A hot water supply apparatus associated with a heat pump is disclosed herein. The hot water supply apparatus may include a main refrigerant circuit that includes a compressor, an indoor heat exchanger, an expander, and an outdoor heat exchanger; a hot water supply circuit connected to the main refrigerant circuit; a first flowrate regulator that adjusts a first flowrate of refrigerant that flows from the compressor through the main refrigerant circuit; a second flowrate regulator that adjusts a second flowrate of refrigerant that flows from the compressor to the hot water supply circuit; and a controller configured to control the first and second flowrate regulators based on a load on at least one of the main refrigerant circuit or the hot water supply circuit.
FIG. 3

START

SIMULTANEOUS OPERATION MODE SIGNAL RECEIVED?

YES

ADJUST REFRIGERANT FLOW RATE SO THAT HOT WATER SUPPLY SIDE REFRIGERANT FLOW RATE > HEATING SIDE REFRIGERANT FLOW RATE

DETECT HOT WATER TEMPERATURE AND HEATING TEMPERATURE

THE CURRENT HOT WATER TEMPERATURE > TARGET HOT WATER TEMPERATURE AND THE CURRENT HEATING TEMPERATURE > TARGET HEATING TEMPERATURE?

YES

INCREASE OPERATIONAL RATE OF COMPRESSOR

NO

INCREASE HOT WATER SUPPLY SIDE REFRIGERANT FLOW RATE AND DECREASE HEATING SIDE REFRIGERANT FLOW RATE

THE CURRENT HOT WATER TEMPERATURE < TARGET HOT WATER TEMPERATURE?

YES

INCREASE HEATING SIDE REFRIGERANT FLOW RATE AND DECREASE HOT WATER SUPPLY SIDE REFRIGERANT FLOW RATE

NO

SWITCH OR OPERATION STOP SIGNAL?

YES

END

NO
FIG. 4

START

HOT WATER SUPPLY PRIORITY MODE SIGNAL RECEIVED? NO

YES S32

DETECT HOT WATER TEMPERATURE

TEMPERATURE DIFFERENCE BETWEEN TARGET HOT WATER TEMPERATURE AND THE CURRENT HOT WATER TEMPERATURE < REFERENCE? NO S35

INTERCEPT FLOW OF REFRIGERANT DIRECTLY FLOWING TOWARD COOLING/HEATING SIDE

YES S36

DETECT HOT WATER TEMPERATURE

TEMPERATURE DIFFERENCE BETWEEN TARGET HOT WATER TEMPERATURE AND THE CURRENT HOT WATER TEMPERATURE < REFERENCE? YES S38

RETURN TO STATE PRIOR TO INTERCEPTING FLOW OF COOLING/HEATING SIDE REFRIGERANT

NO S34

MODE SWITCH OR OPERATION STOP SIGNAL? NO

YES

END
FIG. 9

START

DETECT FLOW RATE OF HOT WATER SUPPLY SIDE REFRIGERANT AND FLOW RATE OF HEATING SIDE REFRIGERANT

S41

IS RATIO OF HOT WATER SUPPLY SIDE REFRIGERANT FLOW RATE TO HEATING SIDE REFRIGERANT FLOW RATE GREATER THAN PRESCRIBED VALVE?

S42

NO

INTRODUCE HOT WATER DISCHARGE REFRIGERANT INTO INDOOR HEAT EXCHANGER

S43

YES

S44

HOT WATER DISCHARGE REFRIGERANT BYPASS INDOOR HEAT EXCHANGER

NO

MODE SWITCH OR OPERATION STOP SIGNAL?

S45

YES

END
HOT WATER SUPPLY DEVICE ASSOCIATED WITH HEAT PUMP AND METHOD FOR CONTROLLING THE SAME

CROSS-REFERENCE TO RELATED APPLICATION(S)


BACKGROUND

[0002] 1. Field
[0003] A hot water supply apparatus for a heat pump and a method for controlling the same are disclosed herein.
[0004] 2. Background
[0005] Hot water supply apparatuses for a heat pump and methods for controlling the same are known. However, they suffer from various disadvantages.

BRIEF DESCRIPTION OF THE DRAWINGS

[0006] The embodiments will be described in detail with reference to the following drawings in which like reference numerals refer to like elements wherein:
[0007] FIG. 1 is a schematic view of a hot water supply apparatus associated with a heat pump according to an embodiment;
[0008] FIG. 2 is a control block diagram of the hot water supply apparatus associated with the heat pump of FIG. 1;
[0009] FIG. 3 is a flowchart of a method of controlling a hot water supply apparatus associated with a heat pump which is operated in a hot water supply and heating modes at the same time according to an embodiment;
[0010] FIG. 4 is a flowchart of a method of controlling a hot water supply apparatus associated with a heat pump which is operated in a hot water supply priority mode according to an embodiment;
[0011] FIG. 5 is a schematic view of a hot water supply apparatus associated with a heat pump according to another embodiment;
[0012] FIG. 6 is a schematic view of a hot water supply apparatus associated with a heat pump according to another embodiment;
[0013] FIG. 7 is a schematic view of a hot water supply apparatus associated with a heat pump according to another embodiment;
[0014] FIG. 8 is a schematic view of a hot water supply apparatus associated with a heat pump according to another embodiment;
[0015] FIG. 9 is a flowchart of a method of controlling the hot water supply apparatus associated with the heat pump of FIG. 8;
[0016] FIG. 10 is a schematic view of a hot water supply apparatus associated with a heat pump according to another embodiment; and
[0017] FIG. 11 is a schematic view of a hot water supply apparatus associated with a heat pump according to another embodiment.

DETAILED DESCRIPTION

[0018] A hot water supply apparatus may use a heating source to heat water and supply the heated water to a user. In this case, an apparatus that includes a heat pump to heat water and to supply the heated water to a user can be referred to as a hot water supply apparatus associated with a heat pump.

[0019] The hot water supply apparatus associated with the heat pump may include a water supply passage that supplies water, a water storage part that stores the water supplied through the water supply passage, a heating source that heats the supplied water, and a water discharge passage that supplies the heated water to a user.

[0020] The heat pump may include a compressor that compresses a refrigerant, a condenser that condenses the refrigerant discharged from the expander, an expander that expands the refrigerant from the condenser, an evaporator that evaporates the refrigerant expanded through the expander, and a refrigerant pipe that connects the compressor, the condenser, the expander, and the evaporator to form a refrigerant cycle.

[0021] While the refrigerant flows in the heat pump, the refrigerant may absorb heat in the evaporator and may emit heat in the condenser. The refrigerant may transmit heat to the water in the hot water supply apparatus, so that the hot water supply apparatus can perform a hot water supply operation.

[0022] FIG. 1 is a schematic view of a hot water supply apparatus associated with a heat pump according to an embodiment. Here, a hot water supply apparatus 1 associated with a heat pump may include a main refrigerant circuit 10 and a hot water supply heat exchanger 121. The main refrigerant circuit 10 may include a compressor 101, an indoor heat exchanger 102, an expander 103, and an outdoor heat exchanger 104 to form a refrigerant cycle. The hot water supply heat exchanger 121 may perform a hot water supply operation using high-temperature refrigerant discharged from the compressor 101 of the main refrigerant circuit 10.

[0023] The main refrigerant circuit 10 may further include a cooling/heating switch 105 (flow switch) which may selectively reverse a flow direction of the refrigerant discharged from the compressor 101 to allow the refrigerant to flow toward one of the indoor heat exchanger 102 or the outdoor heat exchanger 104. The main refrigerant circuit 10 may also include a main refrigerant pipe 11 that connects the compressor 101, the cooling/heating switch 105, the indoor heat exchanger 102, the expander 103, and the outdoor heat exchanger 104 to each other.

[0024] Here, the flow direction of the refrigerant may be reversed by the cooling/heating switch 105 such that the main refrigerant circuit 10 operates in an indoor air-conditioning mode for either cooling or heating. For example, an air-conditioning operation performed by the main refrigerant circuit 10 may be performed through a heating operation to heat indoor air or a cooling operation to cool the indoor air.

[0025] Also, the main refrigerant pipe 11 may include a compressor discharge side pipe 111 in which the refrigerant discharged from the compressor 101 may flow, an indoor heat exchanger connection pipe 112 which may connect the cooling/heating switch 105 to the indoor heat exchanger 102, an indoor heat exchanger-expander connection pipe 113 which may connect the indoor heat exchanger 102 to the expander 103, an outdoor heat exchanger-expander connection pipe 114 which may connect the outdoor heat exchanger 104 to the expander 103, an outdoor heat exchanger connection pipe 115 which may connect the outdoor heat exchanger 104 to the cooling/heating switch part 105, and a compressor inflow side pipe 116 in which the refrigerant passing through the cooling/heating switch 105 may flow toward the compressor 101.

[0026] In more detail, when the hot water supply apparatus 1 associated with the heat pump performs the heating oper-
tion, the cooling/heating switch 105 may connect the compressor discharge side pipe 111 to the indoor heat exchanger connection pipe 112 and the outdoor heat exchanger connection pipe 115 to the compressor inflow side pipe 116. The refrigerant discharged from the compressor 101 may sequentially pass through the indoor heat exchanger 102, the expander 103, and the outdoor heat exchanger 104, and reintroduced into the compressor 101. Thus, the indoor heat exchanger may serve as a condenser. For example, the refrigerant may be condensed in the indoor heat exchanger 102 to heat the indoor air, e.g., to perform the indoor heating operation.

[0027] Also, when the hot water supply apparatus 1 associated with the heat pump performs the cooling operation, the heating/cooling switch 105 may connect the compressor discharge side pipe 111 to the outdoor heat exchanger connection pipe 115 and the indoor heat exchanger connection pipe 112 to the compressor inflow side pipe 116. The refrigerant discharged from the compressor 101 may be configured to sequentially pass through the outdoor heat exchanger 104, the expander 103, and the indoor heat exchanger 102, and then returned to the compressor 101. Thus, the indoor heat exchanger 102 may operate as an evaporator. For example, the indoor heat exchanger 102 may be configured to evaporate the refrigerant to cool the indoor air, e.g., to perform the indoor cooling operation.

[0028] An accumulator 106 which may prevent the refrigerant in a liquid state from being introduced into the compressor 101 may be installed on the compressor inflow side pipe 116. Also, an oil separator 107 may be provided on the compressor discharge side pipe 111 to separate oil contained in the refrigerant discharged from the compressor 101. The oil separator 107 may return the recovered oil back to the compressor 101.

[0029] The indoor heat exchanger 102 may perform the indoor cooling or heating operations by performing heat exchange between the indoor air and the refrigerant. An indoor fan 108 may be installed on a surface (e.g., an outer circumferential surface) of the indoor heat exchanger 102 to circulate the indoor air into the indoor heat exchanger 102.

[0030] Also, in the outdoor heat exchanger 104, the refrigerant may undergo heat-exchange, and thus may be condensed or evaporated. The outdoor heat exchanger 104 may include an air cooling type heat exchanger in which a heat exchange process may be performed between the outdoor air and the refrigerant or a water cooling type heat exchanger in which a heat exchange process may be performed between cooling water and the refrigerant. Simply for ease of explanation, an outdoor heat exchanger that includes the air cooling type heat exchanger will be described hereinafter as an example. In this case, an outdoor fan 109 that blows the outdoor air into the outdoor heat exchanger 104 may be installed at a circumferential surface of the outdoor heat exchanger 104.

[0031] The expander 103 may be disposed between the indoor heat exchanger 102 and the outdoor heat exchanger 104 in the refrigeration cycle. The expander 103 may expand the condensed refrigerant in the indoor heat exchanger 102 or the outdoor heat exchanger 104.

[0032] A hot water supply passage 12 may be connected to the main refrigerant circuit 10. The hot water supply passage 12 may allow refrigerant flowing toward the main refrigerant circuit 10 to be bypassed into the hot water supply heat exchanger 121. The hot water supply passage 12 may include a hot water side inflow pipe 122 that guides the refrigerant from the main refrigerant circuit 10 (e.g., the refrigerant discharged from the compressor 101) to the hot water supply heat exchanger 121, and a hot water side discharge pipe 123 that guides the refrigerant from the hot water supply heat exchanger 121 back to the main refrigerant circuit 10 (e.g., at the cooling/heating switch part 105). The hot water side inflow pipe 122 and the hot water side discharge pipe 123 may be connected to the main refrigerant pipe 11 between the compressor 101 and the cooling/heating switch 105 in the refrigeration cycle.

[0033] In more detail, the hot water side inflow pipe 122 may have one end connected to the compressor discharge side pipe 111 and the other end connected to the hot water supply heat exchanger 121. Also, the hot water side discharge pipe 123 may have one end connected to the hot water supply heat exchanger 121 and the other end connected to the compressor discharge side pipe 111.

[0034] The hot water supply heat exchanger 121 may include a refrigerant passage, through which an overheated refrigerant may pass, and a water passage, through which water used for the hot water supply may pass. The hot water supply heat exchanger 121 may include a double pipe type heat exchanger in which two pipes having coaxial radii which are different from each other forms the refrigerant passage and the water passage. In one embodiment, the hot water supply heat exchanger 121 may include a plate type heat exchanger in which the refrigerant passage and the water passage may be alternately disposed with a heat transfer member provided therebetween.

[0035] The hot water supply heat exchanger 121 may be connected to a hot water supply tank 125 by the hot water supply pipe 124. The hot water supply pipe 124 may guide the water to circulate the water between the hot water supply heat exchanger 121 and the hot water supply tank 125. A pump 126 may be provided on the hot water supply pipe 124 to forcibly circulate the water within the hot water supply pipe 124. Also, the hot water supply tank 125 may store water to be supplied to a user. A water supply passage 127 may be provided on the hot water supply tank 125 to supply external water. Moreover, a water discharge passage 128 may connect the hot water supply tank 125 to a water outlet such as a shower head or faucet.

[0036] Here, the hot water supply tank 125 may be configured to directly supply the water introduced into the hot water supply tank 125 to the user through the water discharge passage 128 after the water is heated in the hot water supply heat exchanger 121. Also, a hot water supply coil connected to the hot water supply pipe 124 may be installed inside the hot water supply tank 125. The water heated in the hot water supply heat exchanger 121 may heat the water within the hot water supply tank 125 while passing through the hot water supply coil. Also, the water supplied into the water supply passage 127 may be heated by the hot water supply coil, and then may be supplied to the user through the water discharge passage 128.

[0037] The hot water supply device 1 associated with the heat pump may further include a flowrate adjustment part 13 (flowrate regulator or flowrate controller) that adjusts an amount of the refrigerant introduced into the hot water supply heat exchanger 121 and an amount of the refrigerant that bypasses the hot water supply heat exchanger 121. The flowrate regulator 13 may adjust an amount of the refrigerant discharged from the compressor 101 to flow along the main
refrigerant circuit 10 and an amount of the refrigerant that bypasses the hot water supply heat exchanger 121.

[0038] The flowrate regulator 13 may include a cooling/heating side flowrate regulator 131 provided on the compressor discharge side pipe 111 and a hot water supply side flowrate regulator 132 provided on the hot water side inflow pipe 112. The cooling/heating side flowrate regulator 131 may be installed on the main refrigerant pipe 11 between the ends of the hot water supply passage 12 in the refrigerant cycle.

[0039] Here, the cooling/heating side flowrate regulator 131 and the hot water supply side flowrate regulator 132 may be linearly adjust a degree in which the flowrate regulators are open. Thus, an amount of refrigerant introduced into the hot water supply heat exchanger 121 (e.g., the hot water supply side) and an amount of refrigerant that bypasses the hot water supply heat exchanger 121 to flow into the main refrigerant circuit 10 (e.g., the cooling/heating side) may be varied linearly according to a ratio between an open degree of the cooling/heating side flowrate regulator 131 and a open degree of the hot water supply side flowrate regulator 132.

[0040] For example, when a hot water supply load is greater than a cooling/heating load, either the cooling/heating side flowrate regulator 131 may be closed a greater degree or the hot water supply side flowrate regulator 132 may opened a greater degree. Thus, an amount of the refrigerant introduced into the hot water supply side may be relatively increased. Also, when the cooling/heating load is greater than the hot water supply load, either the hot water supply side flowrate regulator 132 may be closed to a greater degree or the cooling/heating side flowrate regulator 131 may be opened to a greater degree to relatively increase an amount of the refrigerant introduced into the cooling/heating side.

[0041] Of course, the cooling/heating side flowrate regulator 131 may be completely closed or the hot water supply side flowrate regulator 132 may be completely closed to allow the discharge side refrigerant of the compressor 101 to flow completely into the hot water supply heat exchanger 121 or to bypass the hot water supply heat exchanger 121 to flow directly into the cooling/heating side, e.g., the main refrigerant circuit.

[0042] Referring again to FIG. 1, a flow of refrigerant when the hot water supply apparatus 1 associated with the heat pump operates in the heating mode will be described. The flow of refrigerant in the heating mode is illustrated in the drawings by solid arrows and the flow of refrigerant in the cooling mode is illustrated in the drawings by dotted arrows. The refrigerant discharged from the compressor 101 may pass sequentially through the cooling/heating switch 105, the indoor heat exchanger 102, the expander 103, and the outdoor heat exchanger 104, and then may be reintroduced into the compressor 101 through the cooling/heating switch 105, as illustrated by the solid arrows. Here, since the refrigerant heats the indoor air while being condensed in the indoor heat exchanger 102, indoor heating may be performed.

[0043] When the hot water supply apparatus 1 associated with the heat pump operates in the cooling mode, the refrigerant discharged from the compressor 101 may pass sequentially through the cooling/heating switch 105, the outdoor heat exchanger 104, the expander 103, and the indoor heat exchanger 102, and then may be reintroduced into the compressor 101 through the cooling/heating switch 105, as illustrated by the dotted arrows. Here, since the refrigerant cools the indoor air while being evaporated in the indoor heat exchanger 102, indoor cooling may be performed.

[0044] Also, when the hot water supply apparatus 1 associated with the heat pump performs a defrosting operation, a reverse cycle refrigerant flow may be performed in the main refrigerant circuit 10 while the hot water supply operation is continued. In more detail, the refrigerant flow during the defrosting operation may correspond to a reverse cycle with respect to the refrigerant flow during the heating operation of the hot water supply apparatus 1 associated with the heat pump. For example, the refrigerant flow when the hot water supply apparatus 1 associated with the heat pump performs the defrosting operation is equal to that when the hot water supply apparatus 1 associated with the heat pump performs the cooling operation.

[0045] Regardless of the direction in which the refrigerant flows in the main refrigerant circuit 10, at least portion of the refrigerant discharged from the compressor 101 may be introduced into the hot water supply heat exchanger 121. In other words, regardless of whether the hot water supply apparatus 1 associated with the heat pump operates in the cooling mode or defrost mode, the hot water supply process may be continuously performed by the hot water supply apparatus 1.

[0046] A portion of the refrigerant discharged from the compressor 101 during the heating operation or cooling operation may be introduced into the hot water supply heat exchanger 121 to perform the hot water supply operation and the heating operation at the same time, or the hot water supply operation and the cooling operation at the same time. Also, a state of the cooling/heating side flowrate regulator 131 and the hot water supply side flowrate regulator 132 may be adjusted to vary an amount of the refrigerant introduced into the hot water supply heat exchanger 121 and an amount of the refrigerant introduced into the cooling/heating switch part 105 without passing through the hot water supply heat exchanger 121. In other words, during a simultaneous hot water supply and heating operation or during the simultaneous hot water supply and cooling operation, a performance of the hot water supply, heating, or cooling operations may be varied.

[0047] Here, when the cooling/heating side flowrate regulator 131 is at least partially opened, the hot water supply heat exchanger 121 may serve as a desuperheater in which high-temperature overheated refrigerant discharged from the compressor 101 may undergo heat-exchange with water for the hot water supply and may be condensed to generate the hot water.

[0048] The hot water supply apparatus 1 associated with the heat pump may include an outdoor unit 14 and an indoor unit 15, which are disposed in an outdoor space and an indoor space, and a hot water supply device 16 provided for the hot water supply.

[0049] The compressor 101, the cooling/heating switch 105, the outdoor heat exchanger 104, and the outdoor fan 109 may be installed in the outdoor unit 14. Also, the expander 103, the indoor heat exchanger 102, and the indoor fan 108 may be installed in the indoor unit 15. The hot water supply heat exchanger 121, the hot water supply pump 126, and the hot water supply tank 125 may be installed in the hot water supply unit 16. Also, the cooling/heating flowrate regulator 131 and the hot water supply side flowrate regulator 132 may be installed in the outdoor unit 14. However, it should be
appreciated that the locations of the components may be variable and positioned based on a desired configuration and other considerations.

[0050] FIG. 2 is a control block diagram of the hot water supply apparatus associated with the heat pump according to the embodiment of FIG. 1. FIG. 3 is a flowchart of a method of controlling a hot water supply apparatus associated with a heat pump which is operated in a hot water supply and heating modes at the same time according to an embodiment. FIG. 4 is a flowchart of a method of controlling a hot water supply apparatus associated with a heat pump which is operated in a hot water supply priority mode according to an embodiment.

[0051] Referring to FIG. 2, the hot water supply apparatus 1 associated with the heat pump may include a hot water temperature detection part 171 (hot water temperature sensor) that detects a hot water temperature, a cooling/heating temperature detection part 172 (cooling/heating temperature sensor) that detects a cooling/heating temperature, an input interface 173 to input various operational signals or inputs may be inputted, and a controller 175 that controls an operation of the hot water supply side flow rate regulator 132 and the cooling/heating side flow rate regulator 131 according to signals transmitted from the hot water temperature sensor 171, the cooling/heating temperature sensor 172, and the input interface 173.

[0052] Here, the hot water temperature may represent a temperature of hot water, and the cooling/heating temperature may represent a temperature of an object to be heated. For example, the hot water temperature may be a water discharge temperature supplied to the user through the water discharge passage 128, and the cooling/heating temperature may be an indoor temperature. The signals transmitted from the hot water temperature sensor 171, the cooling/heating temperature sensor 172, and the input interface 173 may be signals that correspond to the hot water temperature and the cooling/heating temperature and signals inputted through the input interface 173. Moreover, the input interface 173 may be a user interface or various types of circuitry or application programs that generate inputs to the controller 175.

[0053] Next, referring to FIG. 3, during the operation of the hot water supply apparatus 1 associated with the heat pump, a signal for a simultaneous operation mode may be inputted, in step S11. A hot water supply side refrigerant flow rate may be adjusted to be greater than a heating side refrigerant flow rate, in step S12.

[0054] For example, when the signal to operate in the simultaneous operation mode is received, the hot water supply side flow rate regulator 132 may be adjusted to be opened a greater amount than the cooling/heating side flow rate regulator 131. For example, when the hot water supply apparatus 1 associated with the heat pump is operated in the simultaneous operation mode, the hot water supply side refrigerant flow rate may be set to be greater than the heating side refrigerant flow rate. Thus, in the simultaneous operation mode, the hot water supply capability may be greater than the cooling/heating capability.

[0055] Next, the hot water temperature and the heating temperature may be detected, in step S13. When the current hot water temperature is above a target hot water temperature and the current heating temperature is determined to be above a target heating temperature, in step S14, it may be determined whether a signal for a mode switch or an operation stop is received, in step S15. If instructions to change the mode of operation or to end the process is not received, the process may return to step S14 to detect the hot water and heating temperatures. Here, the target hot water temperature and the target heating temperature may represent target temperature values preset by a user or set as default values in a preference setting. Moreover, the target temperatures may be calculated in the controller 175 based on operating conditions of the hot water supply apparatus 1. For example, the target temperatures may be set by the controller based on at least one of user set values, outdoor temperature, ambient indoor temperature, untreated cold water temperature, or other appropriate types of conditions.

[0056] However, when the current hot water temperature is less than the target hot water temperature and the current heating temperature is less than the target heating temperature, as determined in step S16, an operational rate of the compressor 101 may be increased in step S17. For example, the compressor 101 may be a variable output compressor that may be controlled to increase its output, e.g., increase the flow rate and/or the temperature of the output refrigerant.

[0057] However, when the current hot water temperature is less than the target hot water temperature and the current heating temperature is above the target heating temperature, as determined in step S18, the hot water supply side refrigerant flow rate may be increased and the heating side refrigerant flow rate may be decreased, in step S19. For example, the hot water supply side flow rate regulator 132 may be adjusted to be opened to a greater degree and the cooling/heating side flow rate regulator 131 may be adjusted to be opened to a lesser degree.

[0058] However, when the current heating temperature is less than the target heating temperature and the current hot water temperature is above the target hot water temperature, as determined in step S18, the heating side refrigerant flow rate may be increased and the hot water supply side refrigerant flow rate may be decreased, in step S20. For example, the cooling/heating side flow rate regulator 131 may be adjusted to be opened to a greater degree and the hot water supply side flow rate regulator 132 may be adjusted to be opened to a lesser degree.

[0059] After the operational ratio of the compressor 101 is increased or the hot water supply side refrigerant flow rate and the heating side refrigerant flow rate are adjusted, the process may return to step S13 to detect the hot water temperature and the heating temperature, unless a mode switch or an operational stop signal is received, in step S15.

[0060] For example, according to the above-described processes, when the hot water supply apparatus 1 associated with the heat pump operates to simultaneously perform the hot water supply and heating operations, the hot water supply side refrigerant flow rate may be maintained to be greater than the heating side refrigerant flow rate, and then, the hot water supply capability and the heating capability may be adjusted according to a change in the hot water supply load and the heating load.

[0061] For example, when the current hot water temperature is below the target hot water temperature and the current heating temperature exceeds the target heating temperature, the hot water supply load may be greater than the heating load. Thus, it may be necessary that the hot water supply capability be greater than the heating capability. According to the hot water supply apparatus 1 associated with the heat pump, in this case, since the hot water supply side refrigerant flow rate may be greater than the heating side refrigerant flow rate, the hot water supply capability may be greater than
the heating capability. Thus, the current hot water temperature may be more likely to reach the target hot water temperature.

[0062] When the current heating temperature is less than the target heating temperature and the current hot water temperature exceeds the target hot water temperature, the heating side refrigerant flowrate may be greater than the hot water supply side refrigerant flowrate. Thus, since the heating capability may be greater than the hot water supply capability, the current heating temperature may be more likely to reach the target hot water temperature.

[0063] Also, when the current hot water temperature is less than the target hot water temperature and the current heating temperature is less than the target heating temperature, the hot water supply load may be greater than the heating load. Thus, it may be necessary to increase both the hot water supply capability and the heating capability. In this case, since the operational rate of the compressor 101 may be increased to simultaneously increase the hot water supply side and heating side refrigerant flowrates as well as increase a temperature of the discharge side refrigerant of the compressor 101, both the hot water supply capability and the heating capability may be improved. Thus, the current hot water temperature and the current heating temperature may be more likely to reach the target hot water temperature and the target heating temperature, respectively.

[0064] Referring to FIG. 4, during the operation of the hot water supply apparatus 1 associated with the heat pump, a signal to operate in a hot water supply priority mode may be received, in step S31. The hot water temperature may be detected in step S32. When a difference between the target hot water temperature and the current hot water temperature is determined to be less than a reference temperature difference (a prescribed temperature difference or a range of temperature differences), in step S33, it may be determined whether a signal for a mode switch or an operation stop signal is received, in step S34. If the signal is not received, the process may return to step S32 to detect the temperature of the hot water supply.

[0065] However, when the difference between the target hot water temperature and the current hot water temperature is determined to be above the reference temperature difference, in step S35, a flow of the cooling/heating side refrigerant may be intercepted, in step S36. For example, a portion of the refrigerant that bypasses the heat exchanger 121 to flow directly into the main refrigerant circuit 10 (e.g., toward the cooling/heating switch 105) may be diverted toward the hot water supply heat exchanger 121. On the other hand, all refrigerant discharged from the compressor 101 may be routed through the hot water supply heat exchanger 121 prior to being introduced into the main refrigerant circuit 10, i.e., the cooling/heating side.

[0066] Next, the hot water temperature may be detected again in step S36. If the difference between the target hot water temperature and the current hot water temperature is determined to be greater than the reference temperature difference, in step S37, the processes may return to steps S36 and S37 to continuously monitor the temperature of the water.

[0067] However, when the difference between the target hot water temperature and the current hot water temperature is determined to be less than the reference temperature difference, in step S37, the hot water supply apparatus 1 associated with the heat pump may be returned to a state that existed prior to intercepting the cooling/heating side refrigerant flow, in step S38. Unless the signals for the mode switch and operation stop are inputted in step S34, the hot water temperature may be detected again, in step S32.

[0068] In other words, in the hot water supply priority mode, if the temperature of the hot water is within a prescribed temperature range (e.g., a difference between the actual and target temperatures is less than a reference value), the hot water supply and heating operations may continue without interruption. The temperature of the water may decrease for various reasons. For example, during use of water stored in the hot water supply tank 125, additional water may be introduced from an external source into the hot water supply tank 125. The added water may be at a lower temperature than the heated water and may decrease the water discharge temperature, e.g., the hot water temperature. Here, if the temperature of the water decreases but remains within the desired temperature range (e.g., the difference between the actual and target temperatures is less than a reference value), the existing hot water supply and heating operations may continue to be performed.

[0069] However, if the temperature of the hot water falls below a prescribed temperature range (e.g., a difference between the actual and target temperatures is greater than a reference value), a greater amount of refrigerant from the compressor 101 may be diverted to the hot water supply heat exchanger 121. For example, if all refrigerant discharged from the compressor 101 is passed through the water supply heat exchanger 121, the capability of the hot water supply operation may be maximized. Moreover, since the refrigerant passing through the hot water supply heat exchanger 121 is introduced into the indoor heat exchanger 102 even during the hot water supply priority mode, the heating by the main refrigerant circuit may continue to be performed.

[0070] When the temperature of the hot water rises to be within the predetermined range during the hot water supply priority mode (e.g., the difference between the target hot water temperature and the current hot water temperature is reduced to within the reference temperature difference), the operational mode of the hot water supply apparatus 1 associated with the heat pump may be returned to the simultaneous hot water supply and heating operation mode. Moreover, the temperature of the hot water (e.g., temperature of the water stored in the water supply tank 125) may be continuously monitored.

[0071] Moreover, the reference temperature difference may be used to determine whether the exclusive hot water supply operation is required. For example, when the difference between the target hot water temperature and the current hot water temperature is relatively small, the current hot water temperature may be raised relatively quickly to the target hot water temperature, even when the hot water supply apparatus 1 is used for hot water supply and the heating operations. However, when the difference between the target hot water temperature and the current hot water temperature is relatively large, a relatively large amount of time may be required to increase the current hot water temperature to the target hot water temperature. The required amount of time may be higher if the hot water supply apparatus 1 is operating in the simultaneous operation mode to both supply hot water as well as to provide heating/cooling through the main refrigerant circuit 10.

[0072] In this case, output of the hot water supply apparatus 1 may be concentrated into the hot water supply operation. Thus, the stored water may be heated to the desired tempera-
tures in a shorter amount of time. Moreover, since the resources of the hot water supply apparatus 1 is diverted to the hot water supply function for a relatively short amount of time, an impact to the performance of the heating operation of the main refrigerant circuit 10 may be minimized.

Here, the predetermined temperature difference (reference temperature difference) between the target and actual hot water temperature may be used to determine whether the overall capability of the hot water supply apparatus 1 associated with the heat pump should be distributed between the hot water supply and the heating operations or concentrated on the hot water supply operation. Accordingly, as described in the above described embodiments, the hot water supply function and the heating function may be optimized according to changes in the hot water supply load.

In more detail, the hot water temperature may change by a relatively greater amount in case where the user uses the hot water when compared to a change of the hot water temperature due to different factors. For example, during the usage of the hot water supply apparatus 1 associated with the heat pump, the hot water supply load may be significantly changed when compared to the heating load in the main refrigerant circuit 10.

In the hot water supply apparatus 1 associated with the heat pump as disclosed, when the hot water supply load is significantly increased, e.g., the hot water temperature is significantly decreased, since the exclusive hot water supply operation may be performed to concentrate the resources of the hot water supply apparatus 1 associated with the heat pump into the hot water supply operation, the hot water temperature may be raised the target hot water temperature in a relatively shorter period of time.

When the hot water temperature approaches the target hot water temperature (e.g., is within a predetermined temperature range), since the operation of the hot water supply apparatus 1 associated with the heat pump may be automatically returned to a state that existed prior to the exclusive hot water supply operation being performed, the hot water supply function and the heating function may be optimized according to changes in the hot water load and the heating load.

FIG. 5 is a schematic view of a hot water supply apparatus associated with a heat pump according to another embodiment. In contrast to the embodiment of FIG. 1, in this embodiment, refrigerant discharged from a hot water supply heat exchanger (hot water discharge side refrigerant) may be introduced directly into an indoor heat exchanger or an outdoor heat exchanger based on whether the main refrigerant circuit is in a heating or cooling mode. The hot water supply apparatus in this embodiment includes components which are similar to corresponding components discussed above with respect to the previous embodiment, and thus further detailed description of the similar components will be omitted hereinafter.

A hot water supply apparatus 2 associated with a heat pump may include an indoor side guide pipe 281 that guides refrigerant flowing from a hot water side discharge pipe 223 into an indoor heat exchanger connection pipe 212, and an outdoor side guide pipe 282 that guides refrigerant flowing from the hot water side discharge pipe 223 into an outdoor heat exchanger connection pipe 215. The hot water supply apparatus 2 associated with the heat pump may further include a hot water supply side flow switch 280 (flow switch) that selectively reverses a flow direction of the refrigerant flowing from the hot water side discharge pipe 223 into one of the indoor side guide pipe 281 or the outdoor side guide pipe 282.

The hot water supply side flow switch 280 may be connected to the hot water side discharge pipe 223, the indoor side guide pipe 281, and the outdoor side guide pipe 282. Also, the hot water supply side flow switch part 280 may guide the refrigerant discharged from the hot water supply heat exchanger 221 (hot water discharge side refrigerant) into the indoor side guide pipe 281 or the outdoor side guide pipe 282 according to a heating operation or a cooling operation.

The indoor side guide pipe 281 may have one end connected to the hot water supply side flow switch 280 and the other end connected to the indoor heat exchanger connection pipe 212. The outdoor side guide pipe 282 may have one end connected to the hot water supply side flow switch 280 and the other end connected to the outdoor heat exchanger connection pipe 215.

When the main refrigerant circuit 20 is operating to provide heat (e.g., heating operation mode), the hot water discharge side refrigerant may be introduced directly into the indoor heat exchanger 202 through the indoor side guide pipe 281 and the indoor heat exchanger connection pipe 212. Here, the hot water supply side flow switch 280 may maintain a state in which the hot water supply side discharge pipe 223 communicates with (e.g., open a flow path to) the indoor side guide pipe 281.

Also, in the cooling operation mode, the hot water discharge side refrigerant may be introduced directly into the outdoor heat exchanger 204 through the outdoor side guide pipe 282 and the indoor heat exchanger connection pipe 215. Here, the hot water supply side flow switch 280 may maintain a state in which the hot water supply side discharge pipe 223 communicates with (e.g., open a flow path to) the outdoor side guide pipe 282.

According to the present embodiment, during the heating operation, since the refrigerant that flows through the hot water supply heat exchanger 221 (a hot water supply side) is introduced into the indoor heat exchanger 202 or the outdoor heat exchanger 204 without passing through a cooling/heating switch 205, losses in pressure due to passing through the cooling/heating switch 205 may be avoided.

FIG. 6 is a schematic view of a hot water supply apparatus associated with a heat pump according to another embodiment. In contrast to the previous embodiments, in this embodiment, refrigerant discharged from a hot water supply heat exchanger (hot water discharge side refrigerant) may bypass the indoor heat exchanger or directly introduced into an outdoor heat exchanger based on whether the main refrigerant circuit is in a heating or cooling mode. The hot water supply apparatus in this embodiment includes components which are similar to corresponding components discussed above with respect to previous embodiments, and thus further detailed description of the similar components will be omitted hereinafter.

A hot water supply apparatus 3 associated with a heat pump may include an indoor side guide pipe 381 that guides a refrigerant flowing from a hot water side discharge pipe 323 into an indoor heat exchanger expander connection pipe 313 and an outdoor side guide pipe 382 that guides the refrigerant flowing from the hot water side discharge pipe 323 into an outdoor heat exchanger connection pipe 315. The hot water supply apparatus 3 associated with the heat pump may further include a hot water supply side flow switch 380 (flow switch) to selectively switch a flow direction of the refrigerant
flowing from the hot water side discharge pipe 323 into one of the indoor side guide pipe 381 or the outdoor side guide pipe 382.

[0086] The hot water supply side flow switch 380 may be connected to the hot water side discharge pipe 323, the indoor side guide pipe 381, and the outdoor side guide pipe 382. Also, the hot water supply side flow switch 380 may guide the hot water discharge side refrigerant into the indoor side guide pipe 381 or the outdoor side guide pipe 382 according to a heating operation or a cooling operation.

[0087] The indoor side guide pipe 381 may have one end connected to the hot water supply side flow switch 380 and the other end connected to the indoor heat exchanger expander connection pipe 313. The outdoor side guide pipe 382 may have one end connected to the hot water supply side flow switch 380 and the other end connected to the outdoor heat exchanger connection pipe 315.

[0088] Although the indoor side guide pipe 381 and the expander 303 are disclosed herein as being installed in an outdoor unit 34, as shown in FIG. 6, it should be appreciated that the indoor side guide pipe 381 and the expander 303 may be installed in the indoor unit 35.

[0089] When the main refrigerant circuit 30 is operating to provide heat (e.g., heating operation mode), the hot water discharge side refrigerant may be introduced into the indoor heat exchanger expander connection pipe 313 through the indoor side guide pipe 381. Also, the hot water discharge side refrigerant may flow into the expander 303 together with the refrigerant condensed while passing through the indoor heat exchanger 302. In other words, the hot water discharge side refrigerant may bypass the indoor heat exchanger 302. Here, the hot water supply side flow switch 380 may maintain a state in which the hot water side discharge pipe 323 communicates with (e.g., open a flow path to) the indoor side guide pipe 381.

[0090] Also, in the cooling operation mode, the hot water discharge side refrigerant may be introduced directly into the outdoor heat exchanger 304 through the outdoor side guide pipe 382 and the indoor heat exchanger connection pipe 315. Here, the hot water supply side flow switch 380 may maintain a state in which the hot water side discharge pipe 323 communicates with (e.g., open a flow path to) the outdoor side guide pipe 382.

[0091] According to the present embodiment, during the heating operation, the refrigerant passing through the hot water supply heat exchanger 321 (hot water supply side) may be introduced into the expander 303 by bypassing the indoor heat exchanger 302. For example, the indoor heat exchanger 302 may only receive refrigerant which bypasses the water supply device, and therefore may have a relatively higher temperature. Refrigerant which is condensed in the hot water supply heat exchanger 321 may be routed to bypass the indoor heat exchanger 302. Hence, the temperature of the refrigerant that flows through the indoor heat exchanger 302 may be increased, and thus, indoor heating performance through the indoor heat exchanger 302 may be further improved.

[0092] During the cooling operation, the refrigerant passing through the hot water supply heat exchanger 321 (hot water supply side) may be discharged from the compressor 301 and condensed by passing through the outdoor heat exchanger 304 together with the refrigerant primarily condensed while a cooling side refrigerant directly introduced into the outdoor heat exchanger 304 passes through the hot water supply heat exchanger 321. For example, refrigerant condensed through the hot water supply heat exchanger 321 and refrigerant that flows directly from the compressor 301 may be introduced into the outdoor heat exchanger 304. Thus, since evaporation heat of the refrigerant in the outdoor heat exchanger 304 may be further increased, the cooling performance in the indoor heat exchanger 302 may be further improved.

[0093] Also, during the cooling operation, since the refrigerant that passes through the hot water supply side may be directly introduced into the outdoor heat exchanger 304 by bypassing the cooling/heating switch valve 305, a refrigerant pressure loss due to the cooling/heating switch 305 may be avoided.

[0094] FIG. 7 is a schematic view of a hot water supply apparatus associated with a heat pump according to another embodiment. In contrast to previous embodiments, in this embodiment, refrigerant discharged from the hot water supply heat exchanger (hot water discharge side refrigerant) may bypass an indoor heat exchanger or may be directly introduced into a cooling/heating switch according to whether a heating operation or a cooling operation is being performed. The hot water supply apparatus in this embodiment includes components which are similar to corresponding components discussed above with respect to previous embodiments, and thus further detailed description of the similar components will be omitted hereinbelow.

[0095] A hot water supply apparatus 4 associated with a heat pump may include an indoor side guide pipe 481 that guides a refrigerant flowing from a hot water side discharge pipe 423 into an indoor heat exchanger expander connection pipe 413, and an outdoor side guide pipe 482 that guides the refrigerant flowing from the hot water side discharge pipe 423 into a compressor discharge side pipe 411. The hot water supply apparatus 4 associated with the heat pump may further include a hot water supply side flow switch 480 (flow switch) for selectively switching a flow direction of the refrigerant flowing from the hot water side discharge pipe 423 into one of the indoor side guide pipe 481 or the outdoor side guide pipe 482.

[0096] The hot water supply side flow switch 480 may be connected to the hot water side discharge pipe 423, the indoor side guide pipe 481, and the outdoor side guide pipe 482. Also, the hot water supply side flow switch 480 may guide the hot water discharge side refrigerant into the indoor side guide pipe 481 or the outdoor side guide pipe 482 according to a heating operation or a cooling operation.

[0097] The indoor side guide pipe 481 may have one end connected to the hot water supply side flow switch 480 and the other end connected to the indoor heat exchanger expander connection pipe 413. The outdoor side guide pipe 482 may have one end connected to the hot water supply side flow switch 480 and the other end connected to the outdoor heat exchanger expander connection pipe 414. The outdoor side guide pipe 482 may directly guide the hot water discharge side refrigerant into the cooling/heating switch 405. For example, the outdoor side guide pipe 482 may directly guide the heat water discharge side refrigerant into the cooling/heating switch 405.

[0098] Although the indoor side guide pipe 481 and the expander 403 are disclosed in this embodiment as being installed in an outdoor unit 44, the expander 403 and the indoor side guide pipe 481 may be installed in the indoor unit 45.

[0099] In a heating operation, the hot water discharge side refrigerant may be introduced into the indoor heat exchanger expander connection pipe 413 through the indoor side guide pipe 481. Also, the hot water discharge side refrigerant may be introduced into the expander 403 together with the refrig-
erant condensed while passing through the indoor heat exchanger 402. For example, refrigerant discharged from the hot water supply heat exchanger 421 may bypass the indoor heat exchanger 402. Here, the hot water supply side flow switch part 480 may maintain a state in which the hot water side discharge pipe 423 communicates with (e.g., open a flow path to) the indoor side guide pipe 481.

[0100] Also, in a cooling operation, the hot water discharge side refrigerant may be directly introduced into the cooling/heating switch 405 through the outdoor side guide pipe 482 and the compressor discharge side pipe 411. Here, the hot water supply side flow switch 480 may maintain a state in which the hot water side discharge pipe 423 communicates with (e.g., open a flow path to) the outdoor side guide pipe 482.

[0101] According to the present embodiment, during the heating operation, the refrigerant that passes through the hot water supply heat exchanger 421 (the hot water supply side) may be introduced into the expander 403 by bypassing the indoor heat exchanger 402. For example, since the heating side refrigerant discharged from the compressor 401 and directly introduced into the indoor heat exchanger 402 may be introduced into the indoor heat exchanger 402 in a state where the heating side refrigerant is separated from the refrigerant which has been cool-condensed while passing through the hot water supply heat exchanger 421, a temperature of the refrigerant introduced into the indoor heat exchanger 402 may be further increased. Thus, indoor heating performance through the indoor heat exchanger 402 may be further improved.

[0102] During the cooling operation, the refrigerant that passes through the hot water supply heat exchanger 421 (the hot water supply side) may be discharged from the compressor 401 and condensed by passing through the outdoor heat exchanger 404 via the cooling/heating switch 405 together with the refrigerant primarily condensed while a cooling side refrigerant directly introduced into the outdoor heat exchanger 404 passes through the hot water supply heat exchanger 421. For example, refrigerant condensed through the hot water supply heat exchanger 421 and refrigerant that flows directly from the compressor 401 may be introduced into the outdoor heat exchanger 304. Thus, since evaporation heat of the refrigerant in the outdoor heat exchanger 409 may be further increased, the cooling performance in the indoor heat exchanger 402 may be further improved.

[0103] FIG. 8 is a schematic view of a hot water supply apparatus associated with a heat pump according to another embodiment. FIG. 9 is a flowchart of a method of controlling a hot water supply apparatus in which refrigerant discharged from the hot water supply heat exchanger may be introduced into or bypassed around an indoor heat exchanger based on an amount of a hot water supply side refrigerant and an amount of heating/cooling side refrigerant of the hot water supply apparatus associated with the heat pump according to the embodiment of FIG. 8. The hot water supply apparatus in these embodiments includes components which are similar to corresponding components discussed above with respect to previous embodiments, and thus, further detailed description of the similar components will be omitted hereinbelow.

[0104] Referring to FIG. 8, a hot water supply apparatus 5 associated with a heat pump may include indoor side guide pipes 581 and 582 that guides a refrigerant flowing from a hot water side discharge pipe 523 into an indoor heat exchanger connection pipe 512 or an indoor heat exchanger expander connection pipe 513, respectively, and an outdoor side guide pipe 585 that guides the refrigerant flowing from the hot water side discharge pipe 523 into a compressor discharge side pipe 511. The hot water supply apparatus 5 associated with the heat pump may further include a hot water supply side flow switch 580 (flow switch) for selectively switching a flow direction of the refrigerant flowing from the hot water side discharge pipe 523 into one of the indoor side guide pipes 581 or 582 and the outdoor side guide pipe 585.

[0105] The hot water supply side flow switch 580 may be connected to the hot water side discharge pipe 523, the indoor side guide pipes 581 and 582, and the outdoor side guide pipe 582. Also, the hot water supply side flow switch part 580 may guide the refrigerant discharged from the hot water heat exchanger 512 into the indoor side guide pipes 581 and 582 or the outdoor side guide pipe 582 according to a heating operation or a cooling operation.

[0106] The indoor side guide pipes 581 may be an indoor side inflow pipe that guides the refrigerant into the indoor heat exchanger connection pipe 512. The indoor side guide pipe 582 may be an indoor side bypass pipe that guides the refrigerant into the indoor heat exchanger expander connection pipe 513. The indoor side inflow pipe 581 and the indoor side bypass pipe 582 may each have one end connected to the hot water side flow switch 580 in a state where the ends are joined together and the other ends connected to the indoor heat exchanger connection pipe 512 and the indoor heat exchanger expander connection pipe 513, respectively. For example, the indoor side guide pipes 581 and 582 may directly guide the hot water discharge side refrigerant into the indoor heat exchanger 502 or to bypass the indoor heat exchanger 502.

[0107] An indoor side inflow valve 583 and an indoor side bypass valve 584 may selectively intercepting a flow of the refrigerant flowing into the indoor side inflow pipe 581 and the indoor side bypass pipe 582. The inflow valve 583 and the bypass valve 584 may be disposed in the indoor side inflow pipe 581 and the indoor side bypass pipe 582, respectively. For example, the indoor side inflow valve 583 may selectively block flow of refrigerant to the indoor heat exchanger 502, and the indoor side bypass valve 584 may selectively block flow of refrigerant that bypasses the indoor heat exchanger 502 after passing through the hot water supply side. Also, the outdoor side guide pipe 585 may have one end connected to the hot water supply side flow switch 580 and the other end connected to the outdoor heat exchanger connection pipe 515.

[0108] Although the indoor side guide pipes 581, 582 and the expander 503 are disclosed in this embodiment as being installed in the outdoor unit 54, it should be appreciated that the indoor side guide pipes 581, 582 and the expander 503 may be installed in the indoor unit 55.

[0109] In the heating operation, the hot water discharge side refrigerant may pass through the hot water supply side flow switch part 580 from the hot water side discharge pipe 523 and may be introduced into the indoor side guide pipes 581, 582. Here, the hot water supply side flow switch part 580 may maintain a state in which the hot water side discharge pipe 523 communicates with (e.g., open a flow path to) the indoor side guide pipes 581, 582.

[0110] Also, the refrigerant introduced into the indoor side guide pipes 581, 582 may be directly introduced into the indoor heat exchanger 502 through the indoor side inflow pipe 581 or bypass the indoor heat exchanger 502 through the indoor side bypass pipe 582. In more detail, in a state where the indoor side bypass valve 584 is closed and the indoor side inflow valve 583 is opened, the hot water discharge side
refrigerant may be introduced directly into the indoor heat exchanger 502. Also, in a state where the indoor side inflow valve 583 is closed and the indoor side bypass valve 584 is opened, the hot water discharge side refrigerant may bypass the indoor heat exchanger 502.

In case where the refrigerant introduced into the indoor side guide pipes 581, 582 is directly introduced into the indoor heat exchanger 502, the hot water side discharge refrigerant may be introduced into the indoor heat exchanger 502 together with the heating side refrigerant discharged from the compressor 511 to directly flow toward the indoor heat exchanger 502. Also, in case where the refrigerant introduced into the indoor side guide pipes 581, 582 bypasses the indoor heat exchanger 502, the hot water side discharge refrigerant may be introduced into the expander 503 together with the refrigerant condensed while passing through the indoor heat exchanger 502.

In the cooling operation, the hot water discharge side refrigerant may be introduced directly into the outdoor heat exchanger 504 along the outdoor side guide pipe 585 and the outdoor heat exchanger connection pipe 515. Here, the hot water supply side flow switch 580 may maintain a state in which the hot water side discharge pipe 523 communicates with (e.g., open a flow path to) the outdoor side guide pipe 585.

Referring to FIG. 9, during the heating operation, a flow direction of the refrigerant flowing from the hot water supply heat exchanger 521 (hot water supply side) may be selectively switched to introduce the refrigerant directly into the indoor heat exchanger 502 or bypass the indoor heat exchanger 502 according to a ratio of the hot water supply side refrigerant flowrate and the heating side refrigerant flowrate.

In more detail, when the hot water supply apparatus 5 is associated with the heat pump performs the heating operation, the hot water supply side refrigerant flowrate and the heating side refrigerant flowrate may be detected, in step 41. Here, for example, the hot water supply side refrigerant flowrate and the heating side refrigerant flowrate may be detected based on a degree to which a hot water supply flowrate regulator 532 and a heating side flowrate regulator 531 are open.

In comparing the hot water supply side refrigerant flowrate to the heating side refrigerant flowrate, when a ratio of the hot water supply side refrigerant flowrate to the heating side refrigerant flowrate is determined to be above a reference value, in step S42, the indoor side bypass valve 584 may be closed and the indoor side inflow valve 583 may be opened. Thus, the hot water discharge side refrigerant may be introduced into the indoor heat exchanger in step S43.

However, when a ratio of the hot water supply side refrigerant flowrate to the heating side refrigerant flowrate is below the reference value, in step S42, the indoor side inflow valve 583 may be closed and the indoor side bypass valve 584 may be opened. Thus, the hot water discharge side refrigerant may bypass the indoor heat exchanger 502, in step S44. Next, unless a signal for a mode switch or operation stop is received, in step S45, the process may return to step S41 to detect the hot water supply side refrigerant flowrate and the heating side refrigerant flowrate.

In the present embodiment, the hot water supply capability and the heating capability of the hot water supply apparatus 5 may be optimized according to the operational state. In more detail, in the heating operation mode, when the hot water supply side refrigerant flowrate is relatively greater than the heating side refrigerant flowrate, heating capability of the heating side may deteriorate as the heating side refrigerant flowrate is relatively reduced. However, in the present embodiment, since the refrigerant from the hot water supply side may be introduced into the indoor heat exchanger 502, the refrigerant flowrate that flows through the indoor heat exchanger 502 may be increased, and thus, may compensate to increase the indoor heating capability.

On the other hand, when the hot water supply side refrigerant flowrate is relatively less than the heating side refrigerant flowrate, the refrigerant from the hot water supply side be controlled to bypass the indoor heat exchanger 502. Thus, since the heating side refrigerant is introduced into the indoor heat exchanger 502 in a state where the heating side refrigerant is separated from the hot water supply side refrigerant, an overall temperature of the refrigerant flowing through the indoor heat exchanger 502 may be increased. Therefore, the indoor heating capability may be further improved.

While a ratio of flowrates of the hot water supply side refrigerant and the heating side refrigerant is disclosed as being used to control the operation of the indoor side valves 583, 584, it should be appreciated that other variables may also be used. For example, relative temperatures of the hot water and the air temperature, relative loads of the hot water supply or heating operation, or the like, may also be used to adjust the flow of refrigerant through the indoor side valves.

During the cooling operation, the refrigerant passing through the hot water supply heat exchanger 521 (hot water supply side) may be discharged from the compressor 501 and condensed by passing through the outdoor heat exchanger 504 via the cooling/heating switch part 505 together with the refrigerant primarily condensed while a cooling side refrigerant directly introduced into the outdoor heat exchanger 504 passes through the hot water supply heat exchanger 521. For example, refrigerant condensed through the hot water supply heat exchanger 521 and refrigerant that flows directly from the compressor 501 may be introduced into the outdoor heat exchanger 504. Thus, since evaporation heat of the refrigerant in the outdoor heat exchanger 504 may be further increased, the cooling performance in the indoor heat exchanger 502 may be further improved.

FIG. 10 is a schematic view of a hot water supply apparatus associated with a heat pump according to another embodiment. The hot water supply apparatus in this embodiment includes components which are similar to corresponding components discussed above with respect to previous embodiments, and thus, further detailed description of the similar components will be omitted hereinafter.

A hot water supply apparatus 6 associated with a heat pump may include components to inject refrigerant that flows between an indoor heat exchanger 602 and an outdoor heat exchanger 604 into a compressor 601. In detail, the compressor 601 may be a multi-stage compressor that includes a lower end compressor 681 in which a refrigerant is primarily compressed and an intermediate compressor 682 in which refrigerant from the lower end compressor 681 may be compressed together with the injected refrigerant.

In the present embodiment, the hot water supply apparatus 6 associated with the heat pump may include a phase separator 683. The phase separator 683 may be positioned between the indoor heat exchanger 602 and the outdoor heat exchanger 604, as shown in FIG. 10. The phase separator 683 may separate the condensed refrigerant that
flows between the indoor heat exchanger 602 or the outdoor heat exchanger 604 into a vapor refrigerant and a liquid refrigerant. An injection pipe 684 may guide the vapor refrigerant, separated in the phase separator 683, into the intermediate compressor 682.

[0124] In the present embodiment, since the refrigerant that flows between the indoor heat exchanger 602 and the outdoor heat exchanger 604 may be injected into the compressor 601, an amount of the refrigerant flowing into the outdoor heat exchanger 604 may be increased to improve the heating capability. In particular, when the hot water supply apparatus 6 associated with the heat pump is used in very low temperature conditions, evaporation heat of the refrigerant in the outdoor heat exchanger 604 can decrease, deteriorating the overall heating capacity and performance. However, as described above, the refrigerant may be injected to compensate for the diminished heating capability.

[0125] An injection valve which may selectively close the injection pipe 684 may be provided to selectively inject the refrigerant toward the compressor 601 based on the ambient temperature. For example, when the external temperature is above a predetermined temperature (e.g., a reference temperature), the injection valve may be maintained in a closed state. Also, when the ambient temperature is less than or equal to the reference temperature, the injection valve may be maintained in an open state. Hence, the injection of refrigerant into the compressor may be performed in relatively low temperature conditions to improve performance of the heating operation.

[0126] FIG. 11 is a schematic view of a hot water supply apparatus associated with a heat pump according to another embodiment. The hot water supply apparatus in this embodiment includes components which are similar to corresponding components discussed above with respect to previous embodiments, and thus, further detailed description of the similar components will be omitted hereinbelow.

[0127] A hot water supply apparatus 7 associated with a heat pump may include an indoor side guide pipe 781 that guides a refrigerant flowing from a hot water side discharge pipe 723 into an indoor heat exchanger connection pipe 712, and an outdoor side guide pipe 782 that guides the refrigerant flowing from the hot water side discharge pipe 723 into an outdoor heat exchanger connection pipe 715. The hot water supply apparatus may include a hot water supply side flow switch 780 that selectively switches a flow direction of the refrigerant flowing from the hot water side discharge pipe 723 into one of the indoor side guide pipe 781 or the outdoor side guide pipe 782.

[0128] The hot water supply side flow switch 780 may be connected to the hot water side discharge pipe 723, the indoor side guide pipe 781, and the outdoor side guide pipe 782. Also, the hot water supply side flow switch 780 may guide the hot water discharge side refrigerant into the indoor side guide pipe 781 or the outdoor side guide pipe 782 according to a heating operation or a cooling operation.

[0129] The indoor side guide pipe 781 may have one end connected to the hot water supply side flow switch 780 and the other end connected to the indoor heat exchanger connection pipe 712. The outdoor side guide pipe 782 may have one end connected to the hot water supply side flow switch 780 and the other end connected to the outdoor heat exchanger connection pipe 715.

[0130] In a heating operation, the hot water discharge side refrigerant may be introduced directly into the indoor heat exchanger 702 through the indoor side guide pipe 781 and the indoor heat exchanger connection pipe 712. Here, the hot water supply side flow switch 780 may maintain a state in which the hot water side discharge pipe 723 communicates with (e.g., open a flow path to) the indoor side guide pipe 781.

[0131] Also, in case of the cooling operation, the hot water discharge side refrigerant may be directly introduced into the outdoor heat exchanger 704 through the outdoor side guide pipe 782 and the indoor heat exchanger connection pipe 715. Here, the hot water supply side flow switch 780 may maintain a state in which the hot water side discharge pipe 723 communicates with (e.g., open a flow path to) the outdoor side guide pipe 782.

[0132] A hot water supply device associated with a heat pump is embodied and broadly described herein, in which hot water supply performance and heating performance may be optimized according to a hot water supply load and a cooling/heating load. The hot water supply device associated with a heat pump may include a main refrigerant circuit including a compressor, an indoor heat exchanger, an expander, and an outdoor heat exchanger to form a refrigerant cycle; and a hot water supply heat exchanger connected to the main refrigerant circuit to perform hot water supply using a high-temperature refrigerant discharged from the compressor, wherein the hot water supply heat exchanger may be used as a primary condenser in which the discharge side refrigerant of the compressor is primarily condensed, and one of the indoor heat exchanger or the outdoor heat exchanger may be used as a secondary condenser in which the discharge side refrigerant of the compressor is secondarily condensed, wherein, when the hot water supply and cooling/heating operations are performed at the same time, an amount of a hot water supply side refrigerant flowing into the hot water supply heat exchanger and an amount of a cooling/heating side refrigerant bypassing the hot water supply heat exchanger to directly flow into the indoor heat exchanger or the outdoor heat exchanger may be adjusted according to a hot water supply load and a cooling/heating load. Therefore, as disclosed herein, the hot water supply performance and the heating performance may be optimized according to the hot water supply load and the cooling/heating load.

[0133] In one embodiment, a hot water supply apparatus associated with a heat pump may include a main refrigerant circuit having a compressor, an indoor heat exchanger, an expander, and an outdoor heat exchanger, and configured to perform at least one of a cooling or heating operation; a hot water supply heat exchanger connected to the main refrigerant circuit and configured to generate hot water using high-temperature refrigerant discharged from the compressor; and a controller configured to control a flow of refrigerant through the main refrigerant circuit and the hot water supply heat exchanger. The hot water supply heat exchanger may be configured as a primary condenser in which the refrigerant discharged from the compressor is primarily condensed, and at least one of the indoor heat exchanger or the outdoor heat exchanger may be configured as a secondary condenser in which the refrigerant discharged from the compressor is secondarily condensed. The high-temperature refrigerant discharged from the compressor may be divided into a hot water supply side refrigerant that flows into the hot water supply heat exchanger and a cooling/heating side refrigerant that bypasses the hot water supply heat exchanger to flow directly into the indoor heat exchanger or the outdoor heat exchanger. When the hot water supply and cooling/heating operations
are performed at the same time, a flowrate of at least one of the hot water supply side refrigerant or the cooling/heating side refrigerant may be adjusted according to a hot water supply load or a cooling/heating load.

[0134] In this embodiment, a hot water supply side flowrate regulator may be disposed upstream of the hot water supply heat exchanger with respect to a flow direction of the refrigerant that adjusts the flowrate of the hot water supply side refrigerant; and a cooling/heating side flowrate regulator may be disposed upstream of the indoor heat exchanger and the outdoor heat exchanger with respect to the flow direction of the refrigerant to adjust the flowrate of the cooling/heating side refrigerant. The hot water supply side flowrate regulator and the cooling/heating side flowrate regulator may be linearly adjusted according to a temperature of the hot water and a cooling/heating temperature.

[0135] Moreover, when the hot water supply load exceeds a prescribed load, the flowrate of the hot water supply side refrigerant may be increased and the flowrate of the cooling/heating side refrigerant may be decreased. When the hot water supply load exceeds a prescribed load, the flowrate of the hot water supply side refrigerant may be increased, and the flowrate of the cooling/heating side refrigerant may be decreased or an output of the compressor is increased. When the cooling/heating load exceeds a prescribed load, the flowrate of the cooling/heating side refrigerant may be increased and the flowrate of the hot water supply side refrigerant may be decreased. When the cooling/heating load exceeds a prescribed load, the flowrate of the cooling/heating side refrigerant may be increased and the flowrate of the hot water supply side refrigerant may be decreased, or an output of the compressor may be increased.

[0136] When the hot water supply and cooling/heating operations are performed at the same time, the flowrate of the hot water supply side refrigerant may be greater than the flowrate of the cooling/heating side refrigerant. When the hot water supply and cooling/heating operations are performed at the same time, the flowrate of the cooling/heating side refrigerant may be greater than the flowrate of the hot water supply side refrigerant if the hot water supply load is satisfied. Here, the refrigerant from the hot water supply heat exchanger may be joined with the refrigerant that bypasses the hot water supply heat exchanger, wherein the joined refrigerant may be configured to the indoor heat exchanger or the outdoor heat exchanger. The hot water supply apparatus may further include a flow switch that changes a flow direction of refrigerant received from the compressor toward one of the indoor heat exchanger or the outdoor heat exchanger, wherein the refrigerant received from the hot water supply heat exchanger is configured to flow into a first pipe provided between the flow switch and the indoor heat exchanger in the refrigerant cycle during the cooling operation or is configured to flow into a second pipe provided between the flow switch and the outdoor heat exchanger in the refrigerant cycle during the cooling operation. A second flow switch may be configured to switch a flow direction of the refrigerant received from the hot water supply heat exchanger into the flow switch or the first pipe provided between the indoor heat exchanger and the outdoor heat exchanger.

[0137] In this embodiment, the hot water supply apparatus may be configured to operate in a hot water priority mode, wherein when a difference between the current hot water temperature and a target hot water temperature exceeds a prescribed temperature difference, the controller increases the flowrate of refrigerant to the hot water supply heat exchanger to reduce the temperature difference, and when the temperature difference between the current hot water temperature and the target hot water temperature is below the prescribed temperature difference, the controller restores the flowrate of refrigerant to the hot water supply heat exchanger.

[0138] Moreover, the hot water supply apparatus may further include a flow switch that changes a flow direction of refrigerant received from the compressor toward one of the indoor heat exchanger or the outdoor heat exchanger, wherein the controller controls the flow switch to change the flow direction of refrigerant in the main refrigerant circuit during a defrost mode of the heating operation such that the hot water is continuously generated during the defrost mode. The hot water supply apparatus may also include a phase separator that separates the refrigerant flowing between the indoor heat exchanger and the outdoor heat exchanger into a vapor refrigerant and a liquid refrigerant; and an injection pipe provided to guide the vapor refrigerant from the phase separator to the compressor, wherein the compressor includes a lower end compressor and an intermediate compressor that compresses the refrigerant that flows from the lower end compressor, the vapor refrigerant configured to be injected into the intermediate compressor.

[0139] A flow switch may be provided that changes a flow direction of refrigerant received from the compressor toward one of the indoor heat exchanger or the outdoor heat exchanger, wherein the refrigerant from the hot water supply heat exchanger is configured to flow into the flow switch during the heating operation and configured to flow into a first pipe provided between the indoor heat exchanger and the outdoor heat exchanger in the refrigerant cycle during the cooling operation. A second pipe may be provided between the flow switch and the first pipe may be provided between the indoor heat exchanger and the outdoor heat exchanger in the refrigerant cycle, the second pipe configured to guide refrigerant from the flow switch to the first pipe. A second flow switch may be configured to switch a flow direction of the refrigerant received from the hot water supply heat exchanger into the flow switch or the first pipe provided between the indoor heat exchanger and the outdoor heat exchanger.

[0140] In this embodiment, the hot water supply apparatus may further include a flow switch that changes a flow direction of refrigerant received from the compressor toward one of the indoor heat exchanger or the outdoor heat exchanger, wherein the refrigerant received from the hot water supply heat exchanger is configured to flow into a first pipe provided between the flow switch and the indoor heat exchanger in the refrigerant cycle during the heating operation or is configured to flow into a second pipe provided between the flow switch and the outdoor heat exchanger in the refrigerant cycle during the cooling operation. A second flow switch may be configured to guide the refrigerant received from the hot water supply heat exchanger into one of the first pipe or the second pipe.

[0141] Moreover, the hot water supply apparatus may include an indoor side inflow pipe configured to guide the refrigerant received from the hot water supply heat exchanger to an inflow side of the indoor heat exchanger; an indoor side bypass pipe configured to guide the refrigerant received from the hot water supply heat exchanger to a discharge side of the indoor heat exchanger, thereby bypassing the indoor heat exchanger; an indoor side inflow valve provided on the an indoor side inflow pipe to control a flow of the refrigerant received from the hot water supply side refrigerant into the indoor heat exchanger; and an indoor side bypass valve provided on the indoor side bypass pipe to control a flow of the refrigerant received from the hot water supply side refrigerant to bypass the indoor heat exchanger, wherein the controller is configured to control the indoor side inflow valve to open and the indoor side bypass valve to close, and when the ratio of the hot water supply side refrigerant flowrate to the heating side refrigerant flowrate is less than a prescribed ratio, the controller is
configured to control the indoor side inflow valve to close and the indoor side bypass valve to open such that the indoor heat exchanger is bypassed.

[0142] A flow switch may be provided that changes a flow direction of refrigerant received from the compressor toward one of the indoor heat exchanger or the outdoor heat exchanger, wherein the refrigerant received from the hot water supply heat exchanger is configured to flow into a first pipe provided between the indoor heat exchanger and the outdoor heat exchanger in the refrigerant cycle during the heating operation or is configured to flow into a second pipe provided between the flow switch and the outdoor heat exchanger in the refrigerant cycle during the cooling operation. A second flow switch may be configured to change a flow direction of the refrigerant received from the hot water supply heat exchanger towards one of the first pipe or the second pipe.

[0143] In another embodiment as broadly disclosed herein, a hot water supply apparatus may include a main refrigerant circuit that includes a compressor, an indoor heat exchanger, an expander, and an outdoor heat exchanger; a hot water supply circuit connected to the main refrigerant circuit; a first flowrate regulator that adjusts a first flowrate of refrigerant that flows from the compressor through the main refrigerant circuit; a second flowrate regulator that adjusts a second flowrate of refrigerant that flows from the compressor to the hot water supply circuit; at least one flow switch provided to receive the at least one of the first flow of refrigerant or the second flow of refrigerant and configured to change a flow direction of the first and second flows of refrigerant into the main refrigerant circuit; and a controller configured to control the first and second flowrate regulators and the at least one flow switch based on a load on at least one of the main refrigerant circuit or the hot water supply circuit.

[0144] Any reference in this specification to “one embodiment,” “an embodiment,” “example embodiment,” etc., means that a particular feature, structure, or characteristic described in connection with the embodiment is included in at least one embodiment of the invention. The appearances of such phrases in various places in the specification are not necessarily all referring to the same embodiment. Further, when a particular feature, structure, or characteristic is described in connection with any embodiment, it is submitted that it is within the purview of one skilled in the art to effect such feature, structure, or characteristic in connection with other ones of the embodiments.

[0145] Although embodiments have been described with reference to a number of illustrative embodiments thereof, it should be understood that numerous other modifications and embodiments can be devised by those skilled in the art that will fall within the spirit and scope of the principles of this disclosure. More particularly, various variations and modifications are possible in the component parts and/or arrangements of the subject combination arrangement within the scope of the disclosure, the drawings and the appended claims. In addition to variations and modifications in the component parts and/or arrangements, alternative uses will also be apparent to those skilled in the art.

What is claimed is:

1. A hot water supply apparatus associated with a heat pump, comprising:
   a main refrigerant circuit having a compressor, an indoor heat exchanger, an expander, and an outdoor heat exchanger, and configured to perform at least one of a cooling or heating operation;
   a hot water supply heat exchanger connected to the main refrigerant circuit and configured to generate hot water using high-temperature refrigerant discharged from the compressor; and
   a controller configured to control a flow of refrigerant through the main refrigerant circuit and the hot water supply heat exchanger,
   wherein the hot water supply heat exchanger is configured as a primary condenser in which the refrigerant discharged from the compressor is primarily condensed, and at least one of the indoor heat exchanger or the outdoor heat exchanger is configured as a secondary condenser in which the refrigerant discharged from the compressor is secondarily condensed,
   wherein the high-temperature refrigerant discharged from the compressor is divided into a hot water supply side refrigerant that flows into the hot water supply heat exchanger and a cooling/heating side refrigerant that bypasses the hot water supply heat exchanger to flow directly into the indoor heat exchanger or the outdoor heat exchanger, and
   wherein, when the hot water supply and cooling/heating operations are performed at the same time, a flowrate of at least one of the hot water supply side refrigerant or the cooling/heating side refrigerant are adjusted according to a hot water supply load or a cooling/heating load.

2. The hot water supply apparatus according to claim 1, further comprising:
   a hot water supply side flowrate regulator disposed upstream of the hot water supply heat exchanger with respect to a flow direction of the refrigerant that adjusts the flowrate of the hot water supply side refrigerant; and
   a cooling/heating side flowrate regulator disposed upstream of the indoor heat exchanger and the outdoor heat exchanger with respect to the flow direction of the refrigerant to adjust the flowrate of the cooling/heating side refrigerant.

3. The hot water supply apparatus according to claim 2, wherein the hot water supply side flowrate regulator and the cooling/heating side flowrate regulator are linearly adjusted according to a temperature of the hot water and a cooling/heating temperature.

4. The hot water supply apparatus according to claim 1, wherein, when the hot water supply load exceeds a prescribed load, the flowrate of the hot water supply side refrigerant is increased and the flowrate of the cooling/heating side refrigerant is decreased.

5. The hot water supply apparatus according to claim 1, wherein, when the hot water supply load exceeds a prescribed load, the flowrate of the hot water supply side refrigerant is increased, and the flowrate of the cooling/heating side refrigerant is decreased or an output of the compressor is increased.

6. The hot water supply apparatus according to claim 1, wherein, when the cooling/heating load exceeds a prescribed load, the flowrate of the cooling/heating side refrigerant is increased and the flowrate of the hot water supply side refrigerant is decreased.

7. The hot water supply apparatus according to claim 1, wherein, when the cooling/heating load exceeds a prescribed load, the flowrate of the cooling/heating side refrigerant is increased and the flowrate of the indoor heat exchanger is decreased.
increased and the flowrate of the hot water supply side refrigerant is decreased, or an output of the compressor is increased.

8. The hot water supply apparatus according to claim 1, wherein, when the hot water supply and cooling/heating operations are performed at the same time, the flowrate of the hot water supply side refrigerant is greater than the flowrate of the cooling/heating side refrigerant.

9. The hot water supply apparatus according to claim 1, wherein, when the hot water supply and cooling/heating operations are performed at the same time, the flowrate of the cooling/heating side refrigerant is greater than the flowrate of the hot water supply side refrigerant if the hot water supply load is satisfied.

10. The hot water supply apparatus according to claim 1, wherein the refrigerant from the hot water supply heat exchanger is joined with the refrigerant that bypasses the hot water supply heat exchanger, and wherein the joined refrigerant is configured to flow into one of the indoor heat exchanger or the outdoor heat exchanger prior to the other heat exchanger.

11. The hot water supply apparatus according to claim 1, wherein the hot water supply apparatus is configured to operate in a hot water priority mode, wherein when a difference between the current hot water temperature and a target hot water temperature exceeds a prescribed temperature difference, the controller increases the flowrate of refrigerant to the hot water supply heat exchanger to reduce the temperature difference, and when the temperature difference between the current hot water temperature and the target hot water temperature is below the prescribed temperature difference, the controller restores the flowrate of refrigerant to the hot water supply heat exchanger.

12. The hot water supply apparatus according to claim 1, further comprising
a flow switch that changes a flow direction of refrigerant received from the compressor toward one of the indoor heat exchanger or the outdoor heat exchanger, wherein the controller controls the flow switch to change the flow direction of refrigerant in the main refrigerant circuit during a defrost mode of the heating operation such that the hot water is continuously generated during the defrost mode.

13. The hot water supply apparatus according to claim 1, further comprising
a phase separator that separates the refrigerant flowing between the indoor heat exchanger and the outdoor heat exchanger into a vapor refrigerant and a liquid refrigerant; and
an injection pipe provided to guide the vapor refrigerant from the phase separator to the compressor, wherein the compressor includes a lower end compressor and an intermediate compressor that compresses the refrigerant that flows from the lower end compressor, the vapor refrigerant configured to be injected into the intermediate compressor.

14. The hot water supply apparatus according to claim 1, further comprising a flow switch that changes a flow direction of refrigerant received from the compressor toward one of the indoor heat exchanger or the outdoor heat exchanger, wherein the refrigerant from the hot water supply heat exchanger is configured to flow into the flow switch during the heating operation and configured to flow into a first pipe provided between the indoor heat exchanger and the outdoor heat exchanger in the refrigerant cycle during the cooling operation.

15. The hot water supply apparatus according to claim 14, further comprising
a second pipe provided between the flow switch and the first pipe provided between the indoor heat exchanger and the outdoor heat exchanger in the refrigerant cycle, the second pipe configured to guide refrigerant from the flow switch to the first pipe; and
a second flow switch configured to switch a flow direction of the refrigerant received from the hot water supply heat exchanger into the flow switch or the first pipe provided between the indoor heat exchanger and the outdoor heat exchanger.

16. The hot water supply apparatus according to claim 1, further comprising a flow switch that changes a flow direction of refrigerant received from the compressor toward one of the indoor heat exchanger or the outdoor heat exchanger, wherein the refrigerant received from the hot water supply heat exchanger is configured to flow into a first pipe provided between the flow switch and the indoor heat exchanger in the refrigerant cycle during the heating operation or is configured to flow into a second pipe provided between the flow switch and the outdoor heat exchanger in the refrigerant cycle during the cooling operation.

17. The hot water supply apparatus according to claim 16, further comprising a second flow switch configured to guide the refrigerant received from the hot water supply heat exchanger into one of the first pipe or the second pipe.

18. The hot water supply apparatus according to claim 1, further comprising
an indoor side inflow pipe configured to guide the refrigerant received from the hot water supply heat exchanger to an inflow side of the indoor heat exchanger; an indoor side bypass pipe configured to guide the refrigerant received from the hot water supply heat exchanger to a discharge side of the indoor heat exchanger, thereby bypassing the indoor heat exchanger; an indoor side inflow valve provided on the an indoor side inflow pipe to control a flow of the refrigerant received from the hot water supply side refrigerant into the indoor heat exchanger; and
an indoor side bypass valve provided on the indoor side bypass pipe to control a flow of the refrigerant received from the hot water supply side refrigerant to bypass the indoor heat exchanger.

19. The hot water supply apparatus according to claim 1, further comprising a flow switch that changes a flow direction of refrigerant received from the compressor toward one of the indoor heat exchanger or the outdoor heat exchanger,
wherein the refrigerant received from the hot water supply heat exchanger is configured to flow into a first pipe provided between the indoor heat exchanger and the outdoor heat exchanger in the refrigerant cycle during the heating operation or is configured to flow into a second pipe provided between the flow switch and the outdoor heat exchanger in the refrigerant cycle during the cooling operation.

20. The hot water supply apparatus according to claim 19, further comprising:
   a second flow switch configured to change a flow direction of the refrigerant received from the main refrigerant circuit towards one of the first pipe or the second pipe.

21. A hot water supply apparatus, comprising:
   a main refrigerant circuit that includes a compressor, an indoor heat exchanger, an expander, and an outdoor heat exchanger;
   a hot water supply circuit connected to the main refrigerant circuit;
   a first flowrate regulator that adjusts a first flowrate of refrigerant that flows from the compressor through the main refrigerant circuit;
   a second flowrate regulator that adjusts a second flowrate of refrigerant that flows from the compressor to the hot water supply circuit;
   at least one flow switch provided to receive the at least one of the first flow of refrigerant or the second flow of refrigerant and configured to change a flow direction of the first and second flows of refrigerant into the main refrigerant circuit; and
   a controller configured to control the first and second flowrate regulators and the at least one flow switch based on a load on at least one of the main refrigerant circuit or the hot water supply circuit.

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