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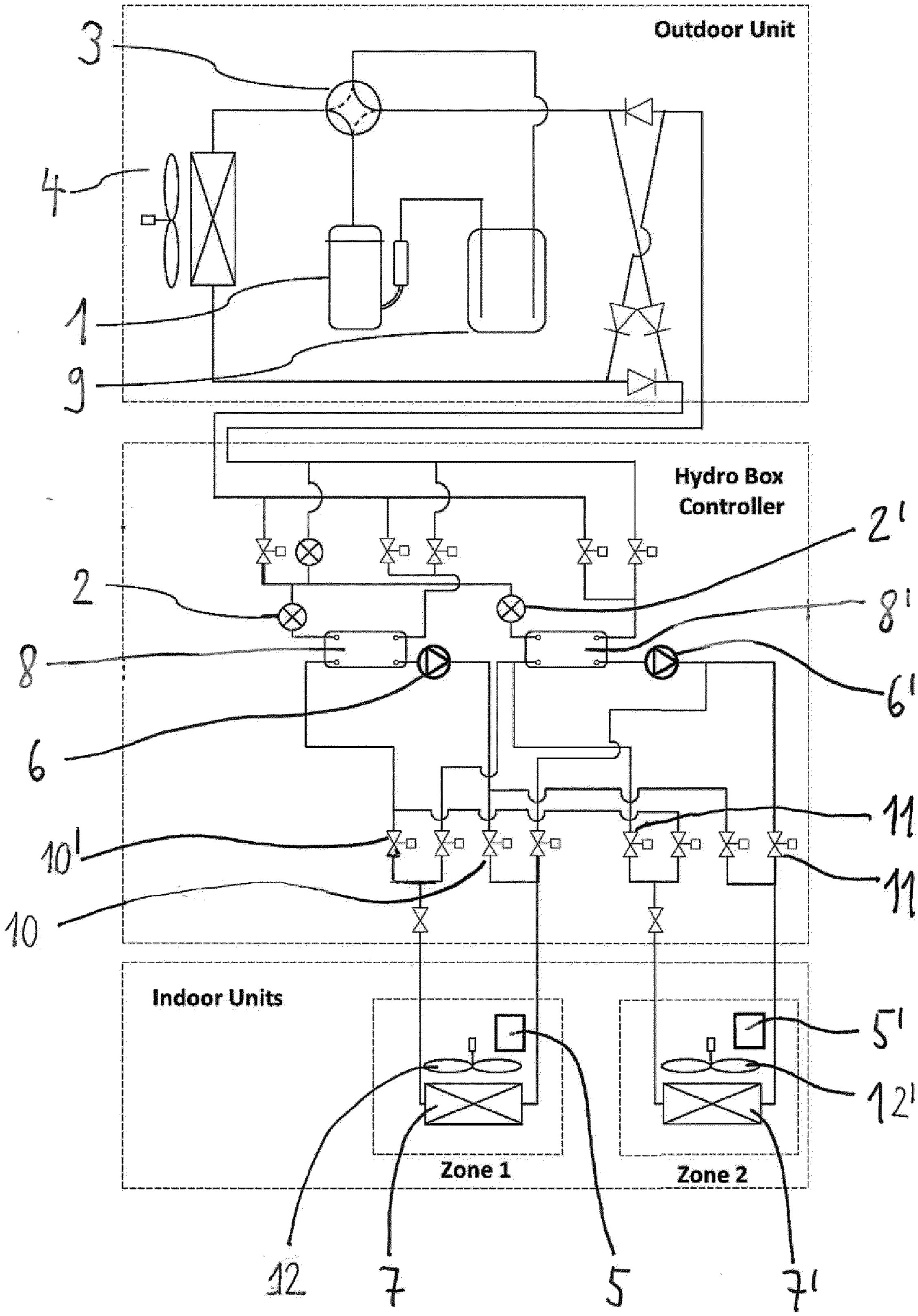
(54) SYSTEM AND METHOD FOR HEATING AND/OR COOLING AT LEAST ONE SPACE

(57) A system and method for heating and/or cooling at least one space is provided. The system and method are characterized in that a second heat transfer fluid is used which comprises or consists of water, at least one first encapsulated phase change material and at least one second encapsulated phase change material, wherein the first phase change material has a phase change temperature which is lower than the phase change temperature of the second phase change material. At least two indoor heat exchangers are employed, wherein each of the at least two indoor heat exchangers has a temperature sensor configured to determine a temperature information of the indoor space in which the indoor heat exchanger is located. A controller is employed which receives a temperature information from the temperature sensors and controls the system based on said temperature information. The system and method show an improved efficiency in heating and/or cooling at least one space compared to known systems and methods.

Figure 3


Outdoor Unit
Hydro Box
Controller
Indoor Units
Zone 1
Zone 2
3
4
1
9
2
2'
8
8'
6
6'
10'
10
11'
11
5'
12'
12
7
5
7'

Description

[0001] A system and method for heating and/or cooling at least one space is provided. The system and method are characterized in that a second heat transfer fluid is used which comprises or consists of water, at least one first encapsulated phase change material and at least one second encapsulated phase change material, wherein the first phase change material has a phase change temperature which is lower than the phase change temperature of the second phase change material. At least two indoor heat exchangers are employed, wherein each of the at least two indoor heat exchangers has a temperature sensor configured to determine a temperature information of the indoor space in which the indoor heat exchanger is located. A controller is employed which receives a temperature information from the temperature sensors and controls the system based on said temperature information. The system and method show an improved efficiency in heating and/or cooling at least one space compared to known systems and methods.

[0002] Heating and cooling are important for maintaining the thermal comfort in building environments. Hybrid HVRF has the potential to reduce fluorine gas (F gas) and improve the efficiency of the system. With introduction of a PCM slurry as the heat transfer fluid, the pumping power can be reduced and heat transfer can potentially be enhanced.

[0003] EP 2 667 107 A1 discloses an air-conditioning apparatus including a refrigerant circulating circuit and a heat medium circulating circuit that performs passing of heat to and from the refrigerant circulating circuit. The heat medium circulating circuit is a closed circuit, the maximum pump pressure of a pump of the heat medium circulating circuit is 150 kPa or more, and a pressure near at least a suction side of the pump is set to a charged pressure that is maintained equal to or higher than the atmospheric pressure during operation of the pump.

[0004] JP 2000 161724 A discloses a system in which a slurry-like heat carrying medium produced by mixing heating/cooling microcapsules into water is employed. The heating microcapsules are filled with a heat storage material for heating which changes the phase when hot heat is conveyed and the cooling microcapsules are filled with a heat storage material for cooling which changes the phase when cold heat is conveyed. Hot heat and cold heat are conveyed utilizing latent heat of the heat storage materials for heating and cooling. This system has the disadvantage that the heating and/or cooling of at least one space is not very efficient.

[0005] Starting therefrom, it was the object of the present application to provide a system and a method which does not have the disadvantages of prior art systems and methods. Specifically, it should be possible with the system and method to improve the efficiency of heating and/or cooling at least one space.

[0006] The object is solved by the device having the features of claim 1 and the method having the features of claim 8. The dependent claims illustrate advantageous embodiments of the invention.

[0007] According to the invention, a system for heating and/or cooling at least one space is provided, comprising

a) a refrigeration circuit, comprising

a first heat transfer fluid comprising or consisting of refrigerant,
a compressor,
at least one expansion device,
a four-way reversible valve, and
an outdoor heat exchanger suitable for transferring heat between the first heat transfer fluid and outside air;

b) a heat medium circuit, comprising

a second heat transfer fluid comprising or consisting of water, at least one first phase change material and at least one second phase change material, wherein the first phase change material and the second phase change material are encapsulated and wherein the first phase change material has a phase change temperature which is lower than the phase change temperature of the second phase change material,
a first heat indoor exchanger located in a first indoor space and suitable for transferring heat between the second heat transfer fluid and the first indoor space, and a first temperature sensor configured to determine a temperature information of the first indoor space in which the first indoor heat exchanger is located,
a second indoor heat exchanger located in a second indoor space suitable for transferring heat between the second heat transfer fluid and the second indoor space, and a second temperature sensor configured to determine a temperature information of the second indoor space in which the second indoor heat exchanger is located, and
at least one conveying means for circulating the second heat transfer fluid through the first heat medium heat exchanger and the second heat medium exchanger;

c) at least one heat exchanger comprised by both the refrigeration circuit and the heat medium circuit, and being suitable for transferring heat between the first heat transfer fluid and the second heat transfer fluid; and

d) a controller configured to receive a temperature information from at least the first temperature sensor and the second temperature sensor, wherein the controller is configured to control the system based on a temperature information received from at least the first temperature sensor and the second temperature sensor.

[0008] In view of the configuration of the controller to receive a temperature information from at least the first temperature sensor and the second temperature sensor and to control the system based on a temperature information received from at least the first temperature sensor and the second temperature sensor, the efficiency of heating and/or cooling at least one space is improved compared to prior art systems which use a second heat transfer fluid comprising or consisting of water, at least one first phase change material and at least one second phase change material.

[0009] The second heat transfer fluid can comprise or consist of a slurry.

[0010] The at least one conveying means can be at least two conveying means. Furthermore, the at least one conveying means and/or at least one further conveying means can comprise a pump and/or a pressure device, or consist thereof. A pressure device can be beneficial to avoid a damage to the encapsulated first phase change material and to the encapsulated second phase change material present in the second heat transfer fluid.

[0011] The first phase change material can have a phase transition temperature in the range of 5 °C to 15 °C, preferably in the range of 8 °C to 12 °C, especially 10 °C. The first phase change material can comprise or consist of a material selected from the group consisting of paraffins, sugars, clathrate hydrates and combinations thereof.

[0012] The second phase change material can have a phase transition temperature in the range of 35 °C to 45 °C, preferably in the range of 38 °C to 42 °C, especially 40 °C. The second phase change material can comprise or consist of a material selected from the group consisting of paraffins, sugars, clathrate hydrates and combinations thereof.

[0013] The encapsulation of the first phase change material and/or of the second phase change material can comprise or consist of a material selected from the group consisting of inorganic materials, polymeric resins, metals, metal alloys and combinations thereof.

[0014] The encapsulated first phase change material and/or second phase change material can form capsules having a diameter in the range of 1 to 20 μm, preferably in the range of 1.5 to 10 μm, more preferably in the range of 2 to 5 μm. The diameter can refer to a diameter determined by laser diffraction, dynamic light scattering, optical microscopy and/or electron microscopy.

[0015] The second heat transfer fluid can comprise the first phase change material in an amount of 10 to 25 wt.-%, in relation to the total weight of the second heat transfer fluid. Moreover, the second heat transfer fluid can comprise the second phase change material in an amount of 10 to 25 wt.-%, in relation to the total weight of the second heat transfer fluid. The remaining weight of the second heat transfer fluid can be made up by water.

[0016] The first indoor heat exchanger and/or the second indoor heat exchanger can comprise a fan.

[0017] The heat medium circuit of the system, preferably a fluid circuit of the first indoor heat exchanger and/or the second indoor heat exchanger, can comprise at least one motorized valve.

[0018] In a preferred embodiment, the controller is configured to determine, in a cooling operation mode of the system, which indoor heat exchanger has the highest cooling load based on the temperature information received from at least the first temperature sensor and the second temperature sensor, wherein the controller is configured to

i) control a fan of the indoor heat exchanger which has the highest cooling load to be always on at a fixed speed, wherein the fixed speed is preferably selectable by a user of the indoor heat exchanger;
ii) control a speed of the compressor to achieve a target temperature of the first phase change material in an indoor space in which the indoor heat exchanger determined to have the highest cooling load is located, wherein the target temperature of the first phase change material is set according to a temperature difference between a target temperature in an indoor space in which the indoor heat exchanger determined to have the highest cooling load is located and an actual temperature in said indoor space (determined by a temperature sensor in said indoor space);
iii) control an opening degree of at least one motorized valve located in a fluid circuit of the indoor heat exchanger which has the highest cooling load to achieve a target temperature of the first phase change material at said indoor heat exchanger, wherein the target temperature is a temperature in a range determined by the phase change temperature of the first phase change material $\pm$ a predetermined target temperature difference of the first phase change material, wherein the predetermined target temperature difference of the first phase change material is preferably in the range of >0 K to 10 K, more preferably in the range of 0.5 K to 10 K, particularly preferably in the range of 1 K to 5 K; and
iv) set a target temperature of the first phase change material to be a temperature which is the phase change temperature of the first phase change material minus the predetermined target temperature difference of the first phase change material.

[0019] The system can comprise a thermostat controlling the first indoor heat exchanger. Furthermore, the system can comprise a thermostat controlling the second indoor heat exchanger.

[0020] Moreover, the controller can be configured to determine, in a cooling operation mode of the system, which indoor heat exchanger has a lower than highest cooling load based on a temperature information received from at least the first temperature sensor and the second temperature sensor, wherein the controller is configured to

i) control a fan of the indoor heat exchanger which has a lower than highest cooling load to switch on or off based on a setting of a thermostat controlling said indoor heat exchanger to maintain a temperature of an indoor space in which said indoor heat exchanger is located within a dead band; and
ii) control an opening degree of a motorized valve located in a fluid circuit of the indoor heat exchanger which has a lower than highest heating load to achieve a predetermined target temperature difference of the first phase change material at the indoor heat exchanger which has a lower than highest cooling load, wherein the predetermined target temperature difference of the first phase change material is preferably in the range of >0 K to 10 K, more preferably in the range of 0.5 K to 10 K, particularly preferably in the range of 1 K to 5 K.

[0021] In a further preferred embodiment, the controller is configured to determine, in a heating operation mode of the system, which indoor heat exchanger has the highest heating load based on the temperature information received from at least the first temperature sensor and the second temperature sensor, wherein the controller is configured to

i) control a fan of the indoor heat exchanger which has the highest heating load to be always on at a fixed speed, wherein the fixed speed is preferably selectable by a user of the indoor heat exchanger;
ii) control a speed of the compressor to achieve a target temperature of the second phase change material in an indoor space in which the indoor heat exchanger determined to have the highest heating load is located, wherein the target temperature of the second phase change material is set according to a temperature difference between a target temperature in an indoor space in which the indoor heat exchanger determined to have the highest heating load is located and an actual temperature in said indoor space (determined by a temperature sensor in said indoor space);
iii) control an opening degree of at least one motorized valve located in a fluid circuit of the indoor heat exchanger which has the highest heating load to achieve a target temperature of the second phase change material at said indoor heat exchanger, wherein the target temperature is a temperature in a range determined by the phase change temperature of the second phase change material $\pm$ a predetermined target temperature difference of the second phase change material, wherein the predetermined target temperature difference of the second phase change material is preferably in the range of >0 K to 10 K, more preferably in the range of 0.5 K to 10 K, particularly preferably in the range of 1 K to 5 K; and
iv) set a target temperature of the second phase change material to be a temperature which is the phase change temperature of the second phase change material plus the predetermined target temperature difference of the first phase change material.

[0022] Moreover, the controller can be configured to determine, in a heating operation mode of the system, which indoor heat exchanger has a lower than highest heating load based on a temperature information received from at least the first temperature sensor and the second temperature sensor, wherein the controller is configured to

i) control a fan of the indoor heat exchanger which has a lower than highest heating load to switch on or off based on a setting of a thermostat controlling said indoor heat exchanger to maintain a temperature of an indoor space in which said indoor heat exchanger is located within a dead band; and
ii) control an opening degree of a motorized valve located in a fluid circuit of the indoor heat exchanger which has a lower than highest heating load to achieve a predetermined target temperature difference of the second phase change material at the indoor heat exchanger which has a lower than highest heating load, wherein the predetermined target temperature difference of the second phase change material is preferably in the range of >0 K to 10 K, more preferably in the range of 0.5 K to 10 K, particularly preferably in the range of 1 K to 5 K.

[0023] Furthermore, the controller can be configured to, in a cooling operation of the system and/or in a heating operation mode of the system,

i) control a speed of the at least one conveying means to achieve a target flow-rate of the second heat transfer fluid in the first heat indoor exchanger and/or in the second indoor heat exchanger; and
ii) control an opening degree of the at least one expansion device to achieve a target superheat in the refrigeration circuit.

[0024] The refrigeration circuit of the system can comprise an accumulator. The heat medium circuit of the system can comprise at least one, preferably at least two, storage device(s) for storing the second heat transfer fluid.

[0025] According to the invention, a method for heating and/or cooling at least one space is provided, comprising

a) providing a system comprising

i) a refrigeration circuit, comprising

a first heat transfer fluid comprising or consisting of refrigerant,
a compressor,
at least one expansion device,
a four-way reversible valve, and
an outdoor heat exchanger suitable for transferring heat between the first heat transfer fluid and outside air;

ii) a heat medium circuit, comprising

a second heat transfer fluid comprising or consisting of water, at least one first phase change material and at least one second phase change material, wherein the first phase change material and the second phase change material are encapsulated and wherein the first phase change material has a phase change temperature which is lower than the phase change temperature of the second phase change material,
a first heat indoor exchanger located in a first indoor space and suitable for transferring heat between the second heat transfer fluid and the first indoor space, and a first temperature sensor configured to determine a temperature information of the first indoor space in which the first indoor heat exchanger is located,
a second indoor heat exchanger located in a second indoor space suitable for transferring heat between the second heat transfer fluid and the second indoor space, and a second temperature sensor configured to determine a temperature information of the second indoor space in which the second indoor heat exchanger is located, and
at least one conveying means for circulating the second heat transfer fluid through the first heat medium heat exchanger and the second heat medium exchanger;

iii) at least one heat exchanger comprised by both the refrigeration circuit and the heat medium circuit, and being suitable for transferring heat between the first heat transfer fluid and the second heat transfer fluid; and
iv) a controller configured to receive a temperature information from at least the first temperature sensor and the second temperature sensor,

b) control the system based on a temperature information received from at least the first temperature sensor and the second temperature sensor.

[0026] In view of the configuration of the controller to receive a temperature information from at least the first temperature sensor and the second temperature sensor and the control of the system based on a temperature information received from at least the first temperature sensor and the second temperature sensor, the efficiency of heating and/or cooling at least one space is improved compared to prior art methods which use a second heat transfer fluid comprising or consisting of water, at least one first phase change material and at least one second phase change material.

[0027] In the method according to the invention, a system according to the invention can be provided in step a). Moreover, in the method according to the invention, the control and/or each setting performed in the method can be implemented by a controller of the system, preferably by a controller of a system according to the invention.

[0028] In a preferred embodiment of the method, it is determined, in a cooling operation mode of the system, which indoor heat exchanger has the highest cooling load based on the temperature information received from at least the first temperature sensor and the second temperature sensor, wherein

i) a fan of the indoor heat exchanger which has the highest cooling load is set to be always on at a fixed speed, wherein the fixed speed is preferably selected by a user of the indoor heat exchanger;
ii) a speed of the compressor is set to achieve a target temperature of the first phase change material in an indoor space in which the indoor heat exchanger determined to have the highest cooling load is located, wherein the target temperature of the first phase change material is set according to a temperature difference between a target temperature in an indoor space in which the indoor heat exchanger determined to have the highest cooling load is located and an actual temperature in said indoor space (determined by a temperature sensor in said indoor space);
iii) an opening degree of at least one motorized valve located in a fluid circuit of the indoor heat exchanger which has the highest cooling load is set to achieve a target temperature of the first phase change material at said indoor heat exchanger, wherein the target temperature is a temperature in a range determined by the phase change temperature of the first phase change material $\pm$ a predetermined target temperature difference of the first phase change material, wherein the predetermined target temperature difference of the first phase change material is preferably in the range of >0 K to 10 K, more preferably in the range of 0.5 K to 10 K, particularly preferably in the range of 1 K to 5 K; and
iv) a target temperature of the first phase change material is set to be a temperature which is the phase change temperature of the first phase change material minus the predetermined target temperature difference of the first phase change material.

[0029] In a cooling operation mode of the system, it can be determined in the method which indoor heat exchanger has a lower than highest cooling load based on a temperature information received from at least the first temperature sensor and the second temperature sensor, wherein

i) a fan of the indoor heat exchanger (which has a lower than highest cooling load is set to switch on or off based on a setting of a thermostat controlling said indoor heat exchanger to maintain a temperature of an indoor space in which said indoor heat exchanger is located within a dead band; and
ii) an opening degree of a motorized valve located in a fluid circuit of the indoor heat exchanger which has a lower than highest heating load is set to achieve a predetermined target temperature difference of the first phase change material at the indoor heat exchanger which has a lower than highest cooling load, wherein the predetermined target temperature difference of the first phase change material is preferably in the range of >0 K to 10 K, more preferably in the range of 0.5 K to 10 K, particularly preferably in the range of 1 K to 5 K.

[0030] In a further preferred embodiment of the method, it is determined, in a heating operation mode of the system, which indoor heat exchanger has the highest heating load based on the temperature information received from at least the first temperature sensor and the second temperature sensor, wherein

i) a fan of the indoor heat exchanger which has the highest heating load is set to be always on at a fixed speed, wherein the fixed speed is preferably selectable by a user of the indoor heat exchanger;
ii) a speed of the compressor is set to achieve a target temperature of the second phase change material in an indoor space in which the indoor heat exchanger determined to have the highest heating load is located, wherein the target temperature of the second phase change material is set according to a temperature difference between a target temperature in an indoor space in which the indoor heat exchanger determined to have the highest heating load is located and an actual temperature in said indoor space (determined by a temperature sensor in said indoor space);
iii) an opening degree of at least one motorized valve located in a fluid circuit of the indoor heat exchanger which has the highest heating load is set to achieve a target temperature of the second phase change material at said indoor heat exchanger, wherein the target temperature is a temperature in a range determined by the phase change temperature of the second phase change material ± a predetermined target temperature difference of the second phase change material, wherein the predetermined target temperature difference of the second phase change material is preferably in the range of >0 K to 10 K, more preferably in the range of 0.5 K to 10 K, particularly preferably in the range of 1 K to 5 K; and
iv) a target temperature of the second phase change material is set to be a temperature which is the phase change temperature of the second phase change material plus the predetermined target temperature difference of the first phase change material.

[0031] In a heating operation mode of the system, it can be determined in the method which indoor heat exchanger has a lower than highest heating load based on a temperature information received from at least the first temperature sensor and the second temperature sensor, wherein

i) a fan of the indoor heat exchanger which has a lower than highest heating load is set to switch on or off based on a setting of a thermostat controlling said indoor heat exchanger to maintain a temperature of an indoor space in which said indoor heat exchanger is located within a dead band; and
ii) an opening degree of a motorized valve located in a fluid circuit of the indoor heat exchanger which has a lower than highest heating load is set to achieve a predetermined target temperature difference of the second phase change material at the indoor heat exchanger which has a lower than highest heating load, wherein the predetermined target temperature difference of the second phase change material is preferably in the range of >0 K to 10 K, more preferably in the range of 0.5 K to 10 K, particularly preferably in the range of 1 K to 5 K.

[0032] Furthermore, in a preferred embodiment of the method, in a cooling operation of the system and/or in a heating operation mode of the system,

i) a speed of the at least one conveying means is set to achieve a target flow-rate of the second heat transfer fluid in the first heat indoor exchanger and/or in the second indoor heat exchanger; and
ii) an opening degree of the at least one expansion device is set to achieve a target superheat in the refrigeration circuit.

[0033] In the method, the refrigeration circuit of the system can comprise an accumulator. Moreover, in the method, the heat medium circuit of the system cab comprises at least one, preferably at least two, storage device(s) for storing the second heat transfer fluid.
[0034] With reference to the following figures and examples, the subject according to the invention is intended to be explained in more detail without wishing to restrict said subject to the specific embodiments shown here.

Figure 1 illustrates graph showing the dependency of an enthalpy of a first phase change material and of a second phase change material depending on the temperature. For example, the first phase change material, which can be used for a cooling operation mode, has a phase change temperature (PCT1) of 10 °C and second phase change material PCM2, which can be used for a heating operation mode, has a phase change temperature (PCT2) of 40 °C. For each phase change material, an equilibrium temperature with a phase change temperature band can be characterized, wherein the phase change temperature band is formed by the respective phase change temperature PCT1, PCT2 $\pm$ a predetermined target temperature difference Δ_PCM1, Δ_PCM2 of the respective phase change material. The predetermined target temperature difference Δ_PCM1, Δ_PCM2 can be obtained in advance as default values and further tuned in the real system. For example, the first phase change material has a predetermined target temperature difference Δ_PCM1 of 2 K and the second phase change material has a predetermined target temperature difference Δ_PCM2 of 3 K. It follows that the phase change temperature band of the first phase change material is 10 °C $\pm$ 2 K and the phase change temperature band of the second phase change material is 40 °C $\pm$ 3 K.

Figure 2 illustrates a multiple PCM slurry based HVAC system according to the invention.

Figure 3 illustrates the multiple PCM slurry based HVAC system according to the invention shown in Figure 2 schematically. The system comprises a refrigeration circuit which comprises a first heat transfer fluid comprising or consisting of refrigerant, a compressor 1, at least one expansion device 2, 2', a four-way reversible valve 3 and an outdoor heat exchanger suitable for transferring heat between the first heat transfer fluid and outside air. The system further comprises a heat medium circuit which comprises a second heat transfer fluid comprising or consisting of water, at least one first phase change material PCM1 and at least one second phase change material PCM2, wherein the first phase change material and the second phase change material are encapsulated and wherein the first phase change material PCM1 has a phase change temperature PCM 1 which is lower than the phase change temperature of the second phase change material PCM2. Moreover, the heat medium circuit comprises a first heat indoor exchanger 7 located in a first indoor space and suitable for transferring heat between the second heat transfer fluid and the first indoor space, and a first temperature sensor 5 configured to determine a temperature information of the first indoor space in which the first indoor heat exchanger 7 is located. Furthermore, the heat medium circuit comprises a second indoor heat exchanger 7' located in a second indoor space suitable for transferring heat between the second heat transfer fluid and the second indoor space, and a second temperature sensor 5' configured to determine a temperature information of the second indoor space in which the second indoor heat exchanger 7' is located. In addition, the system comprises two pumps 6, 6' as conveying means for circulating the second heat transfer fluid through the first heat medium heat exchanger 7 and the second heat medium exchanger 7' and two heat exchangers 8, 8' comprised by both the refrigeration circuit and the heat medium circuit, and are suitable for transferring heat between the first heat transfer fluid and the second heat transfer fluid. The system further comprises a controller (not shown) configured to receive a temperature information from at least the first temperature sensor 5 and the second temperature sensor 5', wherein the controller is configured to control the system based on a temperature information received from at least the first temperature sensor 5 and the second temperature sensor 5'.

Figure 4 illustrates schematically operational modes of the system according to the invention. The cooling operation mode is subdivided into a cooling only mode and a cooling main mode and the heating operation mode is subdivided into a heating only mode and a heating main mode. Between the cooling main mode and a heating main mode, a total heat recovery mode is illustrated.

Figure 5 illustrates schematically a control diagram for the compressor of the refrigerant circuit and for a motorized valve of the refrigerant circuit regarding an indoor heat exchanger which has the highest cooling load.

Figure 6 illustrates schematically a control diagram for a fan of the heat medium circuit and for a motorized valve of the refrigerant circuit regarding an indoor heat exchanger of which has a lower than highest cooling load.

Figure 7 illustrates schematically a control diagram for a pump as the at least one conveying means of the heat medium circuit and an expansion valve of the refrigerant circuit regarding all indoor heat exchangers which have a cooling load.

Figure 8 illustrates schematically a control diagram for the compressor of the refrigerant circuit and for a motorized valve of the refrigerant circuit regarding the indoor heat exchanger which has the highest heating load.

Figure 9 illustrates schematically a control diagram for a fan of the heat medium circuit and for a motorized valve of the refrigerant circuit regarding an indoor heat exchanger which has a lower than highest heating load.

Figure 10 illustrates schematically a control diagram for a pump as the at least one conveying means of the heat medium circuit and an expansion valve of the refrigerant circuit regarding all indoor heat exchangers of the inventive system which have a heating load.

Example 1 - Configuration of controller in the cooling (only) operation mode (Figures 5 to 7)

[0035] For example, both Zone 1 and Zone 2 illustrated in Figure 3 need cooling.

[0036] For an indoor heat exchanger with the highest cooling load among all indoor heat exchangers of the system, the main algorithm is explained below and in Figure 5 by using PI as the example control mechanism:

- Indoor unit fan is always on at a fixed speed (selected by occupant).
- Compressor speed adjusted automatically to achieve target T_PCM1. Target T_PCM1 set according to ΔT between room set point and actual room temperature.
- Valve position on indoor unit branch (either diverting/bypass valve or regulated ball valve) set according to the branch's target flow-rate. Target flow-rate to indoor unit set to achieve target ΔT_PCM1.
- The target temperature T_PCM1 should be set at PCM (of the first phase change material) - ΔT_PCM1. By doing so the latent energy of phase change will be fully utilized.

[0037] For an indoor heat exchanger with a lower than highest cooling load among all indoor heat exchangers of the system, the main algorithm is explained below and in Figure 6 by using PI as the example control mechanism:

- Indoor unit fan switches on or off according to thermostat to maintain room temperature with dead band.
- T_PCM1 to indoor unit is fixed according to the zone with the highest cooling load (see above).
- Valve position on indoor unit branch set according to the branch's target flow-rate. Target flow-rate to indoor unit set to achieve target ΔT_PCM1.

[0038] For all indoor heat exchangers of the system, the control mechanism of a pump of the heat medium circuit (pump of Hydronic Box) and an expansion valve of the refrigerant circuit (expansion valve of outdoor unit) is explained below and in Figure 7:

- Pump speed set to achieve target slurry flow-rate in indoor heat exchanger;
- Expansion valve opening degree set to achieve target superheat on refrigerant side.

Example 2 - Configuration of controller in the heating (only) operation mode (Figures 8 to 10)

[0039] For example, both Zone 1 and Zone 2 illustrated in Figure 3 need heating.

[0040] For an indoor heat exchanger with the highest heating load among all indoor heat exchangers of the system, the main algorithm is explained below and in Figure 8 by using PI as the example control mechanism:

- Indoor unit fan is always on at a fixed speed (selected by occupant).
- Compressor speed adjusted automatically to achieve target T_PCM2. Target T_PCM2 set according to ΔT between room set point and actual room temperature.
- Valve position on indoor unit branch (either diverting/bypass valve or regulated ball valve) set according to the branch's target flow-rate. Target flow-rate to indoor unit set to achieve target ΔT_PCM2.
- The target temperature T_PCM2 should be set at PCM (of the second phase change material) + ΔT_PCM2. By doing so the latent energy of phase change will be fully utilized

[0041] For an indoor heat exchanger with a lower than highest heating load among all indoor heat exchangers of the system, the main algorithm is explained below and in Figure 8 by using PI as the example control mechanism:

- Indoor unit fan switches on or off according to thermostat to maintain room temperature with dead band.
- T_PCM2 to indoor unit is fixed according to the zone with the highest cooling load (see above).
- Valve position on indoor unit branch set according to the branch's target flow-rate. Target flow-rate to indoor unit set to achieve target ΔT_PCM2.

[0042] For all indoor heat exchangers of the system, the control mechanism of a pump of the heat medium circuit (pump of Hydronic Box) and an expansion valve of the refrigerant circuit (expansion valve of outdoor unit) is explained below and in Figure 10:

- Pump speed set to achieve target slurry flow-rate in in indoor heat exchanger;
- Expansion valve opening degree set to achieve target superheat on refrigerant side.

<u>List of reference signs and abbreviations</u>

[0043]

1:	compressor,
2, 2':	expansion device,
3:	four-way reversible valve;
4:	outdoor heat exchanger;
5, 5':	temperature sensor;
6, 6':	pump,
7:	first indoor heat exchanger;
7':	second indoor heat exchanger;
8, 8':	heat exchanger between refrigerant circuit and heat medium circuit;
9:	accumulator;
10, 10':	motorized valve in first indoor heat exchanger circuit;
11, 11':	motorized valve in second second heat exchanger circuit;
12:	fan of first indoor heat exchanger;
12':	fan of second indoor heat exchanger;
SP:	setpoint;
T_{indoor}:	Temperature of first indoor space and/or of second indoor space;
e(t):	error value defined as the difference between a desired setpoint and a measured process variable;
PI:	proportional-integral controller;
PCM1:	first phase change material;
PCM2:	second phase change material;
T_PCM1:	target temperature of the first phase change material;
T_PCM2:	target temperature of the second phase change material;
ΔT:	temperature difference between a target temperature in an indoor space in which an indoor heat exchanger is located and an actual temperature in said indoor space;
ΔT_PCM1:	predetermined target temperature difference of the first phase change material;
ΔT_PCM2:	predetermined target temperature difference of the second phase change material;
Slurry circuit:	circuit of second heat transfer medium;
V_flow:	flow-rate of the second heat transfer fluid;
Super_Heat:	super heat in the refrigeration circuit;
LEV:	expansion device 2, 2';
PCT:	phase change temperature.

Claims

1. A system for heating and/or cooling at least one space, comprising

a) a refrigeration circuit, comprising

a first heat transfer fluid comprising or consisting of refrigerant,
a compressor (1),
at least one expansion device (2, 2'),
a four-way reversible valve (3), and
an outdoor heat exchanger (4) suitable for transferring heat between the first heat transfer fluid and outside air;

b) a heat medium circuit, comprising

a second heat transfer fluid comprising or consisting of water, at least one first phase change material (PCM1) and at least one second phase change material (PCM2), wherein the first phase change material and the second phase change material are encapsulated and wherein the first phase change material (PCM1) has a phase change temperature (PCM) which is lower than the phase change temperature of the second phase change material (PCM2),
a first heat indoor exchanger (7) located in a first indoor space and suitable for transferring heat between the second heat transfer fluid and the first indoor space, and a first temperature sensor (5) configured to determine a temperature information of the first indoor space in which the first indoor heat exchanger (7) is located,
a second indoor heat exchanger (7') located in a second indoor space suitable for transferring heat between the second heat transfer fluid and the second indoor space, and a second temperature sensor (5') configured to determine a temperature information of the second indoor space in which the second indoor heat exchanger (7') is located, and
at least one conveying means (6, 6') for circulating the second heat transfer fluid through the first heat medium heat exchanger (7) and the second heat medium exchanger (7');

c) at least one heat exchanger (8, 8') comprised by both the refrigeration circuit and the heat medium circuit, and being suitable for transferring heat between the first heat transfer fluid and the second heat transfer fluid; and
d) a controller configured to receive a temperature information from at least the first temperature sensor (5) and the second temperature sensor (5'), wherein the controller is configured to control the system based on a temperature information received from at least the first temperature sensor (5) and the second temperature sensor (5').

2. System according claim 1, **characterized in that** the controller is configured to determine, in a cooling operation mode of the system, which indoor heat exchanger (7, 7') has the highest cooling load based on the temperature information received from at least the first temperature sensor (5) and the second temperature sensor (5'), wherein the controller is configured to

i) control a fan (12,12') of the indoor heat exchanger (7, 7') which has the highest cooling load to be always on at a fixed speed, wherein the fixed speed is preferably selectable by a user of the indoor heat exchanger (7, 7');
ii) control a speed of the compressor (1) to achieve a target temperature (T_PCM1) of the first phase change material (PCM1) in an indoor space in which the indoor heat exchanger (7, 7') determined to have the highest cooling load is located, wherein the target temperature (T_PCM1) of the first phase change material (PCM1) is set according to a temperature difference (ΔT) between a target temperature in an indoor space in which the indoor heat exchanger (7, 7') determined to have the highest cooling load is located and an actual temperature in said indoor space;
iii) control an opening degree of at least one motorized valve (10, 10', 11, 11') located in a fluid circuit of the indoor heat exchanger (7, 7') which has the highest cooling load to achieve a target temperature (T_PCM1) of the first phase change material (PCM1) at said indoor heat exchanger (7, 7'), wherein the target temperature (T_PCM1) is a temperature in a range determined by the phase change temperature (PCT) of the first phase change material (PCM1) ± a predetermined target temperature difference (ΔT_PCM1) of the first phase change material (PCM1), wherein the predetermined target temperature difference (ΔT_PCM1) of the first phase change material (PCM1) is preferably in the range of >0 K to 10 K, more preferably in the range of 0.5 K to 10 K, particularly preferably in the range of 1 K to 5 K; and
iv) set a target temperature (T_PCM1) of the first phase change material (PCM1) to be a temperature which is the phase change temperature of the first phase change material (PCM1) minus the predetermined target temperature difference (ΔT_PCM1) of the first phase change material (PCM1).

3. System according to one of the preceding claims, **characterized in that** the controller is configured to determine, in a cooling operation mode of the system, which indoor heat exchanger (7, 7') has a lower than highest cooling load based on a temperature information received from at least the first temperature sensor (5) and the second temperature sensor (5'), wherein the controller is configured to

i) control a fan (12,12') of the indoor heat exchanger (7, 7') which has a lower than highest cooling load to switch on or off based on a setting of a thermostat controlling said indoor heat exchanger (7, 7') to maintain a temperature of an indoor space in which said indoor heat exchanger is located within a dead band; and
ii) control an opening degree of a motorized valve (10, 10', 11, 11') located in a fluid circuit of the indoor heat exchanger (7, 7') which has a lower than highest heating load to achieve a predetermined target temperature difference (ΔT_PCM1) of the first phase change material (PCM1) at the indoor heat exchanger (7, 7') which has a lower than highest cooling load, wherein the predetermined target temperature difference (ΔT_PCM1) of the first phase change material (PCM1) is preferably in the range of >0 K to 10K, more preferably in the range of 0.5 K to 10 K, particularly preferably in the range of 1 K to 5 K.

4. System according to one of the preceding claims, **characterized in that** the controller is configured to determine, in a heating operation mode of the system, which indoor heat exchanger (7, 7') has the highest heating load based on the temperature information received from at least the first temperature sensor (5) and the second temperature sensor (5'), wherein the controller is configured to

i) control a fan (12, 12') of the indoor heat exchanger (7, 7') which has the highest heating load to be always on at a fixed speed, wherein the fixed speed is preferably selectable by a user of the indoor heat exchanger (7, 7');
ii) control a speed of the compressor (1) to achieve a target temperature (T_PCM2) of the second phase change material (PCM2) in an indoor space in which the indoor heat exchanger (7, 7') determined to have the highest heating load is located, wherein the target temperature (T_PCM2) of the second phase change material (PCM2) is set according to a temperature difference (ΔT) between a target temperature in an indoor space in which the indoor heat exchanger (7, 7') determined to have the highest heating load is located and an actual temperature in said indoor space;
iii) control an opening degree of at least one motorized valve (10, 10', 11, 11') located in a fluid circuit of the indoor heat exchanger (7, 7') which has the highest heating load to achieve a target temperature (T_PCM2) of the second phase change material (PCM2) at said indoor heat ex-

changer (7, 7'), wherein the target temperature (T_PCM2) is a temperature in a range determined by the phase change temperature (PCT) of the second phase change material (PCM2) ± a predetermined target temperature difference (ΔT_PCM2) of the second phase change material (PCM1), wherein the predetermined target temperature difference (ΔT_PCM2) of the second phase change material (PCM2) is preferably in the range of >0 K to 10 K, more preferably in the range of 0.5 K to 10 K, particularly preferably in the range of 1 K to 5 K; and
iv) set a target temperature (T_PCM2) of the second phase change material (PCM2) to be a temperature which is the phase change temperature (PCM) of the second phase change material (PCM2) plus the predetermined target temperature difference (ΔT_PCM2) of the first phase change material (PCM2).

5. System according to one of the preceding claims, **characterized in that** the controller is configured to determine, in a heating operation mode of the system, which indoor heat exchanger (7, 7') has a lower than highest heating load based on a temperature information received from at least the first temperature sensor (5) and the second temperature sensor (5'), wherein the controller is configured to

i) control a fan (12,12') of the indoor heat exchanger (7, 7') which has a lower than highest heating load to switch on or off based on a setting of a thermostat controlling said indoor heat exchanger (7, 7') to maintain a temperature of an indoor space in which said indoor heat exchanger is located within a dead band; and
ii) control an opening degree of a motorized valve (10, 10', 11, 11') located in a fluid circuit of the indoor heat exchanger (7, 7') which has a lower than highest heating load to achieve a predetermined target temperature difference (ΔT_PCM2) of the second phase change material (PCM2) at the indoor heat exchanger (7, 7') which has a lower than highest heating load, wherein the predetermined target temperature difference (ΔT_PCM2) of the second phase change material (PCM2) is preferably in the range of >0 K to 10 K, more preferably in the range of 0.5 K to 10 K, particularly preferably in the range of 1 K to 5 K.

6. System according to one of the preceding claims, **characterized in that** the controller is configured to, in a cooling operation of the system and/or in a heating operation mode of the system,

i) control a speed of the at least one conveying means (6, 6') to achieve a target flow-rate (V_flow) of the second heat transfer fluid in the first heat indoor exchanger (7) and/or in the second indoor heat exchanger (7'); and
ii) control an opening degree of the at least one expansion device (2, 2') to achieve a target superheat (Super_Heat) in the refrigeration circuit.

7. System according to one of the preceding claims, **characterized in that** the refrigeration circuit comprises an accumulator (9) and/or the heat medium circuit comprises at least one, preferably at least two, storage device(s) for storing the second heat transfer fluid.

8. A method for heating and/or cooling at least one space, comprising

a) providing a system comprising

i) a refrigeration circuit, comprising

a first heat transfer fluid comprising or consisting of refrigerant,
a compressor (1),
at least one expansion device (2, 2'),
a four-way reversible valve (3), and
an outdoor heat exchanger (4) suitable for transferring heat between the first heat transfer fluid and outside air;

ii) a heat medium circuit, comprising

a second heat transfer fluid comprising or consisting of water, at least one first phase change material (PCM1) and at least one second phase change material (PCM2), wherein the first phase change material and the second phase change material are encapsulated and wherein the first phase change material (PCM1) has a phase change temperature which is lower than the phase change temperature of the second phase change material (PCM2),
a first heat indoor exchanger (7) located in a first indoor space and suitable for transferring heat between the second heat transfer fluid and the first indoor space, and a first temperature sensor (5) configured to determine a temperature information of the first indoor space in which the first indoor heat exchanger (7) is located,
a second indoor heat exchanger (7') located in a second indoor space suitable for transferring heat between the second heat transfer fluid and the second indoor space, and a second tempera-

ture sensor (5’) configured to determine a temperature information of the second indoor space in which the second indoor heat exchanger (7’) is located, and

at least one conveying means (6, 6’) for circulating the second heat transfer fluid through the first heat medium heat exchanger (7) and the second heat medium exchanger (7’);

iii) at least one heat exchanger (8, 8’) comprised by both the refrigeration circuit and the heat medium circuit, and being suitable for transferring heat between the first heat transfer fluid and the second heat transfer fluid; and

iv) a controller configured to receive a temperature information from at least the first temperature sensor (5) and the second temperature sensor (5’),

b) control the system based on a temperature information received from at least the first temperature sensor (5) and the second temperature sensor (5’).

9. Method according to claim 8, **characterized in that** it is determined, in a cooling operation mode of the system, which indoor heat exchanger (7, 7’) has the highest cooling load based on the temperature information received from at least the first temperature sensor (5) and the second temperature sensor (5’), wherein

i) a fan (12, 12’) of the indoor heat exchanger (7, 7’) which has the highest cooling load is set to be always on at a fixed speed, wherein the fixed speed is preferably selected by a user of the indoor heat exchanger (7, 7’);

ii) a speed of the compressor (1) is set to achieve a target temperature (T_PCM1) of the first phase change material (PCM1) in an indoor space in which the indoor heat exchanger (7, 7’) determined to have the highest cooling load is located, wherein the target temperature (T_PCM1) of the first phase change material (PCM1) is set according to a temperature difference (ΔT) between a target temperature in an indoor space in which the indoor heat exchanger (7, 7’) determined to have the highest cooling load is located and an actual temperature in said indoor space;

iii) an opening degree of at least one motorized valve (10, 10’, 11, 11’) located in a fluid circuit of the indoor heat exchanger (7, 7’) which has the highest cooling load is set to achieve a target temperature (T_PCM1) of the first phase change material (PCM1) at said indoor heat exchanger (7, 7’), wherein the target temperature (T_PCM1) is a temperature in a range determined by the phase change temperature (PCT) of the first phase change material (PCM1) $\pm$ a predetermined target temperature difference (ΔT_PCM1) of the first phase change material (PCM1), wherein the predetermined target temperature difference (ΔT_PCM1) of the first phase change material (PCM1) is preferably in the range of >0 K to 10 K, more preferably in the range of 0.5 K to 10 K, particularly preferably in the range of 1 K to 5 K; and

iv) a target temperature (T_PCM1) of the first phase change material (PCM1) is set to be a temperature which is the phase change temperature of the first phase change material (PCM1) minus the predetermined target temperature difference (ΔT_PCM1) of the first phase change material (PCM1).

10. Method according to one of claims 8 or 9, **characterized in that** it is determined, in a cooling operation mode of the system, which indoor heat exchanger (7, 7’) has a lower than highest cooling load based on a temperature information received from at least the first temperature sensor (5) and the second temperature sensor (5’), wherein

i) a fan (12, 12’) of the indoor heat exchanger (7, 7’) which has a lower than highest cooling load is set to switch on or off based on a setting of a thermostat controlling said indoor heat exchanger (7, 7’) to maintain a temperature of an indoor space in which said indoor heat exchanger is located within a dead band; and

ii) an opening degree of a motorized valve (10, 10’, 11, 11’) located in a fluid circuit of the indoor heat exchanger (7, 7’) which has a lower than highest heating load is set to achieve a predetermined target temperature difference (ΔT_PCM1) of the first phase change material (PCM1) at the indoor heat exchanger (7, 7’) which has a lower than highest cooling load, wherein the predetermined target temperature difference (ΔT_PCM1) of the first phase change material (PCM1) is preferably in the range of >0 K to 10 K,more preferably in the range of 0.5 K to 5 K, particularly preferably in the range of 1 K to 5 K.

11. Method according to one of claims 8 to 10, **characterized in that** it is determined, in a heating operation mode of the system, which indoor heat exchanger (7, 7’) has the highest heating load based on the temperature information received from at least the first temperature sensor (5) and the second temperature sensor (5’), wherein

i) a fan (12, 12') of the indoor heat exchanger (7, 7') which has the highest heating load is set to be always on at a fixed speed, wherein the fixed speed is preferably selectable by a user of the indoor heat exchanger (7, 7');
ii) a speed of the compressor (1) is set to achieve a target temperature (T_PCM2) of the second phase change material (PCM2) in an indoor space in which the indoor heat exchanger (7, 7') determined to have the highest heating load is located, wherein the target temperature (T_PCM2) of the second phase change material (PCM2) is set according to a temperature difference (ΔT) between a target temperature in an indoor space in which the indoor heat exchanger (7, 7') determined to have the highest heating load is located and an actual temperature in said indoor space;
iii) an opening degree of at least one motorized valve (10, 10', 11, 11') located in a fluid circuit of the indoor heat exchanger (7, 7') which has the highest heating load is set to achieve a target temperature (T_PCM2) of the second phase change material (PCM2) at said indoor heat exchanger (7, 7'), wherein the target temperature (T_PCM2) is a temperature in a range determined by the phase change temperature (PCT) of the second phase change material (PCM2) ± a predetermined target temperature difference (ΔT_PCM1) of the second phase change material (PCM2), wherein the predetermined target temperature difference (ΔT_PCM2) of the second phase change material (PCM2) is preferably in the range of >0 K to 10 K, more preferably in the range of 0.5 K to 10 K, particularly preferably in the range of 1 K to 5 K; and
iv) a target temperature (T_PCM2) of the second phase change material (PCM2) is set to be a temperature which is the phase change temperature (PCM) of the second phase change material (PCM2) plus the predetermined target temperature difference (ΔT_PCM2) of the first phase change material (PCM2).

12. Method according to one of claims 8 to 11, **characterized in that** it is determined, in a heating operation mode of the system, which indoor heat exchanger (7, 7') has a lower than highest heating load based on a temperature information received from at least the first temperature sensor (5) and the second temperature sensor (5'), wherein

i) a fan (12, 12') of the indoor heat exchanger (7, 7') which has a lower than highest heating load is set to switch on or off based on a setting of a thermostat controlling said indoor heat exchanger (7, 7') to maintain a temperature of an indoor space in which said indoor heat exchanger is located within a dead band; and
ii) an opening degree of a motorized valve (10, 10', 11, 11') located in a fluid circuit of the indoor heat exchanger (7, 7') which has a lower than highest heating load is set to achieve a predetermined target temperature difference (ΔT_PCM2) of the second phase change material (PCM2) at the indoor heat exchanger (7, 7') which has a lower than highest heating load, wherein the predetermined target temperature difference (ΔT_PCM2) of the second phase change material (PCM2) is preferably in the range of >0 K to 10 K, more preferably in the range of 0.5 K to 10 K, particularly preferably in the range of 1 K to 5 K.

13. Method according to one of claims 8 to 12, **characterized in that**, in a cooling operation of the system and/or in a heating operation mode of the system,

i) a speed of the at least one conveying means (6, 6') is set to achieve a target flow-rate (V_flow) of the second heat transfer fluid in the first heat indoor exchanger (7) and/or in the second indoor heat exchanger (7'); and
ii) an opening degree of the at least one expansion device (2, 2') is set to achieve a target superheat (Super_Heat) in the refrigeration circuit.

14. Method according to one of claims 8 to 13, **characterized in that** the refrigeration circuit comprises an accumulator (9) and/or the heat medium circuit comprises at least one, preferably at least two, storage device(s) for storing the second heat transfer fluid.

Figure 1

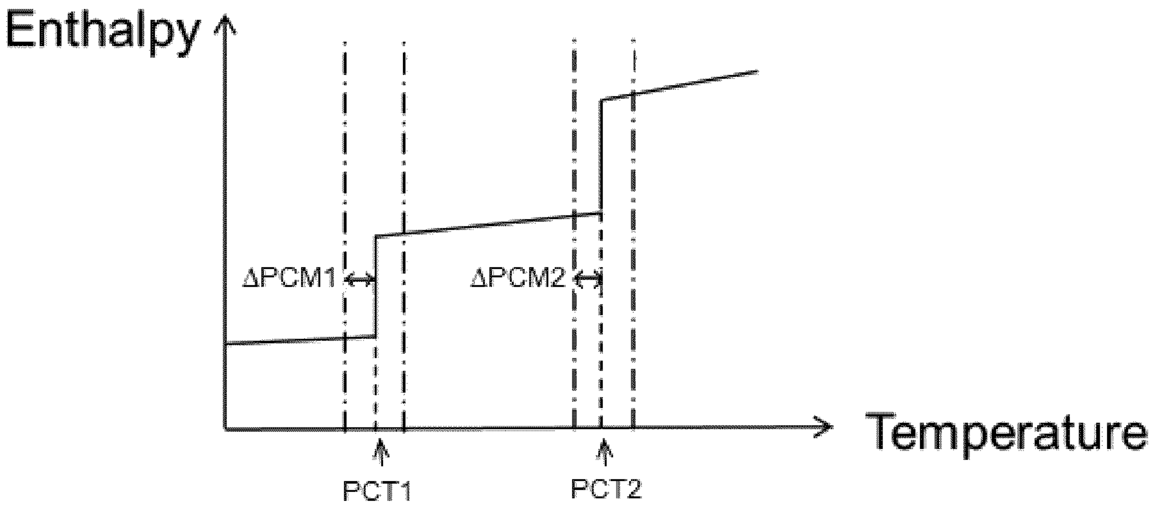


Figure 2

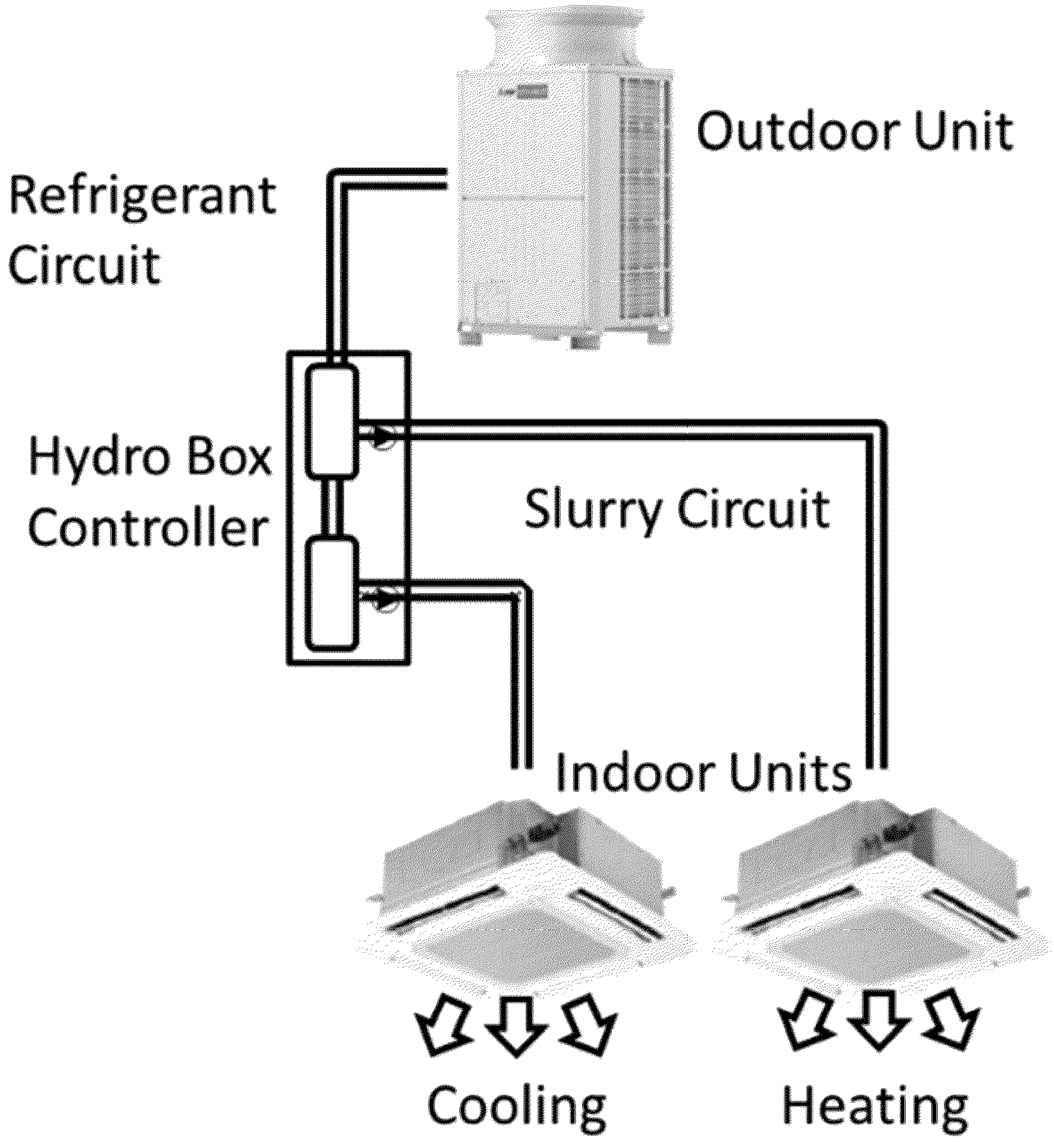

Outdoor Unit
Refrigerant Circuit
Hydro Box Controller
Slurry Circuit
Indoor Units
Cooling
Heating

Figure 3

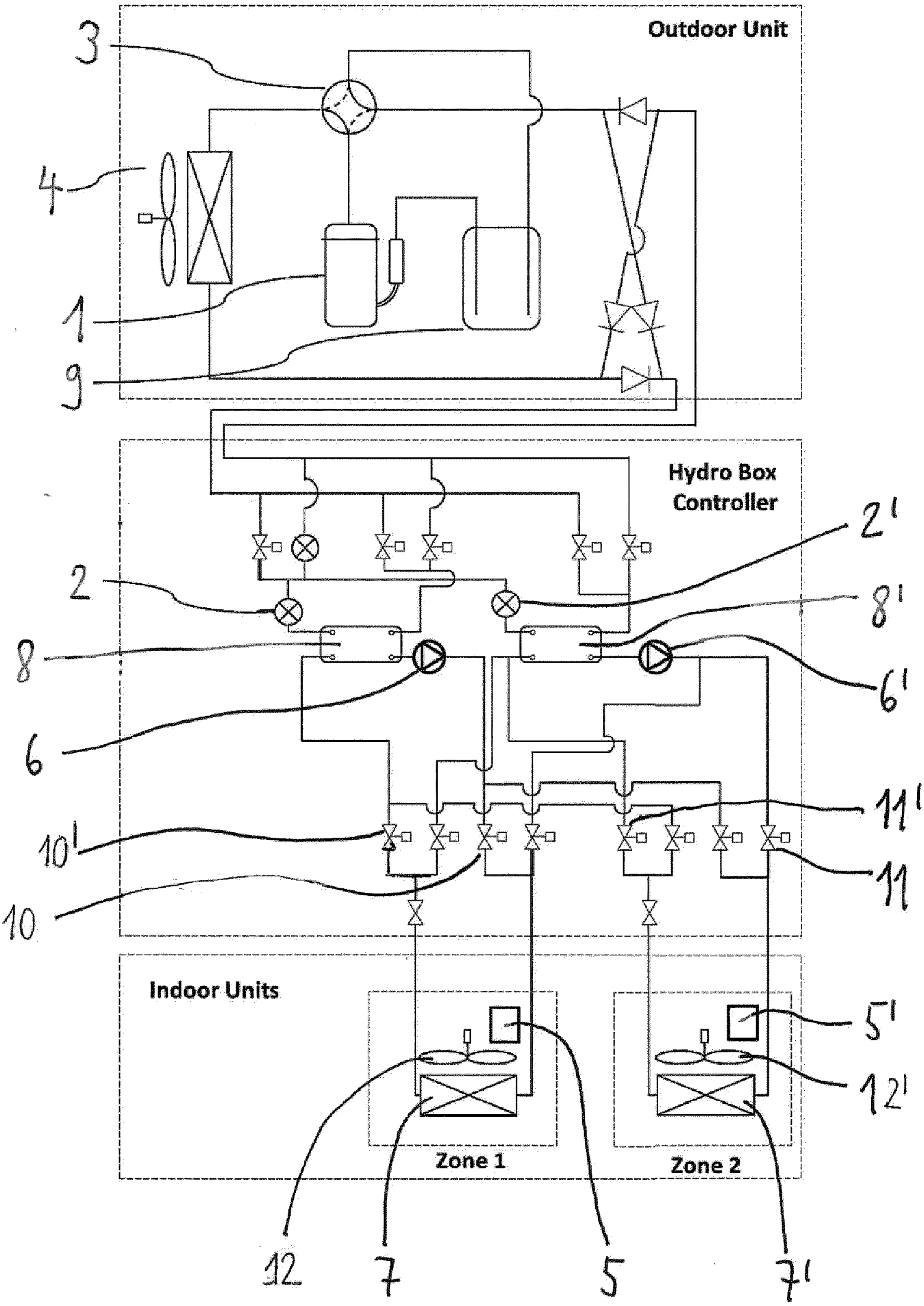

Outdoor Unit
Hydro Box
Controller
Indoor Units
Zone 1
Zone 2
3
4
1
9
2
2'
8'
8
6'
6
11'
10'
11
10
5'
12'
12
7
5
7'

Figure 4

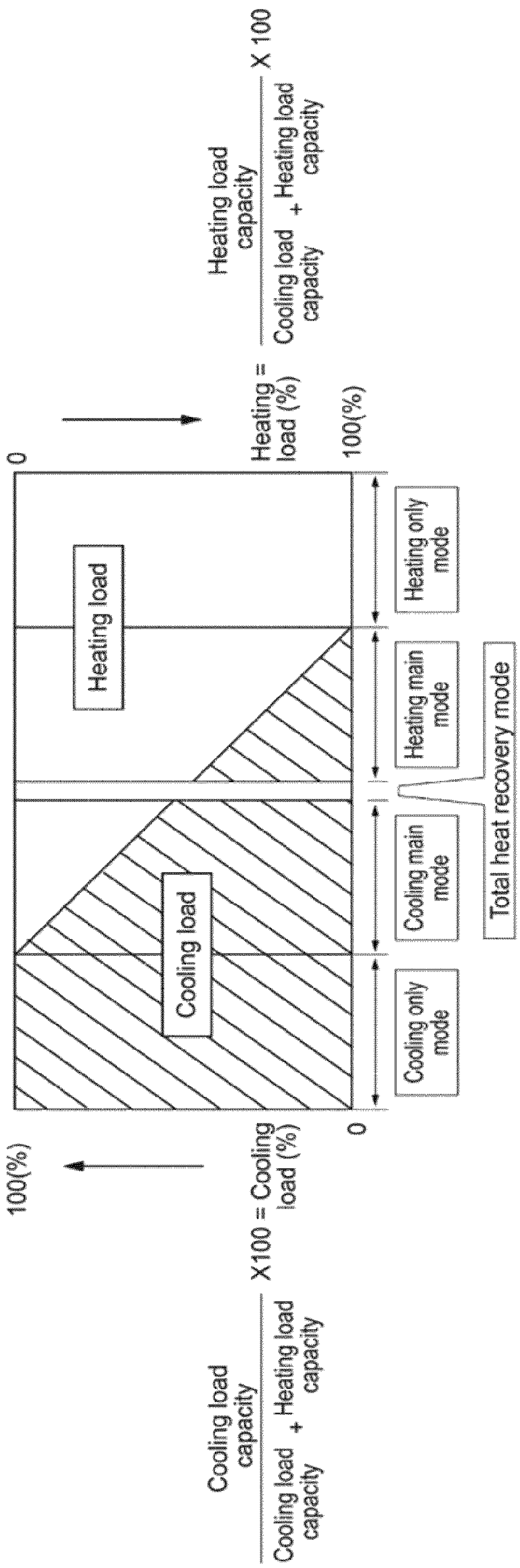

Heating = load (%) = Heating load capacity / (Cooling load capacity + Heating load capacity) X 100
Cooling load capacity / (Cooling load capacity + Heating load capacity) X100 = Cooling load (%)
0
100(%)
Heating load
Cooling load
Heating only mode
Heating main mode
Cooling main mode
Cooling only mode
Total heat recovery mode

Figure 5

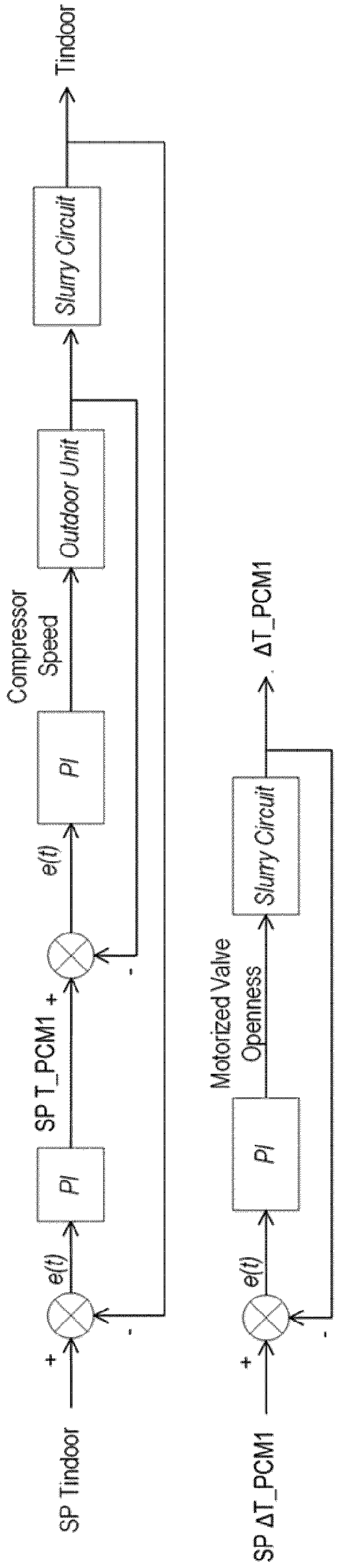

SP Tindoor
+
-
e(t)
PI
SP T_PCM1
+
-
e(t)
PI
Compressor Speed
Outdoor Unit
Slurry Circuit
Tindoor
SP ΔT_PCM1
+
-
e(t)
PI
Motorized Valve Openness
Slurry Circuit
ΔT_PCM1

Figure 6

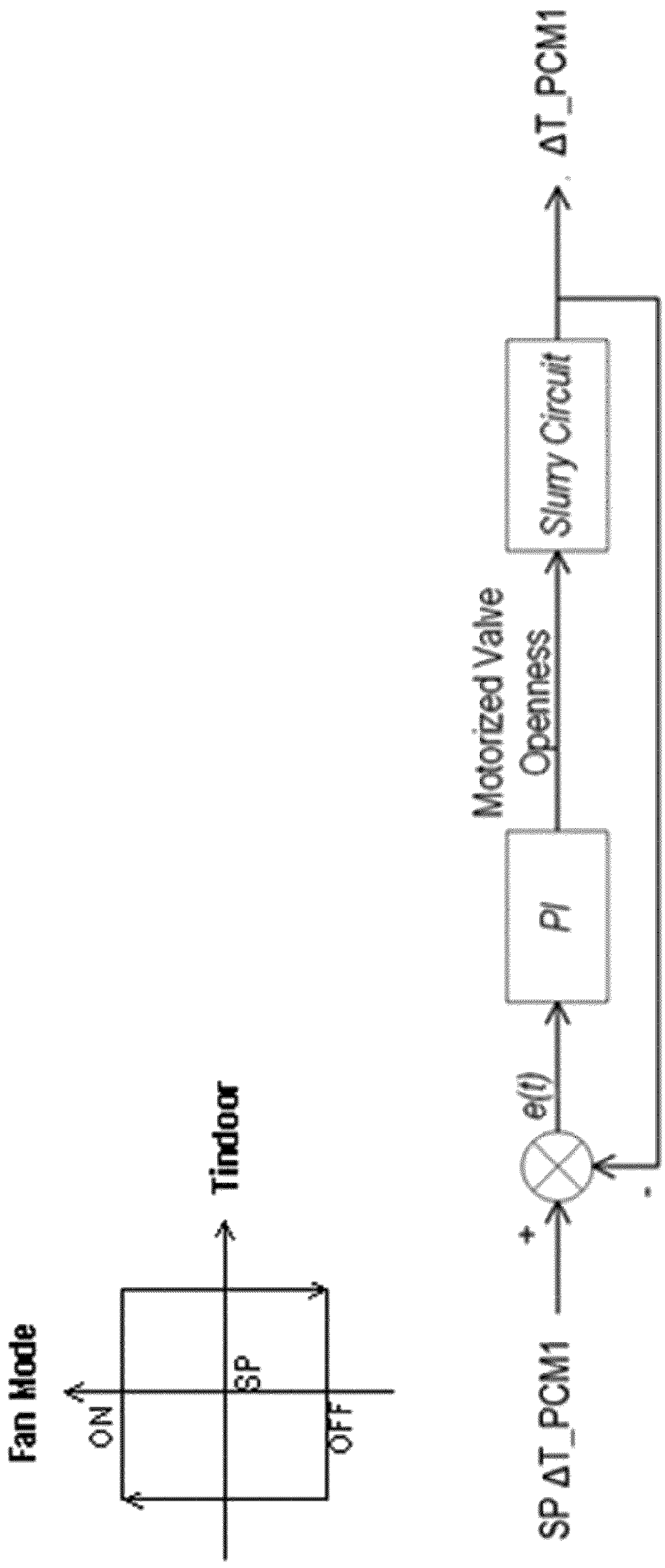

Fan Mode
ON
OFF
SP
Tindoor
SP ΔT_PCM1
+
-
e(t)
PI
Motorized Valve
Openness
Slurry Circuit
ΔT_PCM1

Figure 7

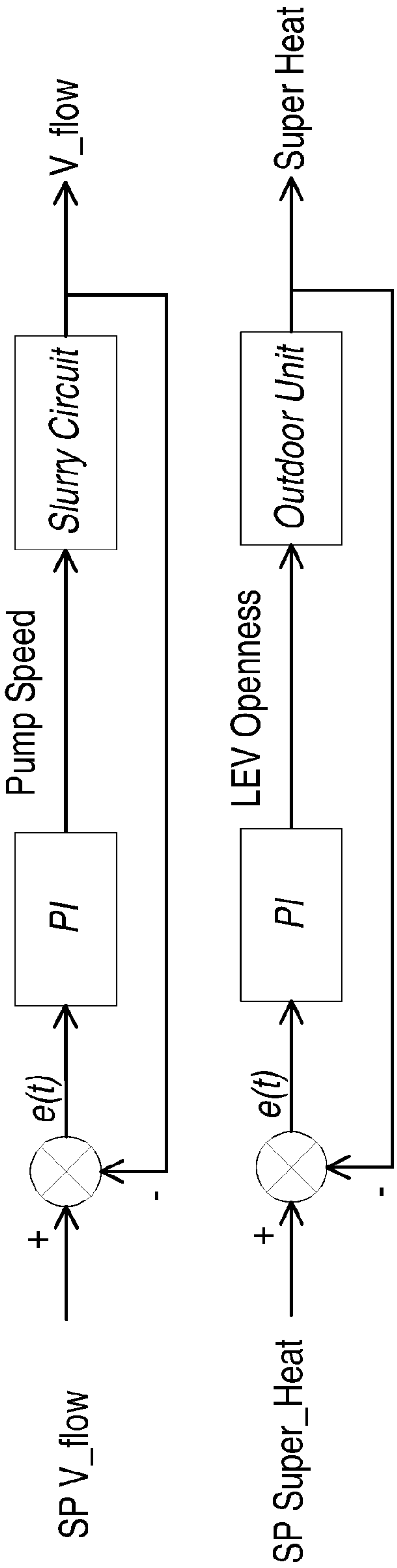

SP V_flow
+
-
e(t)
PI
Pump Speed
Slurry Circuit
V_flow
SP Super_Heat
+
-
e(t)
PI
LEV Openness
Outdoor Unit
Super Heat

Figure 8

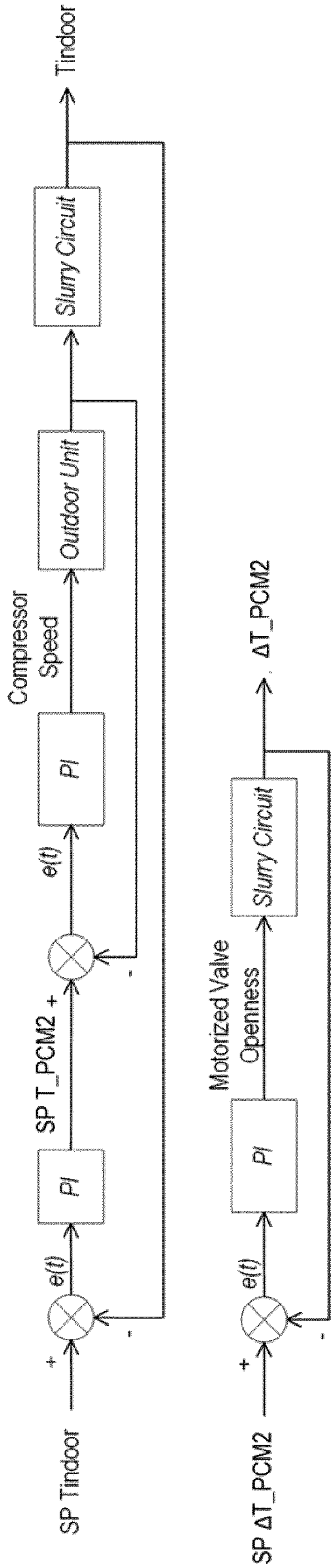

SP Tindoor
+
-
e(t)
PI
SP T_PCM2
+
-
e(t)
PI
Compressor
Speed
Outdoor Unit
Slurry Circuit
Tindoor
SP ΔT_PCM2
+
-
e(t)
PI
Motorized Valve
Openness
Slurry Circuit
ΔT_PCM2

Figure 9

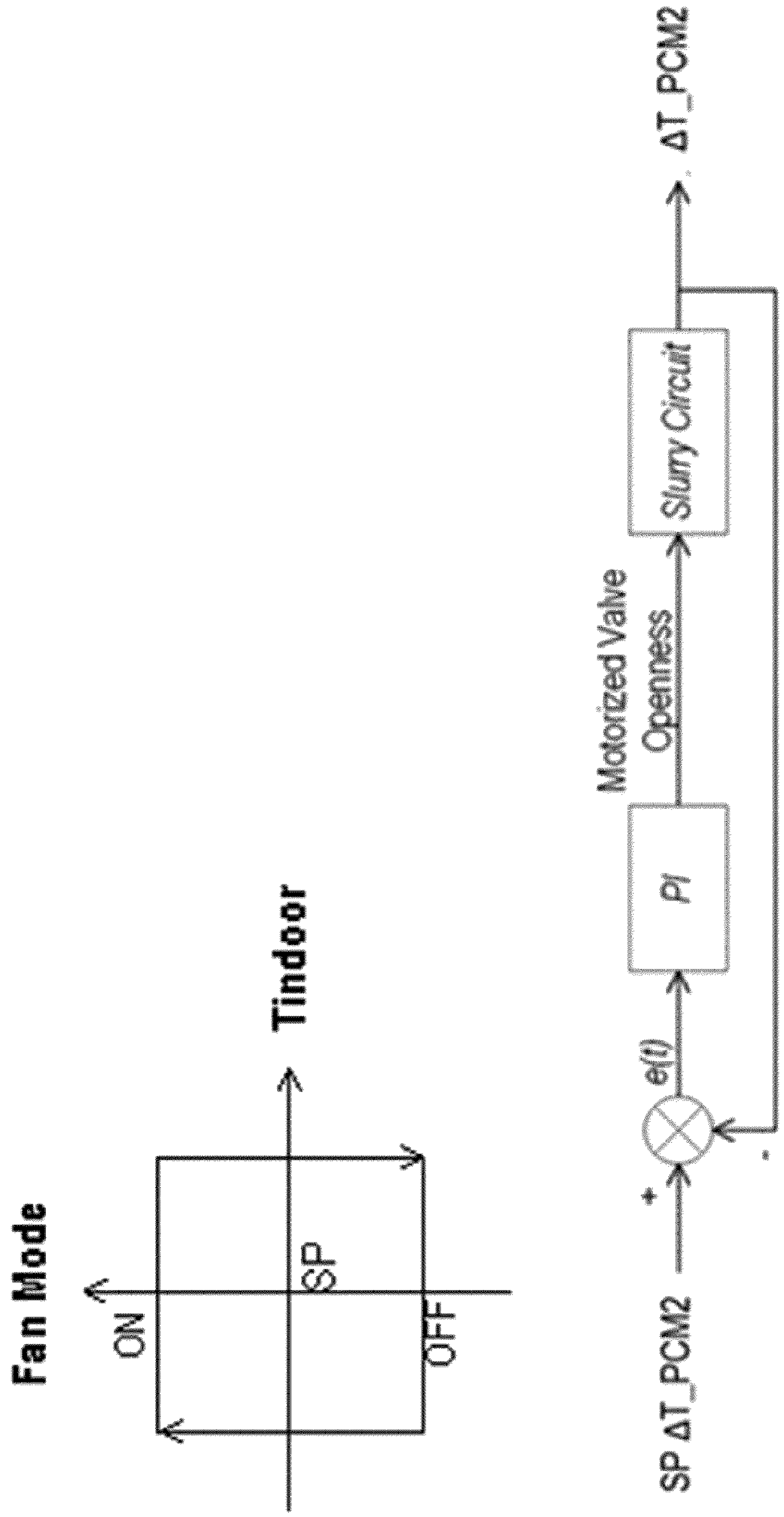
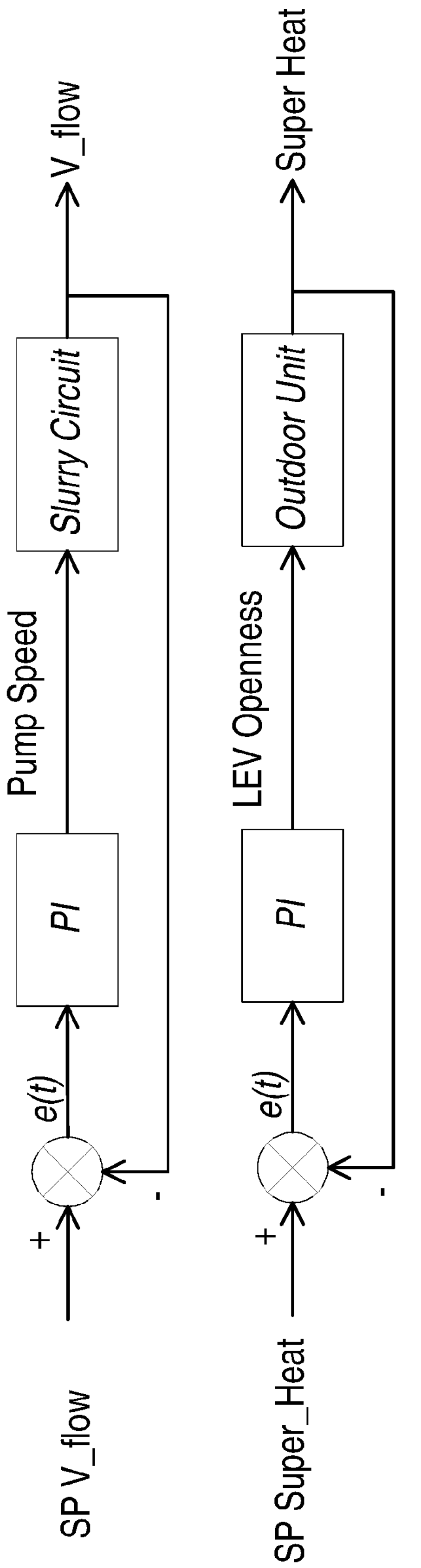

Fan Mode
ON
SP
OFF
Tindoor
SP ΔT_PCM2
+
-
e(t)
PI
Motorized Valve
Openness
Slurry Circuit
ΔT_PCM2

Figure 10


SP V_flow
+
-
e(t)
PI
Pump Speed
Slurry Circuit
V_flow
SP Super_Heat
+
-
e(t)
PI
LEV Openness
Outdoor Unit
Super Heat

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 22 16 4205

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
Y	EP 3 961 127 A1 (MITSUBISHI ELECTRIC R&D CT EUROPE BV [GB] ET AL.) 2 March 2022 (2022-03-02) * paragraphs [0010] - [0031]; figures 1-8 *	1-14	INV. F24F1/0003 F24F1/0007 F24F5/00 F24F11/30 F24F11/63 F24F11/83 F24F11/84 F24F11/85 F24F11/86 F25B13/00 F25B25/00 ADD. F24F110/10 F24F140/20
Y,D	JP 2000 161724 A (DAIKIN IND LTD) 16 June 2000 (2000-06-16) * paragraphs [0027], [0028], [0034] - [0036], [0055] - [0057]; figures 1, 2 *	1-14	
A	EP 3 779 308 A1 (MITSUBISHI ELECTRIC CORP [JP]) 17 February 2021 (2021-02-17) * the whole document *	1-14	
A	EP 1 884 719 A1 (BARCOL AIR [CH]) 6 February 2008 (2008-02-06) * the whole document *	1-14	
			TECHNICAL FIELDS SEARCHED (IPC)
			F24F F25B

The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
Munich	6 September 2022	Schwaiger, Bernd

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06-09-2022

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JP 2000161724 A	16-06-2000	NONE	
EP 3779308 A1	17-02-2021	EP 3779308 A1	17-02-2021
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		US 2021025627 A1	28-01-2021
		WO 2019193712 A1	10-10-2019
EP 1884719 A1	06-02-2008	NONE	

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

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- JP 2000161724 A **[0004]**