

{ DESCRIPTION}

{ Title of Invention}

HEAT SOURCE SYSTEM, CONTROL METHOD THEREFOR, AND PROGRAM
THEREFOR

5 { Technical Field}

{ 0001}

The present invention relates to a heat source system of facilities requiring cooling such as buildings, factories, data centers, and local heating and cooling, and more particularly
10 to a heat source system which performs energy saving, a control method therefor, and a program therefor.

{ Background Art}

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The heat source system is conventionally a facility for
15 circulating cold water, which is produced by a chiller, in a room or an apparatus on a load side and cooling the room or the apparatus on the load side by exchanging heat with air on the load side. The chiller is controlled in a capacity corresponding to the load size according to an increase or
20 decrease of the load. Further, the number of the chiller is increased or decreased so as to supply a capacity corresponding to the load in some cases. The cold water is circulated by a pump between the load side and the chiller.

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There are following Patent Documents 1, 2 as prior art documents related to the present invention. Patent Document 1 describes that if an operational round-trip temperature difference, which is a round-trip temperature difference of a heat medium during operation, is less than a set round-trip temperature difference, which is a round-trip temperature difference of the medium at the time of design, the heat medium flow rate is shifted to an excess flow rate. Patent Document 2 describes an operation control method for a cold source machine capable of improving a system COP (Coefficient Of Performance) under consideration of auxiliary machines such as cold water pumps, cooling water pumps, and cooling towers.

{Citation List}

{Patent Literature}

15 {0004}

{Patent Document 1}

Japanese Patent No. 3854586

{Patent Document 2}

Japanese Patent Application Publication No. 2008-134013

20 {Summary of Invention}

{Technical Problem}

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The heat source system is designed with a flow rate condition and a temperature of cold water corresponding to a

maximum load expected at the time of design, however, a temperature of returning water from the load is low in many cases in actual operations, with respect to the round-trip temperature difference used to design the load of the cold water.

5 FIG. 18 is a diagram showing a relationship between the COP and a cooling amount (%) in a centrifugal chiller. In an operation state in which the round-trip temperature difference for the load of cold water is small, the COP of the chiller decreases and the flow rate required for cooling the load increases, and
10 thereby the required pump power increases in some cases as shown in FIG. 18.

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Further, there is a problem that the cooling amount of the load in the designed flow rate decreases and the designed
15 maximum amount of heat processing cannot be performed. For example, when one chiller and one constant flow rate pump are provided, if the flow rate of the pump is increased before the cooling capacity of the chiller becomes 100 % when the temperature difference is small, two chillers and two pumps are
20 required to be operated instead of one chiller and one pump. Therefore, the system COP of the heat source system decreases.

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In view of the actual circumstances described above, the object of the present invention is to provide a heat source

system which improves a system COP without decreasing an operating efficiency of a cold source, and also a control method therefor and a program therefor.

{ Solution to Problem}

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A heat source system according to claims 1, 2, 5 is one for which pumps that send a heat medium to at least one of a cold source for cooling the heat medium and a heat exchanger for exchanging heat between the cooled heat medium and a load,
10 the cold source, and the heat exchanger of the load, are connected by pipes through which the heat medium flows, and has the following characteristics.

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The heat source system according to claim 1 includes a
15 load heat amount measurement unit that measures an amount of heat which the heat medium exchanges with the load, a cold water return temperature measurement unit that measures a temperature of the heat medium which exchanges heat with the load and returns to the cold source, and a first control unit that lowers a
20 temperature set value of the heat medium at an outlet of the cold source, if a temperature of the heat medium falls below a temperature set value thereof and a difference between the temperature of the heat medium and the temperature set value of the heat medium at the outlet of the cold source becomes less

than a predetermined set value.

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The heat source system according to claim 2 includes a load heat amount measurement unit that measures an amount of heat which the heat medium exchanges with the load, a cold water return temperature measurement unit that measures a temperature of the heat medium which exchanges heat with the load and returns to the cold source, and a second control unit that changes a temperature set value of the heat medium at an outlet of the cold source to be lower than a predetermined temperature set value at the time of a maximum load.

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The heat source system according to claim 5 includes a load heat amount measurement unit that measures an amount of heat which the heat medium exchanges with the load, a cold water return temperature measurement unit that measures a temperature of the heat medium which exchanges heat with the load and returns to the cold source, a heat medium flow rate measurement unit that measures a flow rate of the heat medium which exchanges heat with the load, and a third control unit that raises a temperature set value of the heat medium which is cooled by the cold source if the flow rate of the heat medium is in a set range of temperature raising determination flow rate, and on the other hand, lowers the temperature set value of the heat medium which

is cooled by the cold source if the flow rate of the heat medium is in a set range of temperature lowering determination flow rate and the temperature of the heat medium is lower than a predetermined temperature lowering determination temperature.

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Control methods according to claims 11, 12, 15 for heat source systems are control methods for heat source systems according to claims 1, 2, 5, respectively.

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10 A program according to claim 19 for the heat source system is a program for performing on a computer the control method according to any one of claims 11, 12, 15 for the heat source system.

{ Advantageous Effects of Invention}

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According to the present invention, it is possible to provide a heat source system which prevents the system COP from decreasing without reducing the operating efficiency of the cold source, and also a control method therefor, and a program
20 therefor.

{ Brief Description of Drawings}

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FIG. 1 is a block diagram of a heat source system according to a first embodiment of the present invention.

FIG. 2A is a diagram showing an operation example of two chillers as cold sources when a cold water outlet temperature is 7 °C.

FIG. 2B is a diagram showing an operation example of one
5 chiller as a cold source when the cold water outlet temperature is 5.5 °C.

FIG. 3 is a diagram showing a graph of a relationship between a coefficient of performance (COP) ratio (%) and a cooling load factor (%) per chiller when the cold water outlet
10 temperatures are 5.5 °C and 7 °C.

FIG. 4 is a diagram showing a control flow of a control method for the heat source system according to the first embodiment.

FIG. 5 is a block diagram showing a heat source system
15 according to a second embodiment of the present invention.

FIG. 6 is a diagram showing a control flow of a control method for the heat source system according to the second embodiment.

FIG. 7 is a diagram showing power of cold water pumps,
20 power of chillers as cold sources, and total power consumption, against cold water feed temperature (temperature at the outlets of cold sources).

FIG. 8 is a block diagram showing a heat source system according to a third embodiment of the present invention.

FIG. 9 is a diagram showing a control flow of a control method for the heat source system according to the third embodiment.

FIG. 10 is a block diagram showing a heat source system according to a fourth embodiment of the present invention.

FIG. 11 is a diagram showing a control flow of a control method for the heat source system according to the fourth embodiment.

FIG. 12 is a diagram showing a COP against a cooling amount (%) at each cold water feed temperature (temperature at an outlet of a chiller as a cold source).

FIG. 13 is a diagram showing power of cold water pumps, power of chillers as cold sources, and total power consumption, against cold water feed temperature (temperature of cold water going out of the cold sources) when cold sources of a constant flow rate are controlled in the number thereof.

FIG. 14 is a diagram showing a relationship between power and a flow rate when each pump controlled in the number thereof is controlled by a constant flow rate control or a variable flow rate control (inverter control).

FIG. 15 is a block diagram showing a heat source system according to a fifth embodiment of the present invention.

FIG. 16A is a diagram showing a total head against a flow rate of device characteristics of a pump.

FIG. 16B is a diagram showing power of a pump against the flow rate.

FIG. 16C is a diagram showing a pipe resistance against the flow rate.

5 FIG. 17 is a block diagram showing a heat source system according to a sixth embodiment of the present invention.

FIG. 18 is a diagram showing a relationship between the COP and a cooling amount (%) in a centrifugal chiller.

{Description of Embodiments}

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Hereinafter, embodiments of the present invention will be described with reference to the accompanying drawings. Heat source systems N (N1 to N5) according to the embodiments of the present invention are heat source systems for cooling facilities such as buildings, factories, data centers, and local heating and cooling.

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<<First Embodiment>>

FIG. 1 is a block diagram of a heat source system N1 according to a first embodiment of the present invention. The heat source system N1 according to the first embodiment includes one or more cold sources R (R1, R2, ---) which cool water as a heat medium and provide the cold water of desired temperature, and loads 1 (1a, 1b, ---) (air in cooling target facilities)

which are heat exchanged in heat exchangers (not shown) with the cold water sent from the cold sources R.

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The heat source system N1 includes cold water pumps P (P1, P2, ---) which circulate water as a heat medium to each of cold sources R provided on the primary side, pumps P3 (P3a, P3b, ---) which send the cold water produced by the cold sources R to each of the loads 1 (1a, 1b, ---) provided on the secondary side, a water tank 5 having a low temperature side tank 5A in which the cold water produced by the cold sources R is stored and a high temperature side tank 5B in which water heated by heat exchanging with the loads 1 is stored, and a computing unit 2 which controls the heat source system N1.

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The cold water pumps P and the pumps P3 perform rated operations, respectively. The computing unit 2 is a controller such as a PLC (Programmable Logic Controller). Control of the heat source system N1 is performed by executing a program stored in a memory of the controller.

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The cold water cooled by the cold sources R (R1, R2) is sent to and stored in the low temperature side tank 5A via cold water lines r1, r2 by the cold water pumps P (P1, P2), respectively. The cold water stored in the low temperature side

tank 5A is sent to each of the loads 1 (1a, 1b, ---) by the pumps P3 (P3a, P3b, ---) on the secondary side. The cold water which has been heated by heat exchanging with the loads 1 (1a, 1b, ---) is sent to and stored in the high temperature side tank 5B of the water tank 5 by the pumps P3 on the secondary side.

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The cold water in the high temperature side tank 5B is sent by the cold water pumps P (P1, P2) on the primary side to the cold sources R (R1, R2) to be cooled again, and sent to and stored in the low temperature side tank 5A of the water tank 5. The heat source system N1 includes a flow rate sensor 3 and a temperature sensor 4 as sensors for measuring physical quantities thereof. The flow rate sensor 3 measures a flow rate of the cold water which exchanges heat with the loads 1 (1a, 1b, ---) in the heat exchangers (not shown) and returns to the cold sources R, and the temperature sensor 4 measures a temperature (cold water return temperature) of the returning cold water. The flow rate sensor 3 and the temperature sensor 4 are adapted to respectively measure the flow rate and temperature (cold water return temperature) of the cold water which is sent from the cold sources R (R1, R2) and heated by heat exchanging with the loads 1.

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The cold source R is a cold water production heat source

system composed of chillers such as a centrifugal chiller and an absorption chiller, and direct-contact cooling towers or closed-circuit cooling towers. The cold sources R (R1, R2) are, for example, chillers which are capable of controlling the temperature (cold water outlet temperature) of the cold water cooled by the cold sources R to be constant, and are capable of changing a set value of the cold water outlet temperature (outward temperature) of the cold sources R. The cold sources R are capable of setting the cold water outlet temperature lower than the temperature set value of the cold water to be supplied to the loads 1.

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Controls of the pumps 3 (P3a, P3b, ---) on the secondary side may be flow rate controls such as an optimized flow rate control and a constant pressure control of the cold water. As described above, the heat source system N1 is configured with, for example, a plurality of chillers as the heat sources R, and the cold water is sent at a constant flow rate by the cold water pumps P on the primary side and pumps P3 on the secondary side, which perform the rated operations.

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FIGS. 2A and 2B are diagrams showing operation state examples when cold water temperature of chillers R_t as cold sources R is lowered, wherein FIG. 2A shows an operation example

of two chillers Rt as cold sources R when a cold water outlet temperature is 7 °C, and FIG. 2B shows an operation example of one chiller Rt as a cold source R when the cold water outlet temperature is 5.5 °C. FIG. 3 shows a graph of a relationship
5 between a coefficient of performance (COP) ratio (%) and a cooling load factor (%) per chiller Rt when the cold water outlet temperatures of the chillers Rt as the cold sources R are 5.5 °C and 7 °C.

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10 In FIG. 2A, a cold water inlet temperature which is a temperature of the cold water entering each of chillers Rt1, Rt2 as cold sources R1, R2 is 8.5 °C, and the cold water outlet temperature thereof is 7 °C (see FIG. 3). When the cold water of a designed flow rate flows with 1.5 °C temperature
15 differences between the cold water inlet temperature and the cold water outlet temperature, the two chillers are operated with the load factor 30 % of each of chillers Rt1, Rt2 as the cold sources R1 and the total load factor 60 % of the cold source R1. In FIG. 2B, the chiller R2 is not operated, and the cold
20 water outlet temperature of the chiller Rt1 as the cold source R1 is 5.5 °C, and the cold water inlet temperature thereof is 8.5 °C. This means that the temperature differences between the cold water inlet temperature and the cold water outlet temperature of the chiller Rt1 is 3 °C, and one chiller Rt1 as

the cold source R1 with 60 % load factor is capable of processing the loads (see FIG. 3). The cold source R1 may be the chiller Rt1 and the cold source R2 may be the chiller Rt2.

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5 100 % load factor in FIG. 3 shows an example of 5 °C temperature differences between the cold water inlet temperature and the cold water outlet temperature of each of the chillers Rt1, Rt2 with rated flow rates. In FIGS. 1 and 2, although the cooling towers and cooling water pumps sending
10 the cooling water from the cooling towers are not illustrated, they are operated in conjunction with each of chillers Rt1, Rt2 as the cold sources R. In FIG. 3, by lowering the cold water outlet temperature of the cold sources R, the number of the cold sources R in operation is reduced. In other words, operations
15 of the chillers Rt1, Rt2 turn to be an operation of only the chiller Rt1, and thereby the COP ratio is improved. Further, the number of pumps in operation is reduced, and powers of the cold water pump P, the cooling water pump sending the cooling water from the cooling tower, and the chiller Rt1 as the cold
20 source R per unit load, are reduced compared with a case of two chillers. The centrifugal chiller may be an inverter centrifugal chiller, and the COP of the inverter centrifugal chiller is higher than that of a constant rate centrifugal chiller. In a heat source of heat pump type targeting a heating

load, when a temperature of returning hot water is higher than a designed value, by raising a hot water outlet temperature and by raising a load factor of the heat source of heat pump type, the COP of the heat source operation is improved and a system
5 COP of a heat source system is improved, and thereby power consumption is reduced.

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<Control method for heat source system N1>

Next, a control method for the heat source system N1 will
10 be described with reference to FIG. 4 which shows a control flow thereof. The control of the heat source system N1 shown in FIG. 4 is performed by the computing unit 2 at a predetermined time interval, for example, at any time interval such as 5 minutes interval, 1 hour interval by measuring time using a timer.
15 First, in Step S100, a flow rate (cold water flow rate) and a temperature (cold water return temperature) of the cold water returning to the cold sources R after heat exchanging with the loads 1 (1a, 1b, ---) are measured respectively by the flow rate sensor 3 and the temperature sensor 4 in FIG. 1. In addition,
20 a temperature (cold water outward temperature) of the cold water on an outward path to the loads 1 from the cold sources R is obtained from a temperature control of the cold water in the cold sources R.

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An amount of heat exchanged with the loads 1 is calculated from the flow rate of the cold water measured by the flow rate sensor 3 and a temperature difference between the temperature of the cold water on the outward paths of the cold sources R and the temperature of the cold water measured by the temperature sensor 4 on a return path after heat exchanging with the loads 1. The temperature of the cold water on the outward paths of the cold sources R may be measured by providing a temperature sensor in the low temperature side tank 5A of the water tank 5 or in a pipe leading to the loads 1 on the secondary side, or may be obtained from a cooling control of the cold sources R.

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Next, in Step S101, it is determined whether or not the flow rate of the cold water measured by the flow rate sensor 3 is smaller than a minimum flow rate of the cold water pump P plus B (margin amount). If the flow rate of the cold water is smaller than the minimum flow rate of the cold water pump P plus B (margin amount) ("Yes" in Step S101), the control flow goes to Step S102, and it is determined whether or not the flow rate of the cold water measured by the flow rate sensor 3 is equal to or larger than the minimum flow rate of the cold water pump P.

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If the flow rate of the cold water measured by the flow rate sensor 3 is equal to or larger than the minimum flow rate of the cold water pump P ("Yes" in Step S102), the control flow goes to Step S105, and a current set value of the temperature of the cold water on the outward paths of the cold sources R is maintained. On the other hand, if the flow rate of the cold water measured by the flow rate sensor 3 is smaller than the minimum flow rate of the cold water pump P ("No" in Step S102), the control flow goes to Step S106, and a temperature set value of the cold water on the outward paths of the cold sources R is raised by a predetermined value, for example, 0.5 °C, 1 °C. A temperature width to be raised can be set appropriately to any value in each heat source system. The temperature width to be raised is, for example, 0.5 °C and changed periodically.

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In Step S101, if the flow rate of the cold water is not smaller than the minimum flow rate of the cold water pump P plus B (margin amount), i.e., the flow rate of the cold water is equal to or larger than the minimum flow rate of the cold water pump P plus B (margin amount) ("No" in Step S101), the control flow goes to Step S103, and it is determined whether or not the temperature of the cold water returning to the cold sources R after heat exchanging with the loads 1 (1a, 1b, ---) is lower than a temperature lowering determination temperature.

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The temperature lowering determination temperature is, for example, less than the designed value at the time of the maximum load. For example, the temperature lowering
5 determination temperature is 8 °C when the cold water outward temperature is 6 °C and the cold water return temperature is 11 °C. Here, the temperature lowering determination temperature is a temperature of the cold water and is set to have a width such as $8\text{ °C} \pm \alpha\text{ °C}$. Although the temperature
10 lowering determination temperature can be 8 °C without a width, it is desirable to have a width such as $8\text{ °C} \pm \alpha\text{ °C}$ because the control of the heat source system is more stable and practical when the temperature lowering determination temperature has the width. Note that the temperature lowering determination
15 temperature can be set arbitrarily for each of the heat source systems to be applied.

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If the cold water return temperature is determined not to be lower than the temperature lowering determination
20 temperature ("No" in Step S103), it is determined whether or not the temperature (cold water return temperature) of the cold water retuning to the cold sources R after heat exchanging with the loads 1 (1a, 1b, ---) is equal to the temperature lowering determination temperature (Step S104). If the temperature

(cold water return temperature) of the cold water retuning after heat exchanging with the loads 1 (1a, 1b, ---) is determined to be equal to the temperature lowering determination temperature ("Yes" in Step S104), the control flow goes to Step S105, and the current set value of the temperature of the cold water on the outward paths of the cold sources R is maintained.
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On the other hand, in Step S104, if the temperature (cold water return temperature) of the cold water retuning to the cold sources R after heat exchanging with the loads 1 (1a, 1b, ---) is determined to be different from the temperature lowering determination temperature, i.e., higher than the temperature lowering determination temperature ("No" in Step S104), the control flow goes to Step S106, and the temperature set value of the cold water on the outward paths of the cold sources R is raised by the predetermined value.

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In Step S103, if the cold water return temperature is determined to be lower than the temperature lowering determination temperature ("Yes" in Step S103), it is determined whether or not the temperature set value of the cold water on the outward paths of the cold sources R (R1, R2) is a specific minimum value of the temperature set value determined by devices of the cold sources R (Step S107). If the temperature

set value of the cold water on the outward paths of the cold sources R (R1, R2) is determined to be the specific minimum value of the temperature set value determined by the devices of the cold sources R ("Yes" in Step S107), the control flow goes to
5 Step S105, and the current set value of the temperature of the cold water on the outward paths of the cold sources R is maintained (Step S105).

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On the other hand, in Step S107, if the temperature set
10 value of the cold water on the outward paths of the cold sources R (R1, R2) is determined not to be the specific minimum value of the temperature set value determined by the devices of the cold sources R ("No" in Step S107), the temperature set value of the cold water on the outward paths of the cold sources R
15 is raised by a predetermined value, for example, 0.5 °C, 1 °C. The temperature width to be raised is, for example, 0.5 °C and changed periodically (Step S108). At this time, the temperature set values of the cold water on the outlets (outward paths) of the cold sources R are changed in some cases to be
20 lower than a predetermined temperature set value at the time of the maximum load. Hereinabove, a flow of the control method for the heat source system N1 shown in FIG. 4 has been explained.

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According to the control method for the heat source system

N1, at the time of low load, even if the cold water temperature is lowered when the cold water on the secondary side is the minimum flow rate and a minimum operation number (for example, one) of the cold heat sources R is enough for cooling loads, the flow rate of the cold water does not decrease, and thereby the power of the cold water pumps P, and the pumps P3 cannot be reduced. Therefore, at the time of low load, the cold water temperature of the cold sources R is not lowered, but the temperature when the cold water is the minimum flow rate is maintained. Thus, it is possible to prevent the decrease of the coefficient of performance (COP) caused by lowering the cold water outlet temperature of the chillers Rt as the cold sources R.

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Characteristics of the heat source system N1 according to the first embodiment are as follows. If the cold water return temperature (the temperature, which is measured by the temperature sensor 4, of the cold water returning to the cold resources R after heat exchanging with the loads 1) on the secondary side is low, the cold water feed temperature (the outlet temperature of the cold water cooled by the cold sources R) is lowered so as to increase a temperature difference between the cold water return temperature and the cold water feed temperature. By increasing the temperature difference, a heat

amount per unit flow rate is increased and an efficiency of the system is increased, and thereby it is possible to reduce waste of the power of the cold water pumps P on the primary side and the power of the pumps P3 on the secondary side. Incidentally,
5 the cold water feed temperature is the same as the cold water outward temperature or substantially the same.

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For the chillers Rt1, Rt2 as the cold sources R whose efficiency is lowered in general when the cold water temperature
10 is lowered, it is possible to prevent the temperature difference from reducing by lowering the temperature of the cold water, and to prevent the decrease of the COP of the chillers Rt1, Rt2 as the cold sources R caused by the increase of the number of the chillers in operation, thereby increasing the overall
15 system efficiency.

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<<Second Embodiment>>

FIG. 5 is a block diagram showing a heat source system N2 according to a second embodiment of the present invention.
20 The heat source system N2 according to the second embodiment includes one or more cold sources R (R1, R2, ---) which cool water as a heat medium and provide the cold water of desired temperature, and loads 1 (1a, 1b, ---) which are heat exchanged in heat exchangers (not shown) with the cold water sent from

the cold sources R. In FIG. 5, bypass routes between feed headers and return headers are omitted. The heat source system N2 includes cold water pumps P (P1, P2, ---) which are inverter controlled and circulate the cold water to each of cold sources R, and a computing unit 2 which controls the heat source system N2 (cold sources R, cold water pumps P, and the like).

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The computing unit 2 is a controller such as a PLC (Programmable Logic Controller). Control of the heat source system N2 is performed by executing a program stored in a memory of the controller. The cold water produced by the cold sources R (R1, R2, ---) is sent by the cold water pump P (P1, P2, ---) to the loads 1 (1a, 1b, ---) from the cold sources R (R1, R2, ---) via the cold water lines (r1, r2, ---), respectively.

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The heat source system N2 includes a flow rate sensor 3 and a temperature sensor 4 as sensors for measuring physical quantities thereof. The flow rate sensor 3 measures a flow rate of the cold water which exchanges heat with the loads 1 (1a, 1b, ---) in the heat exchangers (not shown) and returns to the cold sources R, and the temperature sensor 4 measures a temperature (cold water return temperature) of the returning cold water. Thus, the heat source system N2 is capable of measuring the flow rate and temperature (cold water return

temperature) of the cold water, which is sent from the cold sources R (R1, R2, ---) and heated by heat exchanging with the loads 1 in the heat exchangers (not shown), respectively by the flow rate sensor 3 and the temperature sensor 4.

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The cold source R is a cold water production heat source system composed of chillers such as a centrifugal chiller and an absorption chiller, and direct-contact cooling towers or closed-circuit cooling towers. The cold sources R (R1, R2) are,
10 for example, chillers which are capable of controlling the cold water feed temperature (cold water outlet temperature of the cold water cooled by the cold sources R) to be constant, and are capable of changing a set value of the cold water feed temperature of the cold sources R. The cold water outlet
15 temperature (cold water temperature at the outlets of the sold resources R) of the chillers as the cold resources R can be set lower than the temperature set value designed for the cold water to be supplied to the loads 1. Controls of the cold water pumps P may be flow rate controls such as an optimized flow rate control
20 and a constant pressure control of the cold water.

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<Control method for heat source system N2>

Next, a control method for the heat source system N2 will be described with reference to FIG. 6 which shows a control flow

thereof. The control of the heat source system N2 shown in FIG. 6 is performed by the computing unit 2 at a predetermined time interval, for example, at any time interval such as 5 minutes interval by measuring time using a timer.

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First, in Step S201 in FIG. 6, a flow rate (cold water flow rate) and temperature (cold water return temperature) of the cold water returning to the cold sources R after heat exchanging with the loads 1 (1a, 1b, ---) are measured
10 respectively by the flow rate sensor 3 and the temperature sensor 4. In addition, a temperature (cold water outward temperature) of the cold water on an outward path to the loads 1 from the cold sources R is obtained from a temperature control of the cold water in the cold sources R, or measured by a
15 temperature sensor provided on a pipe of the outward path to the loads 1. An amount of heat exchanged with the loads 1 is calculated from the flow rate of the cold water and a temperature difference between the temperature of the cold water on the outward paths of the cold sources R and the temperature (cold
20 water return temperature) of the cold water measured by the temperature sensor 4 on a return path after heat exchanging with the loads 1.

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FIG. 7 is a diagram showing power of cold water pumps P,

power of chillers as cold sources R, and total power consumption against cold water feed temperature (cold water temperature at the outlets of the cold sources R). As shown in FIG. 7, the overall power consumption increases when the outlet temperature
5 of the cold sources R is high (the flow rate of the cold water pump P is large because the amount of heat exchange is small) and when the outlet temperature of the cold sources R is low (the flow rate of the cold water pump P is small because the amount of heat exchange is large).

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In Step S202 in FIG. 6, it is determined by using a range of temperature raising determination flow rate whether or not the flow rate of the cold water which exchanges heat with the loads 1 is too small. Then, in Step S203, it is determined by
15 using a range of temperature lowering determination flow rate whether or not the flow rate of the cold water which exchanges heat with the loads 1 is too large. If the flow rate is too small, the efficiency of the cold sources R decreases and thereby the system COP decreases. On the other hand, if the
20 flow rate is too large, the efficiency of the pumps P decreases and thereby the system COP decreases. Therefore, in each case, the temperature set value of the cold water on the outward paths of the cold sources R is reset, so that the flow rates of the pumps P are optimized.

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In Step S202, it is determined whether or not the flow rate, detected by the flow rate sensor 3, of the cold water which exchanges heat with the loads 1 (1a, 1b, ---) is in the predetermined range of temperature raising determination flow rate (range of flow rate which is too small). In Step S202, if it is determined that the flow rate of the cold water which exchanges heat with the loads 1 is in the predetermined range of temperature raising determination flow rate (range of flow rate which is too small) ("Yes" in Step S202), it is determined whether or not a current temperature set value of the cold water on the outward paths of the cold sources R is a maximum value of the temperature set value determined by the devices of the cold sources R (Step S204).

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If it is determined that the current temperature set value of the cold water on the outward paths of the cold sources R is the maximum value of the temperature set value of the cold sources R ("Yes" in Step S204), the current temperature set value of the cold water on the outward paths of the cold sources R is maintained (Step S205). On the other hand, if it is determined that the current temperature set value of the cold water on the outward paths of the cold sources R is not the maximum value of the temperature set value of the cold sources

R ("No" in Step S204), the current temperature set value of the cold water on the outward paths of the cold sources R is raised by a predetermined value, for example, a temperature width such as 0.5 °C and 1 °C. A temperature width to be raised can be
5 set appropriately to any value in each heat source system. The temperature width to be raised is, for example, 0.5 °C and changed periodically (Step S206).

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On the other hand, in Step 202, if it is determined that
10 the flow rate of the cold water which exchanges heat with the loads 1 is not in the predetermined range of temperature raising determination flow rate (range of flow rate which is too small) ("No" in Step S202), it is determined whether or not the flow rate of the cold water which exchanges heat with the loads 1
15 is in the predetermined range of temperature lowering determination flow rate (range of flow rate which is too large) in Step S203. If it is determined that the flow rate of the cold water which exchanges heat with the loads 1 is not in the predetermined range of temperature lowering determination flow
20 rate (range of flow rate which is too large) ("No" in Step S203), the control flow goes to Step S205, and the current temperature set value of the cold water on the outward paths of the cold sources R is maintained.

{ 0051}

On the other hand, if it is determined that the flow rate of the cold water which exchanges heat with the loads 1 is in the predetermined range of temperature lowering determination flow rate (range of flow rate which is too large) ("Yes" in Step 5 S203), the control flow goes to Step S207, and it is determined whether or not a temperature of the flow returning from the loads 1 is lower than a predetermined temperature lowering determination temperature. The temperature lowering determination temperature is, for example, less than the 10 designed value at the time of the maximum load. For example, the temperature lowering determination temperature is 8 °C when the cold water outward temperature is 6 °C and the cold water return temperature is 11 °C. Here, since the cold water flows in pipes, the temperature lowering determination temperature 15 is set to have a width such as 8 °C ± 0.5 °C. Although the temperature lowering determination temperature can be 8 °C without a width, it is desirable to have a width such as 8 °C ± 0.5 °C because the control of the heat source system is more stable and practical when the temperature lowering 20 determination temperature has the width. Note that the temperature lowering determination temperature can be set arbitrarily for each of the heat source systems.

{ 0052}

In Step S207, if it is determined that the temperature

(cold water return temperature) of the flow returning from the loads 1 is not lower than the predetermined temperature lowering determination temperature ("No" in Step S207), the control flow goes to Step S208, and it is determined whether or not the temperature of the flow returning from the loads 1 is equal to the predetermined temperature lowering determination temperature. In Step S208, if it is determined that the temperature of the flow returning from the loads 1 is equal to the predetermined temperature lowering determination temperature ("Yes" in Step S208), the control flow goes to Step S205, and the current temperature set value of the cold water on the outward paths of the cold sources R is maintained.

{ 0053}

On the other hand, in Step S208, if it is determined that the temperature of the flow returning from the loads 1 is not equal to the predetermined temperature lowering determination temperature, i.e., higher than the predetermined temperature lowering determination temperature ("No" in Step S208), the control flow goes to Step S206, and the current temperature set value of the cold water on the outward paths of the cold sources R is raised by a predetermined value, for example, a temperature width such as 0.5 °C and 1 °C. In Step S207, if it is determined that the temperature of the flow returning from the loads 1 is lower than the predetermined temperature lowering

determination temperature ("Yes" in Step S207), the control flow goes to Step S209, and it is determined whether or not the temperature set value of the cold water on the outward paths of the cold sources R (R1, R2) is a specific minimum value of the temperature set value determined by the devices of the cold sources R (Step S209).

{ 0054}

In Step 209, if it is determined that the temperature set value of the cold water on the outward paths of the cold sources R (R1, R2) is the minimum value of the temperature set value of the cold sources R ("Yes" in Step S209), the control flow goes to Step S205, and the current temperature set value of the cold water on the outward paths of the cold sources R is maintained. On the other hand, in Step 209, if it is determined that the temperature set value of the cold water on the outward paths of the cold sources R (R1, R2) is not the minimum value of the temperature set value of the cold sources R ("No" in Step S209), the control flow goes to Step S210, and the current temperature set value of the cold water on the outward paths of the cold sources R is lowered by a temperature width such as 0.5 °C and 1 °C. The temperature width to be lowered is, for example, 0.5 °C and changed periodically (Step S210). At this time, the temperature set values of the cold water on the outlets (outward paths) of the cold sources R are changed in

some cases to be lower than a predetermined temperature set value at the time of the maximum load. Hereinabove, a flow of the control method for the heat source system N2 shown in FIG. 6 has been explained.

5 { 0055}

The heat source system N2 according to the second embodiment uses chillers capable of setting the cold water temperature of the chillers as the cold sources R to be lower than an initial temperature set value, so that the cold water outlet temperature of the chillers as the cold sources R can be lowered by utilizing measured values of the cold water flow rate and the cold water return temperature. For example, it is possible to lower the cold water outlet temperature of the cold sources R so that the cold water pumps P operate at rated flows, thereby reducing the number of the cold water pumps P in operation. Therefore, it is possible to reduce the cold water flow rate while the cold sources R are operated in high efficiency, thereby improving the COP of the heat source system N2.

20 { 0056}

<<Third Embodiment>>

FIG. 8 is a block diagram showing a heat source system N3 according to a third embodiment of the present invention. The heat source system N3 according to the third embodiment

includes any number of cold sources R (Ra, Rb, ---) connected in series instead of in parallel in the heat source system N2 according to the second embodiment. Since the heat source system N3 includes the cold sources R (Ra, Rb, ---) connected in series, there is one cold water line rl, and one inverter-controlled pump P1 are used. When the cold sources R are two, there are a high temperature side cold source Ra and a low temperature side cold source Rb.

{ 0057}

10 This means that the heat source system N3 is a heat source system including two chillers connected in series as the cold sources R. One is a high temperature side chiller (Ra) which cools the loads, for example, from 16 °C to 11 °C at the time of the maximum load, and the other is a low temperature side
15 chiller (Rb) which cools the loads, for example, from 11 °C to 6 °C at the time of the maximum load. In FIG. 8, two cold sources R (Ra, Rb) connected in series are illustrated, but any number of the cold sources R can be connected in series. The chiller as a high temperature side cold source Ra and the chiller as
20 a low temperature side cold source Rb can be set at temperatures lower than temperature set values at the time of the maximum load. Since the other configurations of the heat source system N3 are the same as the heat source system N2 according to the second embodiment, detailed description thereof will be

omitted.

{ 0058}

<Control method for heat source system N3>

Next, a control method for the heat source system N3 will
5 be described with reference to FIG. 9 which shows a control flow
thereof. The control of the heat source system N3 shown in FIG.
9 is performed by the computing unit 2 at a predetermined time
interval, for example, at any time interval such as 5 minutes
interval and 1 hour interval by measuring time using a timer.

10 { 0059}

The cold water outlet temperatures of the chillers as the
high temperature side and low temperature side cold sources Ra,
Rb can be lowered respectively from the temperature set values,
according to the measured value of the cold water flow rate
15 measured by the flow rate sensor 3 and the cold water return
temperature measured by the temperature sensor 4. First, in
Step S301 in FIG. 9, a flow rate (cold water flow rate) and a
temperature (cold water return temperature) of the cold water
returning to the cold sources R after heat exchanging with the
20 loads 1 (1a, 1b, ---) in heat exchangers (not shown) are measured
respectively by the flow rate sensor 3 and the temperature
sensor 4 shown in FIG. 8. A temperature of the cold water on
an outward path to the loads 1 (1a, 1b, ---) is obtained from
a temperature control of the cold water cooled in the high

temperature side and low temperature side cold sources Ra, Rb, or measured by a temperature sensor (not shown) provided on the outward path to the loads 1 (1a, 1b, ---).

{ 0060}

5 An amount of heat exchanged with the loads 1 is calculated from a temperature difference between the temperature of the cold water on the outward path of the cold source Rb and the cold water temperature measured by the temperature sensor 4 on a return path. Next, in Step S302, it is determined by using
10 a range of temperature raising determination flow rate whether or not the flow rate of the cold water which flows for exchanging heat with the loads 1 is too small. Then, in Step S303, it is determined by using a range of temperature lowering determination flow rate whether or not the flow rate of the cold
15 water which flows for exchanging heat with the loads 1 is too large.

{ 0061}

 If the flow rate of the cold water which exchanges heat with the loads 1 in heat exchangers (not shown) is too small,
20 the efficiency of the cold sources R (Ra, Rb) decreases and thereby the system COP of the heat source system N3 decreases. On the other hand, if the flow rate is too large, the efficiency of the pump P1 decreases and thereby the system COP of the heat source system N3 decreases. Therefore, in each case, the

temperature set values of the cold water on the outward paths of the cold sources Ra, Rb are reset, so that the flow rate of the pump P1 is optimized.

{ 0062}

5 First, in Step S302, it is determined whether or not the flow rate, detected by the flow rate sensor 3, of the cold water which exchanges heat with the loads 1 is in the predetermined range of temperature raising determination flow rate (range of flow rate which is too small). In Step S302, if it is determined
10 that the flow rate of the cold water which exchanges heat with the loads 1 in the heat exchangers (not shown) is in the predetermined range of temperature raising determination flow rate (range of flow rate which is too small) ("Yes" in Step S302), it is determined whether or not a current temperature set value
15 of the cold water on the outward path of the high temperature side and low temperature side cold sources Ra, Rb is a maximum value of the temperature set value determined by the devices of each of the cold sources R (Ra, Rb) (Step S304).

{ 0063}

20 If it is determined that the current temperature set value of the cold water on the outward path of the high temperature side and low temperature side cold sources Ra, Rb is the maximum value of the temperature set value determined by the devices of each of the cold sources R (Ra, Rb) ("Yes" in Step S304),

the current temperature set values of the cold water on each outward path of the high temperature side and low temperature side cold sources Ra, Rb are maintained (Step S305). On the other hand, if it is determined that the current temperature set value of the cold water on the outward path of the high temperature side and low temperature side cold sources Ra, Rb is not the maximum value of the temperature set value determined by the devices of each of the high temperature side and low temperature side cold sources Ra, Rb ("No" in Step S304), the current temperature set values of the cold water on the outward path of the high temperature side and low temperature side cold sources Ra, Rb are raised by a predetermined value, for example, a temperature width such as 0.5 °C and 1 °C (Step S306). A temperature width to be raised can be set appropriately to any value in each heat source system. The temperature width to be raised is, for example, 0.5 °C and changed periodically.

{ 0064 }

On the other hand, in Step 302, if it is determined that the flow rate of the cold water which exchanges heat with the loads 1 (1a, 1b, ---) is not in the predetermined range of temperature raising determination flow rate (range of flow rate which is too small) ("No" in Step S302), it is determined whether or not the flow rate of the cold water which exchanges heat with the loads 1 is in the predetermined range of temperature

lowering determination flow rate (range of flow rate which is too large).

{ 0065}

In Step S303, if it is determined that the flow rate of
5 the cold water which exchanges heat with the loads 1 is not in
the predetermined range of temperature lowering determination
flow rate (range of flow rate which is too large) ("No" in Step
S303), the control flow goes to Step S305, and the current
temperature set values of the cold water on each outward path
10 of the high temperature side and low temperature side cold
sources Ra, Rb are maintained.

{ 0066}

On the other hand, in Step S303, if it is determined that
the flow rate, detected by the flow rate sensor 3, of the cold
15 water which exchanges heat with the loads 1 is in the
predetermined range of temperature lowering determination flow
rate (range of flow rate which is too large) ("Yes" in Step S303),
the control flow goes to Step S307, and it is determined whether
or not a temperature of the cold water returning after heat
20 exchanging with the loads 1 is lower than a predetermined
temperature lowering determination temperature (Step S307).

{ 0067}

The temperature lowering determination temperature is
less than the designed value at the time of the maximum load,

for example, 12 °C (8 °C) when the cold water outward temperature of the low temperature side cold source Rb is 5 °C (6 °C) and the cold water return temperature of the high temperature side cold source Ra is 15 °C. Here, since the cold water flows in pipes, the temperature lowering determination temperature is set to have a width such as 12 °C ± 0.5 °C. Although the temperature lowering determination temperature can be 12 °C (8 °C) without a width, it is desirable to have a width such as 12 °C ± 0.5 °C because the control of the heat source system is more stable and practical when the temperature lowering determination temperature has the width. Note that the temperature lowering determination temperature can be set arbitrarily for each of the heat source systems.

{ 0068 }

In Step S307, if it is determined that the temperature of the cold water returning after heat exchanging with the loads 1 is not lower than the predetermined temperature lowering determination temperature ("No" in Step S307), the control flow goes to Step S308, and it is determined whether or not the temperature (cold water return temperature) of the cold water returning after heat exchanging with the loads 1 is equal to the predetermined temperature lowering determination temperature. In Step S308, if it is determined that the temperature of the flow returning from the loads 1 (1a, 1b, ---)

is equal to the predetermined temperature lowering determination temperature ("Yes" in Step S308), the control flow goes to Step S305, and the current temperature set values of the cold water on the outward paths of the high temperature side and low temperature side cold sources Ra, Rb are maintained.

{ 0069}

On the other hand, in Step S308, if it is determined that the temperature of the flow returning after heat exchanging with the loads 1 is not equal to the predetermined temperature lowering determination temperature ("No" in Step S308), the control flow goes to Step S306, and the current temperature set values of the cold water on each outward path of the high temperature side and low temperature side cold sources Ra, Rb are raised by a predetermined value, for example, a temperature width such as 0.5 °C and 1 °C. In Step S307, if it is determined that the temperature of the flow returning after heat exchanging with the loads 1 (1a, 1b, ---) is lower than the predetermined temperature lowering determination temperature ("Yes" in Step S307), the control flow goes to Step S309, and it is determined whether or not the temperature set value of the cold water on the outward path of the high temperature side and low temperature side cold sources Ra, Rb is a specific minimum value of the temperature set value determined by the devices of the

high temperature side and low temperature side cold sources Ra, Rb (Step S309).

{ 0070}

5 In Step 309, if it is determined that the temperature set value of the cold water on the outward path of the high temperature side and low temperature side cold sources Ra, Rb is the specific minimum value of the temperature set value determined by the devices of the high temperature side and low temperature side cold sources Ra, Rb ("Yes" in Step S309), the control flow goes to Step S305, and the current temperature set values of the cold water on the outward paths of the high temperature side and low temperature side cold sources Ra, Rb are maintained.

{ 0071}

15 On the other hand, in Step 309, if it is determined that the temperature set value of the cold water on the outward path of the high temperature side and low temperature side cold sources Ra, Rb is not the specific minimum value of the temperature set value determined by the devices of the high temperature side and low temperature side cold sources Ra, Rb ("No" in Step S309), the control flow goes to Step S310, and the current temperature set values of the cold water on the outward paths of the high temperature side and low temperature side cold sources Ra, Rb are lowered by a temperature width such

as 0.5 °C and 1 °C (Step S310). The temperature width to be lowered is, for example, 0.5 °C and changed periodically. At this time, the temperature set values of the cold water on the outlets (outward paths) of the high temperature side and low temperature side cold sources Ra, Rb are changed in some cases to be lower than predetermined temperature set values at the time of the maximum load. Hereinabove, a flow of the control method for the heat source system N3 shown in FIG. 9 has been explained.

10 { 0072}

According to the heat source system N3, even when the heat sources R (Ra, Rb, ---) are connected in series, by controlling the cold water outlet temperature of the cold sources R to be low, it is possible to reduce the cold water flow rate while the cold sources R are operated in high efficiency, thereby improving the COP of the heat source system N3.

{ 0073}

<<Fourth Embodiment>>

FIG. 10 is a block diagram showing a heat source system N4 according to a fourth embodiment of the present invention. In the heat source system N4 according to the fourth embodiment, a known unit control (see 13th Edition, Air-Conditioning and Sanitary Engineering Handbook, by The Society of Heating, Air-Conditioning and Sanitary Engineers of Japan, pp. 632 to

20 N4 according to a fourth embodiment of the present invention.

635) of two or more cold sources R (R1, R2, ---) by the computing unit 2 is added to the heat source system N2 according to the second embodiment.

{ 0074}

5 For increasing or decreasing stages of two or more cold sources R (R1, R2, ---), the temperatures of the cold water going out of and returning to the cold sources R are measured so that the computing unit 2 can calculate the number of the stages by using the cold water flow rate and an amount of the loads. In
10 other words, the temperature of the cold water going out of the cold sources R is obtained from the control of the cold sources R or the temperature sensor 14, while the temperature of the cold water returning to the cold sources R after heat exchanging with the loads 1 (1a, 1b, ---) is measured by the temperature
15 sensor 4. In addition, the flow rate of the cold water which exchanges heat with the loads 1 in heat exchangers (not shown) is measured by the flow rate sensor 3. Then, an amount of heat consumed in heat exchanging with the loads 1 is calculated by the computing unit 2 from a temperature difference between
20 temperatures of the cold water going out of and returning to the cold sources R, and the flow rate of the cold water exchanging heat with the loads 1.

{ 0075}

An operation start/stop of the chillers as the cold

resources R (R1, R2, ---) is performed by the unit control by the computing unit 2, and includes performing an operation start/stop of the cold pumps P (P1, P2, ---) and the chillers as the cold resources R. The cold pumps P (P1, P2, ---) may
5 be operated by a constant flow rate control or a variable flow rate control by a pressure control. Since the other configurations of the heat source system N4 is the same as the heat source system N2 according to the second embodiment, detailed description thereof will be omitted.

10 { 0076}

<Control method for heat source system N4>

Next, a control method for the heat source system N4 will be described with reference to FIG. 11 which shows a control flow thereof. The control of the heat source system N4 shown
15 in FIG. 11 is performed by the computing unit 2 at any predetermined time interval by measuring time using a timer. In the heat source system N4, cold water outlet temperatures of the cold sources R (R1, R2, ---) are changed based on the cold water flow rate and the cold water return temperature
20 (temperature of the cold water returning to the cold sources R).

{ 0077}

First, in Step S400 in FIG. 11, the cold sources R as heat source machines are assumed to output maximum powers at the set

(designed) flow rate and the set (designed) temperatures (cold water inlet temperature, cold water outlet temperature), and the unit control for increasing or decreasing the number of the cold sources R is performed based on the values of the flow rates and the temperatures. The number of the cold sources R is controlled based on upper and lower limit values of the cold water flow rate and a cooling amount. Since Steps S401 to S410 in FIG. 11 showing the control method for the heat source system N4 are the same as Steps S201 to S210 in FIG. 6 showing the control method for the heat source system N2, detailed description thereof will be omitted.

{ 0078}

Conventionally, when a temperature difference between the cold water inlet temperature and the cold water outlet temperature of the cold sources R is small (when the cold water feed temperature (temperature of the cold water going out of the cold sources R) is low), as shown in FIG. 7, the cooling amount decreases and the efficiency of the cold sources R falls, and thereby the cold water flow rate is increased to increase the number of the cold sources R. By increasing the number of the cold sources R (R1, R2, ---), the cold water flow rate is increased, and thereby the power of the cold pumps per heat amount is increased.

{ 0079}

In contrast, according to the heat source system N4, as shown in FIG. 11, since the cold water outward temperature (cold water feed temperature) is controlled to be lowered so as to increase a temperature difference between the cold water inlet temperature and the cold water outlet temperature of the cold sources R, a cooling amount is increased to increase a cooling load per flow rate, and thereby it is possible to operate the cold sources R in a range of high efficiency (see FIG. 12). FIG. 12 is a diagram showing a COP against a cooling amount (%) at each cold water outlet temperature (cold water feed temperature) of chillers as cold sources. Therefore, it is possible to prevent increasing the number of the cold sources R (R1, R2, ---), thereby reducing total power consumption for the heat source system N4 as shown in FIGS. 7 and 13.

{ 0080}

FIG. 13 is a diagram showing the power of the cold water pumps P, the power of the chillers as the cold sources R, and the total power consumption, against the cold water feed temperature (temperature of the cold water going out of the cold sources R) when the cold sources R (R1, R2, ---) of a constant flow rate are controlled in the number thereof. Further, by controlling the number of the cold sources R, it is possible to operate the cold sources R having the number and the flow rates more precisely appropriate to the loads 1.

{ 0081}

FIG. 14 is a diagram showing a relationship between the power and the flow rate when each cold water pump P of the unit control is controlled by a constant flow rate control or a variable flow rate control (inverter control). As shown in FIG. 14, although the power of the cold pumps increases stepwise along a solid line indicating one, two, and three pumps when the constant flow rate control is performed for each cold pump P of the unit control, it is possible to reduce the power of the pumps corresponding to hatched portions by performing the variable flow rate control (inverter control) for each pump P, thereby performing energy savings.

{ 0082}

<<Fifth Embodiment>>

FIG. 15 is a block diagram showing a heat source system N5 according to a fifth embodiment of the present invention. The heat source system N5 according to the fifth embodiment is a facility which is capable of switching by a computing unit 52 cold water productions by cold sources R (R1, R2, ---), and has a cold water tank. The heat source system N5 includes the cold sources R (R1, R2) and cooling towers Ry as the devices for producing the cold water which cools loads 51 (51a, 51b, ---), and performs the cold water production by the cold sources R.

{ 0083}

The heat source system N5 includes on the primary side cold water pumps P51a, P51b of rated operations which flow the water returning from the loads 51 to each of the cold sources R1, R2, and cooling water pumps P52a, P52b of rated operations which flow the cooling water cooled by the cooling towers Ry to each of the cold sources R1, R2 via a cooling water line t1. The heat source system N5 further includes a water tank 55 having a low temperature side tank 55A in which cold water cooled by the cold sources R is stored, and a high temperature side tank 55B in which the cold water heated by heat exchanging with the loads 51 is stored.

{ 0084}

The cold water sent to the cold sources R (R1, R2) are sent to the low temperature side tank 55A of the water tank 55 respectively via the cold water lines r1, r2. On the loads 51 side of the secondary side, pumps P53 (53a, 53b, ---) in rated operation for sending the cold water which is cooled by the cold sources R and stored in the low temperature side tank 55A of the water tank 55 to each of the loads 51 (51a, 51b, ---) are provided. Note that pressure control of feed headers on the secondary side is omitted. For example, the cold water may be returned to the water tank so that discharge pressures of the pumps are constant.

{ 0085}

The heat source system N5 includes as sensors a temperature sensor 54 which measures the temperature of the water returning to the cold sources R on the primary side after heat exchanging with the loads 51 (51a, 51b, ---) in heat exchangers (not shown), and a flow rate sensor 53 which measures the flow rate of the water returning to the cold sources R. The heat source system N5 further includes the computing unit 52 such as a controller, as a control unit for controlling the heat source system N5.

{ 0086}

The computing unit 52 outputs control signals to the devices such as the cold sources R while detection information is inputted therein from the flow rate sensor 53, the temperature sensor 54, and the like. The computing unit 52 controls the number of the cold sources R and the cooling towers Ry. Although it is not necessary to control the number of the cold sources R and the cooling towers Ry, it is desirable to control the number because the efficiency of the heat source system N5 becomes high. Switching operation of the cold sources R by the computing unit 52 is instructed by calculating an optimized state of the operation so that energy consumption is minimized based on the conditions such as the loads 51.

{ 0087}

The calculation of the energy consumption is performed by setting pipe resistances and device characteristics of cold water pumps P51, cooling water pumps P52, the pumps P53, the cold sources R, and the like, and using a simulator capable of calculating powers of the cold sources R, the cold water pumps P51, the cooling water pumps P52, the pumps P53, and the like, from operation conditions thereof. For example, the device characteristics of the cold water pumps P51, the cooling water pumps P52, and the pumps P53 are mentioned as a flow rate Q - a total head (see FIG. 16A) and the flow rate Q - a pump power (see FIG. 16B). FIG. 16C shows a relationship between a pipe resistance and the flow rate Q .

{ 0088}

The device characteristics of the chillers as the cold sources R is mentioned as the characteristics indicating how much is the power at a temperature difference between the inlet temperature and the outlet temperature, and a cooling amount (see FIG. 12). The heat source system N5 uses, in each operation state, the temperature (cold water outward temperature) of the cold water which is cooled by the cold sources R and stored in the low temperature side tank 55A of the water tank 55, the cold water flow rate measured by the flow rate sensor 53, and the temperature (cold water return temperature) of the cold water measured by the temperature sensor 54. Incidentally, the

outward temperature of the cold water stored in the low temperature side tank 55A is obtained by a cooling control of the cold sources R, or measured by an outward temperature sensor (not shown) which measures the temperature of the cold water on the outward path provided on the loads 51 side or the temperature of the cold water stored in the low temperature side tank 55A of the water tank 55.

{ 0089}

When the temperature difference between the temperature (cold water outward temperature) of the cold water sent to the loads 51 and the temperature (cold water return temperature) of the cold water measured by the temperature sensor 54 is small and the flow rate of the cold water is large, the temperature set values of cold water outlets of a system including the cold sources R are lowered. At this time, the temperature set values of the cold water on the outlets (outward paths) of the system including the cold sources R are changed in some cases to be lower than a predetermined temperature set value at the time of the maximum load. On the other hand, when the temperature difference between the temperature (cold water outward temperature) of the cold water sent to the loads 51 and the cold water return temperature is close to the designed value (set value) and the flow rate of the cold water is small, the state is controlled to be maintained. Incidentally, by performing

a cooling load prediction by a known load prediction means, a control to reduce the number of the cooling towers Ry and the cold sources R in operation may be incorporated without performing a control of reducing the number of the cooling
5 towers and the cold sources in operation with a margin for hunting prevention.

{ 0090}

As described above, since the temperature of the cold water outlet of the cold sources R may be measured by the
10 temperature sensor provided on the cold water feed pipe lines or obtained from the control of the cold sources R, the temperature can be obtained even if there is no temperature output from the cold sources R.

{ 0091}

15 <<Sixth Embodiment>>

FIG. 17 is a block diagram showing a heat source system N6 according to a sixth embodiment of the present invention. The heat source system N6 according to the sixth embodiment is a facility which enables cold water production by chillers Rt
20 (Rt1, Rt2). The heat source system N6 includes the chillers Rt as the devices for producing the cold water which cools loads 61 (61a, 61b, ---), and performs the cold water production by the chillers Rt.

{ 0092}

The heat source system N6 includes cold water pumps P61a, P61b which flow water returning after heat exchanging with the loads 61 respectively to the chillers Rt1, Rt2, and cooling water pumps P62a, P62b which flow cooling water cooled by cooling towers Ry respectively to the chillers Rt1, Rt2 via a cooling water line t1.

{ 0093}

The cold water pumps P61a, P61b and the cooling water pumps P62a, P62b are inverter controlled and different from the rated operation of the heat source system N5 according to the fifth embodiment. In addition, unlike the heat source system N5 according to the fifth embodiment, the heat source system N6 does not include a tank.

{ 0094}

On the loads 61 side, inverter-controlled pumps P63 (P63a, 63b, ---) for sending the cold water cooled by the chillers Rt (Rt1 Rt2, ---) to each of the loads 61 (61a, 61b, ---) are provided. The heat source system N6 includes, as sensors, an outward temperature sensor 64a for measuring the temperature of the cold water cooled by the chillers Rt and sent to the loads 61 side via the cold water lines r1, r2, a return temperature sensor 64b for measuring the temperature of the water returning to the chillers Rt after heat exchanging with the loads 61 (61a, 61b, ---) in heat exchangers (not shown), a flow rate sensor

63 for measuring the flow rate of the cold water returning to the chillers Rt, an outside air temperature sensor 64c for measuring a temperature of an outside air, and a humidity sensor 65 for measuring a humidity of the outside air.

5 { 0095}

The heat source system N6 further includes a computing unit 62 such as a controller, as a control unit for controlling the heat source system N6. The computing unit 62 outputs control signals to the chillers Rt, the cooling towers Ry, cold
10 water pumps P61, cooling water pumps P62, pumps P63, and the like, while detection information is inputted therein from the outward temperature sensor 64a, the return temperature sensor 64b, the flow rate sensor 63, the outside air temperature sensor 64c, the humidity sensor 65, and the like.

15 { 0096}

The computing unit 62 in the heat source system N6 controls the number of the cold chillers Rt and the cooling towers Ry. Although it is not necessary to control the number of the chillers Rt and the cooling towers Ry, it is desirable to control
20 the number because the system COP of the heat source system N6 becomes high. Switching operation of the cold sources R by the computing unit 62 is instructed by calculating an optimized state of the operation so that energy consumption is minimized based on the conditions such as the outside air and the loads

61.

{ 0097}

The calculation of the energy consumption is performed by setting pipe resistances and device characteristics of the cold water pumps P61, the cooling water pumps P62, the pumps P63, the chillers Rt, the cooling towers Ry, and the like, and using a simulator capable of calculating powers of the chillers Rt, the cooling towers Ry, the cold water pumps P61, the cooling water pumps P62, the pumps P63, and cooling tower fans, from operation conditions thereof. For example, the device characteristics of the cold water pumps P61, the cooling water pumps P62, and the pumps P63 are mentioned as a flow rate Q - a total head (see FIG. 16A) and the flow rate Q - a pump power (see FIG. 16B). The device characteristics of the chillers Rt is mentioned as the characteristics indicating how much is the power at a temperature difference between the inlet temperature and the outlet temperature, and a cooling amount (see FIG. 12). The device characteristics of the cooling towers Ry is mentioned as the characteristics of the flow rate - the cooling amount - the power.

{ 0098}

The heat source system N6 uses, in each operation state, the cold water outward temperature which is measured by the outward temperature sensor 64a, the cold water flow rate

measured by the flow rate sensor 63, and the cold water return temperature measured by the temperature sensor 64b. When the temperature difference between the cold water outward temperature measured by the outward temperature sensor 64a and
5 the cold water return temperature measured by the return temperature sensor 64b is small and the flow rate of the cold water is large, the temperature set values of cold water outlets of a system including the chillers Rt and the cooling towers Ry are lowered. At this time, the temperature set values of
10 the cold water on the outlets (outward paths) of the system including the chillers Rt and the cooling towers Ry are changed in some cases to be lower than a predetermined temperature set value at the time of the maximum load. On the other hand, when the temperature difference between the temperature (cold water
15 outward temperature) of the cold water sent to the loads 61 and the cold water return temperature is close to the designed value (set value) and the flow rate of the cold water is small, the state is controlled to be maintained.

{ 0099}

20 Incidentally, by performing a cooling load prediction by a known load prediction means, a control to reduce the number of the chillers Rt and the cooling towers Ry may be incorporated on the basis of the prediction results without performing a control of reducing the number of the chillers Rt and the cooling

towers Ry in operation with a margin for hunting prevention. The temperature of the cold water outlet of the chillers Rt may be measured by the outward temperature sensor 64a provided on the cold water feed pipe lines as shown in FIG. 17 or obtained
5 from the temperature control of the chillers Rt on the water feed side, and the temperature can be obtained even if there is no temperature output of the chillers Rt. The chillers Rt may be inverter-controlled centrifugal chillers, and it is possible to perform energy savings of partial loads by the
10 inverter control.

{ 0100}

According to the first to sixth embodiments, when the return temperature of the cold water flowing at a set flow rate after heat exchanging with the loads is lower than a cold water
15 return temperature set at design time, the outward temperature of the cold water going to the loads is lowered to enlarge the temperature difference on the loads side, and thereby a pump power per heat amount is lowered to save energy.

{ 0101}

20 The loads side is composed of heat exchangers in which the temperature difference between the inlet temperature and the outlet temperature is enlarged when the inlet temperature of the cold water in cooling coils and the like used for general plate heat exchangers and air conditioners is lowered. By

performing an automatic control of the temperature set values of the cold water from the cold sources according to the outputs from the computing unit, it is possible to save energy by changing the temperature of the cold water in response to the variation of the loads. When the outward temperature of the cold water sent to the loads from the cold sources is constant and the flow rate of one cold source is not enough, even in a case where the number of the chillers as the cold sources must be increased, by lowering the outward temperature of the cold water sent to the loads from the cold sources, it is possible to reduce the flow rate of the cold water for the loads, thereby extending a load range where it is not necessary to increase the number of the cold sources.

{ 0102}

As shown in FIG. 3, the COP of the centrifugal chiller is small at the time of low loads, for example, 30 % load factor per chiller. Therefore, by operating one chiller at 60 % load factor, it is possible to operate the chiller with the COP higher than that in a case where two chillers are operated at 30 % load factor per chiller, thereby eliminating a waste of transport powers of the pumps. Although a pipe resistance is increased when the flow rate of the cold water is increased, it is possible to operate the chillers in high efficiency by reducing the flow rate by lowering the outlet temperature of the cold sources,

and by increasing the load factor per chiller as a cold source. Transport system of the cold water may be composed of a primary pump system on the cold source side and a secondary pump system on the load side, and when the temperature difference between the temperature of the outward cold water to the loads on the secondary side and the temperature of the return cold water is large, it is possible to reduce the flow rate of the cold water, thereby reducing the power of the secondary pumps.

{ 0103}

In the present embodiment, since the pipe size does not change, it is possible to introduce the heat source system by setting the outward temperature of the cold water sent to the loads lower than a default temperature set value at the time of renewal of a chiller. Note that, in the above embodiments, although water is used as a heat medium as an example, anything other than water may be used as the heat medium. In addition, although each configuration in the first to sixth embodiments has been described individually, it may be configured in any combination as appropriate from among configurations of the first to sixth embodiments.

{ Reference Signs List}

{ 0104}

1, 1a, 51, 51a, 61, 61a: load

2: computing unit (first control unit, second control unit,

third control unit)

3, 53, 63: flow rate sensor (load heat amount measurement unit,
flow rate measurement unit)

4, 54: temperature sensor (load heat amount measurement
5 unit, cold water return temperature measurement unit)

64a: outward temperature sensor (load heat amount measurement
unit)

64b: return temperature sensor (load heat amount measurement
unit, cold water return temperature measurement unit)

10 B: margin amount

N1, N2, N3, N4, N5, N6: heat source system

P, P1, P2, P51, P51a, P51b, P61, P61a, P61b: cold water
pump (pump)

P3, P3a, P3b, P53, P53a, P53b, P63, P63a, P63b: pump

15 P52, P52a, P52b, P62, P62a, P62b: cooling water pump (pump)

r1, r2: cold water line (pipe)

R, R1, R2: cold source

Ra: high temperature side cold source (unit cold source)

Rb: low temperature side cold source (unit cold source)

20 Rt, Rt1, Rt2: chiller (cold source)

Ry: cooling tower (cold source)

t1: cooling water line (pipe)

CLAIMS

1. A heat source system, wherein pumps that send a heat medium to at least one of a cold source for cooling the heat medium and a heat exchanger for exchanging heat between the cooled
5 heat medium and a load, the cold source, and the heat exchanger of the load, are connected by pipes through which the heat medium flows, comprising:

a load heat amount measurement unit that measures an amount of heat which the heat medium exchanges with the load;

10 a cold water return temperature measurement unit that measures a temperature of the heat medium which exchanges heat with the load and returns to the cold source; and

a first control unit that lowers a temperature set value of the heat medium at an outlet of the cold source, if a
15 temperature of the heat medium falls below a temperature set value thereof and a difference between the temperature of the heat medium and the temperature set value of the heat medium at the outlet of the cold source becomes less than a predetermined set value.

20

2. A heat source system, wherein pumps that send a heat medium to at least one of a cold source for cooling the heat medium and a heat exchanger for exchanging heat between the cooled heat medium and a load, the cold source, and the heat

exchanger of the load, are connected by pipes through which the heat medium flows, comprising:

a load heat amount measurement unit that measures an amount of heat which the heat medium exchanges with the load;

5 a cold water return temperature measurement unit that measures a temperature of the heat medium which exchanges heat with the load and returns to the cold source; and

a second control unit that changes a temperature set value of the heat medium at an outlet of the cold source to be lower
10 than a predetermined temperature set value at the time of a maximum load.

3. The heat source system as set forth in claim 2, comprising

a flow rate measurement unit that measures a flow rate
15 of the heat medium which is heat exchanged with the load, wherein

when a flow rate of the heat medium becomes a predetermined set flow rate at the time of the maximum load, if a temperature of the heat medium is lower than the predetermined temperature set value, the second control unit changes the temperature of
20 the heat medium at the outlet of the cold source to be lower than the predetermined temperature set value.

4. The heat source system as set forth in claim 2, comprising

a flow rate measurement unit that measures a flow rate

of the heat medium which is heat exchanged with the load, wherein

the cold source is arranged with a plurality of unit cold sources in series, and

the second control unit changes the temperature set value of the heat medium at each outlet of the plurality of unit cold sources to be lower than the predetermined set value, on the basis of the flow rate and temperature of the heat medium.

5. A heat source system, wherein pumps that send a heat medium to at least one of a cold source for cooling the heat medium and a heat exchanger for exchanging heat between the cooled heat medium and a load, the cold source, and the heat exchanger of the load, are connected by pipes through which the heat medium flows, comprising:

a load heat amount measurement unit that measures an amount of heat which the heat medium exchanges with the load;

a cold water return temperature measurement unit that measures a temperature of the heat medium which exchanges heat with the load and returns to the cold source;

a heat medium flow rate measurement unit that measures a flow rate of the heat medium which exchanges heat with the load; and

a third control unit that raises a temperature set value of the heat medium which is cooled by the cold source if the

flow rate of the heat medium is in a set range of temperature raising determination flow rate, and on the other hand, lowers the temperature set value of the heat medium which is cooled by the cold source if the flow rate of the heat medium is in
5 a set range of temperature lowering determination flow rate and the temperature of the heat medium is lower than a predetermined temperature lowering determination temperature.

6. The heat source system as set forth in claim 5, wherein

10 the third control unit maintains a current temperature set value of the heat medium which is cooled by the cold source, if the flow rate of the heat medium is in the set range of temperature lowering determination flow rate and the temperature of the heat medium is equal to the predetermined
15 temperature lowering determination temperature, and

raises the temperature set value of the heat medium which is cooled by the cold source, if the flow rate of the heat medium is in the set range of temperature lowering determination flow rate and the temperature of the heat medium is higher than the
20 predetermined temperature lowering determination temperature.

7. The heat source system as set forth in claim 5 or 6, wherein

the third control unit raises the temperature set value of the heat medium which is cooled by the cold source, if the

flow rate of the heat medium is less than a predetermined minimum flow rate, and

maintains the current temperature set value of the heat medium which is cooled by the cold source, if the flow rate of the heat medium is equal to or more than the predetermined minimum flow rate and is less than a flow rate of adding a predetermined margin amount to the predetermined minimum flow rate.

8. The heat source system as set forth in any one of claims 1 to 6, wherein the cold sources are two or more, and the plurality of cold sources are controlled in the number thereof.

9. The heat source system as set forth in any one of claims 1 to 6, wherein the pumps perform rated operations or inverter control operations.

10. The heat source system as set forth in any one of claims 1 to 6, wherein the heat medium is water.

11. A control method for a heat source system, wherein pumps that send a heat medium to at least one of a cold source for cooling the heat medium and a heat exchanger for exchanging

heat between the cooled heat medium and a load, the cold source, and the heat exchanger of the load, are connected by pipes through which the heat medium flows, wherein

a temperature set value of the heat medium at an outlet of the cold source is lowered, if a temperature of the heat medium returning to the cold source after heat exchanging with the load falls below a temperature set value thereof and a difference with the temperature set value of the heat medium at the outlet of the cold source becomes less than a predetermined set value.

10

12. A control method for a heat source system, wherein pumps that send a heat medium to at least one of a cold source for cooling the heat medium and a heat exchanger for exchanging heat between the cooled heat medium and a load, the cold source, and the heat exchanger of the load, are connected by pipes through which the heat medium flows, wherein

15

a temperature set value of the heat medium at an outlet of the cold source is changed to be lower than a predetermined temperature set value at the time of a maximum load.

20

13. The control method for the heat source system as set forth in claim 12, wherein

when a flow rate of the heat medium which is heat exchanged with the load becomes a predetermined set flow rate at the time

of the maximum load, if a temperature of the heat medium is lower than the predetermined temperature set value, the temperature of the heat medium at the outlet of the cold source is changed to be lower than the predetermined temperature set value.

5

14. The control method for the heat source system as set forth in claim 12, wherein

the cold source is arranged with a plurality of unit cold sources in series, and

10

the temperature set value of the heat medium at each outlet of the plurality of unit cold sources is changed to be lower than the predetermined set value, on the basis of the temperature and flow rate of the heat medium which is heat exchanged with the load.

15

15. A control method for a heat source system, wherein pumps that send a heat medium to at least one of a cold source for cooling the heat medium and a heat exchanger for exchanging heat between the cooled heat medium and a load, the cold source, and the heat exchanger of the load, are connected by pipes through which the heat medium flows, wherein

20

if a flow rate of the heat medium which is heat exchanged with the load is in a set range of temperature raising determination flow rate, a temperature set value of the heat

medium which is cooled by the cold source is raised, and on the other hand, if the flow rate of the heat medium is in a set range of temperature lowering determination flow rate and the temperature of the heat medium is lower than a predetermined
5 temperature lowering determination temperature, the temperature set value of the heat medium which is cooled by the cold source is lowered.

16. The control method for the heat source system as set forth
10 in claim 15, wherein

if the flow rate of the heat medium is in the set range of temperature lowering determination flow rate and the temperature of the heat medium is equal to the predetermined temperature lowering determination temperature, a current
15 temperature set value of the heat medium which is cooled by the cold source is maintained, and

if the flow rate of the heat medium is in the set range of temperature lowering determination flow rate and the temperature of the heat medium is higher than the predetermined
20 temperature lowering determination temperature, the temperature set value of the heat medium which is cooled by the cold source is raised.

17. The control method for the heat source system as set forth

in claim 15 or 16, wherein

if the flow rate of the heat medium is less than a predetermined minimum flow rate, the temperature set value of the heat medium which is cooled by the cold source is raised,

5 and

if the flow rate of the heat medium is equal to or more than the predetermined minimum flow rate and is less than a flow rate of adding a predetermined margin amount to the predetermined minimum flow rate, the current temperature set
10 value of the heat medium which is cooled by the cold source is maintained.

18. The control method for the heat source system as set forth in any one of claims 11 to 16, wherein the cold sources are
15 more than one, and the plurality of cold sources are controlled in the number.

19. A program for performing on a computer the control method for the heat source system as set forth in any one of claims
20 11 to 16.