SYSTEM AND METHOD FOR PRODUCING ON DEMAND HIGH TEMPERATURE WATER

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ABSTRACT
A system and method for efficiently producing high flow rate on-demand hot water. The system utilizes on-demand hot water heaters, super heated water expansion tanks, and a high flow mixing valve.
SYSTEM AND METHOD FOR PRODUCING ON DEMAND HIGH TEMPERATURE WATER

[0001] This application claims priority to U.S. Provisional Patent Application Ser. No. 60/757,713, entitled “SYSTEM AND METHOD FOR PRODUCING ON DEMAND HIGH TEMPERATURE WATER” filed on Jan. 10, 2006, having Jim McIlwain and Helen McIlwain, listed as the inventors, the entire content of which is hereby incorporated by reference.

BACKGROUND

[0002] The invention is generally related to a water heater system and method of operating the water heater system. More specifically, the invention relates to an energy efficient water heater system for commercial or domestic use that can produce a large scale amount of high temperature water on demand. The water heater system of this invention has a more energy efficient recovery rate than conventional large scale hot water heaters.

[0003] Hotels, apartment complexes, restaurants, laundromats, and other commercial business typically utilize large quantities of hot water throughout the business day. However, the demand for hot water varies greatly with different times of the day and with different seasons of the year. The availability of hot water can have direct consequences to the business owners. For example, hotels and apartment buildings may experience a large demand for hot water in the morning when most patrons are taking showers simultaneously, however, the same hotel or apartment may not experience a great demand for hot water the rest of the day. Restaurants may have a high demand for hot water to wash dishes during the breakfast, lunch, or dinner rush, but not during the rest of the day. Laundromats may have a higher demand for hot water on the weekends compared to the weekdays.

[0004] The amount of energy that it takes to heat and maintain the temperature of enough hot water to meet the demand during peak hours can be considerable. However, the cost of customers not returning to a business because they were inconvenienced by the lack of hot water is considerably higher. Many businesses choose to purchase large scale water heaters to maintain a sufficient hot water supply for the time of day when the demand for hot water is high.

[0005] The Conventional Water Heaters. Generally, conventional water heaters and boilers include a steel tank, insulated by foam encased in a metal jacket. Cold water runs into the steel tank. The cold water can be heated by electrical heating elements or gas with heat exchangers to a predetermined temperature (i.e., 120°F), which is maintained until the hot water is used. Maintaining the temperature of hot water in the tank can be energy inefficient during non-peak times. To utilize the hot water, a user can open a faucet and hot water exits the steel tank through a pipe connected to the faucet. While hot water is drained from the pipe, cold water mixes with the remaining hot water, which reduces the temperature of the remaining water. Reducing the temperature of the water in the tank is especially inefficient during times of peak demand for hot water. During hot water usage, the temperature of the remaining water is lower than the predetermined temperature, which activates the heating device to maintain the water at the pre-determined temperature. The amount of time it takes to reheat a specified number of gallons of water to the predetermined temperature is considered the recovery rate, and is generally measured in gallons/hour. Thus, in order to maintain enough hot water to meet any demand, the tank size can be increased or the predetermined temperature can be increased. Both options are inefficient during non-peak hours. Thus, conventional water heaters have many drawbacks including inefficient heating, easy loss of heat energy, low recovery rates, and high installation space requirements.

[0006] The average temperature of tap water varies throughout any given state, depending upon the location, elevation, and time of year. For the purposes of these examples, a tap water temperature of 70°F Fahrenheit will be used. Therefore, to achieve a temperature of about 160°F Fahrenheit at the faucet, the required rise would be about 90°F.

[0007] For example, one commercially available water heater from Kenmore (Dallas, Tex.) is called the “Kenmore 98 Gallon Natural Gas Commercial Water Heater.” The Kenmore water heater offers a 98 gallon tank capacity has an hourly input of about 75,000 BTU, and a recovery rate, at about a 90°F degree rise, of 78.8 gallons per hour (GPH). Thus, in order to insure a recovery rate of about 800 gallons per hour, one would need about 10 of similar water heaters, using about 800,000 BTU/hour, which does not include the amount of energy required to keep the water at the predetermined temperature for non-peak hours.

[0008] On Demand Heaters. In order to decrease the amount of energy that is required to heat and maintain the temperature of hot water during high demand times, high efficiency on demand commercial water heaters have been introduced. These heaters produce hot water only when needed, so energy to maintain the hot water at a predetermined temperature during non-peak hours is eliminated. For example, one commercially available high efficiency water heater from Rinnai Inc. (Nagoya, Japan) is called the “Continuum” model 2532FU. The Continuum is a temperature controlled continuous flow gas hot water heating system that offers a supply of hot water through multiple outlets simultaneously. One Continuum unit has a typical hot water capacity of about 8.5 gallons per minute (“GPM”), which is enough to run about two showers and a third point of use at the same time without any loss of temperature consistency. The Continuum has a gas input of about 15,000 to about 180,000 BTU/hour with efficiency up to about 87%.

[0009] It is also possible to increase the hot water capacity by using multiple Continuum units. When multiple water heaters are connected, they must be installed in parallel, not in series. The capacity of single and multiple water heaters is shown in the table below:

<table>
<thead>
<tr>
<th>Temp. Rise* (°F)</th>
<th>1 Unit GPM</th>
<th>2 Units GPM</th>
<th>3 Units GPM</th>
<th>3 Units GPH</th>
</tr>
</thead>
<tbody>
<tr>
<td>140°F F.</td>
<td>2.4</td>
<td>4.8</td>
<td>7.2</td>
<td>429.9</td>
</tr>
<tr>
<td>100°F F.</td>
<td>3.3</td>
<td>6.7</td>
<td>10.0</td>
<td>600.8</td>
</tr>
<tr>
<td>90°F F.</td>
<td>3.7</td>
<td>7.4</td>
<td>11.1</td>
<td>688.6</td>
</tr>
<tr>
<td>75°F F.</td>
<td>4.5</td>
<td>8.9</td>
<td>13.4</td>
<td>802.4</td>
</tr>
<tr>
<td>50°F F.</td>
<td>5.6</td>
<td>11.1</td>
<td>15.7</td>
<td>1033.0</td>
</tr>
<tr>
<td>25°F F.</td>
<td>8.5</td>
<td>15.9</td>
<td>25.4</td>
<td>1521.0</td>
</tr>
</tbody>
</table>

* The term “Rise” refers to the temperature of water as it leaves the water heater minus the temperature of the water entering the water heater.

[0010] Thus, in order to insure a recovery rate of about 800 gallons per hour, one would need about 3 of similar water heaters, using about 550,000 BTU/hour.
One of the advantages of an instantaneous water heater is its ability to provide a continuous supply of hot water. However, since the water passes through a heat exchanger, the water must flow through the unit slowly to ensure proper heat transfer.

Therefore, the quantity or rate, at which the hot water is delivered can be significantly less than that provided by a storage water heater. When hot water is utilized at several locations of a facility at the same time the flow of hot water to each fixture can be severely restricted. As a result of the restricted output of instantaneous water heaters, more than one unit may be required, depending on the numbers and types of sinks and equipment present. Due to the flow limitations inherent in the design of instantaneous water heaters, some local health agencies may restrict or prohibit their usage in businesses such as restaurants.

One embodiment of the invention described herein is a hot water mixing system that utilizes at least one hot water heater, such as a standard hot water heater or an on demand hot water heater, one or more superheated water expansion tanks, and one or more super high flow mixing valve to deliver a high flow of hot water having about a 90°F rise, and a recovery rate of between about 400 gallons and 800 gallons per hour using only about 199,000 BTU.

BRIEF DESCRIPTION OF THE DRAWINGS

The following drawings form part of the present specification and are included to further demonstrate certain aspects of the present invention. The invention may be better understood by reference to one or more of these drawings in combination with the detailed description of specific embodiments presented herein.

FIG. 1 shows a diagram of a system for producing demand temperature hot water using a mixing device with at least one water heater.

FIG. 2 shows a diagram of a system for producing demand temperature hot water using a mixing device with at least two water heaters.

FIG. 3 shows a diagram of a system for producing demand temperature hot water using a mixing device with one or more storage tanks.

SUMMARY

The invention described herein comprises a hot water mixing system that may utilize at least one water heater (such as a tankless water heater, an on demand water heater, or a conventional water heater) one superheated water expansion tank, and a super high flow mixing valve to deliver a high flow of hot water having about a 90°F rise, and a recovery rate of about 400 gallons per hour to about 800 gallons per hour using only about 199,000 BTU.

One aspect of the current invention is a water heating system that utilizes a water inlet conduit for supplying water from an external source. A first ball stop valve having an inlet and an outlet, and the inlet is in fluid communication with the water conduit supplying cold water to the system. The outlet is connected to a conduit having a bifurcation. One path of the bifurcation leads to a second ball stop valve, a check valve and a first inlet of a high flow mixing device. The second path of the bifurcation is connected to at least one hot water heater. The cold water entering the hot water heater becomes superheated and exits the heater to flow into an expansion tank and through a hot water conduit system, which also leads to a second inlet of the mixing device. The mixing device will mix superheated water from the heater and cold water to expel hot water that is at a predetermined temperature. The water heating system combines a water heater or water heaters, such as a standard hot water heater or an on demand hot water heater, expansion tanks and mixing valve for energy efficient and high flow rate alternative to conventional hot water heaters.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

Terms: It will be readily apparent to one skilled in the art that various substitutions and modifications may be made in the invention disclosed herein without departing from the scope and spirit of the invention.

The term “a” or “an” as used herein in the specification may mean one or more. As used herein in the claim(s), when used in conjunction with the word “comprising”, the words “a” or “an” may mean one or more than one. As used herein “another” may mean at least a second or more.

The term “Booster Heater” as used herein refers to an instantaneous water heater designed and intended to raise the temperature of hot water to a higher temperature for a specific purpose, such as for the sanitizing rinse on a high temperature automatic dish machine and laundromat machines.

The term “British Thermal Unit” (“BTU”) as used herein refers to the quantity of heat required to raise the temperature of one pound of water one degree Fahrenheit.

The term “Gallons Per Hour” (“GPH”) as used herein refers to the amount of water, in gallons, that is used each hour by the plumbing fixtures and equipment, such as dish machines and laundromat machines.

The term “Gallons Per Minute” (“GPM”) as used herein refers to the amount of water, in gallons, flowing through a plumbing fixture or through an instantaneous water heater per minute.

The term “Instantaneous Water Heater” as used herein refers to a water heater that generates hot water on demand.

The term “Kilowatt” (“KW”) as used herein refers to a unit of electric power equal to 1,000 watts.

The term “Rise” as used herein refers to the temperature of water as it leaves the water heater minus the temperature of the water entering the water heater.

The term “Storage Water Heater” as used herein refers to a water heater that incorporates a thermostat, a storage tank, and a burner or heating elements, to heat and maintain the water within the tank at a specific temperature.

The term “Super Heated Water Storage Tank” as used herein refers to a storage tank that receives superheated water for a period of time during peak hot water demand.

The term “Thermal Efficiency” as used herein refers to the measure of the overall efficiency of the water...
heater, taking Water Heater Guidelines into consideration loss of energy due to combustion, radiation, convection and conduction of heat from the unit.

[0032] The term “Water Heater” or “Hot Water Heater” as used herein may refer to an on-demand water heater, a tankless water heater, a standard water heater, or a number of other embodiments for heating water to a desired temperature.

[0033] The term “Valve” as used herein may refer to a check valve, a ball valve, a regulating flow valve, a tempering valve, a pressure regulator valve, or a number of other types of valves for regulating the flow of fluid.

[0034] A preferred embodiment of the invention comprises at least one water heater and a mechanism for mixing heated water with cold water from a water supply. Cold water may be introduced to the system via a cold water supply conduit, which may contain one or more valves for regulation of the flow of water. The cold water flows through the cold water supply conduit to a bifurcation. One bifurcated path may comprise one or more valves for regulation of the flow of water and leads to a cold water supply inlet of a mixing device, preferable a tempering mixing valve. The second bifurcated path allows water to flow into a water heater, preferably a conventional forced air downdraft heater or a tankless water heater or an on-demand water heater. The water heater and/or the cold water supply conduit may have one or more safety valves, and may be in connection with one or more expansion tanks. The water heater is in fluid communication with a super heated water supply inlet of the mixing device. Water from the cold water supply inlet of the mixing device is mixed with water from the super heated water supply inlet of the mixing device to discharge water of the desired temperature.

[0035] A second preferred embodiment of the invention comprises at least two water heaters connected in parallel and a mechanism for mixing heated water with cold water from a water supply. Cold water may be introduced to the system via a cold water supply conduit, which may contain one or more valves for regulation of the flow of water. The cold water flows through the cold water supply conduit to a bifurcation. One bifurcated path may comprise one or more valves for regulation of the flow of water and leads to a cold water supply inlet of a mixing device, preferable a tempering mixing valve. The second bifurcated path allows water to flow into the two or more water heaters, preferably conventional forced air downdraft heaters or tankless water heaters or on-demand water heaters. The water heaters and/or the cold water supply conduit may have one or more safety valves, and may be in connection with one or more expansion tanks. The water heaters are in fluid communication with a super heated water supply inlet of the mixing device. Water from the cold water supply inlet of the mixing device is mixed with water from the super heated water supply inlet of the mixing device to discharge water of the desired temperature.

[0036] A third preferred embodiment of the invention comprises at least one water heater, a storage tank, and a mechanism for mixing heated water with cold water from a water supply. Cold water may be introduced to the system via a cold water supply conduit, which may contain one or more valves for regulation of the flow of water. The cold water flows through the cold water supply conduit to bifurcation. One bifurcated path may comprise one or more valves for regulation of the flow of water and leads to a cold water supply inlet of a mixing device, preferable a tempering mixing valve. The second bifurcated path allows water to flow into one or more water heaters, preferably a conventional forced air downdraft heater or a tankless water heater or an on-demand water heater. The water heater and/or the cold water supply conduit may have one or more safety valves, and may be in connection with one or more expansion tanks. The water heater is in fluid communication with a super heated water supply inlet of the mixing device. Water from the cold water supply inlet of the mixing device is mixed with water from the super heated water supply inlet of the mixing device to discharge water of the desired temperature. The discharged water flows through a conduit into a storage tank, preferably a tank with a capacity of approximately 100-600 gallons. The storage tank may be in contact with a thermometer and may comprise a pressure safety device for monitoring or regulating the pressure of the storage tank. The storage tank comprises a conduit for discharging water when required for use. The storage tank further comprises a circulation outlet, which allows water to move from the storage tank back to the water heater. The flow of water from the storage tank to the water heater is regulated by a circulating pump, preferably with a capacity of between about 1 gallon/minute and about 100 gallons/minute.

EXAMPLES

[0037] The following examples are provided to further illustrate this invention and the manner in which it may be carried out. It will be understood, however, that the specific details given in the examples have been chosen for purposes of illustration only and not to be construed as limiting the invention.

Example 1

[0038] The embodiments shown and described above are only exemplary. Even though several characteristics and advantages of the present invention have been set forth in the foregoing description together with details of the invention, the disclosure is illustrative only and changes may be made within the principles of the invention to the full extent indicated by the broad general meaning of the terms used in herein and in the attached claim.

[0039] FIG. 1 shows a diagram of a preferred system for super heating water in at least one water heater and mixing hot water and cold water from a cold water supply. Cold water from an external source flows into the cold water supply conduit (105) through a first check valve (101A) and then to a bifurcation (111) in the cold water supply conduit (105). One bifurcated path is in fluid communication with a second check valve (101B), which is in fluid communication with check valve (103) that is in fluid communication with a cold water supply inlet of a mixing device (150). Ball valves (104) are used to regulate flow into and out-of the hot water heater. The second bifurcated path allows water to into the water heater (110) that is in fluid communication with a cold water supply conduit (105) through an inlet located on the hot water heater (110). The cold water supply conduit (105) and the hot water heater (110) have a pop-off safety valve (170). The hot water heater (110) also has an outlet in fluid connection with a super hot water supply conduit system.
(120). Both the cold water supply conduit (105) and super hot water supply conduit systems (120) are in fluid connection with expansion tanks (130). If full demand of hot water is suddenly stopped, the super heated water will try to run back out of the water heater causing sold water line to heat up. The expansion tank on the cold water line allows for hot water expansion in the cold water line because the super heated water cannot pass the cold water check valve. The super heated water supply conduit system (120) is in fluid communication with a third check valve (101C) that is in fluid communication with a super heated water supply inlet of the mixing device (150).

[0040] The water heater system as shown in FIG. 1, is capable of running a laundromat having about 40 washers with no problems maintaining hot water supply during peak demand times. The water heater system, is also capable of running more washers with a storage tank, as shown in FIG. 3. For example, an embodiment of the system can utilize one water heater 199,000 BTU and a 500 gallon storage tank having a circulating pump between the storage tank and water heater. The modified system is capable of servicing a laundromat having about 86 top load washers using about 14 gallons of hot water for each approximate 22 minute cycle with little or no problems meeting the hot water demand.

[0041] Although the system of FIG. 1 is shown with one water heater, at least a second water heater may be connected to the system depending on the type of hot water demand that is needed. This second water heater can be used as a back up heater if the first heater needs service. The additional hot water heater may be used when the demand for hot water is extremely high for more than about 2-7 hours. Additionally, the heaters could be cycled, where one heater could be used one week, and the other would run the next week. For example, FIG. 2 shows a diagram of a preferred system for super heating water in at least two water heaters and mixing hot water and cold water from a cold water supply. Cold water from an external source flows into the cold water supply conduit (105) through a first check valve (101A) and then to a bifurcation (111) in the cold water supply conduit (105). One bifurcated path is in fluid communication with a second check valve (101B), which is in fluid communication with check valve (103) that is in fluid communication with a cold water supply inlet of a mixing device (150). Ball valves (104) are used to regulate flow into and out of the hot water heaters. The second bifurcated path allows water to into a first and a second hot water heater (110) that is in parallel fluid connection with a cold water supply conduit (105) through an inlet located on each of the hot water heaters (110). The cold water supply conduit (105) and each hot water heater (110) have a pop-off safety valve (170). Each hot water heater (110) also has an outlet in parallel fluid connection with a super hot water supply conduit system (120). Both the cold water supply conduit (105) and super hot water supply conduit systems (120) are in fluid connection with expansion tanks (130). The super heated water supply conduit system (120) is in fluid communication with a third check valve (101C) that is in fluid communication with a super heated water supply inlet of the mixing device (150).

[0042] FIG. 3 shows another example of a system for super heating water in at least one water heater and mixing hot and cold water to obtain water of a desired temperature. Cold water from an external source flows into the cold water supply conduit (105). Ball valves (104) and check valves (103) are used to regulate flow into and out of a water heater (110). Both the cold water supply conduit (105) and super hot water supply conduit systems (120) are in fluid connection with expansion tanks (130). The hot water heater (110) has an outlet in parallel fluid connection with a super hot water supply conduit system (120) that is in fluid communication with a super heated water supply inlet of the mixing device (150). The water discharged (180) from the mixing device (150) may be in contact with a thermometer (195) and a temperature safety device (185). The water discharged (180) from the mixing device (150) travels to a storage tank (194). The safety tank is in fluid communication with a thermometer (184) and a pressure safety device (170). The water discharged (180) from the storage tank (194) is regulated by a ball valve (104) and is available for use. The example shown in FIG. 3 further comprises a mechanism for recirculation of water from the storage tank (194) to the water heater (110) through the action of a circulating pump (190).

[0043] The temperature safety device (185) is capable of monitoring the temperature of the water discharged (180) from the mixing device (150) and shutting down the apparatus if the temperature deviates from a given temperature range or number. One of ordinary skill in the art recognizes that a wide variety of temperature safety devices or similar devices could be utilized, including commercially available devices from Aquastat or Flowmaster.

[0044] The pressure safety device (170) is capable of monitoring the temperature of the water discharged (180) from the storage tank (194) and shutting down the apparatus if the pressure deviates from a given acceptable range or number. One of ordinary skill in the art recognizes that a wide variety of pressure safety devices or similar devices could be utilized.

[0045] The storage tank (194) may be commercially obtained from a vendor such as Weben-Jarco, Inc., Williams & Davis, Inc., or Hamilton Engineering. One of ordinary skill in the art recognizes that a wide variety of storage tanks or similar devices could be utilized.

[0046] The circulating pump (190) may be commercially obtained from a vendor such as Gentry, and may vary in capacity depending on the size of the system. Examples include pumps such as Dayton, Teel, SURFLO, Jabso, IR-ARO, Flojet, Giant, Taco, Bell and Gossett, Grundfos, Sherwood, and Rule. Pumps ranging in capacity from about 1 gallon/minute to about 100 gallons/minute may be appropriate. One of ordinary skill in the art recognizes that a wide variety of pumps or similar devices could be utilized, including commercially available pumps from Bell and Gossett, Inc.

[0047] The mixing device (150) described in FIGS. 1-2 are commercially available from Conbraco Inc. (Matthews, N.C.). This valve, one key element of the invention, is a high-velocity valve capable of delivering over 300 gallons/minute of heated water, even as high as 600 gallons/minute. Such a valve may range from approximately 1 inch to 4 inches in diameter. This valve is described in detail in U.S. Pat. No. 6,328,219 issued to Taylor et al., on Dec. 11, 2001 and titled “Temperature-Responsive Mixing Valve,” (“the ‘219 patent”) the entire content of which is herein incorporated by reference. Generally, the ‘219 patent is one type of...
mixing valve that is useful for this invention comprises a temperature-actuated mixing valve for controlling outlet temperature in a fluid flow system including a valve housing having first and second fluid supply inlets for introducing first and second respective supply fluids and a fluid outlet for dispensing a fluid at a predetermined outlet temperature. The mixing valve includes a shuttle assembly positioned in the housing. The shuttle assembly includes a valve member mounted for movement within the housing responsive to the temperature of the supply fluids to vary the mixture ratio of the first and second supply fluids as required to dispense fluid at the predetermined outlet temperature. A shuttle member is positioned within the valve member and is moveable as a unit therewith within a predetermined range of motion responsive to supply fluid temperature variation. A thermal actuator is provided of the type which converts thermal energy into mechanical movement by movement of a piston. A first end of the thermal element engages the movable shuttle member and an opposing second end engages a stationary portion of the housing whereby movement of the piston of the thermal actuator produces corresponding movement of the valve member. An overtravel spring is captured in a tensioned condition between the valve member and the shuttle member for maintaining the shuttle member and the valve member in a stationary condition relative to each other within the predetermined range of motion of the valve member and for permitting movement of the shuttle member relative to the valve member sufficient to accommodate movement of the piston of the thermal actuator when the valve member has reached its limit of travel without accommodating the full extent of movement of the piston of the thermal actuator.

One of ordinary skill in the art understands that hot water mixing valves similar to the system described above can be utilized.

One of ordinary skill in the art understands that there are several similar types of water heaters that can be utilized with the system described above. Some examples of water heaters are: the AO Smith Cyclone Model BT1-199; Reem Vanguard Granger Model No: 6743; Bradford White Hydrojet Commercial Model D80T-199E-3N; and other similar water heaters from suppliers such as Weber Marco, Reem; A.O. Smith Standard; Bradford White; Hamilton; Dayton; Larther; Sand Blaster; Lavzrers; Natco; E.V.O; Anderson; and U.S. Tank Master.

One of ordinary skill in the art understands that there are several similar types of ball valves that can be utilized with the system described above. Some examples of ball valves are: from Boston USAD9101, USAD 9201; Locke M568; M929 and M935; and other similar ball valves available from: Boston; U.S. Brass; Asco; Brass Craft; Watts; Conbraco; Nebo; Jamesbury; Dyna Quip; Alfio; George Fischer; Capitol; Sharon; Fermeo; Beck; Parker; Cash ACME. Similarly, check valves and relief valves such as Granger No GNN98; Conbraco Granger No. 6K088; Watts Granger No.: 4A815; Watts Locke No.E96-40F-S-150; Cash ACME Locke No: J579-FWL-2 and Watts Locke No. E100XL-150; and other similar valves that are available from: Woodford; Oatey; P.P.P. Inc.; Studor; Fluidmaster; Pasco; Kirkhill; soqia; Anderson; B and K; Dayton; and Dornmont.

One of ordinary skill in the art understands that there are several similar types of safety pop off valves from: Watts; Conbraco; Parker; Nebxo; U.S. Brass; Brass Craft; Anderson; Beck; Capitol; Dayton; Boston; Asco.

Although a specific example for a laundromat hot water system was described above, one of ordinary skill in the art will understand that such a system could be utilized for meeting the hot water demands of hotels, restaurants, car washes, hospitals, nursing homes, and other facilities. Additionally, such a system could be modified to work as pool and spa heaters.

For conventional hot water heaters, the recovery rate is typically the amount of time it takes to heat water from about 70°F to about 120°F. Most recovery rates are measured in hours, for example if a home or restaurant has a demand of 100 gallons of hot water (120°F) per hour ("GPH"), the water heating system must produce at least 100 gallons of 120°F hot water per hour to have a 100% recovery rate per hour. If the home or restaurant has a demand of about 800 gallons of hot water per hour, the water heating system must produce at least 800 gallons of hot water per hour to have a 100% recovery rate per hour. Many large capacity conventional water heaters use about 1.2-1.4 million BTU's to achieve and maintain hot water to have about 800 gal/hour recovery rate. As discussed above, one way to get a similar recovery rate of 800 gal/hour is to use a tank of about 6-8 or more conventional hot water heaters having the same capacity and using the same BTU, which will take normal temperature water (i.e. about 70°F) and raise the temperature to about 120°F.

A more efficient way to achieve the same recovery rate of about 800 gallons/hour is to use the water heating and high flow mixing system that is shown in FIG. 1. An efficient range of operation temperatures for hot water heaters, such as standard hot water heaters or on demand hot water heaters, is about 140°F-160°F. Cold water having a temperature of about 70°F can be mixed with super heated water having a temperature of about 160°F, which results in heated water having a temperature of about 120°F. The super high flow mixing valve controls the flow of super heated hot water, and the expansion tanks are used to hold super heated water having a temperature above 140°F. As demand increases the mixing device brings more super heated hot water into the system. It is possible to get about 800 gal/hour recovery rate using only about 398,000 BTU with at least two heaters, which is about a quarter of the energy required to maintain hot water for peak demand times in many large capacity conventional water heaters.

While the systems and methods of this invention have described in terms of preferred embodiments, it will be apparent to those of skill in the art that variations may be applied to the systems, methods, and in the steps or in the sequence of steps of the method described herein without departing from the concept, spirit and scope of the invention. More specifically, it will be apparent that certain materials that are both functionally and mechanically related might be substituted for the materials described herein while the same or similar results would be achieved. All such similar substitutes and modifications to those skilled in the art are deemed to be within the spirit, scope and concept of the invention as defined by the appended claims.
REFERENCES CITED

[0056] The following references, to the extent that they provide exemplary procedural or other details supplementary to those set forth herein, are specifically incorporated herein by reference.

U.S. Patent Documents


[0060] U.S. Pat. No. 6,328,219 issued to Taylor et al., on Dec. 11, 2001 and titled “Temperature-Responsive Mixing Valve.”

[0061] U.S. Pat. No. 4,150,665, issued to Wolfson on Apr. 24, 1979, and titled “Heater For Hot Tubs and Storage Tanks.”


[0064] U.S. Pat. No. 1,560,528 issued to Baum on Apr. 25, 1924, and titled “Hot Water Heating System.”

What is claimed is:

1. A water heating system comprising:

(a) a water inlet conduit for supplying water from an external source;

(b) a first valve having an inlet and an outlet, wherein the inlet of the first valve is in fluid communication with the water inlet conduit, and the outlet of the first valve is in fluid communication with a water conduit having a bifurcation with at least a first and a second bifurcated path;

(c) a second valve having an inlet and an outlet, wherein the inlet of the second valve is in fluid communication with the outlet of the first valve through the first bifurcated path of the water conduit;

(d) a mixing valve having a first inlet, a second inlet, and an outlet, wherein the first inlet of the mixing valve is in fluid communication with the outlet of the second valve;

(e) a hot water heater having an inlet port and an outlet port, wherein the inlet port of the hot water heater is in fluid communication with the second bifurcated path of the water conduit;

(f) a hot water expansion tank in fluid communication with the hot water heater;

(g) a third valve having an inlet and an outlet, wherein the hot water heater and the hot water expansion tank are in fluid communication with the inlet of the third valve, and the outlet of the third valve is in fluid communication with the second inlet of the mixing valve; and

(h) a hot water conduit in fluid communication with the outlet of the mixing valve.

2. A process for producing hot water using the water heating system of claim 1 comprising:

(a) allowing the water from an external source to flow into the water inlet conduit, subsequently flowing through the inlet of the first valve, followed by flowing through the outlet of the first valve, and then flowing through the water conduit reaching the first and the second bifurcated paths of the water conduit;

(b) allowing a first portion of the water reaching the water conduit to flow through the first bifurcated path of the water conduit, then through the inlet of the second valve, subsequently through the outlet of the second valve, and then through the first inlet of the mixing valve;

(c) allowing a second portion of the water reaching the water conduit to flow through the second bifurcated path of the water conduit, then through the inlet port of the hot water heater, subsequently through the outlet port of the hot water heater, then through the inlet of the third valve, subsequently through the outlet of the third valve, and then through the second inlet of the mixing valve;

(d) allowing water from the first inlet of the mixing valve to combine with water from the second inlet of the mixing valve to give a heated water; and

(e) allowing the heated water to flow through the outlet of the mixing valve to the hot water conduit.

3. The water heating system of claim 1, wherein the water conduit is in fluid contact with a pop-off safety valve or an expansion tank.

4. The water heating system of claim 1, wherein the hot water heater is in fluid communication with a pop-off safety valve or an expansion tank.

5. The water heating system of claim 1, wherein the hot water heater inlet port or outlet port comprises a ball valve.

6. The water heating system of claim 1, wherein the hot water conduit is in fluid communication with a thermometer or temperature safety device.

7. A water heating system comprising:

(a) a water inlet conduit for supplying water from an external source;

(b) a first valve having an inlet and an outlet, wherein the inlet of the first valve is in fluid communication with the water inlet conduit, and the outlet of the first valve is in fluid communication with a water conduit having a bifurcation with at least a first and a second bifurcated path;

(c) a second valve having an inlet and an outlet, wherein the inlet of the second valve is in fluid communication with the outlet of the first valve through the first bifurcated path of the water conduit;

(d) a mixing valve having a first inlet, a second inlet, and an outlet, wherein the first inlet of the mixing valve is in fluid communication with the outlet of the second valve;

(e) one or more hot water heaters, each having an inlet port and an outlet port, wherein the inlet port of each hot water heater is in fluid communication with the second bifurcated path of the water conduit;
(f) one or more hot water expansion tanks in fluid communication with one or both of the hot water heaters;

(g) a third valve having an inlet and an outlet, wherein each of the hot water heaters and each of the hot water expansion tanks are in fluid communication with the inlet of the third valve, and the outlet of the third valve is in fluid communication with the second inlet to the mixing valve; and

(h) a hot water conduit in fluid communication with the outlet of the mixing valve.

8. A process for producing hot water using the water heating system of claim 7 comprising:

(a) allowing the water from an external source to flow into the water inlet conduit, subsequently flowing through the inlet of the first valve, followed by flowing through the outlet of the first valve, and then flowing through the water conduit reaching the first and the second bifurcated paths of the water conduit;

(b) allowing a first portion of the water reaching the water conduit to flow through the first bifurcated path of the water conduit, then through the inlet of the second valve, subsequently through the outlet of the second valve, and then through the inlet of the mixing valve;

(c) allowing a second portion of the water reaching the water conduit to flow through the second bifurcated path of the water conduit, then through the inlet port of one or more of the hot water heaters, subsequently through the outlet port of one or more of the hot water heaters, then through the inlet of the third valve, subsequently through the outlet of the third valve, and then through the second inlet of the mixing valve;

(d) allowing water from the first inlet of the mixing valve to combine with water from the second inlet of the mixing valve to give a heated water; and

(e) allowing the heated water to flow through the outlet of the mixing valve to the hot water conduit.

9. The water heating system of claim 7, wherein the water conduit is in fluid communication with a pop-off safety valve or an expansion tank.

10. The water heating system of claim 7, wherein one or more of the hot water heaters is in fluid contact with a pop-off safety valve or an expansion tank.

11. The water heating system of claim 7, wherein one or more of the hot water heater inlet ports or hot water heater outlet ports comprises a ball valve.

12. The water heating system of claim 7, wherein the hot water conduit is in fluid communication with a thermometer or temperature safety device.

13. A water heating system comprising:

(a) a water inlet conduit for supplying water from an external source;

(b) a first valve having an inlet and an outlet, wherein the inlet of the first valve is in fluid communication with the water inlet conduit, and the outlet of the first valve is in fluid communication with a water conduit having a bifurcation with at least a first and a second bifurcated path;

(c) a second valve having an inlet and an outlet, wherein the inlet of the second valve is in fluid communication with the outlet of the first valve through the first bifurcated path of the water conduit;

(d) a mixing valve having a first inlet, a second inlet, and an outlet, wherein the first inlet of the mixing valve is in fluid communication with the outlet of the second valve;

(e) one or more hot water heaters, each having an inlet port in fluid communication with the second bifurcated path of the water conduit;

(f) one or more hot water expansion tanks in fluid communication with one or both of the hot water heaters;

(g) a third valve having an inlet and an outlet, wherein the third valve inlet is in fluid communication with each of the hot water heaters and each of the hot water expansion tanks, and the third valve outlet is in fluid communication with the second inlet to the mixing valve;

(h) a discharged water conduit in fluid communication with the outlet of the mixing valve;

(i) a storage tank having an inlet, a first outlet, and a second outlet, wherein the storage tank inlet is in fluid communication with the discharged water conduit;

(j) a fourth valve having an inlet and an outlet, wherein the inlet of the fourth valve is in fluid communication with the first outlet of the storage tank and wherein the outlet of the fourth valve is in fluid communication with a recirculation conduit;

(k) a recirculation pump having an inlet and an outlet, wherein the inlet of the recirculation pump is in fluid communication with the recirculation conduit and the outlet of the recirculation pump is in fluid communication with one or both of the hot water heaters; and

(l) a fifth valve having an inlet and an outlet wherein the inlet of the fifth valve is in fluid communication with the second outlet of the storage tank and the outlet of the fifth valve is in fluid communication with a hot water conduit.

14. A process for producing hot water using the water heating system of claim 13 comprising:

(a) allowing the water from an external source to flow into the water inlet conduit, subsequently flowing through the inlet of the first valve, followed by flowing through the outlet of the first valve, and then flowing through the water conduit reaching the first and the second bifurcated paths of the water conduit;

(b) allowing a first portion of the water reaching the water conduit to flow through the first bifurcated path of the water conduit, then through the inlet of the second valve, subsequently through the outlet of the second valve, and then through the first inlet of the mixing valve;

(c) allowing a second portion of the water reaching the water conduit to flow through the second bifurcated path of the water conduit, then through the inlet port of one or more of the hot water heaters, subsequently through the outlet port of one or more of the hot water heaters, then through the inlet of the third valve, subsequently through the outlet of the third valve, and then through the second inlet of the mixing valve;
subsequently through the outlet of the third valve, and then through the second inlet of the mixing valve;

(d) allowing water from the first inlet of the mixing valve to combine with the water from the second inlet of the mixing valve to give a heated water;

(e) allowing the heated water to flow through the outlet of the mixing valve to the discharged water conduit, then through the inlet of the storage tank to reach the storage tank;

(f) allowing a first portion of the water reaching the storage tank to flow through the inlet of the fourth valve, subsequently through the outlet of the fourth valve, then through the recirculation conduit, then through the inlet of the recirculation pump, subsequently through the outlet of the recirculation pump, then through the inlet port of one or more of the hot water heaters; and

(g) allowing a second portion of the water reaching the storage tank to flow through the second outlet of the storage tank, then through the outlet of the fifth valve, subsequently through the hot water conduit.

15. The water heating system of claim 13, wherein the water conduit is in fluid communication with a pop-off safety valve or an expansion tank.

16. The water heating system of claim 13, wherein one or more of the hot water heaters is in fluid communication with a pop-off safety valve or an expansion tank.

17. The water heating system of claim 13, wherein the discharged water conduit is in fluid communication with a thermometer or a temperature safety device.

18. The water heating system of claim 13, wherein the hot water conduit is in fluid communication with a thermometer or a temperature safety device.

19. The water heating system of claim 13, wherein the storage tank is in fluid communication with a thermometer or a temperature safety device.

20. The water heating system of claim 13, wherein the storage tank is in fluid communication with a pressure safety device.