Heat Source Unit Control System

A heat source unit control system prevents a heat-pump heat source from operating at a maximum outlet temperature of heated water, which is caused by an unnecessarily high temperature of circulating water. A return-water temperature sensor S(in) detects a temperature Tm(in) of circulating water which flows through a forward channel 610 in a circulation circuit 600 to return back to a heat-pump heat source 100. A tank-water temperature sensor S(t) detects a temperature Tt of water stored in a hot water storage tank 200. A controller 500 controls the operating frequency of a compressor installed in the heat-pump heat source 100 so that Tm(in) - Tt = ΔTb, where Tm(in) - Tt denotes a temperature difference between the temperature Tm(in) of the circulating water detected by the return-water temperature sensor S(in) and the temperature Tt of the water in the tank detected by the tank-water temperature sensor S(t), and ΔTb denotes a set value.

Fig. 1
Description

CROSS-REFERENCE TO RELATED APPLICATIONS

0001 This application is based on and claims the benefit of priority from Japanese Patent Application No. 2012-016051, filed in Japan on January 30, 2012, the content of which is incorporated herein by reference in its entirety.

Technical Field

0002 The present invention relates to a heat source unit control system, and more particularly to a water heating system or a water heating and hydronic heating system, which has a controller installed therein to control a heat-pump heat source (hereinafter, also referred to as a heat pump device) as a heat source unit so that circulating water to heat domestic hot water is at an optimum temperature.

Background Art

0003 Some water heating systems are designed to indirectly heat domestic hot water (for shower or the like) via circulating water by a heat-pump heat source or the like.

0004 In the water heating operation of this type of water heating system, the heat source, such as a heat-pump heat source, is controlled so that domestic hot water reaches a target temperature. In most cases, however, the temperature of the circulating water is left uncontrolled (see, e.g., Patent Literature 1).

Citation List

Patent Literature

0005 Patent Literature 1 JP 9-68369 A

Summary of Invention

Technical Problem

0006 If the temperature of circulating water is thus left uncontrolled, the amount of heat transferred to circulating water by a heat-pump heat source and the amount of heat transferred to domestic hot water from the circulating water may become unbalanced depending on the temperature of the circulating water, the temperature of the domestic water, or the performance of the heat exchanger exchanging heat between the circulating water and the domestic hot water.

0007 As a result, the temperature of the circulating water rises unnecessarily high, which causes the heat-pump heat source to operate constantly at a maximum outlet temperature of heated water. Accordingly, the heat-pump heat source efficiency is reduced.

0008 An object of the present invention is to provide a heat source unit control system which prevents a heat-pump heat source from operating at a maximum outlet temperature of heated water which is caused by an unnecessarily high temperature of circulating water.

Solution to Problem

0009 A heat source unit control system according to one aspect of the present invention may include:

- a heat-transfer medium circulation circuit in which a heat-transfer medium circulates, the heat-transfer medium circulation circuit including: a tank heat exchanger that receives the heat-transfer medium, and exchanges heat between the heat-transfer medium and water stored in a tank; a heat source unit that receives the heat-transfer medium and performs one of heating and cooling the heat-transfer medium, a forward channel through which the heat-transfer medium flows from the heat source unit to the tank heat exchanger; and a return channel through which the heat-transfer medium flows from the tank heat exchanger to the heat source unit;
- a tank-water temperature sensor that detects a temperature Tt of the water stored in the tank;
- a heat-transfer medium temperature sensor that detects a temperature Tm of the heat-transfer medium at a predetermined portion of the heat-transfer medium circulation circuit; and
- a controller that controls the heat source unit based on a temperature difference between the temperature Tm of the heat-transfer medium detected by the heat-transfer medium temperature sensor and the temperature Tt of the water stored in the tank.
Advantageous Effects of Invention

[0010] A heat source unit control system according to the present invention can prevent a heat-pump heat source from operating at a maximum outlet temperature of heated water which is caused by an unnecessarily high temperature of circulating water.

Brief Description of Drawings

[0011] The present invention will become fully understood from the detailed description given hereinafter in conjunction with the accompanying drawings, in which:

[0012] Fig. 1 shows a configuration of a water heating system 1000 according to a first embodiment;
Fig. 2 shows a configuration of a heat-pump heat source 100 according to the first embodiment;
Fig. 3 is a flow chart illustrating a water heating operation performed by a controller 500 according to the first embodiment;
Fig. 4 is a graph showing a heated-water outlet temperature, a return-water temperature, and a tank-water temperature in a water heating operation which is not controlled by the controller 500, illustrating the first embodiment;
Fig. 5 is a graph showing the heated-water outlet temperature, the return-water temperature, and the tank-water temperature in a water heating operation which is controlled by the controller 500 according to the first embodiment;
Fig. 6 is a flow chart showing a water heating operation which is controlled by the controller 500 according to a second embodiment;
Fig. 7 is a flow chart showing a water heating operation which is controlled by the controller 500 according to a third embodiment;
Fig. 8 shows a configuration of the water heating system 1000 according to a fourth embodiment;
Fig. 9 shows a configuration in part of the water heating system 1000 according to a fifth embodiment; and
Fig. 10 shows a configuration of the heat-pump heat source 100 according to a sixth embodiment.

Description of Embodiments

[0013] In describing preferred embodiments illustrated in the drawings, specific terminology is employed for the sake of clarity. However, the disclosure of the present invention is not intended to be limited to the specific terminology so selected, and it is to be understood that each specific element includes all technical equivalents that operate in a similar manner and achieve a similar result.

(Definition of terminology)

[0014] In the embodiments elaborated hereinafter, a controller controls the operating frequency of a compressor based on temperatures detected by various temperature sensors. The following defines values detected by the temperature sensors.

(1) Heated-water outlet temperature sensor S(out):

\( T_{\text{m(out)}} \) denotes a temperature detected by the heated-water outlet temperature sensor S(out). The detected temperature \( T_{\text{m(out)}} \) is also referred to as a heated-water outlet temperature \( T_{\text{m(out)}} \). The heated-water outlet temperature sensor S(out) is also referred to as a heat-transfer medium temperature sensor.

(2) Return-water temperature sensor S(in):

\( T_{\text{m(in)}} \) denotes a temperature detected by the return-water temperature sensor S(in). The detected temperature \( T_{\text{m(in)}} \) is also referred to as a return-water temperature \( T_{\text{m(in)}} \). The return-water temperature sensor S(in) is also referred to as a heat-transfer medium temperature sensor.

(3) Tank-water temperature sensor S(t):

\( T_{\text{t}} \) denotes a temperature detected by the tank-water temperature sensor S(t). The detected temperature \( T_{\text{t}} \) is
also referred to as a tank-water temperature $T_t$.

**Embodiment 1.**

A first embodiment is described with reference to Fig. 1 to Fig. 5. Fig. 1 shows a water circuit illustrating a water heating system 1000 (heat source unit control system) according to the first embodiment. It is to be noted that the configuration of the water heating system 1000 shown in Fig. 1 is also applied to those described in second and third embodiments. The water heating system 1000 is basically configured to include a heat-pump heat source 100 (example of a heat source unit), an auxiliary heater 300, a tank heat exchanger 201 for tank water, a circulator pump 400, and water circulation channel forming means 601 (e.g., piping) to connect those elements. Water (example of a heat-transfer medium) flows inside the water circulation channel forming means 601. The water circulation channel forming means 601 serially connects the heat-pump heat source 100, the auxiliary heater 300, the tank heat exchanger 201, the circulator pump 400, and the heat-pump heat source 100 again to form a circulation circuit 600 (heat-transfer medium circulation circuit) through which water (hereinafter, referred to as circulating water) as a heat-transfer medium circulates. It is to be noted that water is not the only possible heat-transfer medium that circulates in the circulation circuit 600, and antifreeze liquid, or any type of refrigerant other than antifreeze liquid may alternatively be employed. The circulation circuit 600 includes a forward channel 610 (A - B in Fig. 1) through which water in the water circulation channel forming means 601 flows from the heat-pump heat source 100 to the tank heat exchanger 201, and a return channel 620 (C - D in Fig. 1) through which water in the water circulation channel forming means 601 flows from the tank heat exchanger 201 to the heat-pump heat source 100. Thus, the heat-pump heat source 100 and the tank heat exchanger 201 are connected via the forward channel 610 and the return channel 620 in the circulation circuit 600.

The water heating system 1000 has a controller 500 installed therein. The controller 500 controls the operating frequency of a compressor 101 (see Fig. 2). It is to be noted that the controller 500 also controls an electric three-way valve 720 (see Fig. 8) described in a fourth embodiment later, and a four-way valve 105 (see Fig. 10) described in a sixth embodiment later.

(Three sensors)

(1) Heated-water outlet temperature sensor $S_{\text{out}}$:

In the water heating and support system 1000, the heated-water outlet temperature sensor $S_{\text{out}}$ is installed between the auxiliary heater 300 and the tank heat exchanger 201 along the forward channel. The heated-water outlet temperature sensor $S_{\text{out}}$ measures the temperature (heated-water outlet temperature $T_{\text{m(out)}}$) of heated water supplied to the tank heat exchanger 201.

(2) Return-water temperature sensor $S_{\text{in}}$:

The return-water temperature sensor $S_{\text{in}}$ is installed between the circulator pump 400 and the heat-pump heat source 100. The return-water temperature sensor $S_{\text{in}}$ measures the temperature (return-water temperature $T_{\text{m(in)}}$) of heated water returning to the heat-pump heat source 100.

(3) Tank-water temperature sensor $S_{\text{t}}$:

The tank-water temperature sensor $S_{\text{t}}$ is installed in a hot water storage tank 200. The tank-water temperature sensor $S_{\text{t}}$ measures the temperature (tank-water temperature $T_{\text{t}}$) of domestic hot water stored in the hot water storage tank 200.

(4) It is to be noted that the return-water temperature $T_{\text{m(in)}}$ as measurement information by the return-water temperature sensor $S_{\text{in}}$, and the tank-water temperature $T_{\text{t}}$ as measurement information by the tank-water temperature sensor $S_{\text{t}}$ are utilized in the first embodiment. The heated-water outlet temperature $T_{\text{m(out)}}$ measured by the heated-water outlet temperature sensor $S_{\text{out}}$ is not utilized here in the first embodiment.

(1) More specifically, in the first embodiment, the controller 500 controls the ON/OFF operation of the heat-pump heat source 100 and the operating frequency of the compressor 101 (see Fig. 2) based on the return-water tem-
peratures $T_m(\text{in})$ and the tank-water temperature $T_t$ as the measurement information by the return-water temperature sensor $S(\text{in})$ and the tank-water temperature sensor $S(t)$.

(2) It is to be noted that, in the second embodiment, the controller 500 controls the heat-pump heat source 100 based on the values detected by the heated-water outlet temperature sensor $S(\text{out})$ and the tank-water temperature sensor $S(t)$.

(3) It is also to be noted that, in the third embodiment, the controller 500 controls the heat-pump heat source 100 based on the three values detected by the heated-water outlet temperature sensor $S(\text{out})$, the return-water temperature sensor $S(\text{in})$, and the tank-water temperature sensor $S(t)$.

Thus, as described above, the water heating system 1000 includes the circulation circuit 600, the return-water temperature sensor $S(\text{in})$, the heated-water outlet temperature sensor $S(\text{out})$, the tank-water temperature sensor $S(t)$, and the controller 500.

Fig. 2 shows an example of the configuration of the heat-pump heat source 100. Referring to Fig. 2, the heat-pump heat source 100 includes the compressor 101, a first heat exchanger 102, an expansion mechanism 103, and a second heat exchanger 104 to form a refrigeration cycle. The operating frequency of the compressor 101 can be controlled by the controller 500. In the case of Fig. 2, the first heat exchanger 102 is a radiator to heat the circulating water, and the second heat exchanger 104 is a heat absorber.

A detailed description is now given of the water cycle in the water heating system 1000. The circulating water circulates in the water circuit by the circulator pump 400 while the water heating system is in operation. The circulating water discharged from the circulator pump 400 is heated by the heat-pump heat source 100. The heated circulating water is supplied to the tank heat exchanger 201 via the auxiliary heater 300, and the heat is transferred to the domestic hot water stored in the hot water storage tank 200. After the heat transfer, the circulating water is sucked in by the circulator pump 400.

(Operation of controller 500)

A water heating operation performed in the water heating system 1000 is described with reference to Fig. 3. Fig. 3 is a flow chart showing an operation of the controller 500 in a water heating operation. It is to be noted that the operations in respective steps shown in Fig. 3 are performed by the controller 500.

When conditions for starting a water heating operation are met by the water heating system 1000, the water heating operation is started at step S101.

In step S102, the controller 500 determines whether or not the temperature $T_t$ detected by the tank-water temperature sensor $S(t)$ has reached a preset target value $T_a$. Specifically, it is determined if $T_t \geq T_a$. If the temperature $T_t$ detected by the tank-water temperature sensor $S(t)$ is at or above the target value $T_a$, then the process proceeds to step S103 where the water heating operation is terminated. If not, the process proceeds to step S104.

In step S104, the controller 500 determines whether or not a difference between the temperature $T_m(\text{in})$ detected by the return-water temperature sensor $S(\text{in})$ and the temperature $T_t$ detected by the tank-water temperature sensor $S(t)$ is greater than a preset target value $\Delta T_b1$. Specifically, it is determined if $T_m(\text{in}) - T_t > \Delta T_b1$. If $T_m(\text{in}) - T_t > \Delta T_b1$, it can be assumed that the amount of heat transferred to the circulating water by the heat-pump heat source 100 is greater than a maximum amount of heat transferred to the domestic hot water from the circulating water. Accordingly, the process proceeds to step S105 where the controller 500 controls the compressor 101 to reduce the operating frequency. If not, the process proceeds to step S106.

In step S105, the controller 500 determines whether or not a difference between the temperature $T_m(\text{in})$ detected by the return-water temperature sensor $S(\text{in})$ and the temperature $T_t$ detected by the tank-water temperature sensor $S(t)$ is less than a preset target value $\Delta T_b1$. Specifically, it is determined if $T_m(\text{in}) - T_t < \Delta T_b1$. If $T_m(\text{in}) - T_t < \Delta T_b1$, it can be assumed that the amount of heat transferred to the circulating water by the heat-pump heat source 100 is smaller than the maximum amount of heat transferred to the domestic hot water from the circulating water. Accordingly, the process proceeds to step S107 where the controller 500 controls the compressor 101 to increase the operating frequency. If not, the process proceeds to step S106.

In step S106, the controller 500 determines whether or not a difference between the temperature $T_m(\text{in})$ detected by the return-water temperature sensor $S(\text{in})$ and the temperature $T_t$ detected by the tank-water temperature sensor $S(t)$ is below the target value $\Delta T_b1$. Specifically, it is determined if $T_m(\text{in}) - T_t = \Delta T_b1$. If $T_m(\text{in}) - T_t = \Delta T_b1$, it can be assumed that the amount of heat transferred to the circulating water in the heat-pump heat source 100 is equivalent to the maximum amount of heat transferred to the domestic water from the circulating water. Accordingly, the controller 500 controls the compressor 101 to maintain the operating frequency, and the process goes back to step S102.
In the second embodiment, the controller 500 controls the operating frequency of the heat-pump heat source 100 based on values detected by the heated-water outlet temperature sensor S(out) and the tank-water temperature sensor S(t). More specifically, the operating frequency of the compressor 101 in the heat-pump heat source 100 is controlled based on a temperature difference between the temperature Tm(in) detected by the return-water temperature sensor S(in) and the temperature Tt detected by the tank-water temperature sensor S(t). This is also applied to the second and third embodiments.

Embodiment 2.

[0031] The water heating system 1000 according to a second embodiment is now described with reference to Fig. 6. Fig. 6 corresponds to Fig. 3 showing the first embodiment.

[0032] In the second embodiment, the controller 500 controls the operating frequency of the heat-pump heat source 100 based on values detected by the heated-water outlet temperature sensor S(out) and the tank-water temperature sensor S(t). More specifically, the operating frequency of the compressor 101 in the heat-pump heat source 100 is controlled based on a temperature difference between the temperature Tm(out) detected by the heated-water outlet temperature sensor S(out) shown in Fig. 1 and the temperature Tt detected by the tank-water temperature sensor S(t) shown in Fig. 1. As can be seen, Fig. 6 modifies Fig. 3 by replacing the temperature Tm(out) detected by the heated-water outlet temperature sensor S(out) by the temperature Tm(in) detected by the return-water temperature sensor S(in). More particularly, operations in respective steps S204, S206 and S208 enclosed by a broken line in Fig. 6 differ from those in corresponding steps S104, S106 and S108 enclosed by a broken line in Fig. 3.

[0033] With further reference to Fig. 6, ΔTb2 shown in respective steps S204 to S208 denotes a target value (cf. ΔTb1 in Fig. 3). The target values ΔTb2 and ΔTb1 are not usually the same value if the target value Ta in step S102 in Fig. 6 and the target value Ta in step S102 in Fig. 3 are the same value.

Embodiment 3.

[0034] The water heating system 1000 according to a third embodiment is now described with reference to Fig. 7. Fig. 7 is a flow chart showing an operation of the controller 500 in a water heating operation according to the third embodiment. Fig. 7 corresponds to Fig. 3 showing the first embodiment.

[0035] In the third embodiment, the controller 500 controls the operating frequency of the heat-pump heat source 100 based on the values detected by the return-water temperature sensor S(in), the heated-water outlet temperature sensor S(out), and the tank-water temperature sensor S(t). More specifically, the operating frequency of the compressor 101 in the heat-pump heat source 100 is controlled by the controller 500 based on the temperature difference between the temperature Tt of water in the tank detected by the tank-water temperature sensor S(t) and a mean value (circulation water temperature mean value) of the temperature Tm(out) of the circulating water detected by the heated-water outlet temperature sensor S(out) shown in Fig. 1 and the temperature Tm(in) of the circulating water detected by the return-water temperature sensor S(in) shown in Fig. 1. As can be seen, Fig. 7 modifies Fig. 3 by replacing the temperature Tm(in) detected by the return-water temperature sensor S(in) by the circulation water temperature mean value. The circulation water temperature mean value is determined by the following equation:
where $T_{m\text{(out)}}$ denotes the temperature detected by the heated-water outlet temperature sensor $S_{\text{(out)}}$ and $T_{m\text{(in)}}$ denotes the temperature detected by the return-water temperature sensor $S_{\text{(in)}}$.

More specifically, operations in respective steps S304, S306 and S308 enclosed by a broken line in Fig. 7 differ from those in corresponding steps S104, S106 and S108 enclosed by the broken line in Fig. 3.

[0036] With further reference to Fig. 7, $\Delta Tb_3$ shown in respective steps S304 to S308 denotes a target value (cf $\Delta Tb_1$ in Fig. 3). The target values $\Delta Tb_3$ and $\Delta Tb_1$ are not usually the same value if the target value $Ta$ in step S 102 in Fig. 7 and the target value $Ta$ in step S 102 in Fig. 3 are the same value.

Embodiment 4.

[0037] Fig. 8 shows a water circuit of the water heating system 1000 designed for water heating and hydronic heating according to a fourth embodiment. The water circuit shown in Fig. 8 modifies the water circuit shown in Fig. 1 which illustrates the first to the third embodiments, by adding a diverging point (fork 611) between the auxiliary heater 300 and the tank heat exchanger 201 along the forward channel 610, and a meeting point (junction 621) between the tank heat exchanger 201 and the circulator pump 400 along the return channel 620 to form a branch channel 700. Along the branch channel 700, a hydronic heater 710 (branch heat exchanger) is installed in parallel to the tank heat exchanger 201 by the water circulation channel forming means 601. Additionally, an electric three-way valve 720 (switch) is installed either at the fork 611 along the forward channel 610 or at the junction 621 along the return channel 620 (e.g., the electric three-way valve 720 is disposed at the junction 621 in Fig. 8) to switch between a route via the tank heat exchanger 201 and a route via the hydronic heater 710 (branch channel 700). The configuration shown in Fig. 8 serves to allow the controller 500 to control the electric three-way valve 720 to switch between a water heating operation and a hydronic heating operation.

[0038] Thus, as can be seen in Fig. 8, the water heating system 1000 is configured to include the branch channel 700 which separates from the forward channel at the fork 611 and meets the return channel at the junction 621, and along which the hydronic heater 710 is installed. The electric three-way valve 720 switches the flow of the circulating water between: a route from the heat-pump heat source 100 via the fork 611 along the forward channel, the tank heat exchanger 201, and the junction 621 along the return channel, back to the heat-pump heat source 100; and a route from the heat-pump heat source 100 via the fork 611 along the forward channel, the hydronic heater 710, and the junction 621 along the return channel, back to the heat-pump heat source 100. This switching of the electric three-way valve 720 is controlled by the controller 500.

[0039] It is to be noted that the water heating operation of the fourth embodiment can be performed in a similar manner to any of those described in the first to third embodiments.

Embodiment 5.

[0040] With reference to the foregoing first to fourth embodiments, the tank heat exchanger 201 is installed inside the hot water storage tank 200 as shown in Fig. 1. According to a fifth embodiment, however, as shown in Fig. 9, a heat exchanger 820 as a heat exchanger for tank water of the fifth embodiment, the hot water storage tank 200 and a hot water supply pump 830 are connected by water circulation channel forming means 810 (e.g., piping). The configuration shown in Fig. 9 can also serve to achieve a water heating operation and effects similar to any of those described in the first to fourth embodiments.

[0041] With reference to the foregoing first to fifth embodiments, the water heating system 1000 is configured so that the heat-pump heat source 100, the auxiliary heater 300, the tank heat exchanger 201, and the circulator pump 400 are annularly connected by piping, and heated water is supplied from the heat-pump heat source 100 to the tank heat exchanger 201 via the auxiliary heater 300 to transfer the heat to hot water stored in the hot water storage tank 200. Further, in the water heating system 1000, the heated-water outlet temperature sensor $S_{\text{(out)}}$ is arranged at the outlet of the auxiliary heater 300, the return-water temperature sensor $S_{\text{(in)}}$ is arranged at the inlet of the heat-pump heat source 100, and the tank-water temperature sensor $S_{\text{(t)}}$ is arranged inside the hot water storage tank 200 to detect the temperature of hot water stored in the hot water storage tank 200.

Further, the controller 500 controls the heat-pump heat source 100 so that the temperature of hot water stored in the hot water storage tank 200 becomes the target value $Ta$, that is,

(1) a difference between the temperature $T_{m\text{(in)}}$ detected by the return-water temperature sensor $S_{\text{(in)}}$ and the temperature $T_{t}$ detected by the tank-water temperature sensor $S_{\text{(t)}}$ becomes the target value $\Delta Tb_1$;
(2) a difference between the temperature \(T_{m(out)}\) detected by the heated-water outlet temperature sensor \(S(out)\) and the temperature \(T_t\) detected by the tank-water temperature sensor \(S(t)\) becomes the target value \(\Delta T_b2\); or

(3) a difference between the temperature \(T_t\) detected by the tank-water temperature sensor \(S(t)\) and the mean value of the temperature \(T_{m(out)}\) detected by the heated-water outlet temperature sensor \(S(out)\) and the temperature \(T_{m(in)}\) detected by the return-water temperature sensor \(S(in)\) becomes the target value \(\Delta T_b3\).

Based on the control option (1), (2) or (3), the controller 500 can control the heat-pump heat source 100 so that circulating water to heat domestic hot water (tank water) has an optimum temperature.

**Embodiment 6.**

With reference to the foregoing first to fifth embodiments, water stored in the hot water storage tank 200 is heated in a water heating operation, that is, the circulating water is heated. Alternatively, however, the first to the fifth embodiments may be implemented where the circulating water is cooled. More specifically, the water heating operation may be applied to where water stored in the tank is cooled to the target temperature \(T_a\) or below, and the resultant cool temperature is maintained. In this instance, the inequality signs in the respective steps shown in Fig. 3, Fig. 6 and Fig. 7 are turned round. Then, in this case, the forward channel 610 and the return channel 620 are connected to a heat absorber in the heat-pump heat source 100. For example, as shown in Fig. 10, the heat-pump heat source 100 is configured with a four-way valve 105, and the first heat exchanger 102 is used as a heat absorber. The configuration shown in Fig. 10 can serve to allow the temperature of water stored in the hot-water storage tank 200 to be controlled at or above/below a certain temperature.

With reference to the foregoing first to sixth embodiments, the heat-pump heat source 100 is used as an example of a heat source unit. The heat-pump heat source 100 is, however, not the only possibility if the control of heat transfer capability to circulating water by the controller 500 is allowed, any type of heat source unit can be used.

Numerous additional modifications and variations are possible in light of the above teachings. It is therefore to be understood that, within the scope of the appended claims, the disclosure of this patent specification may be practiced otherwise than as specifically described herein.

**Reference Signs List**

<table>
<thead>
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<th>Reference Signs List</th>
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<tbody>
<tr>
<td>S(out) heated-water outlet temperature sensor</td>
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<tr>
<td>S(in) return-water temperature sensor</td>
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<tr>
<td>S(t) tank-water temperature sensor</td>
</tr>
<tr>
<td>(T_{m(out)}) heated-water outlet temperature</td>
</tr>
<tr>
<td>(T_{m(in)}) return-water temperature</td>
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<td>710 hydronic heater</td>
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<td>720 electric three-way valve</td>
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A heat source unit control system (1000), comprising:

- a heat-transfer medium circulation circuit (600) in which a heat-transfer medium circulates, the heat-transfer medium circulation circuit including:
  - a tank heat exchanger (201) that receives the heat-transfer medium, and exchanges heat between the heat-transfer medium and water stored in a tank;
  - a heat source unit (100) that receives the heat-transfer medium and performs one of heating and cooling the heat-transfer medium,
  - a forward channel (610) through which the heat-transfer medium flows from the heat source unit to the tank heat exchanger; and
  - a return channel (620) through which the heat-transfer medium flows from the tank heat exchanger to the heat source unit;
- a tank-water temperature sensor (S(t)) that detects a temperature Tt of the water stored in the tank;
- a heat-transfer medium temperature sensor (S(in), S(out)) that detects a temperature Tm of the heat-transfer medium at a predetermined portion of the heat-transfer medium circulation circuit; and
- a controller (500) that controls the heat source unit based on a temperature difference between the temperature Tm of the heat-transfer medium detected by the heat-transfer medium temperature sensor and the temperature Tt of the water detected by the tank-water temperature sensor.

The heat source unit control system according to claim 1, wherein:

- the heat-transfer medium temperature sensor detects a temperature Tm(in) of the heat-transfer medium returning back to the heat source unit through the return channel in the heat-transfer medium circulation circuit, as the temperature Tm of the heat-transfer medium;
- the controller controls the heat source unit based on a temperature difference between the temperature Tm(in) of the heat-transfer medium detected by the heat-transfer medium temperature sensor and the temperature Tt of the water detected by the tank-water temperature sensor.

The heat source unit control system according to claim 2, further comprising:

- an additional heat-transfer medium temperature sensor (S(out)) that detects a temperature Tm(out) of the heat-transfer medium flowing out of the heat source unit through the forward channel in the heat-transfer medium circulation circuit, as the temperature Tm of the heat-transfer medium;
- wherein the controller controls the heat source unit based on a temperature difference between the temperature Tt of the water detected by the tank-water temperature sensor and a mean value of the temperature Tm(in) of the heat-transfer medium detected by the heat-transfer medium temperature sensor and the temperature Tm(out) of the heat-transfer medium detected by the additional heat-transfer medium temperature sensor.

The heat source unit control system according to claim 1, wherein:

- the heat-transfer medium temperature sensor detects a temperature Tm(out) of the heat-transfer medium flowing out of the heat source unit through the forward channel in the heat-transfer medium circulation circuit, as the temperature Tm of the heat-transfer medium;
- the controller controls the heat source unit based on a temperature difference between the temperature Tm(out) of the heat-transfer medium detected by the heat-transfer medium temperature sensor and the temperature Tt of the water detected by the tank-water temperature sensor.

The heat source unit control system according to any one of claims 1 to 4, wherein the controller controls the heat
source unit so that the temperature difference reaches a preset value.

6. The heat source unit control system according to any one of claims 1 to 5, wherein:

- the heat source unit is a heat pump device that includes a compressor whose operating frequency is controllable,
- and
- the controller controls the operating frequency of the compressor as the control of the heat source unit.

7. The heat source unit control system according to any one of claims 1 to 6, wherein the heat source unit heats the heat-transfer medium.

8. The heat source unit control system according to any one of claims 1 to 7, further comprising:

- a branch channel (700) that separates from the forward channel at a fork (611) along the forward channel as a diverging point, and joins the return channel at a junction (621) along the return channel as a meeting point,
- a branch heat exchanger (710) installed along the branch channel, and
- a switch (720) that switches the flow of the heat-transfer medium between:

  - a route from the heat source unit via the fork along the forward channel, the tank heat exchanger, and the junction along the return channel, back to the heat source unit, and
  - a route from the the heat source unit via the fork along the forward channel, the branch heat exchanger, and the junction along the return channel, back to the heat source unit.
Fig. 2
Fig. 3

START OF WATER HEATING OPERATION

S102

Tt ≥ Ta

YES → END OF WATER HEATING OPERATION

NO

S104

Tm (in) - Tt > ΔTb1

YES → REDUCE COMPRESSOR OPERATING FREQUENCY

NO

S106

Tm (in) - Tt < ΔTb1

YES → INCREASE COMPRESSOR OPERATING FREQUENCY

NO

S108

Tm (in) - Tt = ΔTb1
Fig. 6

S101

START OF WATER HEATING OPERATION

S102

Tt ≥ Ta

YES

END OF WATER HEATING OPERATION

S103

NO

S204

Tm(out) - Tt > ΔTb2

YES

REDUCE COMPRESSOR OPERATING FREQUENCY

S105

NO

S206

Tm(out) - Tt < ΔTb2

YES

INCREASE COMPRESSOR OPERATING FREQUENCY

S107

NO

S208

Tm(out) - Tt = ΔTb2
Fig. 7

S101
START OF WATER HEATING OPERATION

S102
Tt ≥ Ta
YES
END OF WATER HEATING OPERATION

S304
\[ \frac{(T_m(out) + T_m(in))}{2} - Tt > \Delta T_b3 \]
YES
REDUCE COMPRESSOR OPERATING FREQUENCY

S306
\[ \frac{(T_m(out) + T_m(in))}{2} - Tt < \Delta T_b3 \]
NO

S308
\[ \frac{(T_m(out) + T_m(in))}{2} - Tt = \Delta T_b3 \]
REFERENCES CITED IN THE DESCRIPTION

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