale Build Up (example)

Used heat exchanger with severe signs of scale buildup

- Signs of copper turning black from heat damage. The amount of scale buildup is evident.
- The black discoloring of the fins is severe. This black discoloring can be seen on the bottom and top of the heat exchanger (external).
Product Overview

Product Preservers Anti-Scale Filter is a better solution for tankless water heaters because it prevents scale buildup in the first place:

- The filter promotes formation of inactive scale crystals which flow through the water heater without sticking to the heat exchanger.
- The filter does not add chemicals to the water or require electricity.
- It is virtually maintenance free, only requiring a simple filter change every two years.
# Product Specifications

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Connection Size</td>
<td>3/4” NPT</td>
</tr>
<tr>
<td>Minimum Flow</td>
<td>.5 gpm</td>
</tr>
<tr>
<td>Maximum Flow</td>
<td>10 gpm</td>
</tr>
<tr>
<td>Minimum Pressure</td>
<td>15 psi</td>
</tr>
<tr>
<td>Maximum Pressure</td>
<td>100 psi</td>
</tr>
<tr>
<td>Minimum Temperature</td>
<td>35° F</td>
</tr>
</tbody>
</table>

*Install on cold water lines only*
Installation

Note installation date for replacement element scheduling.
Cartridge Replacement

1. Replace element at least once every years to ensure proper operation.
2. Determine if equipment connected to your Product Preservers System must be turned off before shutting off water.
3. If bypass line is installed, bypass system during filter change. Open bypass valve, close unit inlet valve, and close unit outlet valve. Figure A
4. If no bypass line is installed, turn off feed water.
5. Release pressure to system by pressing red button on top of unit. Figure B
6. Unscrew housing sump using included wrench if necessary. Figure C
7. Discard old cartridge. Retain spacer. Figure D
8. Insert new cartridge into sump. Re-use the spacer that was included with the original unit. Figure D
9. Inspect O-ring for any damage and replace if necessary. Figure E
10. Re-install filter housing sump. HAND TIGHTEN ONLY.
11. Pressurize system by slightly opening feed valve. Once pressurized, open valve fully. Inspect seals for any leaks. If there is a leak, you may tighten the sump slightly more with the wrench.
12. Flush system for 2 minutes with drain valve open. If no drain valve is installed, disconnect from equipment for flush cycle.
13. Turn on all equipment connected to system.
14. Record filter change date for replacement element scheduling.
Warranty

Limited Warranty

Company warrants its Product Preservers® Anti-Scale System as follows:

• The Product Preservers® cartridge system is warranted to be free of defects in materials and workmanship for two years from the date of original shipment.

• Product Preservers® filter cartridges are warranted for performance for a period of two years from the date of original installation when installed and operated in accordance with the instructions in the corresponding Installation and Operation Manual.
Used heat exchanger with severe signs of scale buildup

- Signs of copper turning black from heat damage. The amount of scale buildup is evident.
- The black discoloring of the fins is severe. This black discoloring can be seen on the bottom and top of the heat exchanger (external).
Electrical Requirements
Electricity

- Electrically grounded, but not to the water or gas piping
- AC 120V 60 Hz Supply
- On/Off switch or pigtail
- Surge protector recommended
- Back-up power supply is recommended in areas with frequent outages

Connect power supply: 120VAC 60Hz
Make up Air / Quality
Make up Air

Make-up air volume (*Non-DV indoor installations*)

- Air drawn from indoors – 1 in$^2$ per 1,000 BTU/h
- Air drawn from outdoors – 1 in$^2$ per 4,000 BTU/h

<table>
<thead>
<tr>
<th>Water heater size</th>
<th>When drawing make-up air from outside the building</th>
<th>When drawing make-up air from inside the building (from other rooms within)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAX 199,000 BTU</td>
<td>49.8 Sq. IN</td>
<td>199 Sq. IN</td>
</tr>
</tbody>
</table>

When combustion air is supplied from outside the building, an opening communicating directly with the outside should have a minimum free area of one square inch per 4,000 BTUH input of the total input rating of water heater in the enclosed area. This opening should never be less than 199 sq. in.

Example: Minimum recommended air supply opening size for the 510 model
If you will be installing the unit in a contaminated area with a high level of dust, sand, flour, aerosols or other contaminants/chemicals, they can become airborne and enter and build up within the fan and burner causing damage to the unit. In those environments (e.g. residential or commercial laundry facilities, hair salons, pet salons, chemical plants etc.), please purchase a tankless model that is direct-vent convertible. Direct venting allows the water heater to draw fresh intake air from the outside.
Make-Up Air

Other Ways to Vent a Two-Pipe System

Vertical Concentric Termination System

Two penetrations through the wall or roof

Exhaust termination

Air supply inlet

(Always follow local codes)
Venting Options
Condensing Single Pipe

-Single pipe with room-air intake illustrations-
Typical installations using PVC, ABS, or polypropylene vent

Horizontal Installation

Vertical Installation

Elbow
Hanger
Wall
Roof
Roof flashing
Fire stop

Connect between exhaust vent collar and piping. See the instructions below.
Condensing Two Pipe

Typical installations using PVC, ABS, or polypropylene vent

Horizontal Installation

Vertical Installation

Connect between exhaust vent collar and piping. See the instructions below.
Condensing Common Vent

For details on the installation of a common-vent system, please refer to the vent manufacturer's instructions.
Non-Condensing Stainless Venting

Horizontal Installation Diagram

- Backflow Preventer*
- Vertical Condensation Drain**
- Sidewall Vent Terminator

Vertical Installation Diagram

- Rain Cap
- Roof
- Roof Flashing
- Backflow Preventer*
- Vertical Condensation Drain**

Horizontal Installation Diagram (With direct-venting)

- Wall
- Backflow Preventer*
- Vertical Condensation Drain**
- Sidewall Vent Terminator

Vertical Installation Diagram (With direct-venting)

- Rain Cap
- Roof
- Roof Flashing
- Backflow Preventer*
- Fire stop
- Vertical Condensation Drain**

See the picture below for detailed connection instructions to Direct-Vent Conversion Kit.
Non-Condensing Concentric Venting
To select the right unit or multiple units for a home, three factors are of critical importance:

- Incoming ground water temperature
  - Will determine the amount of “temperature rise” required to achieve the desired hot water outlet temperature
- Set-point temperature
  - Standard factory setting is 120°F or 122°F, but some applications may require lower or higher temperature settings
- Peak hot water demand
  - How much hot water the home will need during its peak demand
Incoming Water Temperature

Average Ground Water Temperatures

“Southern Zone”
Average Ground Water Temperature
62°F to 77°F

“Central Zone”
Average Ground Water Temperature
52°F to 61°F

“Northern Zone”
Average Ground Water Temperature
37°F to 51°F
## Flowrate Guide

**Temperature Rise vs. Gallons per Minute**

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Flow rate is determined by Temperature Rise. To determine your temperature rise, subtract the incoming water temperature from the set output temperature. All units are factory set to 120 or 122°F but can be changed.
Master Shower System (12 GPM)
5 Standard Showers (12 GPM)
2 Kitchens (6 GPM)
Total Possible Demand (30 GPM)
Owner Estimated Demand (20 GPM)
Hot/Cold Mix Ratio of 70/30
70% of 20 GPM = 14 GPM @ 122°F
Installed (2)910s (via Easy Link!)
- Production Capability in the Midwest: 16 GPM @ 122°F
Larger Applications

Application designers/engineers can decide whether to size for full flow, expected flow, or utilize probability models such as the Hunter Curves.

For large-scale applications such as hotels, apartment complexes, and large restaurants, Hunter Curves are commonly used to estimate the peak flow rate demand when given the total amount of fixture units within an application.

It is up to the application designer/engineer to determine the amount of fixture units within any given application.

We are always willing to assist when sizing large-scale applications. Please contact Tankless Technical Support for assistance.
Example of Hunter Curves for Sizing Large Applications

Comparison of Flow Rates vs. Temperature Rise

- **Restaurants**
- **Apartments & Houses**
- **Hospitals, Nursing Homes, Dormitories, Hotels & Motels**
- **Office Buildings & Schools**

- **AT10-910**
- **AT10-710**
- **310 SERIES**
- **320H SERIES**
- **110 SERIES**
Tankless Applications

- **Domestic Hot Water Systems:**
  From an Apartment with a Single Shower, Washer, or Dishwasher to Luxury Homes with Multiple Showers, Spas, and Washers

- **Radiant Floor Heating Systems:** (Check Local Codes For “H” Stamp)
  This is fast becoming the preferred method of heating. Tankless is an excellent heat source!

- **Laundromats, Health Clubs, Beauty Salons*, Etc:**
  * Note: Beauty Salons must have direct vent or source of fresh air.

- **Solar Hot Water Systems:**
  With Tankless Back-up for Heating or DHW or Both!
  Our heaters work great with Solar!

- **Restaurants and Hotels:**
  We can custom size the installation to every need.

- **Storage Tank Systems for Increased dump loads**
Maintenance
If the water heater is installed in a contaminated area with a high level of dust, lint, sand, grease, aerosols, or other contaminants, they can become airborne and enter into the air intake. The contaminants will build up within the fan and burner assembly causing abnormal flame conditions due to lack of combustion air, damaging many components of the unit.

In order to prevent the need for frequent maintenance, it is suggested that the area around the water heater is kept dust or debris-free. In poor environments where air quality cannot be improved, it is suggested that the water heater be direct-vented (if the water heater model is convertible).
Fine-grit sandpaper can be used to polish the flame/AFR sensor. The sensor must be cleaned to a bright finish.

In dirty or dusty environments, the flame sensor can become coated up with black soot. This coating prevents electrical current from the flame sensor to travel to ground.
Burner cleaning

Dirty flame/AFR sensors also indicate that the burner may be too dirty. A dirty burner can possibly cause a number of different error codes such as 101, 111, 121, and 991.

Many times, compressed air is not enough. In these cases, use orange clean, simple green, or other safe degreasers. Take care not to damage the burner gaskets during the cleaning process.
While cleaning the burner, inspect the combustion chamber and fan motor. Dust may have built up on these components as well. Clean with compressed air and a towel.
Heat exchanger replacements

In the case of damaged or leaking heat exchangers, replacement will be needed.

It is important to be careful during the removal and replacement process. Follow all steps carefully. Refer to Takagi’s heat exchanger replacement instructional videos for assistance.
Over time, the inlet filter may get clogged from debris. A dirty/clogged inlet filter can cause numerous issues e.g. loss of pressure, temperature fluctuations, etc.

To clean the filter, close all shut off valves and drain the water heater. Remove the filter and clean with a small brush.

If the water heater will not be in use for a long duration and is installed in a freezing environment, the water heater must be properly drained in order to avoid freeze damage.
Descaling/Flushing

Hard water is a severe problem for the copper coils inside the heat exchanger. Scale buildup tends to occur very readily at high temperatures, sometimes causing the heat exchanger to fail within a very short time. Heat exchanger failure due to scale buildup from hard water conditions is NOT covered by warranty.

A water softener or effective form of scale inhibitor should be installed on the cold water line before the water heater. Preventing scale buildup is highly preferred over descaling/flushing.

By the time flushing or descaling is performed on a water heater, irreversible damage may have already been done to the heat exchanger.
In cases where it is already too late to inform the customer about the benefits of water softening or scale inhibitors, and flushing is needed, use only weak acid based solutions e.g. food-grade citric acid, food-grade phosphorus acid, white vinegar etc.

Use of our accessory isolation valve kits are recommended for easier maintenance.
Advantages
Introduction

Roughly the size of carry-on luggage and the unit mounts high on a wall.
SAVES SPACE
SAVES SPACE
Typical Energy Factor (EF) Range:

- **Tank Type (40 to 75 gal.):**
  - .53 to .64

- **Tankless:**
  - .81 to .95

**Energy Star 2012 Minimum**
- Tank: 0.62
- Tankless: 0.82

**Savings Increase:** 32.3%

**Definition**
Overall energy efficiency based on the amount of hot water produced per unit of fuel consumed over a typical day.
Factors include:
- Recovery Efficiency
- Standby Losses
- Cycling Losses

32.3%
## Typical Annual Operating Costs Range:

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### Savings

- **30% to 50% Annually**
- **$120 to $210**
Temperature Drop: Typical 50 gal. Tank-type Power Vent Model vs. T-K3
(2 x 2.5 GPM showers at 105°F)
Zero Gas Usage

Examples:
- Traveling for Work
- Vacationing

Endless Hot Water

Examples:
- Long Relaxing Shower
- Guests Visiting