

Description

Title of Invention: CONTROL DEVICE, GEOTHERMAL HEAT
UTILIZATION SYSTEM, CONTROL METHOD, AND PROGRAM

5 Technical Field

[0001]

The present disclosure relates to a control device, a geothermal heat
utilization system, a control method, and a program.

10 The present application claims priority to Japanese Patent Application
No. 2023-162956 filed in Japan on September 26, 2023, the content of which is
incorporated herein by reference.

Background Art

[0002]

15 In recent years, geothermal heat utilization systems that utilize heat
stored in the ground have been proposed.

[0003]

20 As a technique related thereto, for example, Patent Document 1
discloses a geothermal heat utilization system that stores cold heat or hot heat
discharged from an air conditioning system.

Citation List

Patent Literature

[0004]

25 Patent Document 1: JP 7179905 B

Summary of Invention

Technical Problem

[0005]

30 The geothermal heat utilization system disclosed in Patent Document 1
adjusts a water injection flow rate from a pumping well to a return water well
in accordance with a set temperature of groundwater returned to the return
water well.

35 However, for example, when a heat load amount required by an
apparatus such as an air conditioning system is large, the geothermal heat
utilization system disclosed in Patent Document 1 may not be able to adjust a
return water temperature.

Therefore, the return water temperature may affect an underground environment.

[0006]

5 The present disclosure provides a control device, a geothermal heat utilization system, a control method, and a program that are less likely to affect an underground environment.

Solution to Problem

[0007]

10 A control device according to the present disclosure is for a geothermal heat utilization system including: a heat source well facility provided with a pumping well, a return water well, a well-side pipe extending from the pumping well to the return water well, and a heat exchanger provided at a middle of the well-side pipe; a geothermal heat utilization circuit provided
15 between the heat exchanger and an apparatus; and an auxiliary heat supply facility provided at the apparatus in parallel with the geothermal heat utilization circuit and provided with a heat source machine. The control device includes a return water temperature acquisition unit that acquires a return water temperature of water returned to the return water well of the geothermal heat
20 utilization system, a flow rate control unit that controls a flow rate of a refrigerant flowing from the geothermal heat utilization circuit to the apparatus based on the return water temperature, and a heat source machine control unit that controls start and stop of the heat source machine based on the return water temperature.

25 [0008]

A control device according to the present disclosure is for a geothermal heat utilization system including: a heat source well facility provided with a pumping well, a return water well, a well-side pipe extending from the pumping well to the return water well, and a heat exchanger provided at a
30 middle of the well-side pipe; and a geothermal heat utilization circuit provided between the heat exchanger and an apparatus. The control device includes a return water temperature acquisition unit that acquires a return water temperature of water returned to the return water well of the geothermal heat utilization system and a flow rate control unit that controls a flow rate of a
35 refrigerant flowing from the geothermal heat utilization circuit to the apparatus based on the return water temperature. The control device further includes a pumping-side water level acquisition unit that acquires a pumping-side water level as a water level of the pumping well and a pumping flow rate control unit

that controls a pumping flow rate from the pumping well based on the pumping-side water level.

[0009]

5 A control device according to the present disclosure is for a geothermal heat utilization system including: a heat source well facility provided with a pumping well, a return water well, a well-side pipe extending from the pumping well to the return water well, and a heat exchanger provided at a middle of the well-side pipe; and a geothermal heat utilization circuit provided between the heat exchanger and an apparatus. The control device includes a
10 return water temperature acquisition unit that acquires a return water temperature of water returned to the return water well of the geothermal heat utilization system and a flow rate control unit that controls a flow rate of a refrigerant flowing from the geothermal heat utilization circuit to the apparatus based on the return water temperature. The control device further includes a
15 return-side water level acquisition unit that acquires a return-side water level as a water level of the return water well and a return water flow rate control unit that controls a return water flow rate to the return water well based on the return-side water level.

[0010]

20 A geothermal heat utilization system according to the present disclosure includes the control device, the heat source well facility, and the heat source utilization circuit.

[0011]

A control method according to the present disclosure is for a geothermal
25 heat utilization system including: a heat source well facility provided with a pumping well, a return water well, a well-side pipe extending from the pumping well to the return water well, and a heat exchanger provided at a middle of the well-side pipe; a geothermal heat utilization circuit provided between the heat exchanger and an apparatus; and an auxiliary heat supply
30 facility provided at the apparatus in parallel with the geothermal heat utilization circuit and provided with a heat source machine. The method includes acquiring a return water temperature of water returned to the return water well of the geothermal heat utilization system, controlling a flow rate of a refrigerant flowing from the geothermal heat utilization circuit to the
35 apparatus based on the return water temperature, and controlling start and stop of the heat source machine based on the return water temperature.

[0012]

A control method according to the present disclosure is for a geothermal heat utilization system including: a heat source well facility provided with a pumping well, a return water well, a well-side pipe extending from the pumping well to the return water well, and a heat exchanger provided at a middle of the well-side pipe; and a geothermal heat utilization circuit provided between the heat exchanger and an apparatus. The method includes acquiring a return water temperature of water returned to the return water well of the geothermal heat utilization system, controlling a flow rate of a refrigerant flowing from the geothermal heat utilization circuit to the apparatus based on the return water temperature, acquiring a pumping-side water level as a water level of the pumping well, and controlling a pumping flow rate from the pumping well based on the pumping-side water level.

[0013]

A control method according to the present disclosure is for a geothermal heat utilization system including: a heat source well facility provided with a pumping well, a return water well, a well-side pipe extending from the pumping well to the return water well, and a heat exchanger provided at a middle of the well-side pipe; and a geothermal heat utilization circuit provided between the heat exchanger and an apparatus. The method includes acquiring a return water temperature of water returned to the return water well of the geothermal heat utilization system, controlling a flow rate of a refrigerant flowing from the geothermal heat utilization circuit to the apparatus based on the return water temperature, acquiring a return-side water level as a water level of the return water well, and controlling a return water flow rate to the return water well based on the return-side water level.

[0014]

A program according to the present disclosure is for a geothermal heat utilization system including: a heat source well facility provided with a pumping well, a return water well, a well-side pipe extending from the pumping well to the return water well, and a heat exchanger provided at a middle of the well-side pipe; a geothermal heat utilization circuit provided between the heat exchanger and an apparatus; and an auxiliary heat supply facility provided at the apparatus in parallel with the geothermal heat utilization circuit and provided with a heat source machine. The program causes a computer to execute acquiring a return water temperature of water returned to the return water well of the geothermal heat utilization system, controlling a flow rate of a refrigerant flowing from the geothermal heat utilization circuit to the apparatus based on the return water temperature, and

controlling start and stop of the heat source machine based on the return water temperature.

[0015]

5 A program according to the present disclosure is for a geothermal heat utilization system including: a heat source well facility provided with a pumping well, a return water well, a well-side pipe extending from the pumping well to the return water well, and a heat exchanger provided at a middle of the well-side pipe; and a geothermal heat utilization circuit provided between the heat exchanger and an apparatus. The program causes a computer
10 to execute acquiring a return water temperature of water returned to the return water well of the geothermal heat utilization system, controlling a flow rate of a refrigerant flowing from the geothermal heat utilization circuit to the apparatus based on the return water temperature, acquiring a pumping-side water level as a water level of the pumping well, and controlling a pumping
15 flow rate from the pumping well based on the pumping-side water level.

[0016]

A program according to the present disclosure is for a geothermal heat utilization system including: a heat source well facility provided with a pumping well, a return water well, a well-side pipe extending from the
20 pumping well to the return water well, and a heat exchanger provided at a middle of the well-side pipe; and a geothermal heat utilization circuit provided between the heat exchanger and an apparatus. The program causes a computer to execute acquiring a return water temperature of water returned to the return water well of the geothermal heat utilization system, controlling a flow rate of
25 a refrigerant flowing from the geothermal heat utilization circuit to the apparatus based on the return water temperature, acquiring a return-side water level as a water level of the return water well, and controlling a return water flow rate to the return water well based on the return-side water level.

30 Advantageous Effects of Invention

[0017]

According to the control device, the geothermal heat utilization system, the control method, and the program of the present disclosure, the underground environment is less likely to be affected.

35

Brief Description of Drawings

[0018]

FIG. 1 is a system diagram of a geothermal heat utilization system according to an embodiment of the present disclosure.

FIG. 2 is a configuration diagram illustrating an example of an installation state of a water level gauge at a static water level in the geothermal heat utilization system according to the embodiment of the present disclosure.

FIG. 3 is a configuration diagram illustrating an example of an installation state of water level gauges during pumping and returning water in the geothermal heat utilization system according to the embodiment of the present disclosure.

FIG. 4 is a detailed system diagram of a flow rate adjustment device according to the embodiment of the present disclosure.

FIG. 5 is a block diagram of a control device according to the embodiment of the present disclosure.

FIG. 6 is a flowchart of a control method for a return water temperature according to the embodiment of the present disclosure.

FIG. 7 is a flowchart of the control method for a return water temperature according to the embodiment of the present disclosure.

FIG. 8 is a flowchart of a control method for a pumping-side water level according to the embodiment of the present disclosure.

FIG. 9 is a flowchart of a control method for a return-side water level according to the embodiment of the present disclosure.

FIG. 10 is a graph showing an example of a concept of sharing a heat load amount between a heat source well facility and an auxiliary heat supply facility according to the embodiment of the present disclosure.

FIG. 11 is an explanatory diagram of an action in an example of a hysteresis provided to a startup temperature and a stop temperature of a heat source machine according to the embodiment of the present disclosure.

FIG. 12 is an explanatory diagram of an action in an example of a hysteresis provided to a startup water level and a stop water level of the heat source machine according to the embodiment of the present disclosure.

Description of Embodiments

[0019]

An embodiment according to the present disclosure will be described below with reference to the drawings. In all the drawings, the same or corresponding components are denoted by the same reference signs, and commonly applicable descriptions are omitted.

[0020]

Embodiments

An embodiment of a geothermal heat utilization system according to the present disclosure will be described below with reference to FIGS. 1 to 12.

5 Configuration of Geothermal Heat Utilization System

As illustrated in FIG. 1, a geothermal heat utilization system 1 includes a heat source well facility 10, a geothermal heat utilization circuit 20, an auxiliary heat supply facility 30, and a control device 50.

10 The heat source well facility 10, the geothermal heat utilization circuit 20, and an apparatus AA are sequentially connected in series so as to be capable of heat transfer.

The auxiliary heat supply facility 30 and the apparatus AA are connected in parallel with the heat source well facility 10 and the geothermal heat utilization circuit 20 so as to be capable of heat transfer.

15 [0021]

When the apparatus AA (e.g., an air conditioning load) is using cooling (hereinafter referred to as "during cooling operation"), the geothermal heat utilization system 1 uses cold heat stored as cooling water in the heat source well facility 10 for the cooling, and at the same time stores exhaust hot heat
20 from the apparatus AA as hot water in the heat source well facility 10.

When the apparatus AA is using heating (hereinafter referred to as "during heating operation"), the geothermal heat utilization system 1 uses hot heat stored as hot water in the heat source well facility 10 for the heating, and at the same time stores exhaust cold heat from the apparatus AA as cold water
25 in the heat source well facility 10.

For example, the geothermal heat utilization system 1 may be a system that uses hot exhaust heat (hot water) from cooling in summer for heating in winter and uses cold exhaust heat (cold water) from the heating in winter for the cooling in summer by switching between a pumping well and a return water
30 well for each season.

[0022]

Configuration of Heat Source Well Facility

The heat source well facility 10 includes a hot water well 11, a cold water well 12, a well-side pipe 13, and a heat exchanger 14.

35 The heat source well facility 10 further includes a water temperature gauge 15 and water level gauge 16 on the respective well sides of the hot water well 11 and the cold water well 12.

[0023]

In order to utilize stored heat for the apparatus AA, the heat source well facility 10 pumps up the groundwater from one of the hot water well 11 and the cold water well 12, exchanges heat aboveground for heat utilization, and then injects the heat-exchanged groundwater to the other one of the hot water well 11 and the cold water well 12.

That is, a stored heat utilization mode of the heat source well facility 10 includes a cold heat utilization mode in which the groundwater is pumped up from the cold water well 12 and then injected into the hot water well 11 during the cooling operation and a hot heat utilization mode in which the groundwater is pumped up from the hot water well 11 and then injected into the cold water well 12 during the heating operation.

[0024]

In the case of the cold heat utilization mode, the groundwater is pumped up from an aquifer LY via the cold water well 12, and thus the cold water well 12 functions as a pumping well.

On the other hand, in the case of the cold heat utilization mode, the pumped groundwater is returned to the aquifer LY via the hot water well 11, and thus the hot water well 11 functions as a return water well.

[0025]

In the case of the hot heat utilization mode, the groundwater is pumped up from the aquifer LY via the hot water well 11, and thus the hot water well 11 functions as a pumping well.

On the other hand, in the case of the hot heat utilization mode, the pumped groundwater is returned to the aquifer LY via the cold water well 12, and thus the cold water well 12 functions as a return water well.

[0026]

Configurations of Hot Water Well and Cold Water Well

Each of the hot water well 11 and the cold water well 12 extends from the ground into the aquifer LY.

The hot water well 11 and the cold water well 12 each includes a casing with a screen and the like, and are configured to take the groundwater in the aquifer LY into the hot water well 11 and the cold water well 12, respectively, and return the groundwater from the respective insides of the hot water well 11 and the cold water well 12 to the aquifer LY.

During steady operation of the geothermal heat utilization system 1, hot water is stored in the aquifer LY around the hot water well 11, and cold water is stored in the aquifer LY around the cold water well 12.

The hot water well 11 and the cold water well 12 are separated from each other at a distance long enough to cause no mixing between the hot water and the cold water stored.

[0027]

5 Configuration of Well-Side Pipe

The well-side pipe 13 extends from the hot water well 11 to the cold water well 12.

The well-side pipe 13 connects the hot water well 11 and the cold water well 12.

10 As illustrated in FIG. 1, a first end 131, which is one end of the well-side pipe 13, extends into the hot water well 11 and is immersed in the groundwater inside the hot water well 11.

A second end 132, which is the other end of the well-side pipe 13, extends into the cold water well 12 and is immersed in the groundwater inside
15 the cold water well 12.

[0028]

Each of the first end 131 and the second end 132 is provided with a underwater pump PP, a water injection valve VA, a check valve VB, and the like that are configured to pump water from the inside of each well into the
20 well-side pipe 13 and to inject water from the inside of the well-side pipe 13 into each well.

The output of the underwater pump PP can be changed by inverter control in response to a command from the control device 50.

[0029]

25 Configuration of Heat Exchanger

The heat exchanger 14 is provided at the middle of the well-side pipe 13.

The heat exchanger 14 exchanges heat between the water inside the well-side pipe 13 and a heat medium on the geothermal heat utilization circuit
30 20 side.

[0030]

During the cooling operation (in the case of the cold heat utilization mode), the heat exchanger 14 exchanges heat between cold water, which is the groundwater pumped from the cold water well 12 and flowing inside the well-side pipe 13, and the heat medium on the geothermal heat utilization circuit 20
35 side. The cold heat received by the heat medium on the geothermal heat utilization circuit 20 side is used in the apparatus AA via the geothermal heat utilization circuit 20. On the other hand, hot water, which is the groundwater

after the heat exchange, flows inside the well-side pipe 13 from the heat exchanger 14 and is injected into the hot water well 11. By this injection, hot water heat storage is performed in the hot water well 11.

[0031]

5 During the heating operation (in the case of the hot heat utilization mode), the heat exchanger 14 exchanges heat between hot water, which is the groundwater pumped from the hot water well 11 and flowing inside the well-side pipe 13, and the heat medium on the geothermal heat utilization circuit 20 side. The hot heat received by the heat medium on the geothermal heat
10 utilization circuit 20 side is used in the apparatus AA via the geothermal heat utilization circuit 20. On the other hand, cold water, which is the groundwater after the heat exchange, flows inside the well-side pipe 13 from the heat exchanger 14 and is injected into the cold water well 12. By this injection, cold water heat storage is performed in the cold water well 12.

15 [0032]

 Here, "cold water" refers to water having a temperature lower than an initial underground temperature of the groundwater in the aquifer LY. On the other hand, "hot water" refers to water having a temperature higher than the initial underground temperature described above. For example, the initial
20 underground temperature of the groundwater in the aquifer LY is 18°C.

[0033]

Configuration of Water Temperature Gauge

 The water temperature gauge 15 on the cold water well 12 side is provided at the middle of the well-side pipe 13 extending from the cold water
25 well 12 toward the heat exchanger 14. For example, the water temperature gauge 15 on the cold water well 12 side may be provided at a position on the ground surface immediately above the cold water well 12.

 The water temperature gauge 15 on the cold water well 12 side measures the temperature of water flowing inside the well-side pipe 13 on the cold water
30 well 12 side, and outputs a measurement result to the control device 50.

[0034]

 The water temperature gauge 15 on the hot water well 11 side is provided at the middle of the well-side pipe 13 extending from the heat exchanger 14 toward the hot water well 11. For example, the water temperature
35 gauge 15 on the hot water well 11 side may be provided at a position on the ground surface immediately above the hot water well 11.

The water temperature gauge 15 on the hot water well 11 side measures the temperature of water flowing inside the well-side pipe 13 on the hot water well 11 side, and outputs a measurement result to the control device 50.

[0035]

5 During the cooling operation (in the case of the cold heat utilization mode), the water temperature gauge 15 on the cold water well 12 side functions as a water temperature gauge that measures a pumping water temperature of the water from the pumping well.

10 At this time, the water temperature gauge 15 on the cold water well 12 side outputs a measurement result as a pumping water temperature to the control device 50.

On the other hand, during the cooling operation, the water temperature gauge 15 on the hot water well 11 side functions as a water temperature gauge that measures a return water temperature of the water to the return water well.

15 At this time, the water temperature gauge 15 on the hot water well 11 side outputs a measurement result as a return water temperature to the control device 50.

[0036]

20 During the heating operation (in the case of the hot heat utilization mode), the water temperature gauge 15 on the hot water well 11 side functions as a water temperature gauge that measures a pumping water temperature of the water from the pumping well.

25 At this time, the water temperature gauge 15 on the hot water well 11 side outputs a measurement result as a pumping water temperature to the control device 50.

On the other hand, during the heating operation, the water temperature gauge 15 on the cold water well 12 side functions as a water temperature gauge that measures a return water temperature of the water to the return water well.

30 At this time, the water temperature gauge 15 on the cold water well 12 side outputs a measurement result as a return water temperature to the control device 50.

[0037]

Configuration of Water Level Gauge

[0038]

35 The water level gauge 16 on the cold water well 12 side is provided in the cold water well 12.

The water level gauge 16 on the cold water well 12 side measures a water level inside the cold water well 12 and outputs a measurement result to the control device 50.

[0039]

5 The water level gauge 16 on the hot water well 11 side is provided in the hot water well 11.

The water level gauge 16 on the hot water well 11 side measures a water level inside the hot water well 11 and outputs a measurement result to the control device 50.

10 [0040]

During the cooling operation (in the case of the cold heat utilization mode), the water level gauge 16 on the cold water well 12 side functions as a water level gauge that measures a pumping-side water level which is a water level of the pumping well.

15 At this time, the water level gauge 16 on the cold water well 12 side outputs a measurement result as a pumping-side water level to the control device 50.

On the other hand, during the cooling operation, the water level gauge 16 on the hot water well 11 side functions as a water level gauge that measures a return-side water level which is a water level of the return water well.

20 At this time, the water level gauge 16 on the hot water well 11 side outputs a measurement result as a return-side water level to the control device 50.

[0041]

25 During the heating operation (in the case of the hot heat utilization mode), the water level gauge 16 on the hot water well 11 side functions as a water level gauge that measures a pumping-side water level which is a water level of the pumping well.

30 At this time, the water level gauge 16 on the hot water well 11 side outputs a measurement result as a pumping-side water level to the control device 50.

On the other hand, during the heating operation, the water level gauge 16 on the cold water well 12 side functions as a water level gauge that measures a return-side water level which is a water level of the return water well.

35 At this time, the water level gauge 16 on the cold water well 12 side outputs a measurement result as a return-side water level to the control device 50.

[0042]

For example, each water level gauge 16 measures, as a water level, a distance from the water surface to a position where the water level gauge 16 is installed.

5 For example, each water level gauge 16 may be provided so as to measure the water level illustrated in FIG. 2 at a static water level.

For example, each water level gauge 16 may be provided so as to measure the water level illustrated in FIG. 3 during pumping and returning.

[0043]

10 Configuration of Geothermal heat Utilization Circuit

The geothermal heat utilization circuit 20 is provided between the heat exchanger 14 and the apparatus AA.

The geothermal heat utilization circuit 20 mediates and controls heat transfer performed between the heat exchanger 14 and the apparatus AA in
15 response to a command from the control device 50.

For example, the geothermal heat utilization circuit 20 may include a heat pump 21, a flow rate adjustment device 22, and a main pipe 23.

[0044]

Configuration of Heat Pump

20 The heat pump 21 includes a condenser, an evaporator, a compressor, and the like.

For example, the heat pump 21 is a turbo heat pump.

The heat pump 21 is provided between the heat exchanger 14 and the flow rate adjustment device 22.

25 The heat pump 21 cools or heats the heat medium subjected to heat exchange with the water inside the well-side pipe 13 by the heat exchanger 14. Thus, the heat pump 21 supplies stored cold heat or stored hot heat received from the water inside the well-side pipe 13 to the apparatus AA, recovers exhaust hot heat or exhaust cold heat discharged from the apparatus AA, and
30 stores the recovered exhaust hot heat or the recovered exhaust cold heat in the water inside the well-side pipe 13 via the heat exchanger 14.

[0045]

During the cooling operation (in the case of the cold heat utilization mode), the heat pump 21 provides the stored cold heat received from the well-
35 side pipe 13 to the apparatus AA via the heat exchanger 14 and via the heat medium flowing between the heat pump 21 and the heat exchanger 14 and the heat medium flowing between the heat pump 21 and the apparatus AA. On the other hand, the heat pump 21 stores the exhaust hot heat discharged from the

apparatus AA in the water inside the well-side pipe 13 via the heat medium flowing between the heat pump 21 and the apparatus AA and the heat medium flowing between the heat pump 21 and the heat exchanger 14, and via the heat exchanger 14.

5 [0046]

During the heating operation (in the case of the hot heat utilization mode), the heat pump 21 provides the stored hot heat received from the well-side pipe 13 to the apparatus AA via the heat exchanger 14 and via the heat medium flowing between the heat pump 21 and the heat exchanger 14 and the
10 heat medium flowing between the heat pump 21 and the apparatus AA. On the other hand, the heat pump 21 stores the exhaust cold heat discharged from the apparatus AA in the water inside the well-side pipe 13 via the heat medium flowing between the heat pump 21 and the apparatus AA and the heat medium flowing between the heat pump 21 and the heat exchanger 14, and via the heat
15 exchanger 14.

[0047]

Configuration of Flow Rate Adjustment Device

The flow rate adjustment device 22 adjusts a flow rate FL of the heat medium flowing from the geothermal heat utilization circuit 20 to the apparatus
20 AA.

As illustrated in FIG. 4, for example, the flow rate adjustment device 22 may include a bypass valve 223 in order to adjust the flow rate FL by self-bypass. Further, the flow rate adjustment device 22 may include a pump 221 and a motor valve 222 at the middle of a path connecting the heat pump 21 and
25 the main pipe 23 in order to adjust the flow rate FL.

[0048]

Configuration of Main Pipe

The main pipe 23 extends from the flow rate adjustment device 22 to the apparatus AA.

30 The main pipe 23 connects the flow rate adjustment device 22 and the apparatus AA so that the heat medium can circulate between the flow rate adjustment device 22 and the apparatus AA.

[0049]

Configuration of Auxiliary Heat Supply Facility

35 The auxiliary heat supply facility 30 assists at least one of supply of hot heat and supply of cold heat to the apparatus AA performed by the heat source well facility 10.

When the cooling is used in the apparatus AA, the auxiliary heat supply facility 30 supplies cold heat to the apparatus AA and recovers exhaust hot heat from the apparatus AA.

When the heating is used in the apparatus AA, the auxiliary heat supply
5 facility 30 supplies hot heat to the apparatus AA and recovers exhaust cold heat from the apparatus AA.

[0050]

The auxiliary heat supply facility 30 includes a plurality of heat source machines 31 and an auxiliary pipe 32.

10 Each heat source machine 31 supplements at least one of the cold heat and the hot heat supplied to the apparatus AA.

For example, the plurality of heat source machines 31 include a turbo freezer, an air-cooled heat pump, an absorption water cooler/heater, and the like.

15 The auxiliary pipe 32 extends from the plurality of heat source machines 31 to the apparatus AA.

The auxiliary pipe 32 connects the plurality of heat source machines 31 and the apparatus AA so that the heat medium can circulate between the plurality of heat source machines 31 and the apparatus AA.

20 [0051]

For example, the auxiliary heat supply facility 30 may include an auxiliary flow rate adjustment device 33 at the middle of the auxiliary pipe 32. At this time, the auxiliary flow rate adjustment device 33 includes a bypass valve, a pump, and a motor valve similar to those of the flow rate adjustment
25 device 22, and adjusts the flow rate of the refrigerant flowing between the auxiliary heat supply facility 30 and the apparatus AA in response to a command from the control device 50.

[0052]

Configuration of Control Device

30 As illustrated in FIG. 5, the control device 50 functionally includes a return water temperature acquisition unit 511, and a flow rate control unit 512.

For example, the control device 50 may further functionally include a heat source machine control unit 513, a pumping-side water level acquisition unit 514, a pumping flow rate control unit 515, a return-side water level
35 acquisition unit 516, and a return water flow rate control unit 517.

[0053]

The control device 50 includes a CPU 51, a memory 52, a communication interface 53, and a recording medium 54 as a hardware configuration.

[0054]

5 The CPU 51 is a processor that operates in accordance with a program prepared in advance to exert various functions. The functions of the CPU 51 will be described below.

[0055]

10 The memory 52 has a memory area necessary for the operation of the CPU 51.

[0056]

15 The communication interface 53 is a connection interface for communicably connecting to another device via a communication line or the like, and is configured to transmit a command or a response to another device and receive a command or a response from another device.

[0057]

20 The recording medium 54 is a local recording medium provided in the housing of the control device 50, and is a mass storage device such as an HDD or an SSD.

[0058]

Next, the functions of the CPU 51 of the control device 50 will be described.

25 The CPU 51 functions as the return water temperature acquisition unit 511 and the flow rate control unit 512 as described above by operating in accordance with a program prepared in advance.

30 Further, the CPU 51 functions as the heat source machine control unit 513, the pumping-side water level acquisition unit 514, the pumping flow rate control unit 515, the return-side water level acquisition unit 516, and the return water flow rate control unit 517 as described above by operating in accordance with a program prepared in advance.

[0059]

35 The return water temperature acquisition unit 511 acquires a measurement result of the water temperature gauge 15 on the cold water well 12 side or the water temperature gauge 15 on the hot water well 11 side as a return water temperature of the water to the return water well.

 The pumping-side water level acquisition unit 514 acquires a measurement result of the water level gauge 16 on the hot water well 11 side or

the water level gauge 16 on the cold water well 12 side as a pumping-side water level.

The return-side water level acquisition unit 516 acquires a measurement result of the water level gauge 16 on the cold water well 12 side or the water level gauge 16 on the hot water well 11 side as a return-side water level.
[0060]

The flow rate control unit 512 controls the flow rate FL by controlling the flow rate adjustment device 22 based on the acquired return water temperature.

For example, the flow rate control unit 512 controls the flow rate FL by controlling the flow rate adjustment device 22 based on the acquired pumping-side water level.

For example, the flow rate control unit 512 controls the flow rate FL by controlling the flow rate adjustment device 22 based on the acquired return-side water level.
[0061]

For example, the flow rate control unit 512 may adjust the flow rate of the refrigerant flowing between the auxiliary heat supply facility 30 and the apparatus AA by controlling the auxiliary flow rate adjustment device 33 based on the acquired return water temperature.

For example, the flow rate control unit 512 may adjust the flow rate of the refrigerant flowing between the auxiliary heat supply facility 30 and the apparatus AA by controlling the auxiliary flow rate adjustment device 33 based on the acquired pumping-side water level.

For example, the flow rate control unit 512 may adjust the flow rate of the refrigerant flowing between the auxiliary heat supply facility 30 and the apparatus AA by controlling the auxiliary flow rate adjustment device 33 based on the acquired return-side water level.
[0062]

The heat source machine control unit 513 may control the start and stop of each heat source machine 31 based on the acquired return water temperature.

For example, the heat source machine control unit 513 may control the start and stop of each heat source machine 31 based on the acquired pumping-side water level.

For example, the heat source machine control unit 513 may control the start and stop of each heat source machine 31 based on the acquired return-side water level.

For example, the heat source machine control unit 513 may perform staging control to increase/decrease the plurality of heat source machines 31. [0063]

5 The pumping flow rate control unit 515 controls the pumping flow rate of the water from the pumping well based on the acquired pumping-side water level.

The return water flow rate control unit 517 controls the return water flow rate of the water to the return water well based on the acquired return-side water level.

10 [0064]

Operation of Control Device

An example of the operation of the control device 50 of the present embodiment will be described below.

15 The operation of the control device 50 corresponds to an embodiment of the control method.

The control device 50 performs each step illustrated in FIGS. 6 to 9. [0065]

Operation of Return Water Temperature Control

20 First, an operation of return water temperature control will be described. When the geothermal heat utilization system 1 is started, as illustrated in FIG. 6, the control device 50 determines whether the apparatus AA is in the cooling operation (ST00).

[0066]

Return Water Temperature Control during Cooling Operation

25 In a case where it is determined in ST00 that the cooling operation is being performed (ST00: Yes), the return water temperature acquisition unit 511 acquires a measurement result of the water temperature gauge 15 on the hot water well 11 side as a return water temperature, and determines whether the acquired return water temperature is higher than a first startup temperature (e.g., 24°C) at which the heat source machine 31 should be started (ST01). For example, the first startup temperature is a set value set in advance.

[0067]

35 In a case where it is determined in ST01 that the acquired return water temperature is higher than the first startup temperature (ST01: Yes), the heat source machine control unit 513 determines whether there is any heat source machine 31 (a different heat source machine) that can be started among the plurality of heat source machines 31 (ST02).

[0068]

In a case where it is determined in ST02 that there is the heat source machine 31 that can be started (ST02: Yes), the heat source machine control unit 513 activates the heat source machine 31 that can be started (ST03), and the control device 50 returns to the execution of ST01.

5 For example, in ST03, the heat source machine control unit 513 first activates one (configurable) heat source machine 31 that can be started. In a case where there are a plurality of heat source machines 31 that can be started, the heat source machine control unit 513 can perform the staging control to increase/decrease by repeating ST01 to ST03. At this time, the heat source
10 machine control unit 513 may perform the staging control to increase/decrease in consideration of the heat amount or the flow rate supplied to the apparatus AA.

On the other hand, as will be described below, the flow rate control unit 512 controls the flow rate FL so that the return water temperature of the heat
15 source well facility 10 falls within a preset allowable value (equal to or lower than a preset upper limit value), and reduces the load of the heat source well facility 10.
[0069]

In a case where it is determined in ST02 that there is no heat source
20 machine 31 that can be started (ST02: No), the control device 50 determines whether preserving the aquifer LY should be prioritized over securing the air conditioning capacity of the apparatus AA (ST04). For example, the control device 50 may determine whether preserving the aquifer LY should be prioritized over securing the air conditioning capacity of the apparatus AA, in
25 accordance with a guideline input by a user or the like.
[0070]

In a case where it is determined in ST04 that preserving the aquifer LY should be prioritized (ST04: Yes), the flow rate control unit 512 controls the flow rate FL (ST05), and the control device 50 returns to the execution of
30 ST01.

For example, in ST05, the flow rate control unit 512 may perform control of opening the bypass valve 223 to reduce the flow rate FL. By this control, the load can be reduced by self-bypass and the return water temperature can be controlled.

35 Further, in ST05, the flow rate control unit 512 may perform control of increasing the flow rate of the heat medium (cold heat medium) flowing between the auxiliary heat supply facility 30 and the apparatus AA by controlling the auxiliary flow rate adjustment device 33.

[0071]

In a case where it is determined in ST04 that the air conditioning capacity of the apparatus AA should be secured (ST04: No), the control device 50 stops heat supply from the geothermal heat utilization system 1 to the apparatus AA (ST06). Thereafter, the user or the like considers using another system that is a substitute for the geothermal heat utilization system 1 and can secure the air conditioning capacity of the apparatus AA.

[0072]

In a case where it is determined in ST01 that the acquired return water temperature is not higher than the first startup temperature (ST01: No), the return water temperature acquisition unit 511 determines whether the acquired return water temperature is lower than a first stop temperature (e.g., 20°C) at which the heat source machine 31 should be stopped (ST07). For example, the first stop temperature is a set value set in advance.

Here, when the geothermal heat utilization system 1 performs the cooling operation for the apparatus AA, the first stop temperature is set to be lower than the first startup temperature in order to provide a hysteresis between the startup condition and the stop condition of the heat source machine 31.

[0073]

In a case where it is not determined in ST07 that the acquired return water temperature is lower than the first stop temperature (ST07: No), the control device 50 returns to the execution of ST01.

[0074]

In a case where it is determined in ST07 that the acquired return water temperature is lower than the first stop temperature (ST07: Yes), the heat source machine control unit 513 determines whether there is any heat source machine 31 (a heat source machine other than the heat source machines included in the heat source well facility 10) that is operating among the plurality of heat source machines 31 (ST08).

[0075]

In a case where it is determined in ST08 that there is the heat source machine 31 that is operating (ST08: Yes), the heat source machine control unit 513 stops the heat source machine 31 that is operating (ST09), and the control device 50 returns to the execution of ST01.

[0076]

In a case where it is determined in ST08 that there is no heat source machine 31 that is operating (ST08: No), the control device 50 returns to the execution of ST01.

[0077]

In a case where it is not determined in ST00 that the cooling operation is being performed (ST00: No), the control device 50 determines whether the apparatus AA is in the heating operation (ST10).

5 [0078]

In a case where it is not determined in ST10 that the heating operation is being performed (ST10: No), the control device 50 causes the heat source well facility 10 to execute cold heat storing operation or hot heat storing operation for the heat source well facility 10 as another control (ST11).

10 [0079]

Return Water Temperature Control during Heating Operation

In a case where it is determined in ST10 that the heating operation is being performed (ST10: Yes), as illustrated in FIG. 7, the return water temperature acquisition unit 511 acquires a measurement result of the water temperature gauge 15 on the cold water well 12 side as a return water temperature, and determines whether the acquired return water temperature is lower than a second startup temperature (e.g., 8°C) at which the heat source machine 31 should be started (ST21). For example, the second startup temperature is a set value set in advance.

20 [0080]

In a case where it is determined in ST21 that the acquired return water temperature is lower than the second startup temperature (ST21: Yes), the heat source machine control unit 513 determines whether there is any heat source machine 31 (a different heat source machine) that can be started among the plurality of heat source machines 31 (ST22).

25 [0081]

In a case where it is determined in ST22 that there is the heat source machine 31 that can be started (ST22: Yes), the heat source machine control unit 513 activates the heat source machine 31 that can be started (ST23), and the control device 50 returns to the execution of ST21.

30

For example, in ST23, the heat source machine control unit 513 first activates one (configurable) heat source machine 31 that can be started. In a case where there are a plurality of heat source machines 31 that can be started, the heat source machine control unit 513 can perform the staging control to increase/decrease by repeating ST21 to ST23. At this time, the heat source machine control unit 513 may perform the staging control to increase/decrease in consideration of the heat amount or the flow rate supplied to the apparatus AA.

35

On the other hand, as will be described below, the flow rate control unit 512 controls the flow rate FL so that the return water temperature of the heat source well facility 10 falls within a preset allowable value (equal to or higher than a preset lower limit value), and reduces the load of the heat source well facility 10.

[0082]

In a case where it is determined in ST22 that there is no heat source machine 31 that can be started (ST22: No), the control device 50 determines whether preserving the aquifer LY should be prioritized over securing the air conditioning capacity of the apparatus AA (ST24). For example, the control device 50 may determine whether preserving the aquifer LY should be prioritized over securing the air conditioning capacity of the apparatus AA, in accordance with a guideline input by a user or the like.

[0083]

In a case where it is determined in ST24 that preserving the aquifer LY should be prioritized (ST24: Yes), the flow rate control unit 512 controls the flow rate FL (ST25), and the control device 50 returns to the execution of ST21.

For example, in ST25, the flow rate control unit 512 may perform control of opening the bypass valve 223 to reduce the flow rate FL. By this control, the load can be reduced by self-bypass and the return water temperature can be controlled.

Further, in ST25, the flow rate control unit 512 may perform control of increasing the flow rate of the heat medium (hot heat medium) flowing between the auxiliary heat supply facility 30 and the apparatus AA by controlling the auxiliary flow rate adjustment device 33.

[0084]

In a case where it is determined in ST24 that the air conditioning capacity of the apparatus AA should be secured (ST24: No), the control device 50 stops heat supply from the geothermal heat utilization system 1 to the apparatus AA (ST26). Thereafter, the user or the like considers using another system that is a substitute for the geothermal heat utilization system 1 and can secure the air conditioning capacity of the apparatus AA.

[0085]

In a case where it is determined in ST21 that the acquired return water temperature is not lower than the second startup temperature (ST21: No), the return water temperature acquisition unit 511 determines whether the acquired return water temperature is higher than a second stop temperature (e.g., 12°C)

at which the heat source machine 31 should be stopped (ST27). For example, the second stop temperature is a set value set in advance.

Here, when the geothermal heat utilization system 1 performs the heating operation for the apparatus AA, the second stop temperature is set to be
5 higher than the second startup temperature in order to provide a hysteresis between the startup condition and the stop condition of the heat source machine 31.

[0086]

In a case where it is not determined in ST27 that the acquired return
10 water temperature is higher than the second stop temperature (ST27: No), the control device 50 returns to the execution of ST21.

[0087]

In a case where it is determined in ST27 that the acquired return water temperature is higher than the second stop temperature (ST27: Yes), the heat
15 source machine control unit 513 determines whether there is any heat source machine 31 (a heat source machine other than the heat source machines included in the heat source well facility 10) that is operating among the plurality of heat source machines 31 (ST28).

[0088]

In a case where it is determined in ST28 that there is the heat source
20 machine 31 that is operating (ST28: Yes), the heat source machine control unit 513 stops the heat source machine 31 that is operating (ST29), and the control device 50 returns to the execution of ST21.

[0089]

In a case where it is determined in ST28 that there is no heat source
25 machine 31 that is operating (ST28: No), the control device 50 returns to the execution of ST21.

[0090]

Operation of Water Level Control of Pumping Well

30 An operation of water level control of the pumping well will be described.

[0091]

When the geothermal heat utilization system 1 is started, as illustrated in FIG. 8, the pumping-side water level acquisition unit 514 acquires a
35 measurement result of the water level gauge 16 on the pumping well side as a pumping-side water level, and determines whether the acquired pumping-side water level is higher than a first limit water level (e.g., 3 m) (ST41). For example, the first limit water level is a set value set in advance.

The first limit water level set here is a water level at or below which the flow rate of pumping water should be limited and at which the heat source machine 31 should be started.

5 In this water level control during the cooling operation, the pumping well is the cold water well 12, and the return water well is the hot water well 11.

On the other hand, in this water level control during the heating operation, the pumping well is the hot water well 11, and the return water well is the cold water well 12.

10 [0092]

In a case where it is determined in ST41 that the acquired pumping-side water level is not higher than the first limit water level (determined to be equal to or lower than the first limit water level) (ST41: No), the heat source machine control unit 513 determines whether there is any heat source machine 31 (a different heat source machine) that can be started among the plurality of heat source machines 31 (ST42).

[0093]

20 In a case where it is determined in ST42 that there is the heat source machine 31 that can be started (ST42: Yes), the heat source machine control unit 513 activates the heat source machine 31 that can be started (ST43), and the control device 50 returns to the execution of ST41.

For example, in ST43, the heat source machine control unit 513 first activates one (configurable) heat source machine 31 that can be started. In a case where there are a plurality of heat source machines 31 that can be started, the heat source machine control unit 513 can perform the staging control to increase/decrease by repeating ST41 to ST43. At this time, the heat source machine control unit 513 may perform the staging control to increase/decrease in consideration of the heat amount or the flow rate supplied to the apparatus AA.

30 [0094]

In addition, in ST43, the pumping flow rate control unit 515 may control the pumping flow rate of the water from the pumping well by limiting the capacity of the underwater pump on the pumping well side or stopping the operation of the underwater pump PP on the pumping well side.

35 On the other hand, the flow rate control unit 512 may control the flow rate adjustment device 22 to reduce the flow rate FL so that the return water temperature of the heat source well facility 10 falls within the allowable value, and reduce the load of the heat source well facility 10. Further, the flow rate

control unit 512 may control the auxiliary flow rate adjustment device 33 to increase the flow rate of the heat medium flowing between the auxiliary heat supply facility 30 and the apparatus AA.

[0095]

5 In a case where it is determined in ST41 that the acquired pumping-side water level is higher than the first limit water level (ST41: Yes), it is determined whether the acquired pumping-side water level is lower than a first release water level (e.g., 10 m) (ST44). For example, the first release water level is a set value set in advance.

10 The first release water level set here is a water level at or above which a limitation on the flow rate of pumping water should be released and at which the heat source machine 31 should be stopped.

 In addition, the first release water level is set to be higher than the first limit water level in order to provide a hysteresis between the startup condition and the stop condition of the heat source machine 31.

15 [0096]

 In a case where it is determined in ST44 that the acquired pumping-side water level is lower than the first release water level (ST44: Yes), the limitation on pumping water should not be released, and the control device 50 returns to the execution of the ST41.

20 [0097]

 In a case where it is not determined in ST44 that the acquired pumping-side water level is lower than the first release water level (determined to be equal to or higher than the first release water level) (ST44: No), there is a possibility that the limitation on pumping water can be released, and the heat source machine control unit 513 determines whether there is any heat source machine 31 (a heat source machine other than the heat source machines included in the heat source well facility 10) that is operating among the plurality of heat source machines 31 (ST45).

25 [0098]

30 In a case where it is determined in ST45 that there is the heat source machine 31 that is operating (ST45: Yes), the heat source machine control unit 513 stops the heat source machine 31 that is operating (ST46), and the control device 50 returns to the execution of ST41. At this time, the pumping flow rate control unit 515 may perform control of increasing the pumping flow rate of the water from the pumping well by releasing the limitation on the capacity of the underwater pump PP on the pumping well side or starting the operation of the underwater pump PP on the pumping well side.

35

On the other hand, the flow rate control unit 512 may control the flow rate adjustment device 22 to increase the flow rate FL and control the auxiliary flow rate adjustment device 33 to reduce the flow rate of the heat medium flowing between the auxiliary heat supply facility 30 and the apparatus AA.

5 [0099]

In a case where it is determined in ST45 that there is no heat source machine 31 that is operating (ST45: No), the control device 50 returns to the execution of ST41.

[0100]

10 In a case where it is determined in ST42 that there is no heat source machine 31 that can be started (ST42: No), the control device 50 stops heat supply from the geothermal heat utilization system 1 to the apparatus AA (ST47). Thereafter, the user or the like considers performing maintenance of each device on the pumping well side, such as elimination of clogging of the
15 screen of the pumping well.

[0101]

Operation of Water Level Control of Return Water Well

An operation of water level control of the return water well will be described.

20 [0102]

When the geothermal heat utilization system 1 is started, as illustrated in FIG. 9, the return-side water level acquisition unit 516 acquires a measurement result of the water level gauge 16 on the return water well side as a return-side water level, and determines whether the acquired return-side water level is
25 lower than a second limit water level (e.g., 25 m) (ST61). For example, the second limit water level is a set value set in advance.

The second limit water level set here is a water level at or above which the flow rate of return water should be limited and at which the heat source machine 31 should be started.

30 Note that, in this water level control during the cooling operation, the return water well is the hot water well 11, and the pumping well is the cold water well 12.

On the other hand, in this water level control during the heating operation, the return water well is the cold water well 12, and the pumping well
35 is the hot water well 11.

[0103]

In a case where it is determined in ST61 that the acquired return-side water level is not lower than the second limit water level (determined to be

equal to or higher than the second limit water level) (ST61: No), the heat source machine control unit 513 determines whether there is any heat source machine 31 (a different heat source machine) that can be started among the plurality of heat source machines 31 (ST62).

5 [0104]

In a case where it is determined in ST62 that there is the heat source machine 31 that can be started (ST62: Yes), the heat source machine control unit 513 activates the heat source machine 31 that can be started (ST63), and the control device 50 returns to the execution of ST61.

10 For example, in ST63, the heat source machine control unit 513 first activates one (configurable) heat source machine 31 that can be started. In a case where there are a plurality of heat source machines 31 that can be started, the heat source machine control unit 513 can perform the staging control to increase/decrease by repeating ST61 to ST63. At this time, the heat source
15 machine control unit 513 may perform the staging control to increase/decrease in consideration of the heat amount or the flow rate supplied to the apparatus AA.

[0105]

In addition, in ST63, the return water flow rate control unit 517 may
20 control the return water flow rate of the water to the return water well by limiting the capacity of the underwater pump PP on the pumping well side or stopping the operation of the underwater pump PP on the pumping well side.

On the other hand, the flow rate control unit 512 may control the flow rate adjustment device 22 to reduce the flow rate FL so that the return water
25 temperature of the heat source well facility 10 falls within the allowable value, and reduce the load of the heat source well facility 10. Further, the flow rate control unit 512 may control the auxiliary flow rate adjustment device 33 to increase the flow rate of the heat medium flowing between the auxiliary heat supply facility 30 and the apparatus AA.

30 [0106]

In a case where it is determined in ST61 that the acquired return-side water level is lower than the second limit water level (ST61: Yes), it is determined whether the acquired return-side water level is higher than a second release water level (e.g., 21 m) (ST64). For example, the second release water
35 level is a set value set in advance.

The second release water level set here is a water level at or below which a limitation on the flow rate of return water should be released and at which the heat source machine 31 should be stopped.

In addition, the second release water level is set to be lower than the second limit water level in order to provide a hysteresis between the startup condition and the stop condition of the heat source machine 31.

[0107]

5 In a case where it is determined in ST64 that the acquired return-side water level is higher than the second release water level (ST64: Yes), the limitation on return water should not be released, and the control device 50 returns to the execution of the ST61.

[0108]

10 In a case where it is not determined in ST64 that the acquired return-side water level is higher than the second release water level (determined to be equal to or lower than the second release water level) (ST64: No), there is a possibility that the limitation on return water can be released, and the heat source machine control unit 513 determines whether there is any heat source
15 machine 31 (a heat source machine other than the heat source machines included in the heat source well facility 10) that is operating among the plurality of heat source machines 31 (ST65).

[0109]

20 In a case where it is determined in ST65 that there is the heat source machine 31 that is operating (ST65: Yes), the heat source machine control unit 513 stops the heat source machine 31 that is operating (ST66), and the control device 50 returns to the execution of ST61. At this time, the return water flow rate control unit 517 may perform control of increasing the return water flow rate of the water to the return water well by releasing the limitation on the
25 capacity of the underwater pump PP on the pumping well side or starting the operation of the underwater pump PP on the pumping well side.

30 On the other hand, the flow rate control unit 512 may control the flow rate adjustment device 22 to increase the flow rate FL and control the auxiliary flow rate adjustment device 33 to reduce the flow rate of the heat medium flowing between the auxiliary heat supply facility 30 and the apparatus AA.

[0110]

 In a case where it is determined in ST65 that there is no heat source machine 31 that is operating (ST65: No), the control device 50 returns to the execution of ST61.

35 [0111]

 In a case where it is determined in ST62 that there is no heat source machine 31 that can be started (ST62: No), the control device 50 stops heat supply from the geothermal heat utilization system 1 to the apparatus AA

(ST67). Thereafter, the user or the like considers performing maintenance of each device on the return water well side, such as elimination of clogging of the screen of the return water well.

[0112]

5 Actions and Effects

According to the present embodiment, the control device 50 controls the flow rate FL based on the return water temperature.

Accordingly, the control device 50 can limit heat discharge from the apparatus AA to the heat source well facility 10 in a case where the heat load
10 amount required by the apparatus AA is large.

Thus, the control device 50 can return groundwater to the return water well after adjusting the temperature of the groundwater to a temperature that is less likely to affect the underground environment, regardless of the heat load amount required by the apparatus AA.

15 Therefore, the control device 50 is less likely to affect the underground environment.

[0113]

As a comparative example, in a geothermal heat utilization system disclosed in Patent Document 1, a return water temperature is controlled by
20 controlling the flow rate of water from a pumping well to a return water well. In the geothermal heat utilization system of the comparative example, in a case where the amount of heat discharged from an apparatus to an aquifer is the same, a temperature difference between a pumping water temperature and an injecting water temperature is determined by the pumping water temperature
25 and a set return water temperature, and thus only the flow rate is a variable value.

Therefore, in the geothermal heat utilization system of the comparative example, since the pumping amount has an upper limit depending on the capacity of the well, when the heat load amount required by the apparatus is
30 large, the return water temperature inevitably exceeds an upper limit value (a lower limit value) even when the pumping amount is maximized.

In addition, in the geothermal heat utilization system of the comparative example, the heat stored in the previous season is used up by the end of the summer season or the winter season, the groundwater temperature becomes
35 close to the initial groundwater temperature, and the available temperature difference becomes small. Therefore, the return water temperature is likely to exceed the upper limit value (the lower limit value) when the apparatus is a high load.

On the other hand, in a geothermal heat utilization system, it is desirable that a return water temperature is a temperature that is less likely to alter the water quality of an aquifer, and for example, it is desirable that the return water temperature is a temperature that is less likely to cause a change in a microbial
5 community structure or the like.

However, in the geothermal heat utilization system of the comparative example, since the return water temperature may exceed the upper limit value (the lower limit value), the water quality of the aquifer is likely to be altered.

In contrast, since the control device 50 controls the flow rate FL based
10 on the return water temperature as described above, the groundwater can be returned to the return water well after the temperature of the groundwater is adjusted to a temperature that is less likely to affect the underground environment, regardless of the heat load amount required by the apparatus AA.

Therefore, the control device 50 is less likely to alter the water quality
15 of the aquifer.
[0114]

According to the present embodiment, the control device 50 controls the start and stop of the heat source machine 31 based on the return water temperature, and thus can start and stop the heat source machine 31 in
20 accordance with a load heat amount required by the apparatus AA.

Accordingly, in a case where the heat load amount required by the apparatus AA is large, the control device 50 can cause the heat load amount required by the apparatus AA to be shared by the heat source well facility 10 and the auxiliary heat supply facility 30.

Thus, the control device 50 can return the groundwater to the return
25 water well after adjusting the temperature of groundwater to a temperature that is less likely to affect the underground environment, regardless of the heat load amount required by the apparatus AA.

Therefore, the control device 50 is less likely to affect the underground
30 environment.
[0115]

For example, the control device 50 can cause the heat load amount required by the apparatus AA to be shared by the heat source well facility 10 and the auxiliary heat supply facility 30 as illustrated in FIG. 10 by controlling
35 the start and stop of the heat source machine 31 based on the return water temperature.

Accordingly, the control device 50 basically operates the heat source well facility 10 having a high efficiency, and in a case where the return water

temperature exceeds the upper limit value even when the pumping amount is maximized, the control device 50 can control (limit) the amount of heat discharged to the aquifer LY by activating the heat source machine 31 different from the heat source machines 31 of the heat source well facility 10 for load
5 distribution.

As a result, the control device 50 can return the groundwater to the return water well after adjusting the temperature of the groundwater to a temperature that is less likely to affect the underground environment, regardless of the heat load amount required by the apparatus AA, by controlling the start
10 and stop of the heat source machine 31 based on the return water temperature as described above.

Therefore, the control device 50 is less likely to alter the water quality of the aquifer.

[0116]

15 According to the present embodiment, when the geothermal heat utilization system 1 performs the cooling operation for the apparatus AA, the first stop temperature at which the heat source machine 31 should be stopped is lower than the first startup temperature at which the heat source machine 31 should be started, and thus the control device 50 can provide a hysteresis to the
20 startup condition and the stop condition of the heat source machine 31.

For example, as illustrated in FIG. 11, the control device 50 can provide a hysteresis to the startup condition and the stop condition of the heat source machine 31.

Accordingly, the control device 50 can suppress, for example, an
25 oscillating operation at the start and stop of the heat source machine 31.

Therefore, the control device 50 can stabilize the operation of the heat source machine 31.

[0117]

30 According to the present embodiment, when the geothermal heat utilization system 1 performs the heating operation for the apparatus AA, the second stop temperature at which the heat source machine 31 should be stopped is higher than the second startup temperature at which the heat source machine 31 should be started, and thus the control device 50 can provide a hysteresis to the startup condition and the stop condition of the heat source machine 31.

35 Accordingly, the control device 50 can suppress, for example, an oscillating operation at the start and stop of the heat source machine 31.

Therefore, the control device 50 can stabilize the operation of the heat source machine 31.

[0118]

According to the present embodiment, the heat source machine control unit 513 can activate the required number of the heat source machines 31 corresponding to a heat load amount shared by the auxiliary heat supply facility
5 out of a heat load amount required by the apparatus AA by performing the staging control to increase/decrease.

Therefore, the control device 50 can efficiently use the plurality of heat source machines 31.

[0119]

10 According to the present embodiment, the pumping flow rate control unit 515 controls a pumping flow rate based on a pumping-side water level.

Accordingly, the control device 50 can limit water level fluctuations in the pumping well, such as a decrease in the water level of the pumping well due to clogging of the screen of the pumping well, for example.

15 Thus, the control device 50 can suppress, for example, a failure due to the idling operation of the underwater pump PP of the pumping well and the progress in clogging of the pumping well.

Therefore, the control device 50 allows the long-term operation of the geothermal heat utilization system 1.

20 [0120]

According to the present embodiment, the heat source machine control unit 513 controls the start and stop of the heat source machine 31 based on a pumping-side water level.

Thus, the control device 50 can supplement the heat load amount
25 required by the apparatus AA based on the pumping-side water level.

Accordingly, even in a case where the heat load amount required by the apparatus AA cannot be borne only by the heat source well facility 10 in order to maintain the pumping-side water level, the control device 50 can cause the heat load amount required by the apparatus AA to be shared by the heat source
30 well facility 10 and the auxiliary heat supply facility 30.

Therefore, the control device 50 can control the geothermal heat utilization system 1 so as to supply the heat load amount required by the apparatus AA.

[0121]

35 As a comparative example, in the geothermal heat utilization system disclosed in Patent Document 1, when pumping is performed at a pumping amount equal to or greater than the capacity of a heat source well, lowering of the water level on the pumping side becomes large, and the idling operation of

an underwater pump PP and/or the progress in clogging due to an increase in the flow rate passing through a screen on the pumping side, or the like may occur.

For example, an upper limit of the pumping amount is set through a
5 pumping test or the like at the time of construction of the heat source well, but there is a case where water level fluctuations become large even with the same pumping amount due to aging deterioration such as clogging of a screen, and thus it is desired to limit the pumping amount with reference to a water level and to utilize a different heat source.

10 On the other hand, for example, the control device 50 basically operates the heat source well facility 10 having a high efficiency, and in a case where the water level on the pumping side is lowered in excess of a set value, the control device 50 can control the pumping flow rate, activate the heat source machine 31 different from the heat source machines of the heat source well
15 facility 10, and distribute the load.

Therefore, according to the control device 50, it is possible to limit the pumping amount and utilize a different heat source based on the pumping-side water level.

[0122]

20 According to the present embodiment, since the first release water level at which the limitation on the pumping flow rate should be released and the heat source machine 31 should be stopped is higher than the first limit water level at which the pumping flow rate should be limited and the heat source machine 31 should be started, the control device 50 can provide a hysteresis to
25 the startup condition and the stop condition of the heat source machine 31.

For example, as illustrated in FIG. 12, the control device 50 can provide a hysteresis to the startup condition and the stop condition of the heat source machine 31.

Accordingly, the control device 50 can suppress, for example, an
30 oscillating operation at the start and stop of the heat source machine 31.

Therefore, the control device 50 can stabilize the operation of the heat source machine 31.

[0123]

According to the present embodiment, the pumping flow rate control
35 unit 515 controls a return water flow rate based on a return-side water level.

Accordingly, the control device 50 can limit water level fluctuations in the return water well, such as a rise in the water level of the return water well due to clogging of the screen of the return water well, for example.

Accordingly, the control device 50 can suppress the progress in clogging of the return water well, for example.

Therefore, the control device 50 allows the long-term operation of the geothermal heat utilization system 1.

5 [0124]

According to the present embodiment, the heat source machine control unit 513 controls the start and stop of the heat source machine 31 based on a return-side water level.

10 Thus, the control device 50 can supplement the heat load amount required by the apparatus AA based on the return-side water level.

Accordingly, even in a case where the heat load amount required by the apparatus AA cannot be borne only by the heat source well facility 10 in order to maintain the return-side water level, the control device 50 can cause the heat load amount required by the apparatus AA to be shared by the heat source well
15 facility 10 and the auxiliary heat supply facility 30.

Therefore, the control device 50 can control the geothermal heat utilization system 1 so as to supply the heat load amount required by the apparatus AA.

[0125]

20 As a comparative example, in the geothermal heat utilization system disclosed in Patent Document 1, when water injection is performed at a return water amount equal to or greater than the capacity of a heat source well, rising of the water level of the return water well becomes large, and the progress in clogging due to an increase in the flow rate passing through a screen on the
25 return water well, or the like may occur.

For example, an upper limit of the return water amount is set through a return water test or the like at the time of construction of the heat source well, but there is a case where water level fluctuations become large even with the same return water amount due to aging deterioration such as clogging of a
30 screen, and thus it is desired to limit the return water amount with reference to a water level and to utilize a different heat source.

On the other hand, for example, the control device 50 basically operates the heat source well facility 10 having a high efficiency, and in a case where the water level of the return water well rises in excess of a set value, the
35 control device 50 can control the return water flow rate, activate the heat source machine 31 different from the heat source machines of the heat source well facility 10, and distribute the load.

Therefore, according to the control device 50, it is possible to limit the return water amount and utilize a different heat source based on the return-side water level.

[0126]

5 According to the present embodiment, since the second release water level at which the limitation on the return water flow rate should be released and the heat source machine 31 should be stopped is lower than the second limit water level at which the return water flow rate should be limited and the heat source machine 31 should be started, the control device 50 can provide a
10 hysteresis to the startup condition and the stop condition of the heat source machine 31.

 Accordingly, the control device 50 can suppress, for example, an oscillating operation at the start and stop of the heat source machine 31.

 Therefore, the control device 50 can stabilize the operation of the heat
15 source machine 31.

[0127]

 According to the present embodiment, the control device 50 uses the heat source well facility 10 and the auxiliary heat supply facility 30 in combination.

20 Therefore, while the heat source well facility 10 is a facility in which the aquifer LY is regarded as a natural heat storage tank and an unexpected situation may occur as a result of nature utilization, the control device 50 uses the auxiliary heat supply facility 30 as a backup of the heat source well facility 10.

25 [0128]

 According to the control device 50 of the present embodiment, since return water temperature management can be easily and automatically controlled, the management on the user side is facilitated, and a general-purpose system in which utilization of underground heat is facilitated can be
30 constructed.

[0129]

Modification Example

 In the above-described example of the embodiment, the control device 50 performs both the control of the flow rate FL and the control of the start and
35 stop of the heat source machine 31 based on a return water temperature, but any control may be performed as long as the return water temperature can be controlled.

As a modification example, the control device 50 may control at least one of the control of the flow rate FL and the control of the start and stop of the heat source machine 31 based on a return water temperature as long as the return water temperature can be controlled. In that case, the geothermal heat utilization system 1 may include at least one of the flow rate adjustment device 22 and the auxiliary heat supply facility 30.

[0130]

In the above-described example of the embodiment, the auxiliary heat supply facility 30 includes the plurality of heat source machines 31, but may include any device as long as the device can assist at least one of the supply of hot heat and the supply of cold heat performed by the heat source well facility 10 for the apparatus AA.

As a modification example, the auxiliary heat supply facility 30 may include one heat source machine 31 instead of the plurality of heat source machines 31.

As another modification example, the auxiliary heat supply facility 30 may include a cooling tower instead of or in addition to the plurality of heat source machines 31.

[0131]

In the above-described example of the embodiment, the auxiliary heat supply facility 30 includes the plurality of heat source machines 31, but may include any device as long as the device can assist at least one of the supply of hot heat and the supply of cold heat performed by the heat source well facility 10 for the apparatus AA.

As a modification example, the auxiliary heat supply facility 30 may include one heat source machine 31 instead of the plurality of heat source machines 31.

As another modification example, the auxiliary heat supply facility 30 may include a cooling tower instead of or in addition to the plurality of heat source machines 31.

[0132]

In the above-described example of the embodiment, the geothermal heat utilization circuit 20 includes the heat pump 21, but may be configured in any way as long as the geothermal heat utilization circuit 20 can mediate and control the heat transfer performed between the heat exchanger 14 and the apparatus AA.

As a modification example, the geothermal heat utilization circuit 20 may include the flow rate adjustment device 22 and the main pipe 23, and may

not include the heat pump 21. In that case, the flow rate adjustment device 22 may adjust the flow rate of the heat medium directly flowing from the apparatus AA side of the heat exchanger 14 to the apparatus AA.

[0133]

5 In the above-described example of the embodiment, the upper limit value (the lower limit value) of the return water temperature is set in advance, but may be set in any way as long as the return water temperature can be controlled to a temperature that is less likely to affect the underground environment.

10 As a modification example, since the upper limit value (the lower limit value) of the return water temperature depends on the initial groundwater temperature of a region where the geothermal heat utilization system 1 is installed, the upper limit value (the lower limit value) of the return water temperature is not particularly limited in the control device 50, and may be
15 updated to a value that can be set as appropriate.

[0134]

 In the above-described example of the embodiment, the flow rate control unit 512 controls the bypass valve 223, but may perform any control as long as the flow rate FL can be controlled.

20 As a modification example, in addition to the control of the bypass valve 223 or instead of the control of the bypass valve 223, the flow rate control unit 512 may control the flow rate FL by performing inverter control of the pump 221 or opening degree control of the motor valve 222.

 Further, the flow rate control unit 512 may adjust the flow rate of the
25 medium flowing from the auxiliary heat supply facility 30 to the apparatus AA by performing the opening degree control of the bypass valve of the auxiliary flow rate adjustment device 33, the inverter control of the pump of the auxiliary flow rate adjustment device 33, or the opening degree control of the motor valve of the auxiliary flow rate adjustment device 33, similarly to the
30 control for the flow rate adjustment device 22.

[0135]

 In the embodiments described above, the various processes are performed in such a manner that a program for achieving the various functions of the control device 50 is recorded in a computer-readable recording medium,
35 and the program recorded in the recording medium is read and executed by a computer system. Here, the procedure of the various processes of the CPU 51 of the computer system is stored in the computer-readable recording medium in the form of a program, and the various processes are performed by a computer

reading and executing the program. The computer-readable recording medium refers to a magnetic disk, a magneto-optical disk, a CD-ROM, a DVD-ROM, a semiconductor memory, and the like. The computer program may be distributed to a computer via a communication line or the like, and the computer having
5 received the distribution may execute the program.

[0136]

Other Embodiments

While the embodiments of the present disclosure have been described above, the embodiments are merely examples, and are not intended to limit the
10 scope of the present disclosure. The embodiments can be implemented in various other forms, and various omissions, substitutions, and modifications can be made without departing from the gist of the present disclosure. The embodiments and the modifications thereof are included in the scope and gist of the present disclosure as well as in the scope the present disclosure and
15 equivalents thereof.

[0137]

Supplementary Notes

The control device 50, the geothermal heat utilization system 1, the control method, and the program according to the embodiments are understood
20 as follows, for example.

[0138]

(1) A control device 50 according to a first aspect is for a geothermal heat utilization system 1,

the geothermal heat utilization system 1 including:

- 25 a heat source well facility 10 including
a pumping well (a cold water well 12 or a hot water well 11),
a return water well (the hot water well 11 or the cold water well 12),
a well-side pipe 13 extending from the pumping well (the cold water well 12 or the hot water well 11) to the return water well (the hot water well 11
30 or the cold water well 12), and
a heat exchanger 14 provided at a middle of the well-side pipe 13; and
a geothermal heat utilization circuit 20 provided between the heat exchanger 14 and an apparatus AA,
the control device 50 including:
35 a return water temperature acquisition unit 511 that acquires a return water temperature of water returned to the return water well (the hot water well 11 or the cold water well 12) of the geothermal heat utilization system 1; and

a flow rate control unit 512 that controls a flow rate FL of a refrigerant flowing from the geothermal heat utilization circuit 20 to the apparatus AA based on the return water temperature.

[0139]

5 According to the present aspect, the control device 50 controls the flow rate FL based on the return water temperature.

 Accordingly, the control device 50 can limit heat discharge from the apparatus AA to the heat source well facility 10 in a case where a heat load amount required by the apparatus AA is large.

10 Thus, the control device 50 can return groundwater to the return water well (the hot water well 11 or the cold water well 12) after adjusting the temperature of the groundwater to a temperature that is less likely to affect the underground environment, regardless of the heat load amount required by the apparatus AA.

15 Therefore, the control device 50 is less likely to affect the underground environment.

[0140]

 (2) A control device 50 according to a second aspect is the control device 50 according to (1), further including an auxiliary heat supply facility
20 30 that is provided at the apparatus AA in parallel with the geothermal heat utilization circuit 20 and provided with a heat source machine 31, and further including a heat source machine control unit 513 that controls start and stop of the heat source machine 31 based on the return water temperature.

[0141]

25 According to the present aspect, the control device 50 can start and stop the heat source machine 31 in accordance with the heat load amount required by the apparatus AA.

 Accordingly, in a case where the heat load amount required by the apparatus AA is large, the control device 50 can cause the heat load amount
30 required by the apparatus AA to be shared by the heat source well facility 10 and the auxiliary heat supply facility 30.

 Thus, the control device 50 can return groundwater to the return water well (the hot water well 11 or the cold water well 12) after adjusting the temperature of the groundwater to a temperature that is less likely to affect the
35 underground environment, regardless of the heat load amount required by the apparatus AA.

 Therefore, the control device 50 is less likely to affect the underground environment.

[0142]

(3) A control device 50 according to a third aspect is the control device 50 of (2), wherein when the geothermal heat utilization system 1 performs cooling operation for the apparatus AA, a first stop temperature at which the stop is to be performed is lower than a first startup temperature at which the start is to be performed.

[0143]

According to the present aspect, the control device 50 can provide a hysteresis to a startup condition and a stop condition of the heat source machine 31.

Accordingly, the control device 50 can suppress, for example, an oscillating operation at the start and stop of the heat source machine 31.

Therefore, the control device 50 can stabilize the operation of the heat source machine 31.

[0144]

(4) A control device 50 according to a fourth aspect is the control device 50 of (2) or (3), wherein when the geothermal heat utilization system performs heating operation for the apparatus AA, a second stop temperature at which the stop is to be performed is higher than a second startup temperature at which the start is to be performed.

[0145]

According to the present aspect, a hysteresis can be provided to the startup condition and the stop condition of the apparatus AA.

Accordingly, the control device 50 can suppress, for example, an oscillating operation at the start and stop of the apparatus AA.

Therefore, the control device 50 can stabilize the operation of the heat source machine 31.

[0146]

(5) A control device 50 according to a fifth aspect is the control device 50 of any one of (2) to (4), wherein the heat source machine 31 includes a plurality of heat source machines 31, and the heat source machine control unit 513 performs staging control to increase/decrease the plurality of heat source machines 31.

[0147]

According to the present aspect, the control device 50 can activate the required number of the heat source machines 31 corresponding to a heat load amount shared by the auxiliary heat supply facility 30 out of the heat load amount required by the apparatus AA.

Therefore, the control device 50 can efficiently use the plurality of heat source machines 31.

[0148]

(6) A control device 50 according to a sixth aspect is the control device 50 of (1), further including a pumping-side water level acquisition unit 514 that acquires a pumping-side water level which is a water level of the pumping well (the cold water well 12 or the hot water well 11), and a pumping flow rate control unit 515 that controls a pumping flow rate from the pumping well (the cold water well 12 or the hot water well 11) based on the pumping-side water level.

[0149]

According to the present aspect, the control device 50 controls the pumping flow rate based on the pumping-side water level.

Accordingly, the control device 50 can limit water level fluctuations in the pumping well (the cold water well 12 or the hot water well 11), such as a decrease in the water level of the pumping well (the cold water well 12 or the hot water well 11) due to clogging of a screen of the pumping well (the cold water well 12 or the hot water well 11), for example.

Thus, the control device 50 can suppress, for example, a failure due to the idling operation of an underwater pump PP of the pumping well (the cold water well 12 or the hot water well 11) and the progress in clogging of the pumping well (the cold water well 12 or the hot water well 11).

Therefore, the control device 50 allows the long-term operation of the geothermal heat utilization system 1.

[0150]

(7) A control device 50 according to a seventh aspect is the control device 50 of (6), wherein the geothermal heat utilization system further includes an auxiliary heat supply facility 30 that is provided at the apparatus in parallel with the geothermal heat utilization circuit 20 and provided with a heat source machine 31, and further includes a heat source machine control unit 513 that controls start and stop of the heat source machine 31 based on the pumping-side water level.

[0151]

According to the present aspect, the control device 50 can supplement the heat load amount required by the apparatus AA based on the pumping-side water level.

Accordingly, even in a case where the heat load amount required by the apparatus AA cannot be borne only by the heat source well facility 10 in order

to maintain the pumping-side water level, the control device 50 can cause the heat load amount required by the apparatus AA to be shared by the heat source well facility 10 and the auxiliary heat supply facility 30.

Therefore, the control device 50 can control the geothermal heat utilization system 1 so as to supply the heat load amount required by the apparatus AA.

[0152]

(8) A control device 50 according to an eighth aspect is the control device 50 of (1), further including a return-side water level acquisition unit 516 that acquires a return-side water level which is a water level of the return water well (the hot water well 11 or the cold water well 12), and a return water flow rate control unit 517 that controls a return water flow rate from the return water well (the hot water well 11 or the cold water well 12) based on the return-side water level.

[0153]

According to the present aspect, the pumping flow rate control unit 515 controls the return water flow rate based on the return-side water level.

Accordingly, the control device 50 can limit water level fluctuations in the return water well (the hot water well 11 or the cold water well 12), such as a rise in the water level of the return water well (the hot water well 11 or the cold water well 12) due to clogging of a screen of the return water well (the hot water well 11 or the cold water well 12), for example.

Accordingly, the control device 50 can suppress the progress in clogging of the return water well (the hot water well 11 or the cold water well 12), for example.

Therefore, the control device 50 allows the long-term operation of the geothermal heat utilization system 1.

[0154]

(9) A control device 50 according to a ninth aspect is the control device 50 of (8), wherein the geothermal heat utilization system 1 further includes an auxiliary heat supply facility 30 that is provided at the apparatus AA in parallel with the geothermal heat utilization circuit 20 and provided with a heat source machine 31, and further includes a heat source machine control unit 513 that controls start and stop of the heat source machine 31 based on the return-side water level.

[0155]

According to the present aspect, the control device 50 can supplement the heat load amount required by the apparatus AA based on the return-side water level.

5 Accordingly, even in a case where the heat load amount required by the apparatus AA cannot be borne only by the heat source well facility 10 in order to maintain the return-side water level, the control device 50 can cause the heat load amount required by the apparatus AA to be shared by the heat source well facility 10 and the auxiliary heat supply facility 30.

Therefore, the control device 50 can control the geothermal heat
10 utilization system 1 so as to supply the heat load amount required by the apparatus AA.

[0156]

(10) A control device 50 according to a tenth aspect is for a geothermal heat utilization system 1,

15 the geothermal heat utilization system 1 including:
a heat source well facility 10 including
a pumping well (a cold water well 12 or a hot water well 11),
a return water well (the hot water well 11 or the cold water well 12),
a well-side pipe 13 extending from the pumping well (the cold water
20 well 12 or the hot water well 11) to the return water well (the hot water well 11 or the cold water well 12), and
a heat exchanger 14 provided at a middle of the well-side pipe 13,
a geothermal heat utilization circuit 20 provided between the heat exchanger 14 and an apparatus AA; and
25 an auxiliary heat supply facility 30 that is provided at the apparatus in parallel with the geothermal heat utilization circuit 20 and provided with a heat source machine 31,
the control device 50 including:
a return water temperature acquisition unit 511 that acquires a return
30 water temperature of water returned to the return water well (the hot water well 11 or the cold water well 12) of the geothermal heat utilization system 1; and
a heat source machine control unit 513 that controls start and stop of the heat source machine 31 based on the return water temperature.

[0157]

35 According to the present aspect, the control device 50 can start and stop the heat source machine 31 in accordance with the heat load amount required by the apparatus AA.

Accordingly, in a case where the heat load amount required by the apparatus AA is large, the control device 50 can cause the heat load amount required by the apparatus AA to be shared by the heat source well facility 10 and the auxiliary heat supply facility 30.

5 Thus, the control device 50 can return groundwater to the return water well (the hot water well 11 or the cold water well 12) after adjusting the temperature of the groundwater to a temperature that is less likely to affect the underground environment, regardless of the heat load amount required by the apparatus AA.

10 Therefore, the control device 50 is less likely to affect the underground environment.

[0158]

(11) A geothermal heat utilization system 1 according to an eleventh aspect includes:

15 the control device 50 according to any one of (1) to (10);
the heat source well facility 10; and
the geothermal heat utilization circuit 20.

[0159]

20 According to the present aspect, the geothermal heat utilization system 1 controls the flow rate FL based on the return water temperature.

Accordingly, the geothermal heat utilization system 1 can limit heat discharge from the apparatus AA to the heat source well facility 10 in a case where the heat load amount required by the apparatus AA is large.

25 Thus, the geothermal heat utilization system 1 can return groundwater to the return water well (the hot water well 11 or the cold water well 12) after adjusting the temperature of the groundwater to a temperature that is less likely to affect the underground environment, regardless of the heat load amount required by the apparatus AA.

30 Therefore, the geothermal heat utilization system 1 is less likely to affect the underground environment.

[0160]

(12) A control method according to a twelfth aspect is for a geothermal heat utilization system 1,

35 the geothermal heat utilization system 1 including:
a heat source well facility 10 including
a pumping well (a cold water well 12 of a hot water well 11),
a return water well (the hot water well 11 or the cold water well 12),

a well-side pipe 13 extending from the pumping well (the cold water well 12 or the hot water well 11) to the return water well (the hot water well 11 or the cold water well 12), and

a heat exchanger 14 provided at a middle of the well-side pipe 13; and

5 a geothermal heat utilization circuit 20 provided between the heat exchanger 14 and an apparatus AA,

the control method including:

acquiring a return water temperature of water returned to the return water well (the hot water well 11 or the cold water well 12) of the geothermal
10 heat utilization system 1, and

controlling a flow rate FL of a refrigerant flowing from the geothermal heat utilization circuit 20 to the apparatus AA based on the return water temperature.

[0161]

15 According to the present aspect, the control method controls the flow rate FL based on the return water temperature.

Accordingly, the control method can limit heat discharge from the apparatus AA to the heat source well facility 10 in a case where the heat load amount required by the apparatus AA is large.

20 Thus, the control method can return groundwater to the return water well (the hot water well 11 or the cold water well 12) after adjusting the temperature of the groundwater to a temperature that is less likely to affect the underground environment, regardless of the heat load amount required by the apparatus AA.

Therefore, the control method is less likely to affect the underground
25 environment.

[0162]

(13) A control method according to a thirteenth aspect is for a geothermal heat utilization system 1,

the geothermal heat utilization system 1 including:

30 a heat source well facility 10 including

a pumping well (a cold water well 12 or a hot water well 11),

a return water well (the hot water well 11 or the cold water well 12),

a well-side pipe 13 extending from the pumping well (the cold water well 12 or the hot water well 11) to the return water well (the hot water well 11
35 or the cold water well 12), and

a heat exchanger 14 provided at a middle of the well-side pipe 13,

a geothermal heat utilization circuit 20 provided between the heat exchanger 14 and an apparatus AA; and

an auxiliary heat supply facility 30 that is provided at the apparatus AA in parallel with the geothermal heat utilization circuit 20 and provided with a heat source machine 31,

the control method including:

5 acquiring a return water temperature of water returned to the return water well (the hot water well 11 or the cold water well 12) of the geothermal heat utilization system 1; and

controlling start and stop of the heat source machine 31 based on the return water temperature.

10 [0163]

According to the present aspect, the control method can start and stop the heat source machine 31 in accordance with the heat load amount required by the apparatus AA.

15 Accordingly, in a case where the load heat amount required by the apparatus AA is large, the control method can cause the load heat amount required by the apparatus AA to be shared by the heat source well facility 10 and the auxiliary heat supply facility 30.

20 Thus, the control method can return groundwater to the return water well (the hot water well 11 or the cold water well 12) after adjusting the temperature of the groundwater to a temperature that is less likely to affect the underground environment, regardless of the heat load amount required by the apparatus AA.

Therefore, the control method is less likely to affect the underground environment.

[0164]

25 (14) A program according to a fourteenth aspect is for a geothermal heat utilization system 1,

the geothermal heat utilization system 1 including:

a heat source well facility 10 including

a pumping well (a cold water well 12 or a hot water well 11),

30 a return water well (the hot water well 11 or the cold water well 12),

a well-side pipe 13 extending from the pumping well (the cold water well 12 or the hot water well 11) to the return water well (the hot water well 11 or the cold water well 12), and

a heat exchanger 14 provided at a middle of the well-side pipe 13; and

35 a geothermal heat utilization circuit 20 provided between the heat exchanger 14 and an apparatus AA,

the program causing a computer to execute:

acquiring a return water temperature of water returned to the return water well (the hot water well 11 or the cold water well 12) of the geothermal heat utilization system 1, and

controlling a flow rate FL of a refrigerant flowing from the geothermal heat utilization circuit 20 to the apparatus AA based on the return water temperature.

[0165]

According to the present aspect, the program controls the flow rate FL based on the return water temperature.

Accordingly, the program can limit heat discharge from the apparatus AA to the heat source well facility 10 in a case where the heat load amount required by the apparatus AA is large.

Thus, the program can return groundwater to the return water well (the hot water well 11 or the cold water well 12) after adjusting the temperature of the groundwater to a temperature that is less likely to affect the underground environment, regardless of the heat load amount required by the apparatus AA.

Therefore, the program is less likely to affect the underground environment.

[0166]

(15) A program according to a fifteenth aspect is for a geothermal heat utilization system 1,

the geothermal heat utilization system 1 including:

a heat source well facility 10 including

a pumping well (a cold water well 12 or a hot water well 11),

a return water well (the hot water well 11 or the cold water well 12),

a well-side pipe 13 extending from the pumping well (the cold water well 12 or the hot water well 11) to the return water well (the hot water well 11 or the cold water well 12), and

a heat exchanger 14 provided at a middle of the well-side pipe 13,

a geothermal heat utilization circuit 20 provided between the heat exchanger 14 and an apparatus AA; and

an auxiliary heat supply facility 30 that is provided at the apparatus AA in parallel with the geothermal heat utilization circuit 20 and provided with a heat source machine 31,

the program causing a computer to execute:

acquiring a return water temperature of water returned to the return water well (the hot water well 11 or the cold water well 12) of the geothermal heat utilization system 1; and

controlling start and stop of the heat source machine based on the return water temperature.

[0167]

5 According to the present aspect, the program can start and stop the heat source machine 31 in accordance with the heat load amount required by the apparatus AA.

10 Accordingly, in a case where the load heat amount required by the apparatus AA is large, the program can cause the load heat amount required by the apparatus AA to be shared by the heat source well facility 10 and the auxiliary heat supply facility 30.

Thus, the program can return groundwater to the return water well (the hot water well 11 or the cold water well 12) after adjusting the temperature of the groundwater to a temperature that is less likely to affect the underground environment, regardless of the heat load amount required by the apparatus AA.

15 Therefore, the program is less likely to affect the underground environment.

Industrial Applicability

[0168]

20 According to the control device, the geothermal heat utilization system, the control method, and the program of the present disclosure, the underground environment is less likely to be affected.

Reference Signs List

25 [0169]

- 1 Geothermal heat utilization system
- 10 Heat source well facility
- 11 Hot water well (return water well or pumping well)
- 12 Cold water well (pumping well or return water well)
- 30 13 Well-side pipe
- 14 Heat exchanger
- 15 Water temperature gauge
- 16 Water level gauge
- 20 Geothermal heat utilization circuit
- 35 21 Heat pump
- 22 Flow rate adjustment device
- 23 Main pipe
- 30 Auxiliary heat supply facility

- 31 Heat source machine
- 32 Auxiliary pipe
- 33 Auxiliary flow rate adjustment device
- 50 Control device
- 5 51 CPU
- 52 Memory
- 53 Communication interface
- 54 Recording medium
- 131 First end
- 10 132 Second end
- 221 Pump
- 222 Motor valve
- 223 Bypass valve
- 511 Return water temperature acquisition unit
- 15 512 Flow rate control unit
- 513 Heat source machine control unit
- 514 Pumping-side water level acquisition unit
- 515 Pumping flow rate control unit
- 516 Return-side water level acquisition unit
- 20 517 Return water flow rate control unit
- AA Apparatus
- FL Flow rate
- LY Aquifer
- PP Underwater pump
- 25 VA Water injection valve
- VB Check valve

Claims

[Claim 1]

A control device for a geothermal heat utilization system,
the geothermal heat utilization system comprising:
a heat source well facility including
a pumping well,
a return water well,
a well-side pipe extending from the pumping well to the return water well, and
a heat exchanger provided at a middle of the well-side pipe;
a geothermal heat utilization circuit provided between the heat exchanger and an apparatus; and
an auxiliary heat supply facility provided at the apparatus in parallel with the geothermal heat utilization circuit and provided with a heat source machine,
the control device comprising:
a return water temperature acquisition unit configured to acquire a return water temperature of water returned to the return water well of the geothermal heat utilization system;
a flow rate control unit configured to control a flow rate of a refrigerant flowing from the geothermal heat utilization circuit to the apparatus based on the return water temperature; and
a heat source machine control unit configured to control start and stop of the heat source machine based on the return water temperature.

[Claim 2]

The control device according to claim 1, wherein
when the geothermal heat utilization system performs cooling operation for the apparatus, a first stop temperature at which the stop is to be performed is lower than a first startup temperature at which the start is to be performed.

[Claim 3]

The control device according claim 1, wherein
when the geothermal heat utilization system performs heating operation for the apparatus, a second stop temperature at which the stop is to be performed is higher than a second startup temperature at which the start is to be performed.

[Claim 4]

The control device according to claim 1, wherein
the heat source machine includes a plurality of heat source machines,
and
the heat source machine control unit performs staging control to
increase/decrease the plurality of heat source machines.

[Claim 5]

A control device for a geothermal heat utilization system,
the geothermal heat utilization system comprising:
a heat source well facility including
a pumping well,
a return water well,
a well-side pipe extending from the pumping well to the return water
well, and
a heat exchanger provided at a middle of the well-side pipe; and
a geothermal heat utilization circuit provided between the heat
exchanger and an apparatus,
the control device comprising:
a return water temperature acquisition unit configured to acquire a return
water temperature of water returned to the return water well of the geothermal
heat utilization system; and
a flow rate control unit configured to control a flow rate of a refrigerant
flowing from the geothermal heat utilization circuit to the apparatus based on
the return water temperature,
wherein the control device further includes
a pumping-side water level acquisition unit configured to acquire a
pumping-side water level as a water level of the pumping well, and
a pumping flow rate control unit configured to control a pumping flow
rate from the pumping well based on the pumping-side water level.

[Claim 6]

The control device according to claim 5, wherein
the geothermal heat utilization system further includes an auxiliary heat
supply facility provided at the apparatus in parallel with the geothermal heat
utilization circuit and provided with a heat source machine, and

the control device further includes a heat source machine control unit that controls start and stop of the heat source machine based on the pumping-side water level.

[Claim 7]

A control device for a geothermal heat utilization system,
the geothermal heat utilization system comprising:
a heat source well facility including
a pumping well,
a return water well,
a well-side pipe extending from the pumping well to the return water well, and
a heat exchanger provided at a middle of the well-side pipe; and
a geothermal heat utilization circuit provided between the heat exchanger and an apparatus,
the control device comprising:
a return water temperature acquisition unit configured to acquire a return water temperature of water returned to the return water well of the geothermal heat utilization system; and
a flow rate control unit configured to control a flow rate of a refrigerant flowing from the geothermal heat utilization circuit to the apparatus based on the return water temperature,
wherein the control device further includes
a return-side water level acquisition unit that acquires a return-side water level as a water level of the return water well, and
a return water flow rate control unit that controls a return water flow rate to the return water well based on the return-side water level.

[Claim 8]

The control device according to claim 7, wherein
the geothermal heat utilization system further includes an auxiliary heat supply facility provided at the apparatus in parallel with the geothermal heat utilization circuit and provided with a heat source machine, and
the control device further includes a heat source machine control unit that controls start and stop of the heat source machine based on the return-side water level.

[Claim 9]

A geothermal heat utilization system comprising:
the control device according to any one of claims 1 to 8;
the heat source well facility; and
the geothermal heat utilization circuit.

[Claim 10]

A control method for a geothermal heat utilization system,
the geothermal heat utilization system comprising:
a heat source well facility including
a pumping well,
a return water well,
a well-side pipe extending from the pumping well to the return water
well, and
a heat exchanger provided at a middle of the well-side pipe;
a geothermal heat utilization circuit provided between the heat
exchanger and an apparatus; and
an auxiliary heat supply facility provided at the apparatus in parallel
with the geothermal heat utilization circuit and provided with a heat source
machine,
the control method comprising:
acquiring a return water temperature of water returned to the return
water well of the geothermal heat utilization system;
controlling a flow rate of a refrigerant flowing from the geothermal heat
utilization circuit to the apparatus based on the return water temperature; and
controlling start and stop of the heat source machine based on the return
water temperature.

[Claim 11]

A control method for a geothermal heat utilization system,
the geothermal heat utilization system comprising:
a heat source well facility including
a pumping well,
a return water well,
a well-side pipe extending from the pumping well to the return water
well, and
a heat exchanger provided at a middle of the well-side pipe; and
a geothermal heat utilization circuit provided between the heat
exchanger and an apparatus,

the control method comprising:
acquiring a return water temperature of water returned to the return water well of the geothermal heat utilization system;
controlling a flow rate of a refrigerant flowing from the geothermal heat utilization circuit to the apparatus based on the return water temperature;
acquiring a pumping-side water level as a water level of the pumping well; and
controlling a pumping flow rate from the pumping well based on the pumping-side water level.

[Claim 12]

A control method for a geothermal heat utilization system
the geothermal heat utilization system comprising:
a heat source well facility including
a pumping well,
a return water well,
a well-side pipe extending from the pumping well to the return water well, and
a heat exchanger provided at a middle of the well-side pipe; and
a geothermal heat utilization circuit provided between the heat exchanger and an apparatus
the control method comprising:
acquiring a return water temperature of water returned to the return water well of the geothermal heat utilization system;
controlling a flow rate of a refrigerant flowing from the geothermal heat utilization circuit to the apparatus based on the return water temperature,
acquiring a return-side water level as a water level of the return water well; and
controlling a return water flow rate to the return water well based on the return-side water level.

[Claim 13]

A program for a geothermal heat utilization system
the geothermal heat utilization system comprising:
a heat source well facility including
a pumping well,
a return water well,

a well-side pipe extending from the pumping well to the return water well, and

a heat exchanger provided at a middle of the well-side pipe;

a geothermal heat utilization circuit provided between the heat exchanger and an apparatus; and

an auxiliary heat supply facility provided at the apparatus in parallel with the geothermal heat utilization circuit and provided with a heat source machine,

the program causing a computer to execute:

acquiring a return water temperature of water returned to the return water well of the geothermal heat utilization system;

controlling a flow rate of a refrigerant flowing from the geothermal heat utilization circuit to the apparatus based on the return water temperature; and

controlling start and stop of the heat source machine based on the return water temperature.

[Claim 14]

A program for a geothermal heat utilization system,

the geothermal heat utilization system comprising:

a heat source well facility including

a pumping well,

a return water well,

a well-side pipe extending from the pumping well to the return water well, and

a heat exchanger provided at a middle of the well-side pipe; and

a geothermal heat utilization circuit provided between the heat exchanger and an apparatus,

the program causing a computer to execute:

acquiring a return water temperature of water returned to the return water well of the geothermal heat utilization system;

controlling a flow rate of a refrigerant flowing from the geothermal heat utilization circuit to the apparatus based on the return water temperature;

acquiring a pumping-side water level as a water level of the pumping well; and

controlling a pumping flow rate from the pumping well based on the pumping-side water level.

[Claim 15]

A program for a geothermal heat utilization system,
the geothermal heat utilization system comprising:
a heat source well facility including
a pumping well,
a return water well,
a well-side pipe extending from the pumping well to the return water
well, and
a heat exchanger provided at a middle of the well-side pipe; and
a geothermal heat utilization circuit provided between the heat
exchanger and an apparatus,
the program causing a computer to execute:
acquiring a return water temperature of water returned to the return
water well of the geothermal heat utilization system;
controlling a flow rate of a refrigerant flowing from the geothermal heat
utilization circuit to the apparatus based on the return water temperature;
acquiring a return-side water level as a water level of the return water
well; and
controlling a return water flow rate to the return water well based on the
return-side water level.