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(54) METHOD FOR OPERATING A HEAT PUMP SYSTEM

VERFAHREN FÜR DEN BETRIEB EINES WÄRMEPUMPENSYSTEMS

PROCÉDÉ DE FONCTIONNEMENT D'UN SYSTÈME DE POMPE À CHALEUR

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(56) References cited:
JP-B2- 5 741 256
US-A1- 2009 020 281
US-A1- 2011 054 701

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Description

[0001] The invention relates to a method for operating a heat pump system wherein an operation of a heat pump is controlled taking into account an operation state of a medium mover as for example a fan. The operation state of the medium mover is determined based on a measurement of a thermodynamic quantity.

[0002] In common heat pump systems the capacity control of a heating/cooling emitter and the control of a heat source are separated. The state of operation of the emitter is therefore usually unknown to the heat source or the heat pump supplying heat to the emitter. In case of a fan coil unit as an example of an emitter, such unit has two thermostats wherein one is an air temperature thermostat measuring a room temperature and the other is a water temperature thermostat or more general a heat transport medium temperature thermostat to prevent providing cold air for heating and hot air for cooling. Furthermore, the heat pump system usually has a room temperature sensor which is at some distance from the emitter and which is read out by a controller of the heat pump system.

[0003] The air temperature thermostat works in order to start the fan when the air temperature goes down to a lower threshold and to stop the fan when the air temperature goes up to a higher threshold in a case of a heating operation and the other way round in a cooling operation.

[0004] The water temperature thermostat (the heat transport medium temperature thermostat) works in order to start the fan when the water flow temperature or heat transport medium flow temperature goes up higher than a threshold in case of heating and goes down lower than a threshold in case of cooling.

[0005] The heat transfer efficiency of a fan coil unit, that is the efficiency of the transfer of heat between the heat transport medium and the space to be heated or cooled, is very low when the fan is stopped. This causes an increase of power consumption of the heat pump.

[0006] The energy efficiency of the heat pump is higher at lower temperatures of the water flow temperature or the heat transport medium flow temperature in case of heating, and at higher temperatures in case of cooling. When the fan is stopped, the water flow temperature or the heat transport medium flow temperature has to be raised to supply the same supplied heat in case of heating and lowered to remove the same removed heat in case of cooling. This causes a lower energy efficiency of the heat pump.

[0007] Usually the air temperature thermostat of the fan coil unit detects that the room temperature rises or drops to a target value earlier than the room thermostat read out by the controller of the heat pump because it detects the air temperature closer to the fan coil unit. Therefore, e. g. in the case of heating, when the air temperature thermostat of the fan coil unit detects that the room temperature rises to the target value, the room temperature detected by the thermostat of the heat pump (which is read out by the controller) is still lower than the threshold to stop the heat pump. Similarly, in the case of operation of cooling the room, the room temperature detected by the thermostat of the heat pump would still be higher than the threshold to stop the heat pump.

[0008] In the following, the problem of the conventional heat pump systems shall be described with reference to a heating operation. However, the problem exists in an analogous way for a cooling operation.

[0009] Figure 2 shows the general behaviour of a heat pump system being controlled conventionally. Figure 2 in the first diagram shows the room temperature over time, in the second diagram the flow temperature of the heat transport medium over time, in the third diagram the fan operation over time and in the lowest diagram the heat pump operation over time. In the uppermost diagram an upper threshold and a lower threshold for the operation of the fan are indicated as dashed lines. Furthermore, a target room temperature is indicated as dashed line between the upper and the lower threshold of the fan operation. Vertical dashed lines indicate corresponding points in time in the first, second and third diagram.

1. In the beginning the room temperature raises due to the heating operation. At point 1 the air temperature thermostat detects that the room temperature arrives at an upper threshold and stops the fan. However, the heat pump is still running.

2. As the fan is stopped the room temperature goes down gradually because the heat transfer efficiency of the fan coil unit drops. In response to this the controller of the heat pump raises the target flow temperature to increase the supplied heat.

3. As a result of the raised target flow temperature of the heat transport medium the room temperature raises again. However, the fan will never restart because the room temperature is always kept higher than the threshold to restart the fan. The heat pump efficiency is therefore permanently lower than with a running fan.

[0010] The water flow temperature to supply sufficient heat to keep the room temperature is changed by the ambient temperature and the target room temperature. When the heat load is small, the target flow temperature can be lower.

[0011] US 2011/0054701 A1 describes an energy saving system for a climate control system including zone controllers which poll temperature difference of each heat exchanger downstream of the thermal station.

[0012] JP 5 741 256 B2 describes a storage type water heater that can suppress an energy loss that is caused in the transition from a reheating operation using a heat pump to a hot water storage operation.

[0013] US 2009/0020281 A1 describes a code generation system for supplying electric power generated by an electric power generator to power load in a household.

[0014] Fig. 3 shows the conventional operation behaviour of the general water temperature thermostat in conventional control methods. The upper-most diagram of Fig. 3 shows the room temperature over time, the middle diagram of Fig. 3 shows the supplied flow temperature of the heat transport medium over time and the lower most diagram shows the fan operation over time.

1. When the heat load is small, the flow temperature required to supply enough heat is lower than the threshold if the fan can keep running.

2. However, due to above described control the fan never runs and the controller of the heat pump raises the target flow temperature of the heat transport medium to a higher value (full line) than the temperature which would be sufficient to supply enough heat if the fan runs (lower dashed line). Thus, in a conventional control the room temperature can be kept without the fan running, however, the efficiency of the heat pump is lower than when the fan runs.

[0015] It is therefore the problem to be solved by the present invention to increase the efficiency of a heat pump system having a heat pump and a heat emitter with a medium mover as for example a fan, in which the heat pump and the heat emitter are controlled independently from each other.

[0016] The problem is solved by the method according to claim 1 and the method according to claim 8. The corresponding dependent claims describe advantageous embodiment of the method according to claim 1 and the method according to claim 8.

[0017] The invention relates to a method for operating a heat pump system. The heat pump system can be used for heating a medium or for cooling a medium. The inventive idea applies to both cases, however, the description shall be made separately here.

[0018] The heat pump system operated in the method according to the invention comprises a heat pump and a heat emitter. The heat emitter comprises a heat exchanger which is configured to exchange heat between a heat transport medium and the medium to be heated. The heat emitter further comprises at least one medium mover for effecting a flow of the medium over the heat exchanger. The medium mover may for example be a fan or an array of fans. However, also other suitable means for effecting said flow of the medium to be heated or cooled over the heat exchanger can be employed.

[0019] Throughout this invention the heat transport medium may for example be water and the medium to be heated or cooled may for example be air in a room to be heated or cooled. The temperature of the medium to be heated or cooled may for example be a room temperature. If reference is made to a medium the medium to be heated or cooled is meant. If reference is made to the heat transport medium, the medium flowing between the heat pump and the heat emitter is meant.

[0020] In common heat pump systems the heat pump and the heat emitter are controlled separately. The operation of the medium mover is usually stopped when the temperature of the medium to be heated as measured by a thermostat at the emitter reaches an upper threshold which here shall be referred to as upper medium mover threshold. The operation of the medium mover is usually started when the temperature of the medium to be heated as measured at the emitter reaches a lower threshold which shall be referred to as lower medium mover threshold here. Usually the temperature of the medium based on which the medium mover is stopped or started, is measured by a thermostat which is mounted at the heat emitter.

[0021] In common heat pump systems the heat pump is controlled to raise the temperature of the heat transport medium if the temperature of the medium to be heated is below a target medium temperature. Usually the temperature based on which the heat pump is controlled is measured by a different thermostat than the temperature based on which the medium mover is stopped or started.

[0022] It should be noted that usually the thermostat used to measure the temperature of the medium to be heated, based on which the heat pump is controlled has a greater distance from the heat emitter than the thermostat with which the temperature is controlled based on which the medium mover is stopped or started.

[0023] In this situation the heat pump controller is usually unaware of the operation state of the medium mover. According to the invention, at least one thermodynamic quantity is measured in the heat pump system in a step, which is here referred to as thermodynamic quantity measuring step. According to the present invention the thermodynamic quantity includes at least one of a measured temperature of the medium to be heated, which is preferably measured by the thermostat used to control the heat pump, and/or a measured return flow temperature of the heat transport medium and/or a measured supplied heat.

[0024] The at least one measured temperature of the medium to be heated is preferably measured by the temperature sensor based on which the heat pump is controlled. This temperature may for example be the room temperature of a room to be heated.

[0025] A return flow temperature of the heat transport medium is usually the temperature which the heat transport medium has after flowing out of the heat emitter. The measured supplied heat is usually for example the amount of heat which is exchanged in the heat emitter in a certain amount of time.

[0026] The method for operating a heat pump system comprises a determining step in which it is determined based on the thermodynamic quantity measured in the thermodynamic quantity measuring step whether the medium mover is operating. In a case where the temperature of the medium to be heated, for example the room temperature, is below the target medium temperature, the heat pump is controlled to stop rising the temperature of the heat transport medium when it is determined in said determining step that the medium mover is not operating. This will allow the temperature of the medium to be heated to reach the lower medium mover threshold so that the medium mover is started. It is ensured that the heat pump system does not permanently operate in the above described inefficient state where the heat pump raises the temperature of the heat transport medium while the medium mover is stopped. The efficiency of the heat pump system is therefore increased compared to the prior art.

[0027] In an advantageous embodiment of the invention the measurements of the thermodynamic quantity obtained in the thermodynamic quantity measuring step can be used to determine a change rate per time of the thermodynamic quantity. It can then be determined in the determining step that the medium mover is stopped if the thermodynamic quantity drops at a change rate per time which is lower than a first change rate threshold or raises at a change rate per time which is higher than a first change rate threshold. This embodiment is based on the insight that e. g. the room temperature drops and the supplied heat decreases quickly when the fan stops and that e. g. the return flow temperature raises quickly if the fan stops.

[0028] In a preferred embodiment the change rate per time of the thermodynamic quantity can be determined based on the results of the thermodynamic quantity measuring step. It can then be determined in said determining step that the medium mover is operating if the thermodynamic quantity raises at a change rate per time which is higher than a second change rate threshold or drops at a change rate per time which is lower than a second change rate threshold. This embodiment uses the insight that the room temperature raises and the supplied heat increases quickly when the medium mover is operating, while the return flow temperature drops quickly if the medium mover is operating.

[0029] In a preferred embodiment of the invention the temperature of the heat transport medium can be measured and the medium mover is controlled not to operate when a temperature of the heat transport medium is below a transport medium threshold. This step ensures that when the medium mover operates the heat transport medium has a sufficient temperature to in fact cause the room to be heated. As long as the temperature of the heat transport medium is too low the medium mover should preferably not be operated.

[0030] In an advantageous embodiment of the invention the heat pump may be stopped when it is detected that the medium mover is not operating.

[0031] Furthermore, the heat pump may be started when the temperature of the medium to be heated, that is for example the room temperature, reaches a lower threshold which shall be referred to as lower heat pump threshold here. This avoids a situation where the heat pump is operating although the medium mover is not operating while the room temperature is sufficiently high.

[0032] In a preferred embodiment of the invention the heat pump may be controlled to lower the temperature of the heat transport medium if the temperature of the medium to be heated is above the target medium temperature. This further improves the efficiency of the heat pump system because the amount of heat supplied by the heat pump is reduced if the temperature of the medium to be heated is already above the target medium temperature.

[0033] The present invention also relates to a method for operating a heat pump system for cooling a medium. Again this medium shall be addressed also as medium to be cooled. Again, the heat pump system comprises a heat pump and an emitter which is here also addressed as cooling emitter. The cooling emitter may be technically the same as a heat emitter, however acting as a heat sink for the surrounding medium to be cooled.

[0034] According to the invention the cooling emitter comprises a heat exchanger for exchanging heat between the heat transport medium and the medium to be cooled. The heat transport medium may flow between the heat pump and the cooling emitter, preferably in a closed circuit.

[0035] The cooling emitter according to the invention further comprises at least one medium mover for effecting a flow of the medium to be cooled over the heat exchanger. Anything said above with respect to the structure of the heat emitter, the heat transport medium and the heat pump is also valid here with respect to the method for cooling a medium.

[0036] Common heat pump systems are controlled so that the operation of the medium mover is stopped when the temperature of the medium to be cooled as measured by a thermostat of the emitter reaches a lower medium mover threshold. On the other hand, the operation of the medium mover is started when the temperature of the medium to be cooled as measured by a thermostat of the emitter reaches an upper medium mover threshold. Furthermore, commonly the heat pump is controlled to lower the temperature of the heat transport medium if the temperature of the medium to be cooled is above the target medium temperature.

[0037] Also in the case of cooling a medium to be cooled a thermodynamic quantity is measured in the heat pump system in a thermodynamic quantity measuring step. As in the case of heating the thermodynamic quantity may be a measured temperature of the medium to be cooled, preferably measured with a thermostat having a greater distance from the emitter than the thermostat of the emitter, and/or a measured return flow temperature of the heat transport medium and/or a measured removed heat.

[0038] Based on the measured thermodynamic quantity it can then be determined in a determining step whether the medium mover is operating or not.

[0039] If now the temperature of the medium to be cooled is above the target medium temperature, the heat pump according to the invention is controlled to stop lowering the temperature of the heat transport medium when it is determined in the determining step that the medium mover is not operating. Similarly as in the case of heating this allows the temperature of the medium to be cooled to reach the upper medium mover threshold so that the medium mover is started. It is therefore avoided that the medium to be cooled is kept below the upper medium mover threshold by excessive operation of the heat pump without the medium mover operating. The efficiency of the heat pump system is therefore increased.

[0040] In a preferred embodiment the change rate per time of the thermodynamic quantity may be determined based on the results of the thermodynamic quantity measuring step and it may be determined in the determining step that the medium mover is stopped if the thermodynamic quantity raises at a change rate per time which is higher than a first change rate threshold or drops at a change rate per time which is lower than a first change rate threshold. Whether a raising or dropping of the thermodynamic quantity is regarded here as in the case of heating depends on the thermodynamic quantity. The temperature of the medium to be cooled will raise if the medium mover is stopped. On the other hand the measured return flow temperature will drop and the measured removed heat will decrease if the medium mover is not operating.

[0041] In a preferred embodiment of the invention a change rate per time of the thermodynamic quantity measured in the thermodynamic quantity measuring step can be determined and it can be determined in the determining step that the medium mover is operating if the thermodynamic quantity drops at a change rate per time which is lower than a second change rate threshold or raises at a change rate per time which is higher than a second change rate threshold. Again, it depends on the chosen thermodynamic quantity whether it drops or raises when the medium mover is operating. The temperature of the medium to be cooled will drop when the medium mover is operating. On the other hand the measured return flow temperature of the heat transport medium will raise and the measured removed heat will increase if the medium mover is operating.

[0042] In an advantageous embodiment the temperature of the heat transport medium can be measured and the medium mover does not operate when the temperature of the heat transport medium is above or equal a transport medium threshold. This ensures that the medium mover only operates when the temperature of the heat transport medium is sufficiently low to in fact effect a cooling on the medium to be cooled.

[0043] In a preferred embodiment of the invention the heat pump may be stopped when it is detected that the medium mover is not operating and the heat pump may be started when the temperature of the medium to be cooled reaches an upper heat pump threshold.

[0044] In a preferred embodiment of the invention the heat pump may be controlled to raise the temperature of the heat transport medium if the temperature of the medium to be cooled is below the target medium temperature. This further improves the efficiency of the heat pump system because the amount of heat removed by the heat pump is reduced if the temperature of the medium to be cooled is already below the target medium temperature.

[0045] In all embodiments of the invention it is preferred in the heating operation as well as the cooling operation that the thermodynamic quantity measuring step is repeatedly carried out in predetermined time intervals. This allows a continuous operation of the heat pump system at optimized efficiency.

[0046] In the following the invention shall be described by way of example with reference to figures. The features shown in the examples can be realized also apart from the examples and can be combined between different examples. Same reference signs denote same or corresponding features.

[0047] It is shown in

Fig. 1 an example configuration of a system in which the method according to the invention can be carried out,

Fig. 2 the operational behaviour of an existing method for operating a heat pump system,

Fig. 3 a water temperature thermostat and fan operation behaviour of an existing control method,

Fig. 4 an operational behaviour of an example implementation of the method for operating a heat pump system according to the invention,

Fig. 5 the water temperature thermostat and fan operation behaviour of the example implementation of the method for operating a heat pump system according to the invention,

Fig. 6 an example flow diagram for the calculation of a target flow temperature,

Fig. 7 an example dependency between the target flow temperature and an outdoor temperature,

Fig. 8 an example procedure for checking permission to change the target for temperature, and

Fig. 9 different options for detecting whether the fan is stopped or runs.

[0048] Fig. 1 shows an example of a heat pump system, which is suitable for heating or cooling a medium as for example the air in a room. The heat pump system shown in Fig. 1 comprises a heat pump 1 and three heat emitters 2a, 2b, 2c. The heat emitters 2a, 2b, 2c are in this example fan coil units comprising a heat exchanger for exchanging heat between a heat transport medium and the medium to be heated or cooled. The heat emitters 2a, 2b, 2c are here always addressed as heat emitters regardless whether they transfer heat from the heat transport medium to the medium or from the medium to the heat transport medium. The heat emitters 2a, 2b, 2c furthermore each comprise at least one medium mover, as for example a fan, for effecting a flow of the medium over the heat exchanger. The fan coil units 2a, 2b, 2c each have an air temperature thermostat 3a, 3b, 3c and a water temperature thermostat.

[0049] A room temperature sensor or room temperature thermostat 4, which is located at a greater distance to the heat exchangers of the fan coil units 2a, 2b, 2c than the temperature sensors 3a, 3b, 3c, measures the room temperature, that is the temperature of the medium to be heated or cooled.

[0050] The heat pump 1 and the fan coil units 2a, 2b, 2c are connected with each other by a heat transport medium circuit 5 which may for example be a water circuit 5.

[0051] The heat pump 1 comprises an evaporator 6 and a condenser 7 in the case of heating or a condenser 6 and an evaporator 7 in the case of cooling. A compressor 9 is arranged between the evaporator 6, 7 and condenser 7, 6 and an expansion valve 8 is arranged between the evaporator 6, 7 and the condenser 7, 6 on the opposite side. The expansion valve 8, the evaporator 6, 7, the compressor 9, and the condenser 7, 6 are arranged together in a refrigerant circuit 10. The condenser or evaporator 7 comprises a heat exchanger for exchanging heat between the refrigerant circuit 10 and the heat transport medium circuit 5. In the heat transport medium circuit 5 the heat transport medium, e. g. water, flows from the heat exchanger in element 7 to the fan coil units 2a, 2b, 2c and from the fan coil units 2a, 2b, 2c back to the heat exchanger in element 7. The flow of the heat transport medium is effected by a circulation pump 11 which is arranged in the heat transport medium circuit 5.

[0052] In the example shown in Fig. 1 an optional tank 12 is shown the content of which can be heated by heat transport medium flowing in a coil 13 within the tank 12. The heat transport medium can be branched off the heat transport medium circuit 5 through a three-way valve 14. The conduit for feeding the coil 13 within the tank 12 bypasses the fan coil unit 2a, 2b, 2c.

[0053] The heat transport medium circuit 5 comprises a heat transport medium temperature sensor 15 located directly before an entry into the heat pump 1, with which sensor 15 the return flow temperature of the heat transport medium can be measured. The example system shown in Fig. 1 further comprises a heat transport medium sensor 16 located directly behind an exit for the heat transport medium of the heat pump 1 with which the temperature of the supplied heat transport medium leaving the heat pump can be measured. Optionally the heat transport medium circuit 5 further comprises a flow rate sensor 19 located in the heat transport medium circuit 5 with which the flow rate of the heat transport medium can be measured. Such flow rate sensor 19 can be used to calculate the supplied or removed heat.

[0054] The method for operating the heat pump system is controlled by a controller 17. The controller 17 receives a temperature measurement from the room temperature sensor 4, optionally the supply flow temperature sensor 16, the return flow temperature sensor 15 as well as optionally the temperature measurement from an ambient temperature sensor 18 located in the heat pump unit. Optionally the controller 17 further receives a flow rate measurement from the flow rate sensor 19. The controller 17 controls the heat pump unit as well as the circulation pump 11 based on the measurement from these sensors.

[0055] Fig. 4 shows an operational behavior of the method for operating a heat pump system according to the invention. Fig. 4 shows the case of heating a room. The operation is analogue in the case of cooling a room, but with lower and upper thresholds inverted.

[0056] The uppermost diagram shows the air temperature over time, the second diagram shows the target flow temperature over time, the third diagram shows the fan operation over time and the lowermost diagram shows the heat pump operation over time.

[0057] In the beginning the fan and the heat pump are operating so the air temperature shown in the uppermost diagram raises. When the air temperature reaches a target room temperature indicated as middle dashed line in the uppermost diagram of Fig. 4, the controller reduces the target flow temperature as shown in the second diagram. As the fan is still operating the air temperature raises further until it reaches an upper medium mover threshold, indicated as uppermost dashed horizontal line in the first diagram of Fig. 4. When this threshold is reached the fan stops operating as shown in the third diagram. The vertical dashed lines indicate corresponding points in time. In response the air temperature drops quickly, which incites an increasing of the target flow temperature. However, according to the invention it is determined that the fan has stopped based on the behavior of the air temperature. The raising of the temperature of the heat transport medium shown in the second diagram is therefore stopped. This results in the air temperature further decreasing until it reaches a lower medium mover threshold, indicated as lowermost dashed horizontal line in the first diagram of Fig. 4. The air temperature reaching the lower medium mover threshold results in the fan being started, as can be seen in the third diagram. As a result the air temperature or room temperature shown in the first diagram starts increasing again, although the target flow temperature has not changed. The quick raise of the air temperature can be detected according to the method of the present invention and can indicate that the fan is operating. Then the target flow temperature is allowed to be changed again and further increased at the time indicated by the rightmost vertical dashed line because the air temperature is still lower than the target room temperature in Fig. 4. As soon as the air temperature reaches the target room temperature the increase of the target flow temperature is stopped and the target flow temperature is maintained constant. The air temperature in the room further increases which results in restarting the fan operation. If the air temperature is already higher than the target room temperature when the fan operation is detected, the target flow temperature is lowered as soon as the target flow temperature is allowed to be changed. As the air temperature reaches the uppermost medium mover threshold the fan is stopped again and the operation cycle starts again as explained above from the point where the fan stopped.

[0058] In this example the heat pump is operating all the time and the target flow temperature is adjusted.

[0059] Fig. 5 shows an operation example wherein the heat pump may be stopped. The uppermost diagram of Fig. 5 shows the air temperature or room temperature, the second diagram shows the supplied flow temperature, the third diagram shows the fan operation and the lowermost diagram shows the heat pump operation.

[0060] In the beginning the room temperature raises as shown in the uppermost diagram because the heat pump operates and the fan operates with excess supplied heat due to a higher target flow temperature than the supplied flow temperature, which amount of supplied heat is sufficient to keep room temperature to keep the fan running. If the room temperature reaches the threshold to stop the fan, indicated as uppermost dashed horizontal line in the first diagram of Fig. 5, the fan stops at the leftmost vertical dashed line. As a result the air temperature drops quickly between the leftmost vertical dashed line and the second vertical dashed line. The quick drop of room temperature indicates according to the invention that the fan has stopped, so the heat pump operation is stopped at the second vertical dashed line.

[0061] As a result the room temperature further drops until it reaches a lower heat pump threshold, indicated as lowermost dashed horizontal line in the first diagram of Fig. 5. At this time the heat pump is started. However, as the fan is still stopped the room temperature does not raise. The fan is therefore restarted after the supplied flow temperature reaches the flow temperature threshold which the fan restarts. As a result the room temperature increases again. When it reaches the threshold to stop the fan (uppermost dashed horizontal line in the first diagram of Fig. 5) the cycle restarts again.

[0062] Fig. 6 shows an example flow diagram for the calculation of the target flow temperature. A controller can determine the target flow temperature based on the flow shown in Fig. 6 at certain control intervals as for example one minute. In the beginning in step S61 it is checked whether a time counter equals the permission check interval longer than the control interval which can detect the change of a thermodynamic quantity. If the time counter equals the permission check interval step S62 is carried out, where the permission status is checked indicating whether to change the target flow temperature. Step S62 is bypassed if step S61 determines that the time counter does not equal the permission check interval.

[0063] It is afterwards checked in step S63 whether target flow temperature change is permitted based on the permission status determined in S62. If the target flow temperature change is not permitted the method ends and restarts at a later time.

[0064] If, however, the change of the target flow temperature is permitted in step S63, the target flow temperature is calculated in step S64. The calculation of the target flow temperature may for example use a characteristic as shown in Fig. 7, showing the flow temperature as a function of the outdoor temperature. For this calculation, the target flow temperature may be adjusted to be raised if the air temperature is lower than the target room temperature or to be lowered if the air temperature is higher than the target room temperature. Either the above first calculation method using the function of the outdoor temperature or the above second calculation method using the function of the deviation between the air temperature and the target room temperature or a combined method of both calculation methods can be used.

[0065] It is then determined in step S65 whether the target flow temperature is lower than the threshold of the water temperature thermostat, shown in the second diagram of figure 5.

[0066] If this is the case, step S66 is carried out in which the target flow temperature is set as the threshold of the water temperature thermostat. If in step S65 the decision is negative, the target flow temperature is set to the calculated value in step S67. The flow then ends and can be carried out again at a subsequent point in time.

[0067] Fig. 8 is a flow diagram showing how the permission status to change the target flow temperature is checked in step S62 in Fig. 6. The example assumes that the thermodynamic quantity to be measured is the room temperature or the temperature of the medium to be heated or cooled. In a first step S81 a temperature change rate α is calculated as $\alpha=\Delta Ta/\Delta ta$, wherein ΔTa is the temperature change (for example -1°C after the fan stops) and Δta is the calculation interval (for example 10 minutes).

[0068] It is then decided in step S82 whether α is equal or lower than the first change rate threshold (the sign is minus, for example -0.1°C/min). If this is the case, the change of the target flow temperature is stopped in step S83. If this is not the case, it is determined in step S84 whether α is equal or greater than a second change rate threshold (a sign is plus, for example +0.1°C/min). If this is the case, the change of the target flow temperature is permitted in step S85. If this is not the case, the current permission status is kept (S86).

In case of cooling, plus/minus sign of these thresholds and the direction of inequality in step 82 and 84 are opposite.

[0069] The determination whether the fan is stopped or running can be based on different thermodynamic quantities measured in the heat pump system.

[0070] Firstly, as already mentioned above, the room temperature can be used as thermodynamic quantity. The change rate of the room temperature per time $\alpha=\Delta Ta/\Delta ta$ is calculated, wherein ΔTa is the temperature change (for example -1°C after the fan stops and +1°C after the fan restarts) and Δta is the calculation interval (for example 10 minutes).

[0071] Fig. 9A shows the room temperature over time. Here ΔTa is exemplified by vertical arrows and Δta is depicted as horizontal arrows.

[0072] A further thermodynamic quantity which can be used for determining whether the fan is stopped or is running can be the return flow temperature which is the temperature of the heat transport medium after having flown through the heat emitter. Again the change rate of the return flow temperature $\beta=\Delta Tb/\Delta tb$ can be regarded wherein ΔTb is the change of the return flow temperature (for example +1°C after the fan stops and -1°C after the fan restarts) and Δtb is the calculation interval (for example 3 minutes). The graphical representation of this method is shown in Fig. 9B at (2). If β is used instead of α in Fig. 8, the sign of the first change rate threshold and the second change rate threshold and the direction of inequality of S82 and S84 are opposite. And in the case of cooling, plus/minus sign of these thresholds and the direction of inequality in step 82 and 84 are opposite to the case of heating.

[0073] A further possibility for a thermodynamic quantity to be used to detect whether the fan is stopped or is running can be the reduction of the supplied heat which occurs if the fan stops. Here the difference of the supplied heat ΔQ is calculated as

$$\Delta Q = Q(t) - Q(t - \Delta tc)$$

$$Q(t) = \rho Cp\ Fw/60 * (Tsup - Tret)$$

wherein Q(t) is the supplied heat (e.g. in kW), ρ is the density of water, Cp is the specific heat, Fw is the flow rate in L/min, Tsup is the supplied flow temperature, Tret is the return flow temperature and Δtc is the calculation interval (for example 3 minutes). The behavior of the return flow temperature is shown in Fig. 9B. The supplied flow temperature is depicted as a constant horizontal line. The return flow temperature in the case of heating operation is lower and is depicted as the lower curve in Fig. 9B. The reduction of the supplied heat is indicated by the arrow (3) while the change of the return flow temperature described above is indicated by the arrows (2), wherein the horizontal arrow is the calculation interval Δtb and the vertical arrow is the temperature change ΔTb.

Claims

1. Method for operating a heat pump system for heating a medium, the heat pump system comprising a heat pump (1) and a heat emitter (2a, 2b, 2c), the heat emitter (2a, 2b, 2c) comprising a heat exchanger for exchanging heat between a heat transport medium and the medium to be heated
the heat emitter further comprising at least one medium mover for effecting a flow of the medium to be heated over the heat exchanger, wherein
the operation of the medium mover is stopped when the temperature of the medium to be heated reaches an upper medium mover threshold,
the operation of the medium mover is started when the temperature of the medium to be heated reaches a lower medium mover threshold,
the heat pump (1) is controlled to raise the temperature of the heat transport medium if the temperature of the medium to be heated is below a target medium temperature
characterised in that in a thermodynamic quantity measuring step at least one thermodynamic quantity is measured in the heat pump system, wherein the thermodynamic quantity includes at least one of a measured temperature of the medium to be heated and/or a measured return flow temperature of the heat transport medium and/or a measured supplied heat
it is determined in a determining step based on the thermodynamic quantity whether the medium mover is operating,
wherein, in case that the temperature of the medium to be heated is below the target medium temperature, the heat pump (1) is controlled to stop raising the temperature of the heat transport medium when it is determined in the determining step that the medium mover is not operating.

2. Method according to the preceding claim,
wherein a change rate per time of the thermodynamic quantity is determined and wherein it is determined in the determining step that the medium mover is stopped if the thermodynamic quantity drops and the change rate per time of the thermodynamic quantity is lower than a first change rate threshold or the thermodynamic quantity raises and the change rate per time of the thermodynamic quantity is higher than a first change rate threshold.

3. Method according to one of the preceding claims,
wherein a change rate per time of the thermodynamic quantity is determined and wherein it is determined in the determining step that the medium mover is operating if the thermodynamic quantity raises and the change rate per time of the thermodynamic quantity is higher than a second change rate threshold or the thermodynamic quantity drops and the change

rate per time of the thermodynamic quantity is lower than a second change rate threshold.

4. Method according to one of the preceding claims, wherein a temperature of the heat transport medium is measured, and the medium mover does not operate when a temperature of the heat transport medium is below or equal a transport medium threshold.

5. Method according to one of the preceding claims, wherein the heat pump (1) is stopped when it is detected that the medium mover is not operating and wherein the heat pump is started when the temperature of the medium to be heated reaches a lower heat pump threshold.

6. Method according to one of the preceding claims, wherein the heat pump (1) is controlled to lower the temperature of the heat transport medium if the temperature of the medium to be heated is above the target medium temperature.

7. Method according to one of the preceding claims, wherein the medium mover is started when the heat pump (1) runs and the temperature of the medium to be heated drops.

8. Method for operating a heat pump system for cooling a medium,
the heat pump system comprising a heat pump (1) and a cooling emitter (2a, 2b, 2c),
the cooling emitter comprising a heat exchanger for exchanging heat between a heat transport medium and the medium to be cooled, the cooling emitter (2a, 2b, 2c) further comprising at least one medium mover for effecting a flow of the medium to be cooled over the heat exchanger,
wherein
the operation of the medium mover is stopped when the temperature of the medium to be cooled reaches a lower medium mover threshold, the operation of the medium mover is started when the temperature of the medium to be cooled reaches an upper medium mover threshold,
the heat pump is controlled to lower the temperature of the heat transport medium if the temperature of the medium to be cooled is above a target medium temperature,
characterised in that in a thermodynamic quantity measuring step at least one thermodynamic quantity is measured in the heat pump system, wherein the thermodynamic quantity includes at least one of a measured temperature of the medium to be cooled and/or a measured return flow temperature of the heat transport medium and/or a measured removed heat
it is determined in a determining step based on the thermodynamic quantity whether the medium mover is operating,
wherein, in case that the temperature of the medium to be cooled is above the target medium temperature, the heat pump (1) is controlled to stop lowering the temperature of the heat transport medium when it is determined in the determining step that the medium mover is not operating.

9. Method according to the preceding claim, wherein a change rate per time of the thermodynamic quantity is determined and wherein it is determined in the determining step that the medium mover is stopped if the thermodynamic quantity raises and the change rate per time of the thermodynamic quantity is higher than a first change rate threshold or the thermodynamic quantity drops and the change rate per time of the thermodynamic quantity is lower than a first change rate threshold.

10. Method according to one of the two preceding claims,
wherein a change rate per time of the thermodynamic quantity is determined and wherein it is determined in the determining step that the medium mover is operating if the thermodynamic quantity drops and the change rate per time of the thermodynamic quantity is lower than a second change rate threshold or the thermodynamic quantity raises and the change rate per time of the thermodynamic quantity is higher than a second change rate threshold.

11. Method according to one of claims 8 to 10, wherein a temperature of the heat transport medium is measured, and the medium mover does not operate when a temperature of the heat transport medium is above or equal a transport medium threshold.

12. Method according to one of claims 8 to 11, wherein the heat pump (1) is stopped when it is detected that the medium mover is not operating and wherein the heat pump (1) is started when the temperature of the medium to be cooled reaches an upper heat pump threshold.

13. Method according to one claims 8 to 12, wherein the heat pump (1) is controlled to raise the temperature of the heat transport medium if the temperature of the medium to be cooled is below the target medium temperature.

14. Method according to one of claims 8 to 13, wherein the medium mover is started when the heat pump (1) runs and the temperature of the medium to be cooled raises.

15. Method according to one of the preceding claims, wherein the thermodynamic quantity measuring step is repeatedly carried out in predetermined time intervals.

Patentansprüche

1. Verfahren zum Betreiben eines Wärmepumpensystems zum Erwärmen eines Mediums, wobei das Wärmepumpensystem eine Wärmepumpe (1) und einen Wärmeemitter (2a, 2b, 2c) umfasst, wobei der Wärmeemitter (2a, 2b, 2c) einen Wärmetauscher zum Austauschen von Wärme zwischen einem Wärmetransportmedium und dem zu erwärmenden Medium umfasst, wobei der Wärmeemitter ferner zumindest einen Mediumbeweger zum Bewirken einer Strömung des zu erwärmenden Mediums über den Wärmetauscher umfasst,
wobei
der Betrieb des Mediumbewegers gestoppt wird, wenn die Temperatur des zu erwärmenden Mediums einen oberen Mediumbewegerschwellenwert erreicht,
der Betrieb des Mediumbewegers gestartet wird, wenn die Temperatur des zu erwärmenden Mediums einen unteren Mediumbewegerschwellenwert erreicht,
die Wärmepumpe (1) gesteuert wird, die Temperatur des Wärmetransportmediums zu erhöhen, falls die Temperatur des zu erwärmenden Mediums unter einer Zielmediumtemperatur liegt
dadurch gekennzeichnet, dass
in einem thermodynamische-Größe-Messungsschritt zumindest eine thermodynamische Größe im Wärmepumpensystem gemessen wird, wobei die thermodynamische Größe zumindest eines von einer gemessenen Temperatur des zu erwärmenden Mediums und/oder einer gemessenen Rückströmungstemperatur des Wärmetransportmediums und/oder einer gemessenen zugeführten Wärme umfasst,
in einem Bestimmungsschritt auf Grundlage der thermodynamischen Größe bestimmt wird, ob der Mediumbeweger arbeitet,
wobei in dem Fall, dass die Temperatur des zu erwärmenden Mediums unter der Zielmediumtemperatur liegt, die Wärmepumpe (1) gesteuert wird, Erhöhung der Temperatur des Wärmetransportmediums zu stoppen, wenn im Bestimmungsschritt bestimmt wird, dass der Medienbeweger nicht arbeitet.

2. Verfahren nach dem vorangehenden Anspruch,
wobei eine Änderungsrate pro Zeiteinheit der thermodynamischen Größe bestimmt wird, und wobei im Bestimmungsschritt bestimmt wird, dass der Mediumbeweger gestoppt wird, falls die thermodynamische Größe abfällt und die Änderungsrate pro Zeiteinheit der thermodynamischen Größe geringer ist als ein erster Änderungsratenschwellenwert oder die thermodynamische Größe ansteigt und die Änderungsrate pro Zeiteinheit der thermodynamischen Größe höher ist als ein erster Änderungsratenschwellenwert.

3. Verfahren nach einem der vorangehenden Ansprüche,
wobei eine Änderungsrate pro Zeiteinheit der thermodynamischen Größe bestimmt wird, und wobei im Bestimmungsschritt bestimmt wird, dass der Medienbeweger arbeitet, falls die thermodynamische Größe ansteigt und die Änderungsrate pro Zeiteinheit der thermodynamischen Größe höher ist als ein zweiter Änderungsratenschwellenwert oder die thermodynamische Größe abfällt und die Änderungsrate pro Zeiteinheit der thermodynamischen Größe geringer ist als ein zweiter Änderungsratenschwellenwert.

4. Verfahren nach einem der vorangehenden Ansprüche,
wobei eine Temperatur des Wärmetransportmediums gemessen wird und der Mediumbeweger nicht arbeitet, wenn eine Temperatur des Wärmetransportmediums unter einem oder gleich wie ein Transportmediumschwellenwert ist.

5. Verfahren nach einem der vorangehenden Ansprüche,
wobei die Wärmepumpe (1) gestoppt wird, wenn erfasst wird, dass der Mediumbeweger nicht arbeitet, und wobei die Wärmepumpe gestartet wird, wenn die Temperatur des zu erwärmenden Mediums einen unteren Wärmepumpenschwellenwert erreicht.

6. Verfahren nach einem der vorangehenden Ansprüche,
wobei die Wärmepumpe (1) gesteuert wird, die Temperatur des Wärmetransportmediums zu senken, falls die Temperatur des zu erwärmenden Mediums über der Zielmediumtemperatur liegt.

7. Verfahren nach einem der vorangehenden Ansprüche,
wobei der Medienbeweger gestartet wird, wenn die Wärmepumpe (1) läuft und die Temperatur des zu erwärmenden Mediums abfällt.

8. Verfahren zum Betreiben eines Wärmepumpensystems zum Kühlen eines Mediums, wobei das Wärmepumpensystem eine Wärmepumpe (1) und einen kühlenden Emitter (2a, 2b, 2c) umfasst,
wobei der kühlende Emitter (2a, 2b, 2c) einen Wärmetauscher zum Austauschen von Wärme zwischen einem Wärmetransportmedium und dem zu kühlenden Medium umfasst,
wobei der kühlende Emitter (2a, 2b, 2c) ferner zumindest einen Mediumbeweger zum Bewirken einer Strömung des zu kühlenden Mediums über den Wär-

metauscher umfasst,
wobei
der Betrieb des Mediumbewegers gestoppt wird, wenn die Temperatur des zu kühlenden Mediums einen unteren Mediumbewegerschwellenwert erreicht, der Betrieb des Mediumbewegers gestartet wird, wenn die Temperatur des zu kühlenden Mediums einen oberen Mediumbewegerschwellenwert erreicht,
die Wärmepumpe gesteuert wird, die Temperatur des Wärmetransportmediums zu senken, falls die Temperatur des zu kühlenden Mediums über einer Zielmediumtemperatur liegt,
dadurch gekennzeichnet, dass
in einem thermodynamische-Größe-Messungsschritt zumindest eine thermodynamische Größe im Wärmepumpensystem gemessen wird, wobei die thermodynamische Größe zumindest eines von einer gemessenen Temperatur des zu kühlenden Mediums und/oder einer gemessenen Rückströmungstemperatur des Wärmetransportmediums und/oder einer gemessenen abgeführten Wärme umfasst,
in einem Bestimmungsschritt auf Grundlage der thermodynamischen Größe bestimmt wird, ob der Medienbeweger arbeitet,
wobei in einem Fall, dass die Temperatur des zu kühlenden Mediums über der Zielmediumtemperatur liegt, die Wärmepumpe (1) gesteuert wird, Absenkung der Temperatur des Wärmetransportmediums zu stoppen, wenn im Bestimmungsschritt bestimmt wird, dass der Mediumbeweger nicht arbeitet.

9. Verfahren nach dem vorangehenden Anspruch, wobei eine Änderungsrate pro Zeiteinheit der thermodynamischen Größe bestimmt wird, und wobei im Bestimmungsschritt bestimmt wird, dass der Medienbeweger gestoppt wird, falls die thermodynamische Größe ansteigt und die Änderungsrate pro Zeiteinheit der thermodynamischen Größe höher ist als ein erster Änderungsratenschwellenwert oder die thermodynamische Größe abfällt und die Änderungsrate pro Zeiteinheit der thermodynamischen Größe geringer ist als ein erster Änderungsratenschwellenwert.

10. Verfahren nach einem der zwei vorangehenden Ansprüche,
wobei eine Änderungsrate pro Zeiteinheit der thermodynamischen Größe bestimmt wird, und wobei im Bestimmungsschritt bestimmt wird, dass der Mediumbeweger arbeitet, falls die thermodynamische Größe abfällt und die Änderungsrate pro Zeiteinheit der thermodynamischen Größe geringer ist als ein zweiter Änderungsratenschwellenwert oder die thermodynamische Größe ansteigt und die Änderungsrate pro Zeiteinheit der thermodynamischen Größe höher ist als ein zweiter Änderungsratenschwellenwert.

11. Verfahren nach einem der Ansprüche 8 bis 10, wobei eine Temperatur des Wärmetransportmediums gemessen wird und der Medienbeweger nicht arbeitet, wenn eine Temperatur des Wärmetransportmediums über einem oder gleich einem Transportmediumschwellenwert ist.

12. Verfahren nach einem der Ansprüche 8 bis 11, wobei die Wärmepumpe (1) gestoppt wird, wenn erfasst wird, dass der Mediumbeweger nicht arbeitet, und wobei die Wärmepumpe (1) gestartet wird, wenn die Temperatur des zu kühlenden Mediums einen oberen Wärmepumpenschwellenwert erreicht.

13. Verfahren nach einem der Ansprüche 8 bis 12, wobei die Wärmepumpe (1) gesteuert wird, die Temperatur des Wärmetransportmediums zu erhöhen, falls die Temperatur des zu kühlenden Mediums unter der Zielmediumtemperatur liegt.

14. Verfahren nach einem der Ansprüche 8 bis 13, wobei der Mediumbeweger gestartet wird, wenn die Wärmepumpe (1) läuft und die Temperatur des zu kühlenden Mediums ansteigt.

15. Verfahren nach einem der vorangehenden Ansprüche,
wobei der thermodynamische-Größe-Messungsschritt in vorherbestimmten Zeitintervallen wiederholt durchgeführt wird.

Revendications

1. Procédé de fonctionnement d'un système de pompe à chaleur pour chauffer un milieu, le système de pompe à chaleur comprenant une pompe à chaleur (1) et un émetteur de chaleur (2a, 2b, 2c), l'émetteur de chaleur (2a, 2b, 2c) comprenant un échangeur de chaleur pour échanger de la chaleur entre un milieu caloporteur et le milieu à chauffer
l'émetteur de chaleur comprenant en outre au moins un dispositif de déplacement de milieu pour effectuer un écoulement du milieu à chauffer sur l'échangeur de chaleur, dans lequel
le fonctionnement du dispositif de déplacement de milieu est arrêté lorsque la température du milieu à chauffer atteint un seuil supérieur de dispositif de déplacement de milieu,
le fonctionnement du dispositif de déplacement de milieu est démarré lorsque la température du milieu à chauffer atteint un seuil inférieur de dispositif de déplacement de milieu,
la pompe à chaleur (1) est commandée pour élever la température du milieu caloporteur si la température du milieu à chauffer est inférieure à une tempé-

rature de milieu cible **caractérisé en ce que**
dans une étape de mesure de quantité thermodynamique, au moins une quantité thermodynamique est mesurée dans le système de pompe à chaleur, dans lequel la quantité thermodynamique comprend au moins l'un parmi une température mesurée du milieu à chauffer et/ou une température d'écoulement de retour mesurée du milieu caloporteur et/ou une chaleur fournie mesurée
il est déterminé dans une étape de détermination sur la base de la quantité thermodynamique si le dispositif de déplacement de milieu fonctionne,
dans lequel, dans le cas où la température du milieu à chauffer est inférieure à la température de milieu cible, la pompe à chaleur (1) est commandée pour arrêter l'élévation de la température du milieu caloporteur lorsqu'il est déterminé dans l'étape de détermination que le dispositif de déplacement de milieu ne fonctionne pas.

2. Procédé selon la revendication précédente, dans lequel un taux de changement en fonction du temps de la quantité thermodynamique est déterminé et dans lequel il est déterminé dans l'étape de détermination que le dispositif de déplacement de milieu est arrêté si la quantité thermodynamique diminue et le taux de changement en fonction du temps de la quantité thermodynamique est inférieur à un premier seuil de taux de changement ou la quantité thermodynamique augmente et le taux de changement en fonction du temps de la quantité thermodynamique est supérieur à un premier seuil de taux de changement.

3. Procédé selon une des revendications précédentes, dans lequel un taux de changement en fonction du temps de la quantité thermodynamique est déterminé et dans lequel il est déterminé dans l'étape de détermination que le dispositif de déplacement de milieu fonctionne si la quantité thermodynamique augmente et le taux de changement en fonction du temps de la quantité thermodynamique est supérieur à un deuxième seuil de taux de changement ou la quantité thermodynamique diminue et le taux de changement en fonction du temps de la quantité thermodynamique est inférieur à un deuxième seuil de taux de changement.

4. Procédé selon une des revendications précédentes, dans lequel une température du milieu caloporteur est mesurée, et le dispositif de déplacement de milieu ne fonctionne pas lorsqu'une température du milieu caloporteur est inférieure ou égale à un seuil de milieu de transport.

5. Procédé selon une des revendications précédentes, dans lequel la pompe à chaleur (1) est arrêtée lorsqu'il est détecté que le dispositif de déplacement de milieu ne fonctionne pas et dans lequel la pompe à chaleur est démarrée lorsque la température du milieu à chauffer atteint un seuil inférieur de pompe à chaleur.

6. Procédé selon une des revendications précédentes, dans lequel la pompe à chaleur (1) est commandée pour abaisser la température du milieu caloporteur si la température du milieu à chauffer est supérieure à la température de milieu cible.

7. Procédé selon une des revendications précédentes, dans lequel le dispositif de déplacement de milieu est démarré lorsque la pompe à chaleur (1) fonctionne et la température du milieu à chauffer diminue.

8. Procédé de fonctionnement d'un système de pompe à chaleur pour refroidir un milieu,
le système de pompe à chaleur comprenant une pompe à chaleur (1) et un émetteur de refroidissement (2a, 2b, 2c),
l'émetteur de refroidissement comprenant un échangeur de chaleur pour échanger de la chaleur entre un milieu caloporteur et le milieu à refroidir, l'émetteur de refroidissement (2a, 2b, 2c) comprenant en outre au moins un dispositif de déplacement de milieu pour effectuer un écoulement du milieu à refroidir sur l'échangeur de chaleur, dans lequel le fonctionnement du dispositif de déplacement de milieu est arrêté lorsque la température du milieu à refroidir atteint un seuil inférieur de dispositif de déplacement de milieu, le fonctionnement du dispositif de déplacement de milieu est démarré lorsque la température du milieu à refroidir atteint un seuil supérieur de dispositif de déplacement de milieu,
la pompe à chaleur est commandée pour abaisser la température du milieu caloporteur si la température du milieu à refroidir est supérieure à une température de milieu cible, **caractérisé en ce que**
dans une étape de mesure de quantité thermodynamique, au moins une quantité thermodynamique est mesurée dans le système de pompe à chaleur, dans lequel la quantité thermodynamique comprend au moins l'un parmi une température mesurée du milieu à refroidir et/ou une température d'écoulement de retour mesurée du milieu caloporteur et/ou une chaleur éliminée mesurée
il est déterminé dans une étape de détermination sur la base de la quantité thermodynamique si le dispositif de déplacement de milieu fonctionne,
dans lequel, dans le cas où la température du milieu à refroidir est supérieure à la température de milieu cible, la pompe à chaleur (1) est commandée pour arrêter d'abaisser la température du milieu caloporteur lorsque il est déterminé dans l'étape de détermination que le dispositif de déplacement de milieu ne fonctionne pas.

9. Procédé selon la revendication précédente, dans lequel un taux de changement en fonction du temps de la quantité thermodynamique est déterminé et dans lequel il est déterminé dans l'étape de détermination que le dispositif de déplacement de milieu est arrêté si la quantité thermodynamique augmente et le taux de changement en fonction du temps de la quantité thermodynamique est supérieur à un premier seuil de taux de changement ou la quantité thermodynamique diminue et le taux de changement en fonction du temps de la quantité thermodynamique est inférieur à un premier seuil de taux de changement.

10. Procédé selon une des deux revendications précédentes,
dans lequel un taux de changement en fonction du temps de la quantité thermodynamique est déterminé et dans lequel il est déterminé dans l'étape de détermination que le dispositif de déplacement de milieu fonctionne si la quantité thermodynamique diminue et le taux de changement en fonction du temps de la quantité thermodynamique est inférieur à un deuxième seuil de taux de changement ou la quantité thermodynamique augmente et le taux de changement en fonction du temps de la quantité thermodynamique est supérieur à un deuxième seuil de taux de changement.

11. Procédé selon une des revendications 8 à 10, dans lequel une température du milieu caloporteur est mesurée, et le dispositif de déplacement de milieu ne fonctionne pas lorsqu'une température du milieu caloporteur est supérieure ou égale à un seuil de milieu de transport.

12. Procédé selon une des revendications 8 à 11, dans lequel la pompe à chaleur (1) est arrêtée lorsqu'il est détecté que le dispositif de déplacement de milieu ne fonctionne pas et dans lequel la pompe à chaleur (1) est démarrée lorsque la température du milieu à refroidir atteint un seuil supérieur de pompe à chaleur.

13. Procédé selon une des revendications 8 à 12, dans lequel la pompe à chaleur (1) est commandée pour élever la température du milieu caloporteur si la température du milieu à refroidir est inférieure à la température de milieu cible.

14. Procédé selon une des revendications 8 à 13, dans lequel le dispositif de déplacement de milieu est démarré lorsque la pompe à chaleur (1) fonctionne et la température du milieu à refroidir augmente.

15. Procédé selon une des revendications précédentes, dans lequel l'étape de mesure de quantité thermodynamique est conduite de façon répétée dans des intervalles de temps prédéterminés.

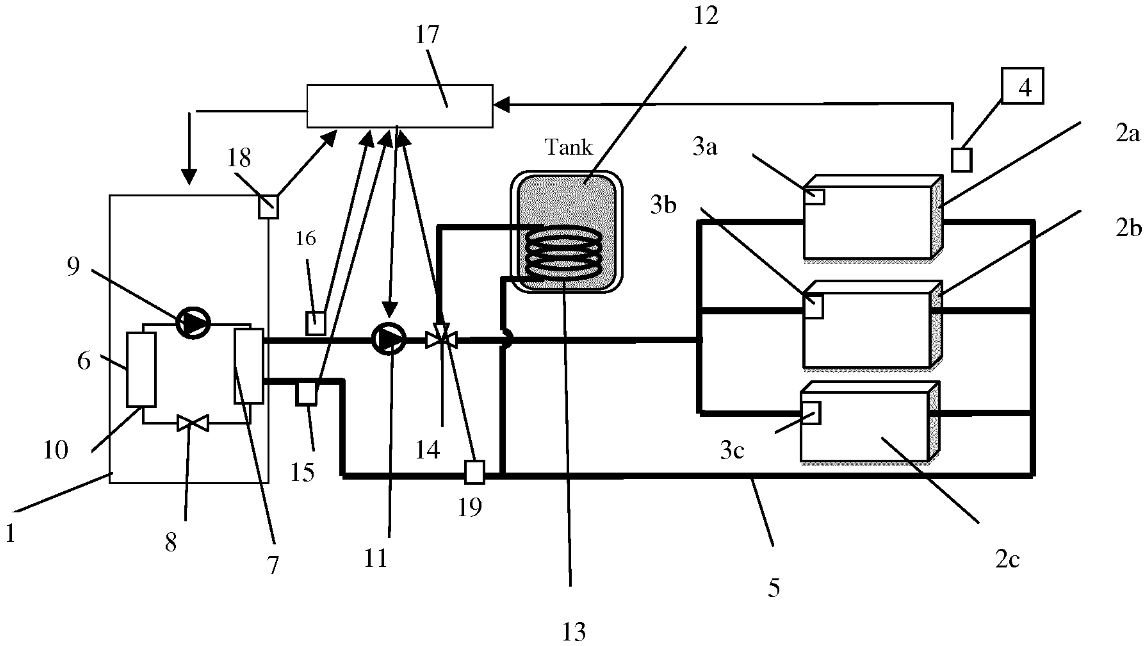

Fig. 1

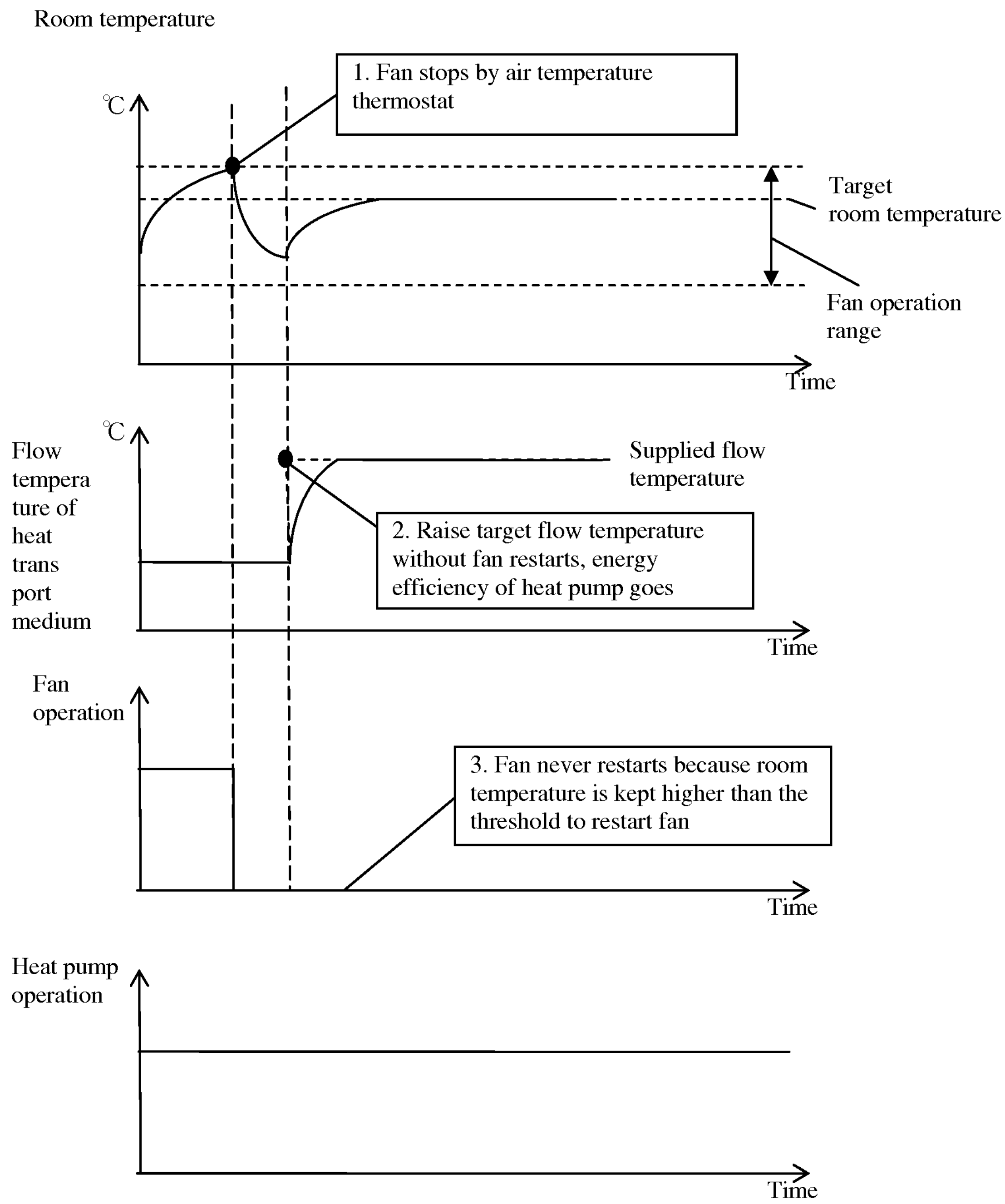
Room temperature
1. Fan stops by air temperature thermostat
℃
Target
room temperature
Fan operation
range
Time
℃
Flow tempera ture of heat trans port medium
Supplied flow temperature
2. Raise target flow temperature without fan restarts, energy efficiency of heat pump goes
Time
Fan operation
3. Fan never restarts because room temperature is kept higher than the threshold to restart fan
Time
Heat pump operation
Time

Fig. 2

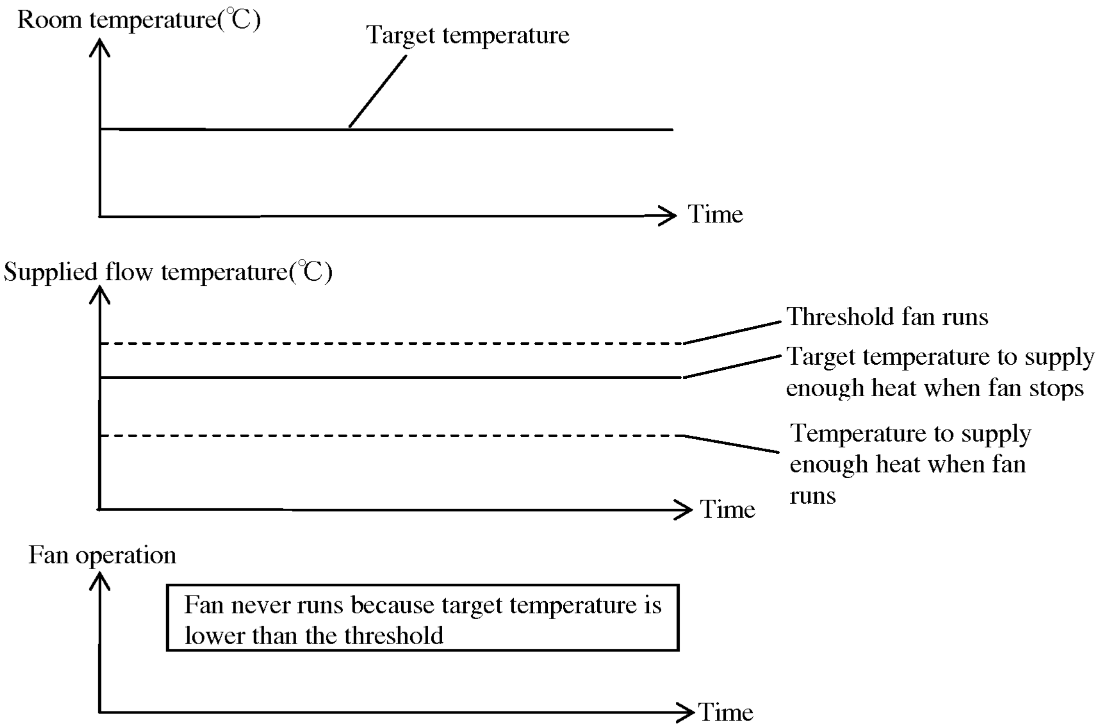
Room temperature(℃)
Target temperature
Time
Supplied flow temperature(℃)
Threshold fan runs
Target temperature to supply enough heat when fan stops
Temperature to supply enough heat when fan runs
Time
Fan operation
Fan never runs because target temperature is lower than the threshold
Time

Fig.3

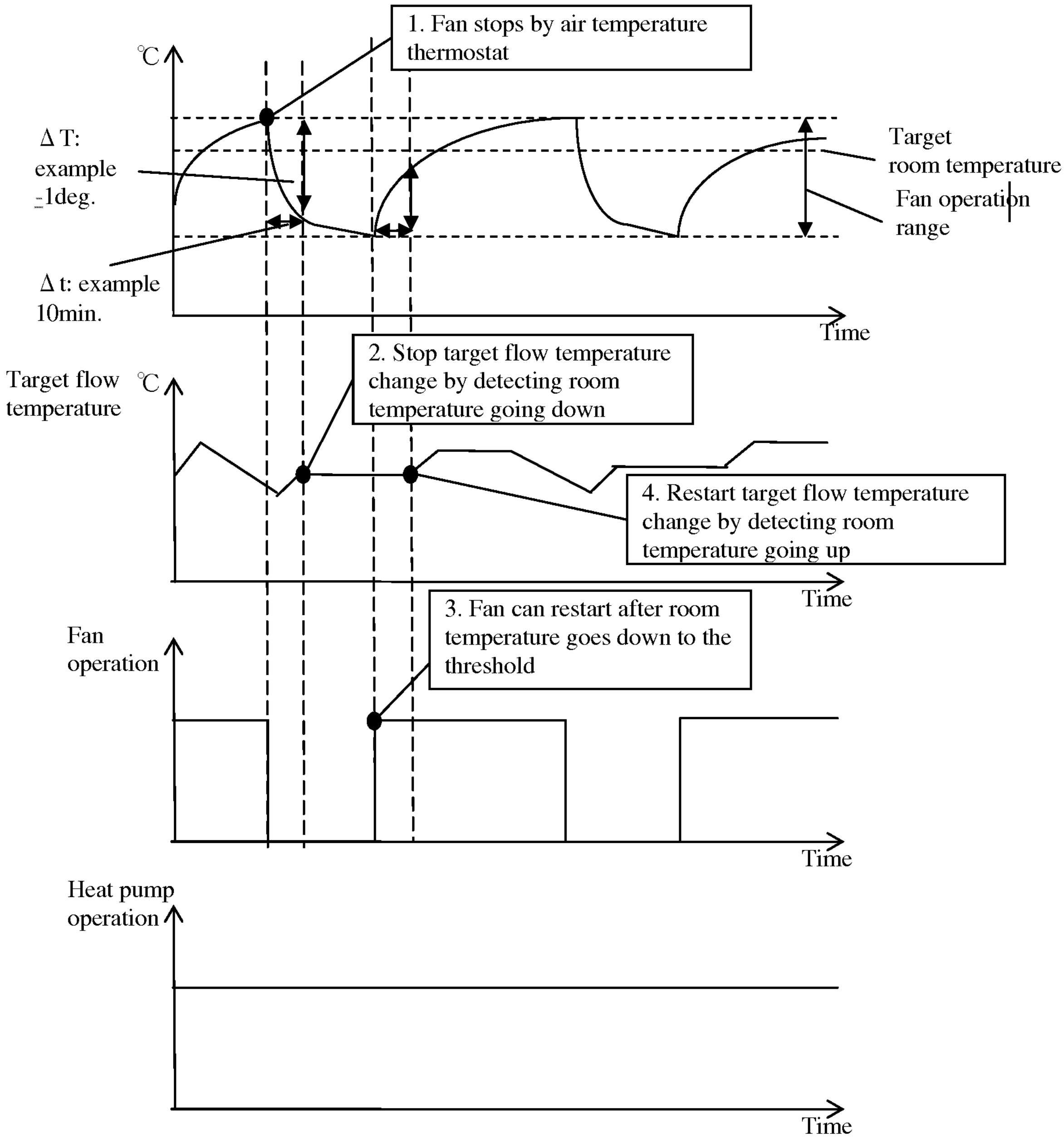
1. Fan stops by air temperature thermostat
℃
ΔT: example -1deg.
Δt: example 10min.
Target room temperature
Fan operation range
Time
2. Stop target flow temperature change by detecting room temperature going down
Target flow temperature
℃
4. Restart target flow temperature change by detecting room temperature going up
Time
3. Fan can restart after room temperature goes down to the threshold
Fan operation
Time
Heat pump operation
Time

Fig. 4

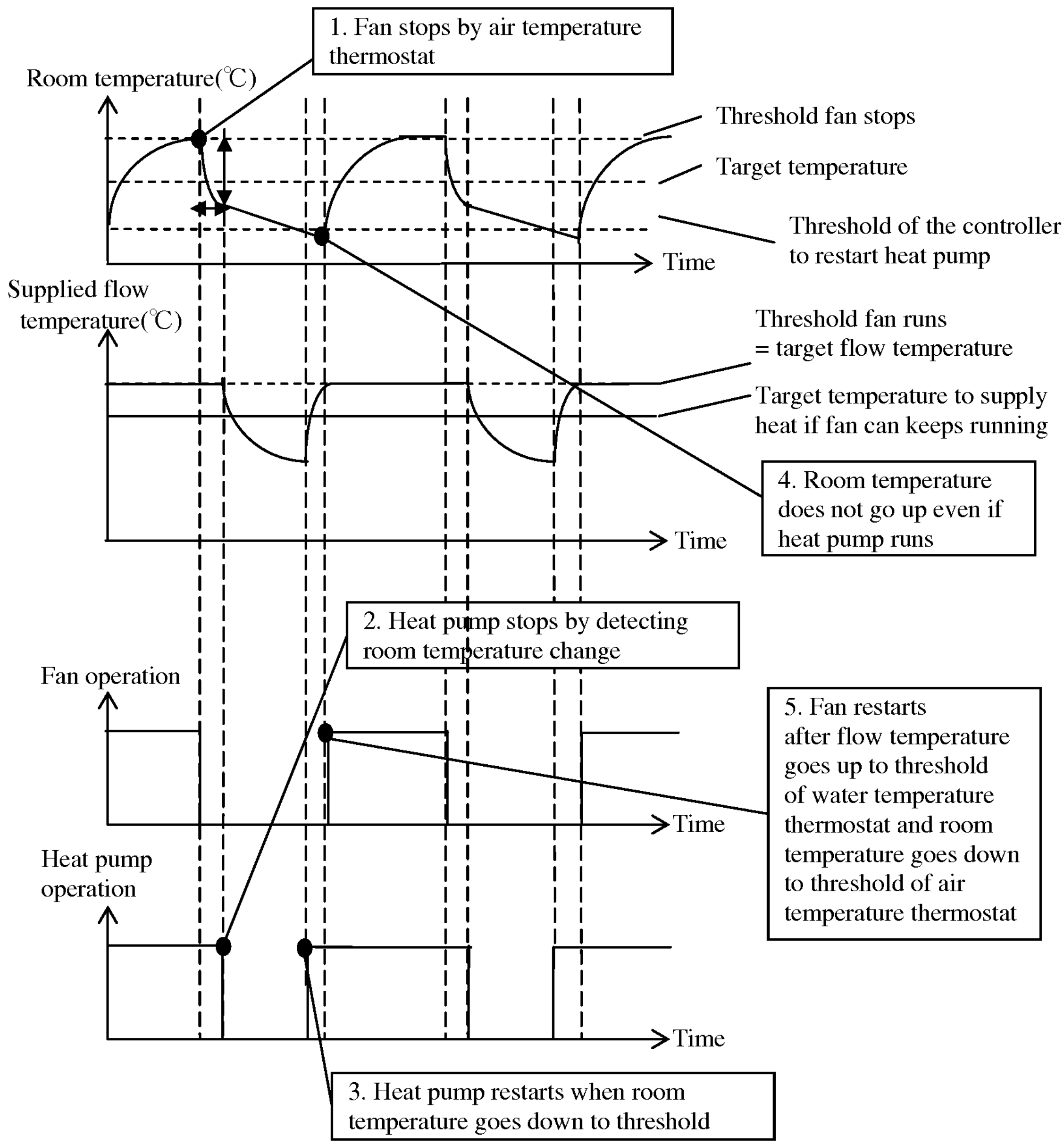
1. Fan stops by air temperature thermostat
Room temperature(℃)
Threshold fan stops
Target temperature
Threshold of the controller to restart heat pump
Time
Supplied flow temperature(℃)
Threshold fan runs = target flow temperature
Target temperature to supply heat if fan can keeps running
4. Room temperature does not go up even if heat pump runs
Time
2. Heat pump stops by detecting room temperature change
Fan operation
5. Fan restarts after flow temperature goes up to threshold of water temperature thermostat and room temperature goes down to threshold of air temperature thermostat
Time
Heat pump operation
Time
3. Heat pump restarts when room temperature goes down to threshold

Fig. 5

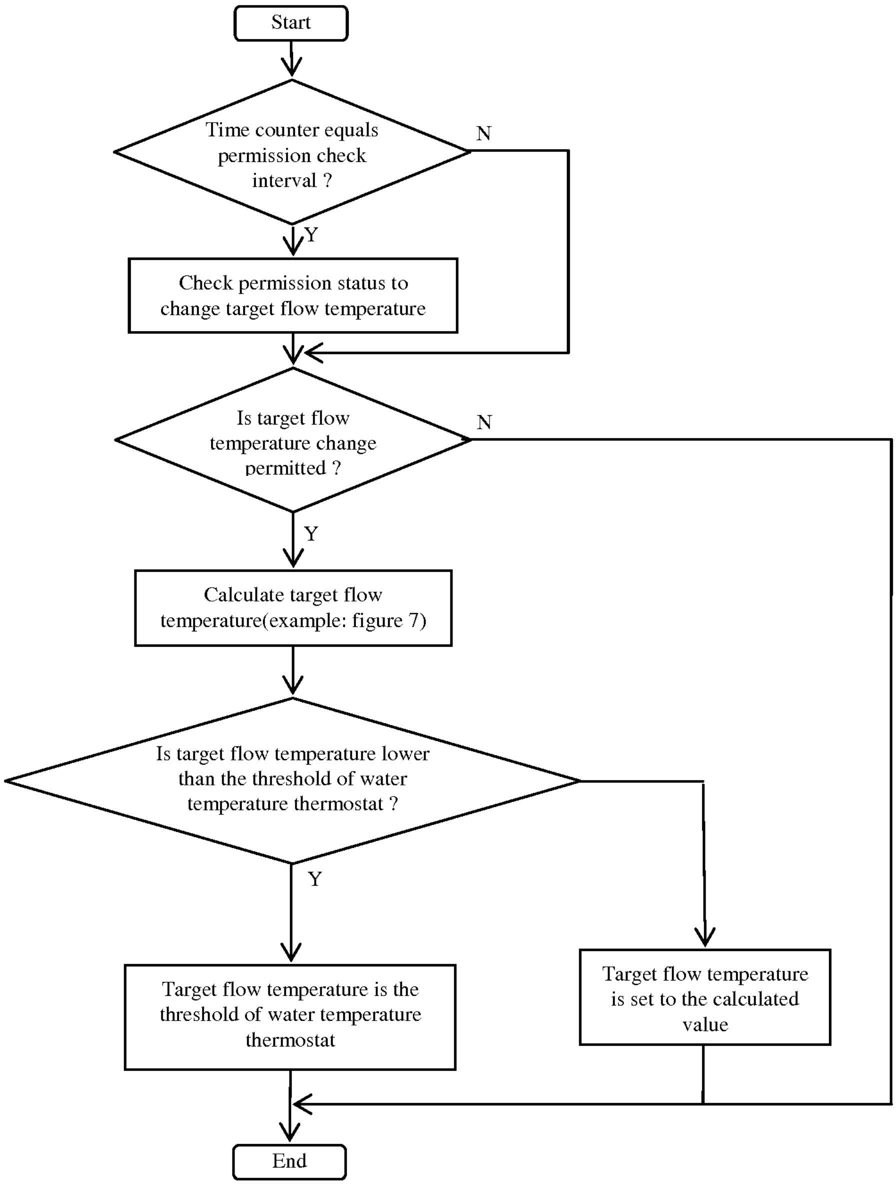
Start
Time counter equals permission check interval ?
N
Y
Check permission status to change target flow temperature
Is target flow temperature change permitted ?
N
Y
Calculate target flow temperature(example: figure 7)
Is target flow temperature lower than the threshold of water temperature thermostat ?
Y
Target flow temperature is the threshold of water temperature thermostat
Target flow temperature is set to the calculated value
End

Fig. 6

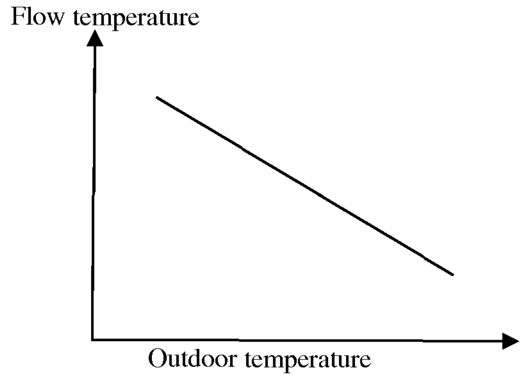
Flow temperature
Outdoor temperature

Fig. 7

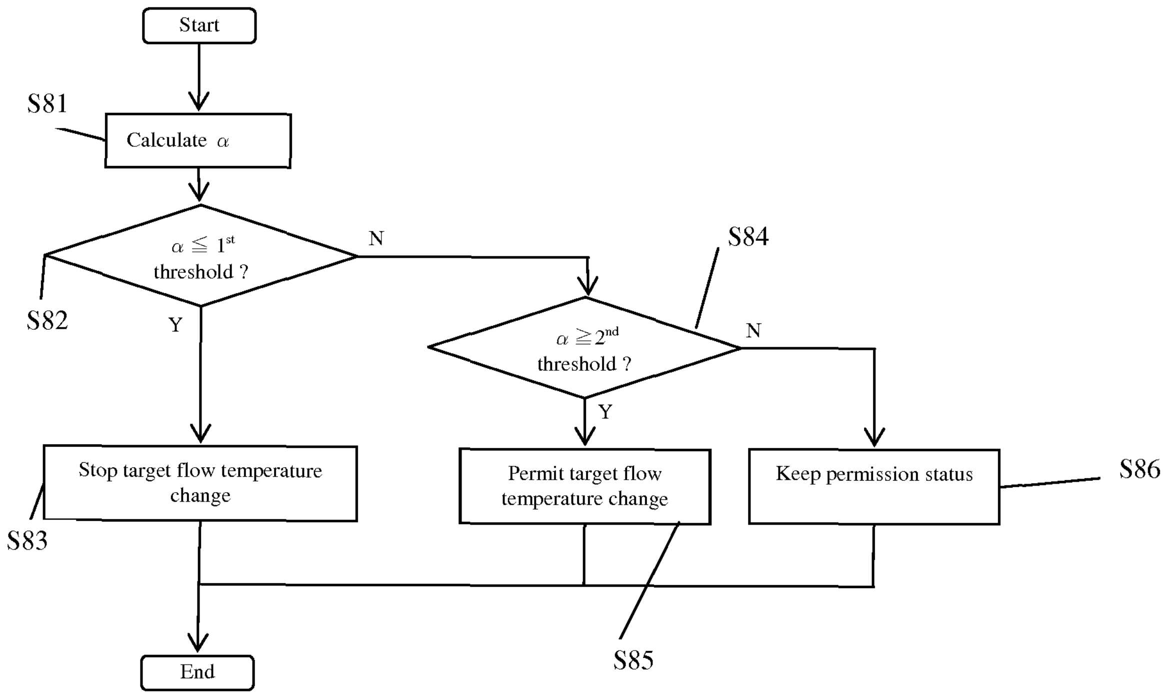
Start
S81
Calculate α
α ≦ 1st threshold ?
N
S82
Y
S84
α ≧ 2nd threshold ?
N
Y
Stop target flow temperature change
Permit target flow temperature change
Keep permission status
S86
S83
S85
End

Fig. 8

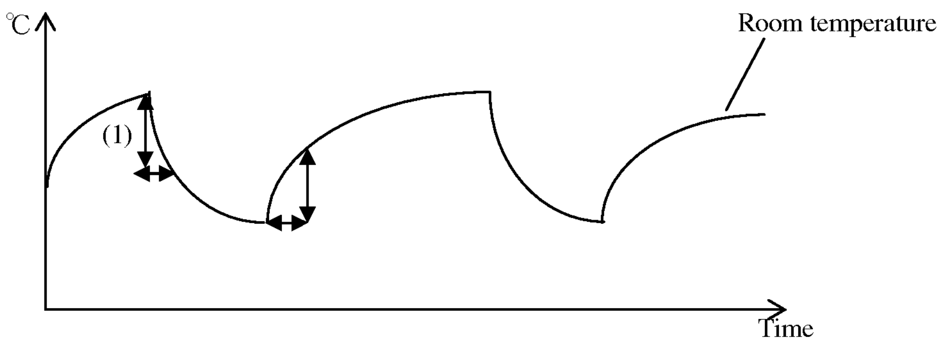
℃
Room temperature
(1)
Time

Fig. 9A

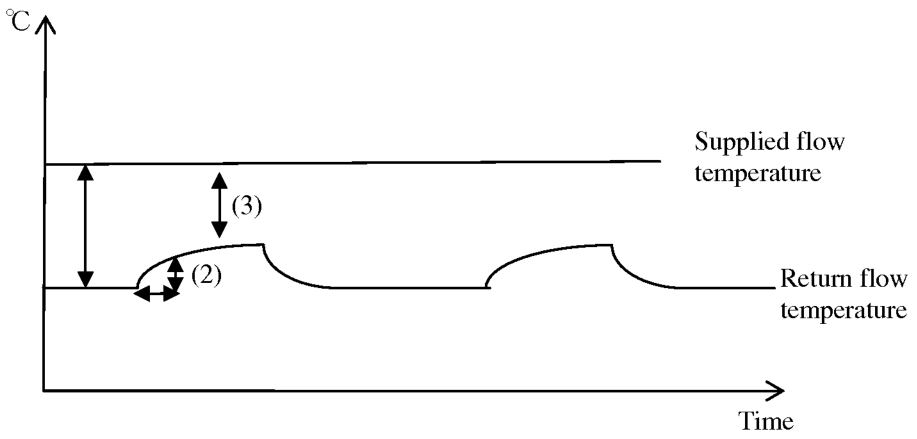
℃
Supplied flow temperature
(3)
(2)
Return flow temperature
Time

Fig. 9B

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- US 20110054701 A1 **[0011]**
- JP 5741256 B **[0012]**
- US 20090020281 A1 **[0013]**