A hot water supply and heating system includes a heating flow rate changing valve that changes the flow rate of hot water flowing through a heating pipe and a priority controller that carries out hot water supply priority control whereby to reduce the flow rate of the hot water flowing through the heating pipe by the heating flow rate changing valve in the case where the total of the amount of heat consumed in a heating operation and the amount of heat consumed in a hot water supply operation is equal to or more than a maximum amount of heat that can be applied by the heat source machine during a simultaneous operation of the heating operation and the hot water supply operation.
FIG. 1

HEAT SOURCE MACHINE CONTROLLER

HEAT SOURCE MACHINE REMOTE CONTROL

HOT WATER SUPPLY CONTROLLER

PRIORITY CONTROLLER

HOT WATER T1set

WATER Fw, Tw
FIG. 2

START

STEP 1
CALCULATE HOT WATER SUPPLY HEAT AMOUNT Q_w

STEP 2
CALCULATE HEATING HEAT AMOUNT Q_c

STEP 3
SET MAXIMUM HEAT AMOUNT Q_{max}

STEP 4
Q_w + Q_c \geq Q_{max} ?

YES

STEP 5
PRIORITY SET TO HOT WATER SUPPLY OPERATION?

NO

STEP 6
(a) DECREASE 1ST DESIRED HOT WATER TEMPERATURE T_{set} (c) DECREASE OPENING DEGREE OF SUPPLIED HOT WATER FLOW RATE CHANGING VALVE

(b) DECREASE OPENING DEGREE OF HEATING FLOW RATE CHANGING VALVE

STEP 7
HAS HOT WATER SUPPLY OPERATION OR HEATING OPERATION STOPPED?

NO

STEP 8
END
FIG. 3
HOT WATER SUPPLY AND HEATING SYSTEM

BACKGROUND OF THE INVENTION

[0001] 1. Field of the Invention
[0002] The present invention relates to a hot water supply and heating system that supplies hot water and performs heating by using hot water generated by heating with a heat source machine.
[0003] 2. Description of the Related Art
[0004] Conventionally, there has been proposed a hot water supply and heating system, which uses a heat source machine connected to a water supply pipe and a hot water supply pipe to heat water supplied from the water supply pipe and output hot water to the hot water supply pipe, and which is capable of performing a heating operation for heating by using the hot water output to the hot water supply pipe from the heat source machine and to perform a hot water supply operation for supplying hot water to a hot water outlet tap connected to a downstream end of the hot water supply pipe (e.g., Japanese Patent Application Laid-Open No. 2008-82633).
[0005] The foregoing hot water supply and heating system is provided with a heating circulation path (a hot water supply circulation circuit 2), which is branched off from the hot water supply pipe (a hot water outlet path 3) and placed in communication with the water supply pipe (a water supply path 1), a bypass pipe (a bypass passage 4), which bypasses the heat source machine (a hot water supply heat exchanger 23) on the downstream side of the heating circulation path to place the hot water supply pipe and the water supply pipe in communication, a pump (a circulating pump 7), which circulates hot water in the heating circulation path, and a bypass control valve (9), which changes the opening degree of the bypass pipe.
[0006] Further, when the foregoing hot water supply and heating system performs a hot water supply operation alone, the system adjusts the heating amount of the heating source machine (the combustion amount of a combustion burner 34), which heats the hot water supply heat exchanger 23, such that the hot water output from the heat source machine reaches a temperature (e.g., 70°C) that is higher than a desired hot water temperature (e.g., 42°C), and also changes the opening degree of the bypass pipe by the bypass control valve such that the temperature of the hot water supplied from the hot water outlet tap becomes the desired hot water temperature.
[0007] Further, a liquid-to-liquid heat exchanger (a heat exchanger 24 on a user side), which carries out heat exchange with the hot water circulating through the heating circuit (42), to which a heating terminal is connected, is provided in the way of the heating circulation path. Further, when the hot water supply and heating system performs a heating operation alone, the system controls the heat source machine such that the hot water output from the heat source machine reaches a temperature (e.g., 85°C) that is higher than a set temperature (e.g., 80°C) of the hot water supplied to the heating circuit.
[0008] Further, when the foregoing hot water supply and heating system performs the hot water supply operation and the heating operation at the same time, the system controls the temperature of the hot water output from the heat source machine to a high level (85°C) and adjusts the flow rate of water, which is supplied into the hot water supply pipe from the bypass pipe, by the bypass control valve so as to supply hot water of a desired hot water temperature from the hot water outlet tap.

[0009] In the foregoing hot water supply and heating system, when the hot water supply operation and the heating operation are simultaneously performed, the hot water heated by the heat source machine and output to the hot water supply pipe is supplied also to the heating circuit branched off from the hot water supply pipe. Therefore, an increase in the amount of heat consumed by the simultaneous operation may lead to shortage of the heating amount in the heat source machine, and the temperature of the hot water supplied to the hot water outlet tap may become lower than a desired hot water temperature.

SUMMARY OF THE INVENTION

[0010] The present invention has been made in view of the above background and an object of the invention is to provide a hot water supply and heating system that prevents the temperature of hot water supplied from a hot water outlet tap from becoming lower than a desired hot water temperature when a hot water supply operation and a heating operation are performed at the same time.
[0011] A hot water supply and heating system in accordance with the present invention includes:
[0012] a heat source machine connected to a water supply pipe and a hot water supply pipe to heat water flowing from the water supply pipe to the hot water supply pipe;
[0013] a heating pipe which is branched off from the hot water supply pipe and which is in communication with the water supply pipe;
[0014] a heater which is connected on a way of the heating pipe and which has a pump, which circulates water in the heating pipe via the heat source machine, and a radiator;
[0015] a hot water supply bypass pipe which provides communication between a portion of the water supply pipe on an upstream side relative to a place where the water supply pipe is connected with the heating pipe and a portion of the hot water supply pipe on a downstream side relative to a place where the hot water supply pipe is connected with the heating pipe;
[0016] a heating controller which is configured to actuate the pump in a state wherein the heat source machine is in operation thereby to carry out a heating operation in which heat is radiated from the radiator;
[0017] a hot water supply controller which is configured to carry out a hot water supply operation by carrying out mixing temperature control whereby to adjust a mixing ratio of the hot water from the hot water supply pipe and the water from the hot water supply bypass pipe at a place where the hot water supply pipe and the hot water supply bypass pipe are connected such that hot water of a first desired hot water temperature is supplied to a hot water outlet tap connected to a downstream end of the hot water supply pipe in the state wherein the heat source machine is in operation;
[0018] a heating flow rate changer which is configured to change the flow rate of hot water flowing through the heating pipe; and
[0019] a priority controller which is configured to carry out hot water supply priority control whereby to reduce the flow rate of the hot water flowing through the heating pipe by the heating flow rate changer in a case where a total of an amount of heat consumed in the heating operation and an amount of heat consumed in the hot water supply operation is equal to or more than a maximum amount of heat that can be applied by the heat source machine during a simultaneous operation of the heating operation and the hot water supply operation.
According to the present invention, if the total of the amount of heat consumed in the heating operation and the amount of heat consumed in the hot water supply operation is equal to or more than the maximum amount of heat during an operation in which the heating operation and the hot water supply operation are being simultaneously performed, then the priority controller carries out the hot water supply priority control to reduce, by the heating flow rate changer, the flow rate of the hot water flowing through the heating pipe.

Thus, the flow rate of the hot water flowing through the heating pipe is reduced by carrying out the hot water supply priority control so as to reduce the flow rate of the hot water supplied into the water supply pipe from the heating pipe, thereby reducing the flow rate of the hot water heated by the heat source machine. This makes it possible to prevent the temperature of the hot water supplied to the hot water outlet tap from becoming lower than the desired hot water temperature due to the shortage of the heating amount in the heat source machine relative to the flow rate of the hot water flowing through the heat source machine.

Preferably, in the present invention, the hot water supply and heating system includes:

- a preferential operation setter which is configured to set priority to either the heating operation or the hot water supply operation during the operation in which the heating operation and the hot water supply operation are simultaneously performed,

- wherein, in the case where the total of the amount of heat consumed in the heating operation and the amount of heat consumed in the hot water supply operation is equal to or more than the maximum amount of heat, the priority controller is configured to carry out the hot water supply priority control in the case where the priority has been set to the hot water supply operation by the preferential operation setter and to carry out a heating priority control to reduce the first desired hot water temperature in the case where the priority has been set to the heating operation by the preferential operation setter.

With this arrangement, the priority controller carries out the heating priority control to reduce the first desired hot water temperature if the priority has been set to the heating operation. Thus, decreasing the first desired hot water temperature results in an increase in the flow rate of water diverging to the hot water supply bypass pipe from the water supply pipe in the mixing temperature control, and the flow rate of the hot water flowing through the heat source machine will be reduced by the foregoing increase in the flow rate of the water. Thus, the heating operation can be performed while preventing the temperature of the hot water, which is supplied to the heating pipe via the hot water supply pipe from the heat source machine, from decreasing due to the shortage of the heating amount in the heat source machine relative to the flow rate of the hot water flowing through the heat source machine.

According to the present invention, preferably, in a case where the heating priority control is carried out at the decreased first desired hot water temperature, the priority controller notifies that it is in a state in which the first desired hot water temperature has been decreased.

This arrangement enables a user to be notified of the state in which the first desired hot water temperature has been decreased, thus making it possible to ease the discomfort of the user caused by the lower temperature of the hot water supplied from the hot water outlet tap.

Preferably, in the present invention, the hot water supply and heating system includes:

- a preferential operation setter which sets priority to either the heating operation or the hot water supply operation during the operation in which the heating operation and the hot water supply operation are simultaneously performed; and

- a supplied water flow rate changer which is configured to change the flow rate of water supplied to the water supply pipe.

In the case where the total of the amount of heat consumed in the heating operation and the amount of heat consumed in the hot water supply operation is equal to or more than the maximum amount of heat, the priority controller carries out the hot water supply priority control in a case where a priority has been set to the hot water supply operation by a preferential operation setter and carries out a heating priority control to reduce, by the supplied water flow rate changer, the flow rate of water to be supplied to the water supply pipe in a case where the priority has been set to the heating operation by the preferential operation setter.

With this arrangement, the priority controller carries out the heating priority control to reduce the flow rate of water to be supplied to the water supply pipe by the supplied water flow rate changer if the priority has been set to the heating operation. Thus, decreasing the flow rate of water to be supplied to the water supply pipe results in a decreased flow rate of the hot water flowing through the heat source machine (the flow rate of water to be supplied to the water supply pipe and the flow rate of hot water to be supplied into the water supply pipe from the heating pipe). Thus, the heating operation can be performed while preventing the temperature of the hot water, which is supplied to the heating pipe via the hot water supply pipe from the heat source machine, from decreasing due to the shortage of the heating amount in the heat source machine relative to the flow rate of the hot water flowing through the heat source machine.

Preferably, in the present invention, the hot water supply and heating system includes:

- a output hot water temperature sensor which detects a temperature of hot water output to the hot water supply pipe from the heat source machine;

- wherein the hot water supply controller carries out the mixing temperature control based on a temperature detected by the output hot water temperature sensor.

In this case, there is no need to provide a configuration for effecting the communication between a hot water supply controller and the heat source machine.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a configuration diagram of a hot water supply and heating system according to a first embodiment;

FIG. 2 is a flowchart of an operation of a priority controller; and

FIG. 3 is a configuration diagram of a hot water supply and heating system according to a second embodiment.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to FIG. 1 to FIG. 3, embodiments of the hot water supply and heating system in accordance with the present invention will be described. First, a hot water supply
and heating system 1a of a first embodiment will be described with reference to FIG. 1 and FIG. 2.

First Embodiment

Referring to FIG. 1, the hot water supply and heating system 1a of the first embodiment is constructed by connecting a heat source machine 10 and a heating connection unit 40a through the intermediary of a water supply pipe 2 and a hot water supply pipe 3. Waterworks (not illustrated) is connected to the water supply pipe 2, and water is supplied to the water supply pipe 2 from the waterworks when a faucet 5 (corresponding to the hot water outlet tap in the present invention), which is connected to a downstream end of the hot water supply pipe 3, is turned on.

The heat source machine 10 has the water supply pipe 2 connected to the inlet end thereof and the outlet end thereof connected to the hot water supply pipe 3. The heat source machine 10 includes a heat exchanger 11 connected to the water supply pipe 2 and the hot water supply pipe 3 to heat water flowing from the water supply pipe 2 into the hot water supply pipe 3, a heat source machine flow rate sensor 12 which detects the flow rate of water supplied from the water supply pipe 2 to the heat exchanger 11, a heat source machine flow rate changing valve 13 which changes the flow rate of the water supplied from the water supply pipe 2 to the heat exchanger 11, an input water temperature sensor 14 which detects the temperature of the water supplied from the water supply pipe 2 to the heat exchanger 11, a first output hot water temperature sensor 15 which detects the temperature of hot water output from the heat exchanger 11 to the hot water supply pipe 3, and a heat source machine controller 20 which controls the entire operation of the heat source machine 10.

The heat source machine controller 20 is an electronic circuit unit composed of a CPU, a memory, an interface circuit and the like (not illustrated). The heat source machine controller 20 executes, on the CPU, a control program for the heat source machine 10 which is retained in the memory thereby to implement a function for controlling the operation of the heat source machine 10.

The heat source machine controller 20 receives detection signals from the heat source machine flow rate sensor 12, the input water temperature sensor 14, and the first output hot water temperature sensor 15. Based on the detection signals, the heat source machine controller 20 recognizes a flow rate Fin of the water supplied to the heat source machine 10 (hereinafter referred to as the heat source flow rate Fin), a temperature Tin of the water supplied from the water supply pipe 2 to the heat source machine 10 (hereinafter referred to as the heat source input water temperature Tin), and a temperature Tout of the hot water output from the heat source machine 10 to the hot water supply pipe 3 (hereinafter referred to as the heat source output hot water temperature Tout).

Further, based on a control signal output from the heat source machine controller 20, the opening degree of the heat source machine flow rate changing valve 13 and the heating amount of the heat exchanger 11 are controlled. The heat exchanger 11 is heated by a burner (not illustrated), which uses gas or oil or the like as the fuel thereof, and the heating amount in the heat exchanger 11 is controlled by changing the combustion amount of the burner.

Further, a heat source machine remote control 30 for setting the temperature of the hot water output from the heat source machine 10 to the hot water supply pipe 3 (a second desired hot water temperature), the temperature of the hot water output from the faucet 5 (a first desired hot water temperature) and the like is connected to the heat source machine controller 20 in an intercommunicable manner.

The heating connection unit 40a includes a hot water supply bypass pipe 45 that provides communication between a branching point A of the water supply pipe 2 and a merging point D of the hot water supply pipe 3, a supplied water flow rate changing valve 80 that changes the opening degree of the water supply pipe 2 (corresponding to the supplied water flow rate changer in the present invention), a heating pipe 46 that provides communication between a branching point C of the hot water supply pipe 3 and a merging point B of the water supply pipe 2, a heating flow rate sensor 41 that detects a flow rate Fc of the hot water flowing through the heating pipe 46 (hereinafter referred to as the heating flow rate Fc), a heating return temperature sensor 42 that detects a temperature Tc of the hot water flowing to the merging point B from the heating pipe 46 (hereinafter referred to as the heating return temperature Tc), a heating flow rate changing valve 44 that changes the opening degree of the heating pipe 46 (corresponding to the heating flow rate changer in the present invention), and a connection unit controller 50a that controls the entire operation of the heating connection unit 40a.

Further, a heater 60 (e.g., a hot air heater or a floor heating equipment) provided with a pump 62 that circulates hot water in the heating pipe 46 and a radiator 61 that radiates heat from the warm water flowing through the heating pipe 46 thereby to carry out heating is connected on the way of the heating pipe 46.

The connection unit controller 50a is an electronic circuit unit composed of a CPU, a memory, an interface circuit and the like, which are not illustrated. The connection unit controller 50a executes, on the CPU, a control program for the heating connection unit 40a stored in the memory so as to function as a heating controller 51a, a hot water supply controller 52a, and a priority controller 53a, thereby controlling the operation of the heating connection unit 40a.

The connection unit controller 50a receives detection signals from the heating flow rate sensor 41 and the heating return temperature sensor 42. The connection unit controller 50a recognizes the heating return temperature Tc and the heating flow rate Fc from the detected signals.

Further, the operations of the pump 62, the heating flow rate changing valve 44, and the supplied water flow rate changing valve 80 are controlled according to control signals output from the connection unit controller 50a. The connection unit controller 50a and the heat source machine controller 20 are connected in an intercommunicable manner.

The connection unit controller 50a recognizes the heat source flow rate Fin, the heat source input water temperature Tin, and the heat source output hot water temperature Tout by communicating with the heat source machine controller 20. The connection unit controller 50a further controls the opening degree of the heat source machine flow rate changing valve 13 by communicating with the heat source machine controller 20.

The user may manipulate the heat source machine remote control 30 to issue an instruction to, for example, set the first desired hot water temperature, the second desired hot water temperature, and to turn on/off the heater 60. The heat source machine remote control 30 transmits the data of the first desired hot water temperature to the heat source machine.
controller 20 when the first desired hot water temperature is set, and transmits the data of the second desired hot water temperature to the heat source machine controller 20 when the second desired hot water temperature is set. Further, the heat source machine controller 20 transfers the data of the first desired hot water temperature and the second desired hot water temperature to the connection unit controller 50a.

[0054] When an instruction for actuating the heater 60 is issued, the heat source machine remote control 30 transmits the data of an instruction to actuate the heater 60 to the heat source machine controller 20. Then, the heat source machine controller 20 transfers the data of the instruction to actuate the heater 60 to the connection unit controller 50a.

[0055] Similarly when an instruction for stopping the heater 60 is issued, the heat source machine remote control 30 transmits the data of the instruction to stop the heater 60 to the heat source machine controller 20. Then, the heat source machine controller 20 transfers the data of the instruction to stop the heater 60 to the connection unit controller 50a.

[0056] The communication between the heat source machine remote control 30 and the heat source machine controller 20 and the communication between the heat source machine controller 20 and the connection unit controller 50a make it possible to set the temperature of the hot water supplied from the faucet 5 and to issue instructions for actuating and stopping the heater 60 by operating the heat source machine remote control 30.

[0057] The heat source machine controller 20 turns on the burner to heat the water flowing through the heat exchanger 11 when the heat source flow rate Fin is equal to or more than an ignition flow rate set beforehand. The heat source machine controller 20 adjusts the combustion amount of the burner such that the heat source output hot water temperature Tout becomes the second desired hot water temperature (e.g. 80°C). Then, when the heat source flow rate Fin reduces to less than the ignition flow rate, the heat source machine controller 20 stops the combustion of the burner.

[0058] The heating controller 51a of the connection unit controller 50a actuates the pump 62 upon receipt of the data of an instruction to start the heating operation from the heat source machine controller 20. As the pump 62 is actuated, the water circulates from the heating pipe 46 to the water supply pipe 2 and the burner of the heat source machine 10 starts combustion, meaning that the heat source machine 10 is in operation. Thus, the heating operation is carried out in which the hot water supplied to the hot water supply pipe 3 from the heat source machine 10 flows into the heating pipe 46 at the branching point C and the heat is dissipated at the radiator 61. While the heating operation is being carried out, the heating flow rate changing valve 44 is basically fully open.

[0059] The heating controller 51a stops the operation of the pump 62 upon receipt of the data of an instruction to stop the heating operation from the heat source machine controller 20. When the pump 62 is stopped, the flow of the hot water from the heating pipe 46 to the water supply pipe 2 is stopped and the combustion of the burner of the heat source machine 10 is stopped. Then, the flow of the hot water from the branching point C of the hot water supply pipe 3 to the heating pipe 46 is stopped, terminating the heating operation.

[0060] The hot water supply controller 52a of the connection unit controller 50a carries out the hot water supply operation when the faucet 5 is turned on and water is supplied to the water supply pipe 2 from a water pipe. At this time, the hot water supply controller 52a changes the opening degree of the heat source machine flow rate changing valve 13 to control the mixing temperature so as to change the mixing ratio between the flow rate of the water to be supplied to the heat source machine 10 from the water supply pipe 2 and the flow rate of the water to be supplied to the hot water supply bypass pipe 45 from the water supply pipe 2 such that the hot water of the first desired hot water temperature is output from the faucet 5. During the hot water supply operation, the supplied water flow rate changing valve 80 is basically fully open.

[0061] Whether the water is being supplied from the water pipe to the water supply pipe 2 is recognized from the difference between the heat source flow rate Fin and the heating flow rate Fc. The hot water supply controller 52a recognizes that the water is being supplied from the water pipe to the water supply pipe 2 when Fin a (a water supply determination value) < Fin = Fc.

[0062] The following will describe the procedure for setting the opening degree of the heat source machine flow rate changing valve 13 to carry out the hot water supply operation at the first desired hot water temperature by the hot water supply controller 52a while the heating operation is being carried out by the heating controller 51a.

[0063] Regarding the hot water flowing through the circulation path of the hot water supply and heating system 1a, a relationship denoted by expression (1) given below holds.

\[ F_{\text{water}} \times T_{\text{set}} = \text{Temperature} \times F_{\text{water}} \times T_{\text{set}} \times (F_{\text{water}} - T_{\text{set}}) \times T_{\text{set}} \times T_{\text{set}} + F_{\text{c}} \]

(1)

[0064] where Fw: Flow rate of water supplied from the water pipe to the water supply pipe 2 (Supplied water flow rate); TSet: 1st desired hot water temperature; Tout: Temperature of the hot water supplied from the heat exchanger 11 to the hot water supply pipe 3 (Temperature of hot water output from the heat source); Fb: Flow rate of the water flowing through the hot water supply bypass pipe 45 (Supplied hot water bypass flow rate, Fb = Fw - Fin + Fc); Tw: Temperature of the water supplied from the water pipe to the water supply pipe 2 (Temperature of supplied water).

[0065] The foregoing expression (1) is transformed into expression (2) below.

\[ F_{\text{b}} = F_{\text{water}} \times (T_{\text{set}} - T_{\text{out}}) + F_{\text{b}} \]

(2)

[0066] Further, the relationship among the supplied water flow rate Fw, the supplied hot water bypass flow rate Fb, and the heating flow rate Fc is denoted by expression (3).

\[ F_{\text{in}} = F_{\text{water}} - F_{\text{water}} \times (T_{\text{set}} - T_{\text{out}}) + F_{\text{c}} \]

(3)

[0067] Substituting the foregoing expression (2) into the foregoing expression (3) leads to expression (4) given below.

\[ F_{\text{in}} = F_{\text{water}} - F_{\text{water}} \times (T_{\text{set}} - T_{\text{out}}) + F_{\text{c}} \]

(4)

[0068] The ratio between the flow rate of the water, which flows from the branching point A of the water supply pipe 2 and the hot water supply bypass pipe 45 to the heat source machine 10 (Fin - Fc), and the flow rate of the water flowing from the branching point A to the hot water supply bypass pipe 45 (the supplied hot water bypass flow rate) Fb changes according to the opening degree of the heat source machine flow rate changing valve 13. More specifically, the relationship denoted by the following expression (5) holds.

\[ F_{\text{in}} - F_{\text{c}} = F_{\text{water}} - F_{\text{b}} \]

(5)
[0069] where k: Distribution ratio of water to the heat source machine 10 at the branching point A, which is set according to the opening degree of the heat source machine flow rate changing valve 13 (0≤k≤1).

[0070] Thus, the supplied water flow rate Fw can be calculated from the detection values of the heat source flow rate Fm, the heating flow rate Fc, and the opening degree of the heat source machine flow rate changing valve 13. Further, the hot water supply controller 52a adjusts the opening degree of the heat source machine flow rate changing valve 13 on the basis of the detected temperature of the heat source output hot water temperature Tout such that the heat source flow rate Fin detected by the heat source machine flow rate sensor 12 coincides with the value calculated according to the foregoing expression (4). Thus, the temperature of the hot water supplied from the hot water supply pipe 3 to the faucet 5 is controlled to the first desired hot water temperature T1set.

[0071] In the mixing temperature control carried out by the hot water supply controller 52a, the data of the second desired hot water temperature may be received from the heat source machine 10 in place of the data of the detected temperature of the heat source output hot water temperature Tout, and the second desired hot water temperature may be used as Tout in the foregoing expression (1).

[0072] Referring now to the flowchart given in FIG. 2, the processing carried out by the priority controller 53a in the operation in which the hot water supply operation and the heating operation are simultaneously performed will be described. The priority controller 53a repeatedly carries out the procedure illustrated by the flowchart of FIG. 2 when the hot water supply operation and the heating operation are simultaneously performed.

[0073] In STEP1 of FIG. 2, the priority controller 53a calculates a hot water supply heat amount Qw, which is the amount of heat consumed in the hot water supply operation, according to expression (6) given below.

\[ Q_w = F_w \times (T_{set} - T_{in}) \]  

(6)

[0074] where Qw: Hot water supply heat amount; Fw: Flow rate of the water supplied from the water pipe to the water supply pipe 2 (Supplied water flow rate); Tset: 1st desired hot water temperature; Tin: Heat source input water temperature

[0075] In subsequent STEP2, the priority controller 53a calculates a heating heat amount Qc, which is the amount of heat consumed in the heating operation, according to expression (7) given below.

\[ Q_c = F_c \times (T_{out} - T_{c}) \]  

(7)

[0076] where Qc: Heat amount of heating; Fc: Heating flow rate; Tout: Heat source output hot water temperature (Heating forward temperature); Tc: Heating return temperature

[0077] In next STEP3, the priority controller 53a sets the maximum heat amount Qmax of the heat source machine 10, i.e. the maximum heat amount that can be obtained from the heat exchanger 11 by the combustion of the burner, through the communication between the connection unit controller 50a and the heat source machine controller 20.

[0078] In next STEP4, the priority controller 53a determines whether the total heat amount of the hot water supply heat amount Qw and the heating heat amount Qc is the maximum heat amount Qmax or more. If the total heat amount of the hot water supply heat amount Qw and the heating heat amount Qc is the maximum heat amount Qmax or more, then the priority controller 53a proceeds to STEP5. If the total heat amount of the hot water supply heat amount Qw and the heating heat amount Qc is less than the maximum heat amount Qmax, then the priority controller 53a branches to STEP7.

[0079] In STEP5, the priority controller 53a determines whether the priority has been set to the hot water supply operation through the heat source machine remote control 30. While the hot water supply operation and the heating operation are being simultaneously performed, the user can operate the heat source machine remote control 30 to set priority to the hot water supply operation so that the hot water supply operation is preferentially performed. However, the priority controller 53a does not preferentially perform heating operation over hot water supply operation.

[0080] Then, the priority controller 53a recognizes whether the priority has been set to the hot water supply operation through the communication with the heat source machine controller 20 and the connection unit controller 50a. The configuration for setting the priority to the hot water supply operation and the priority to the heating operation by the heat source machine remote control 30 corresponds to the preferential operation setter in the present invention.

[0081] If the priority has been set to the hot water supply operation, then the priority controller 53a branches off to STEP20 and carries out one or both of (a) and (b) given below to conduct the hot water supply priority control, which reduces the flow rate of the hot water flowing through the heating pipe 46. The priority controller 53a then proceeds to STEP7.

[0082] (a) decreases the rotational speed of the pump 62

[0083] (b) decreases the opening degree of the heating flow rate changing valve 44

[0084] The configuration for changing the flow rate of the hot water flowing through the heating pipe 46 by changing the rotational speed of the pump 62 or the opening degree of the heating flow rate changing valve 44 corresponds to the heating flow rate changer in the present invention.

[0085] The hot water supply priority control reduces the flow rate of the hot water flowing through the heating pipe 46 to thereby reduce the flow rate of the hot water flowing into the water supply pipe 2 from the heating pipe 46, resulting in a reduced flow rate of the water that flows through the heat exchanger 11 so as to be heated. This makes it possible to maintain the temperature of the hot water output from the heat exchanger 11 to the hot water supply pipe 3 at the second desired hot water temperature T2set, thus preventing the temperature of the hot water supplied from the faucet 5 from becoming lower than the first desired hot water temperature T1set.

[0086] Meanwhile, if it is determined in STEP5 that the priority has not been set for the hot water supply operation, i.e. if the priority has been set to the heating operation, then the priority controller 53a proceeds to STEP6 to carry out one or both of (c) and (d) given below. The priority controller 53a then carries out the heating priority control, by which the flow rate of the water supplied to the heat exchanger 11 from the waterworks through the water supply pipe 2 is reduced, and proceeds to STEP7.

[0087] (c) decreases the first desired hot water temperature T1set. Decreasing the first desired hot water temperature T1set increases the proportion of the water flowing to the hot water supply bypass pipe 45, among the water being supplied to the water supply pipe 2 from the waterworks. Hence, the
flow rate of the hot water supplied to the heat exchanger 11 from the water supply pipe 2 decreases.

(d) decreases the opening degree of the supplied water flow rate changing valve 80. The opening degree of the supplied water flow rate changing valve 80 is decreased to decrease the flow rate of the water supplied to the water supply pipe 2 from the waterworks, thereby decreasing the flow rate of the water supplied to the heat exchanger 11 from the water supply pipe 2.

The heating priority control is carried out to reduce the flow rate of the water supplied to the heat exchanger 11 from the waterworks through the water supply pipe 2 thereby to decrease the flow rate of the water that circulates through the heat exchanger 11 so as to be heated. Thus, the hot water of the second desired hot water temperature T2set can be supplied to the heat exchanger 11 at the second desired hot water temperature T2set, allowing the heating to be implemented by the heater 60.

When the hot water supply operation is being performed with the first desired hot water temperature T1set decreased by the foregoing processing of (c), the first desired hot water temperature T1set, which has been decreased, may be indicated on the display of the heat source machine remote control 30. Alternatively, the fact that the first desired hot water temperature T1set has been decreased by the heating priority control and the temperature of the hot water supplied from the faucet 5 has decreased may be visually or audibly notified.

In STEP7, the priority controller 53a determines whether the hot water supply operation or the heating operation has been stopped and an individual operation of either the hot water supply operation alone or the heating operation alone is being performed. If it is determined that the individual operation is being performed, then the priority controller 53a proceeds to STEP8 and terminates the processing. Meanwhile, if it is determined that the individual operation is not being performed, i.e., if the hot water supply operation and the heating operation are still being simultaneously performed, then the priority controller 53a returns to STEP6 and again carries out the processing from STEP6 and after.

Second Embodiment

Refer to FIG. 3, a hot water supply and heating system 1b of a second embodiment will be described. The same components as those of the hot water supply and heating system 1a of the first embodiment will be assigned the same reference numerals, and the description thereof will be omitted. The configurations of a heat source machine 10 and a heater 60 of the hot water supply and heating system 1b are the same as those of the hot water supply and heating system 1a of the first embodiment.

The hot water supply and heating system 1b differs from the hot water supply and heating system 1a of the first embodiment in that the heating connection unit 40b does not have the function to communicate with the heat source machine 10. Further, in order to perform the hot water supply operation without communication with the heat source machine 10, the heating connection unit 40b is provided with a water temperature sensor 43 that detects a temperature Tout of the hot water supplied from a hot water supply pipe 3 (hereinafter referred to as the heat source output hot water temperature Tout), a supplied hot water bypass temperature sensor 47 that detects a temperature Tb of the water flowing through a hot water supply bypass pipe 45 (hereinafter referred to as the supplied hot water bypass temperature Tb), a supplied hot water bypass flow rate sensor 48 that detects a flow rate Fb of the water flowing through the hot water supply bypass pipe 45 (hereinafter referred to as the supplied hot water bypass flow rate Fb), and a bypass flow rate changing valve 49 that changes the opening degree of the hot water supply bypass pipe 45.

Further, the heating connection unit 40b has a connection unit controller 50b that controls the entire operation of the heating connection unit 40b and a connection unit remote control 70 connected to the connection unit controller 50b.

The connection unit controller 50b is an electronic circuit unit composed of a CPU, a memory, an interface circuit and the like, which are not illustrated. The connection unit controller 50b executes, on the CPU, a control program for the heating connection unit 40b stored in the memory so as to function as a heating controller 51b, a hot water supply controller 52b, and a priority controller 53b, thereby controlling the operation of the heating connection unit 40b.

The connection unit controller 50b recognizes the sensor output hot water temperature Tout, a heating return temperature sensor 41, a heating return temperature sensor 42, an output hot water temperature sensor 43, the supplied hot water bypass temperature sensor 47, and the supplied hot water bypass flow rate sensor 48. From the detection signals, the connection unit controller 50b recognizes the sensor output hot water temperature Tout, a heating return temperature sensor 41, the heating return temperature sensor 42, an output hot water temperature sensor 43, the supplied hot water bypass temperature sensor 47, and the supplied hot water bypass flow rate sensor 48. From the detection signals, the connection unit controller 50b recognizes the sensor output hot water temperature Tout, a heating return temperature sensor 41, the heating return temperature sensor 42, an output hot water temperature sensor 43, the supplied hot water bypass temperature sensor 47, and the supplied hot water bypass flow rate sensor 48.

Further, the operations of a pump 62, the bypass flow rate changing valve 49, a heating flow rate changing valve 44, and a hot water supply flow rate changing valve 80 are controlled according to the control signals output from the connection unit controller 50b.

The connection unit remote control 70 enables a user to, for example, set a first desired hot water temperature and issue instructions for turning on/off the heater 60. The connection unit remote control 70 transmits the data of a desired hot water temperature to the connection unit controller 50b when the first desired hot water temperature is set.

Further, the connection unit remote control 70 transmits the data of an instruction to actuate the heater 60 to the connection unit controller 50b when the instruction for actuating the heater 60 is issued. Similarly, when an instruction for stopping the heater 60 is issued, the connection unit remote control 70 transmits the data of the instruction to stop the heater 60 to the connection unit controller 50b.

The communication between the connection unit remote control 70 and the connection unit controller 50b makes it possible to set the temperature of the hot water output from a faucet 5 and to issue instructions to turn on/off the heater 60 by operating the connection unit remote control 70.

The heating controller 51b of the connection unit controller 50b actuates a pump 62 upon receipt of the data of an instruction to start the heating operation from the connection unit remote control 70. As the pump 62 is actuated, the water flows from a heating pipe 46 to a water supply pipe 2 and the burner of the heat source machine 10 starts combustion, meaning that the heat source machine 10 is in operation. Thus, the heating operation is carried out, in which the hot
water supplied to the hot water supply pipe 3 from the heat source machine 10 flows into the heating pipe 46 at a branching point C and the heat is dissipated at a radiator 61.

The heating controller 51b stops the operation of the pump 62 upon receipt of the data of an instruction to stop the heating operation from the connection unit remote control 70. When the pump 62 is stopped, the flow of the hot water from the heating pipe 46 into the water supply pipe 2 is stopped and the combustion of the burner of the heat source machine 10 is stopped. Then, the flow of the hot water from the branching point C of the hot water supply pipe 3 to the heating pipe 46 is stopped, terminating the heating operation.

The hot water supply controller 52b of the connection unit controller 50b changes the opening degree of the bypass flow rate changing valve 49 so as to change the ratio between the flow rate of the water supplied from the water supply pipe 2 to the heat source machine 10 and the flow rate of the water supplied from the water supply pipe 2 to the hot water supply bypass pipe 45 such that the hot water of a first desired hot water temperature T1set is output from the faucet 5 when the faucet 5 is turned on to supply water from a water pipe to the water supply pipe 2.

The hot water supply controller 52b recognizes that the water is being supplied from the water pipe to the water supply pipe 2 when a supplied hot water bypass flow rate Fb is Fb1 or more (Fb2≥Fb).

A description will now be given of the procedure for setting the bypass ratio when carrying out the hot water supply operation at the first desired hot water temperature T1set by the hot water supply controller 52b.

The relationship denoted by the foregoing expressions (1) to (4) applies to the hot water flowing through the circulating path of the hot water supply and heating system 1b, as with the hot water supply and heating system 1a described above. Further, the ratio between the flow rate of the water flowing from a branching point A of the water supply pipe 2 and the hot water supply bypass pipe 45 to the heat source machine 10 and the flow rate of the water flowing from the branching point A to the hot water supply bypass pipe 45 (the supplied hot water bypass flow rate Fb) changes according to the opening degree of the bypass flow rate changing valve 49. More specifically, the relationship denoted by expression (8) given below holds.

\[ F_b = \frac{F_w}{g} \]  

(8)

where \( F_w \): Flow rate of water supplied from the water pipe to the water supply pipe 2 (supplied water flow rate), \( g \): Proportion of water distributed to the hot water supply bypass pipe 45 at branching point A, which is set on the basis of the opening degree of the bypass flow rate changing valve 49 \((0 \leq g \leq 1)\)

Thus, the supplied water flow rate \( F_w \) can be calculated from the detection value of the supplied hot water bypass flow rate \( F_b \) and the opening degree of the bypass flow rate changing valve 49. Then, the hot water supply controller 52b adjusts the opening degree of the bypass flow rate changing valve 49 on the basis of the detection temperature of the heat source output hot water temperature Tout such that the supplied hot water bypass flow rate \( F_b \) detected by the supplied hot water bypass flow rate sensor 48 coincides with the value calculated according to the foregoing expression (2). Thus, the temperature of the hot water supplied from the hot water supply pipe 3 to the faucet 5 is controlled to the first desired hot water temperature T1set.

Subsequently, as with the priority controller 53a in the first embodiment described above, if the total heat amount of a hot water supply heat amount Qw and a heating heat amount Qc reaches a maximum heat amount Qmax or more while the hot water supply operation and the heating operation are being simultaneously performed, then a priority controller 53b carries out a hot water supply operation priority control or a heating operation priority control.

In the second embodiment, however, there is no communication between the heat source machine controller 20 and the connection unit controller 50b, so that the data of the maximum heat amount Qmax of the heat source machine 10 must be stored beforehand in a memory (not illustrated) of the connection unit controller 50b. The priority controller 53b reads the data retained in the memory to acquire the maximum heat amount Qmax.

Further, the user sets priority to the hot water supply operation and sets priority to the heating operation by operating the connection unit remote control 70 rather than the heat source machine remote control 30. The configuration for setting the priority to the hot water supply operation and the priority to the heating operation by the connection unit remote control 70 corresponds to the preferential operation setter in the present invention.

In the embodiments, the heat source machine 10 provided with a burner 22 has been described as a heating means. However, the present invention can be applied also to a hot water supply device that uses a different type of heating means, such as an electric heater, or a burner that burns a different type of fuel, such as a burner using oil as the fuel thereof.

Further, in the embodiments, the temperature of the hot water supplied from the heat source machines 10 to the heating connection units 40a and 40b (the second desired hot water temperature) has been set by the heat source machine remote control 30; however, the second desired hot water temperature may be a fixed temperature (e.g. 80° C.), which is set in advance.

What is claimed is:

1. A hot water supply and heating system comprising:
   a heat source machine which is connected to a water supply pipe and a hot water supply pipe to heat water flowing from the water supply pipe to the hot water supply pipe; a heating pipe which is branched off from the hot water supply pipe and which is in communication with the water supply pipe;
   a heater which is connected on a way of the heating pipe and which has a pump, which circulates water in the heating pipe via the heat source machine, and a radiator;
   a hot water supply bypass pipe which provides communication between a portion of the water supply pipe on an upstream side relative to a place where the water supply pipe is connected with the heating pipe and a portion of the hot water supply pipe on a downstream side relative to a place where the hot water supply pipe is connected with the heating pipe;
   a heating controller which is configured to actuate the pump in a state, wherein the heat source machine is in operation, thereby to carry out a heating operation in which heat is radiated from the radiator;
   a hot water supply controller which is configured to carry out a hot water supply operation by carrying out mixing temperature control whereby to adjust a mixing ratio of the hot water from the hot water supply pipe and the
water from the hot water supply bypass pipe at a place where the hot water supply pipe and the hot water supply bypass pipe are connected such that hot water of a first desired hot water temperature is supplied to a hot water outlet tap connected to a downstream end of the hot water supply pipe in the state wherein the heat source machine is in operation;

a heating flow rate changer which is configured to change the flow rate of hot water circulating in the heating pipe; and

a priority controller which is configured to carry out hot water supply priority control whereby to reduce the flow rate of the hot water flowing through the heating pipe by the heating flow rate changer in a case where a total of an amount of heat consumed in the heating operation and an amount of heat consumed in the hot water supply operation is equal to or more than a maximum amount of heat that can be applied by the heat source machine during a simultaneous operation of the heating operation and the hot water supply operation.

2. The hot water supply and heating system according to claim 1, comprising:

a preferential operation setter which is configured to set priority to either the heating operation or the hot water supply operation during the simultaneous operation of the heating operation and the hot water supply operation, wherein, in the case where the total of the amount of heat consumed in the heating operation and the amount of heat consumed in the hot water supply operation is equal to or more than the maximum amount of heat, the priority controller is configured to carry out the hot water supply priority control in the case where the priority has been set to the hot water supply operation by the preferential operation setter, and to carry out a heating priority control to reduce the first desired hot water temperature in the case where the priority has been set to the heating operation by the preferential operation setter.

3. The hot water supply and heating system according to claim 2, wherein in a case where the heating priority control whereby the first desired hot water temperature has been decreased is carried out, the priority controller notifies that it is in a state in which the first desired hot water temperature has been decreased.

4. The hot water supply and heating system according to claim 1, comprising:

a preferential operation setter which sets priority to either the heating operation or the hot water supply operation during the simultaneous operation of the heating operation and the hot water supply operation; and

a supplied water flow rate changer which is configured to change the flow rate of water supplied to the water supply pipe,

wherein, in the case where the total of the amount of heat consumed in the heating operation and the amount of heat consumed in the hot water supply operation is equal to or more than the maximum amount of heat, the priority controller carries out the hot water supply priority control in a case where a priority has been set to the hot water supply operation by the preferential operation setter and carries out a heating priority control to reduce, by the supplied water flow rate changer, the flow rate of water to be supplied to the water supply pipe in a case where the priority has been set to the heating operation by the preferential operation setter.

5. The hot water supply and heating system according to claim 1, comprising:

a output hot water temperature sensor which detects a temperature of hot water output to the hot water supply pipe from the heat source machine,

wherein the hot water supply controller carries out the mixing temperature control based on a temperature detected by the output hot water temperature sensor.

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