

Description

Title of Invention

COMPUTATION DEVICE, COMPUTATION METHOD, PROGRAM,
CONTROL DEVICE, CONTROL METHOD, AND CONTROL PROGRAM

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Technical Field

[0001]

The present disclosure relates to a computation device, a computation method, a program, a control device, a control method, and a control program.

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This application claims priority based on Japanese Patent Application No. 2021-78637 filed on May 6, 2021, contents of which are incorporated herein by reference.

Background Art

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[0002]

In recent years, geothermal heat utilization systems that use ground water as a heating heat source or a cooling heat source have been proposed.

[0003]

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For example, Patent Document 1 proposes a geothermal heat utilization system including a heat source well facility including a hot water well, a cold water well, and a well-side pipe connecting the wells, and a heat source device including a refrigeration cycle including a condenser and an evaporator. In this geothermal heat utilization system, an operation mode can be switched between a cold heat storage operation mode and a cold heat discharge operation mode according to the season. In the cold heat storage operation mode, heat is exchanged between the evaporator of the heat source device and the well-side pipe, and heat is also exchanged between the condenser of the heat source device and a load. In the cold heat discharge operation mode, heat is exchanged between the condenser of the heat source device and the well-side pipe, and heat is also exchanged between the evaporator of the heat source device and the load.

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Citation List

Patent Literature

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[0004]

Patent Document 1: JP 2018-173257 A

Summary of Invention

Technical Problem

[0005]

The geothermal heat utilization system as described in Patent Document 1 is desired to always perform more efficient operation. For example, environmental conditions such as a temperature and a humidity change day by day. Thus, it is preferable to operate the geothermal heat utilization system in a more suitable operation mode according to not only the season such as summer or winter but also conditions during operation.

[0006]

To solve the above-mentioned problems, an object of the present disclosure is to provide a computation device, a computation method, a program, a control device, a control method, and a control program enabling an operation in a heat storage mode suitable for an environmental condition.

Solution to Problem

[0007]

To solve the above-mentioned problems, a computation device according to the present disclosure is a computation device that determines a heat storage mode when heat storage is performed in a geothermal heat utilization system, the geothermal heat utilization system including a heat source well facility including a hot water well, a cold water well, a well-side pipe connecting the hot water well and the cold water well, and a pump provided at the well-side pipe, and an auxiliary heat storage facility including a cooling tower, a chiller, and a refrigerant circuit connected to at least one of the cooling tower or the chiller and configured to exchange heat with the well-side pipe, the computation device including an acquisition unit that acquires a simulation condition, a first calculation unit that calculates, based on the simulation condition, a first simulation result being a result of a simulation in a first heat storage mode in which heat storage by the cooling tower is included, a second calculation unit that calculates, based on the simulation condition, a second simulation result being a result of a simulation in a second heat storage mode in which heat storage by the chiller is included, and a determination unit that determines one of the first heat storage mode and the second heat storage mode based on the first simulation result and the second simulation result.

[0008]

A computation method according to the present disclosure is a computation method of determining a heat storage mode when heat storage is performed in a geothermal heat utilization system, the geothermal heat

utilization system including a heat source well facility including a hot water well, a cold water well, a well-side pipe connecting the hot water well and the cold water well, and a pump provided at the well-side pipe, and an auxiliary heat storage facility including a cooling tower, a chiller, and a refrigerant circuit connected to at least one of the cooling tower or the chiller and configured to exchange heat with the well-side pipe, the computation method including acquiring a simulation condition, calculating, based on the simulation condition, a first simulation result being a result of a simulation in a first heat storage mode in which heat storage by the cooling tower is included, calculating, based on the simulation condition, a second simulation result being a result of a simulation in a second heat storage mode in which heat storage by the chiller is included, and determining one of the first heat storage mode and the second heat storage mode based on the first simulation result and the second simulation result.

15 [0009]

A program according to the present disclosure causes a computer to perform a method of determining a heat storage mode when heat storage is performed in a geothermal heat utilization system, the geothermal heat utilization system including a heat source well facility including a hot water well, a cold water well, a well-side pipe connecting the hot water well and the cold water well, and a pump provided at the well-side pipe, and an auxiliary heat storage facility including a cooling tower, a chiller, and a refrigerant circuit connected to at least one of the cooling tower or the chiller and configured to exchange heat with the well-side pipe, the method including acquiring a simulation condition, calculating, based on the simulation condition, a first simulation result being a result of a simulation in a first heat storage mode in which heat storage by the cooling tower is included, calculating, based on the simulation condition, a second simulation result being a result of a simulation in a second heat storage mode in which heat storage by the chiller is included, and determining one of the first heat storage mode and the second heat storage mode based on the first simulation result and the second simulation result.

Advantageous Effects of Invention

35 [0010]

According to the computation device, the computation method, the program, the control device, the control method, and the control program

according to the present disclosure, it is possible to perform an operation in a heat storage mode suitable for an environmental condition.

Brief Description of Drawings

5 [0011]

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

10 FIG. 2 is a block diagram illustrating a functional configuration of the geothermal heat utilization system according to the embodiment of the present disclosure.

FIG. 3 is a diagram illustrating flows of ground water and a medium when an operation in a cooling operation mode is performed in the geothermal heat utilization system according to the embodiment of the present disclosure.

15 FIG. 4 is a diagram illustrating flows of ground water and a medium when an operation in a heating operation mode is performed in the geothermal heat utilization system according to the embodiment of the present disclosure.

20 FIG. 5 is a diagram illustrating flows of ground water and a medium when a cold water heat storage operation is performed in a first heat storage mode in the geothermal heat utilization system according to the embodiment of the present disclosure.

25 FIG. 6 is a diagram illustrating flows of ground water and a medium when a cold water heat storage operation is performed in a second heat storage mode in the geothermal heat utilization system according to the embodiment of the present disclosure.

FIG. 7 is a flowchart illustrating a procedure of a computation method according to the embodiment of the present disclosure.

FIG. 8 is a flowchart illustrating a procedure of a control method according to the embodiment of the present disclosure.

30 FIG. 9 is a diagram illustrating an exemplary hardware configuration of a computer included in each of a computation device and a control device according to the embodiment of the present disclosure.

Description of Embodiments

35 [0012]

An embodiment according to the present disclosure is described below with reference to the drawings. In all drawings, the same or corresponding

configurations are denoted by the same reference signs, and commonly applicable descriptions are omitted.

[0013]

Embodiments

- 5 An embodiment of a geothermal heat utilization system according to the present disclosure will be described below with reference to FIGS. 1 to 8.

Configuration of Geothermal Heat Utilization System

- 10 As illustrated in FIGS. 1 and 2, the geothermal heat utilization system 1 mainly includes a heat source well facility 10, an auxiliary heat storage facility 100, a heat exchanger 4 (see FIG. 1), a computation device 200 (see FIG. 2), and a control device 300 (see FIG. 2).

[0014]

Configuration of Heat Source Well Facility

- 15 As illustrated in FIG. 1, the heat source well facility 10 mainly includes a hot water well 21, a cold water well 22, a well-side pipe 3, and pumps 31.

[0015]

Each of the hot water well 21 and the cold water well 22 extends from the ground into an aquifer.

- 20 Each of the hot water well 21 and the cold water well 22 is configured to take in ground water in the aquifer and return the ground water from the inside of each of the hot water well 21 and the cold water well 22 to the aquifer.

[0016]

- 25 The heat source well facility 10 pumps the ground water from one of the hot water well 21 and the cold water well 22, performs heat exchange at the heat exchanger 4, and then injects the heat-exchanged ground water into the other of the hot water well 21 and the cold water well 22. That is, the heat source well facility 10 includes two operation modes of a mode of pumping the ground water from the hot water well 21 and injecting the water into the cold water well 22, and a mode of pumping the ground water from the cold water well 22 and injecting the water into the hot water well 21.

[0017]

The well-side pipe 3 connects the hot water well 21 and the cold water well 22.

- 35 Both ends of the well-side pipe 3 extend to the insides of the hot water well 21 and the cold water well 22.

For example, both ends of the well-side pipe 3 may be individually immersed in the ground water of the hot water well 21 and the ground water of

the cold water well 22 to connect the hot water well 21 and the cold water well 22.

[0018]

The well-side pipe 3 is provided with the pumps 31.

5 Each of both end portions of the well-side pipe 3 is provided with a corresponding one of the pumps 31.

The pumps 31 pump the water from the hot water well 21 and the cold water well 22 to the well-side pipe 3.

10 For example, the pumps 31 may be provided at both ends of the well-side pipe 3 and immersed in the ground water of the hot water well 21 and the ground water of the cold water well 22.

For example, the output of the pump 31 may be changeable through inverter control.

[0019]

15 The heat exchanger 4 exchanges heat between the ground water inside the well-side pipe 3 and a medium on the auxiliary heat storage facility 100 side.

20 For example, the heat exchanger 4 exchanges heat between the ground water pumped from the hot water well 21 and flowing inside the well-side pipe 3 and the medium on the auxiliary heat storage facility 100 side. The ground water having been subjected to the heat exchange flows inside the well-side pipe 3 from the heat exchanger 4 and is injected into the cold water well 22.

25 For example, the heat exchanger 4 exchanges heat between the ground water pumped from the cold water well 22 and flowing inside the well-side pipe 3 and the medium on the auxiliary heat storage facility 100 side. The ground water having been subjected to the heat exchange flows inside the well-side pipe 3 from the heat exchanger 4 and is injected into the hot water well 21.

For example, the heat exchanger 4 may be provided in the middle of the well-side pipe 3 at the ground.

30 [0020]

When the water having passed through the heat exchanger 4 is hot water, hot water heat storage is performed in the hot water well 21.

When the water having passed through the heat exchanger 4 is cold water, cold water heat storage is performed in the cold water well 22.

35 Here, "hot water" refers to water having a temperature higher than the initial underground temperature of the ground water in the aquifer, and "cold water" refers to water having a temperature lower than the initial underground temperature of the ground water in the aquifer.

For example, the initial underground temperature of the ground water in the aquifer is 18 °C.

[0021]

Configuration of Auxiliary Heat Storage Facility

5 The auxiliary heat storage facility 100 uses the medium that has exchanged heat in the heat exchanger 4 with the ground water in the well-side pipe 3.

The auxiliary heat storage facility 100 includes at least a cooling tower 130, a heat source device 110, and a refrigerant circuit 101.

10 In the present embodiment, the auxiliary heat storage facility 100 includes, for example, the heat source device 110, an air conditioner 120, the cooling tower 130, and the refrigerant circuit 101.

The auxiliary heat storage facility 100 may constitute, for example, an air conditioning system including the heat source device 110 and the air
15 conditioner 120.

[0022]

For example, the heat source device 110 may be a heat pump including a condenser, an evaporator, a compressor, and the like.

The air conditioner 120 performs air conditioning of a space where the
20 air conditioner 120 is installed by exchanging heat with the medium (cold water) supplied from the heat source device 110.

[0023]

The cooling tower 130 cools cooling water by heat of vaporization when the cooling water is brought into contact with the atmosphere and vaporized.
25 The cooling tower 130 circulates the cooling water between the cooling tower 130 and a second heat exchanger 140.

The second heat exchanger 140 performs heat exchange between the medium (cooling water) of the refrigerant circuit 101 on the air conditioning system side and the cooling water on the cooling tower 130 side.

30 The second heat exchanger 140 cools the medium of the refrigerant circuit 101 on the air conditioning system side by heat exchange with the cooling water cooled by the cooling tower 130.

The heat source device 110 and the cooling tower 130 constitute a chiller 150.

35 [0024]

The refrigerant circuit 101 forms a flow path of the medium between the heat exchanger 4, the heat source device 110, the air conditioner 120, and the second heat exchanger 140.

The refrigerant circuit 101 is appropriately provided with a pump, an on-off valve, and the like (not illustrated) and circulates the medium along a predetermined route between the heat exchanger 4, the heat source device 110, the air conditioner 120, and the second heat exchanger 140 in accordance with the operation mode.

For example, the auxiliary heat storage facility 100 can switch an operation mode between a cooling operation mode and a heating operation mode by switching the circulation route of the medium in the refrigerant circuit 101.

[0025]

Configuration of Cooling Operation Mode

As illustrated in FIG. 3, in the cooling operation mode, a cooling operation is performed on the auxiliary heat storage facility 100 side, and hot water heat storage is performed in the hot water well 21. In this case, the pump 31 of the cold water well 22 pumps the ground water and feed the ground water to the heat exchanger 4. The heat exchanger 4 exchanges heat between the ground water inside the well-side pipe 3 and the medium flowing through the refrigerant circuit 101 on the auxiliary heat storage facility 100 side. On the auxiliary heat storage facility 100 side, the medium (cooling water) cooled by the heat exchange in the heat exchanger 4 is fed to the heat source device 110 and exchanges heat in the heat source device 110 with the medium (cold water) on the air conditioner 120 side. This allows the air conditioner 120 connected to the heat source device 110 to perform indoor cooling. On the other hand, the medium (cooling water) heated by the heat exchange in the heat source device 110 is fed again to the heat exchanger 4, cooled, and then circulated. In the heat exchanger 4, heat is exchanged between the heated medium and the ground water flowing inside the well-side pipe 3, and thus the ground water is heated. The heated ground water is injected into the hot water well 21 through the well-side pipe 3, so that hot water heat storage is performed.

[0026]

Configuration of Heating Operation Mode

As illustrated in FIG. 4, in the heating operation mode, a heating operation is performed on the auxiliary heat storage facility 100 side, and cold water heat storage is performed in the cold water well 22. In this case, the pump 31 of the hot water well 21 pumps the ground water (hot water) and feeds the ground water to the heat exchanger 4. The heat exchanger 4 exchanges heat between the ground water inside the well-side pipe 3 and the medium flowing through the refrigerant circuit 101 on the auxiliary heat storage facility 100

side. On the auxiliary heat storage facility 100 side, the medium heated by the heat exchange in the heat exchanger 4 is fed to the heat source device 110 and exchanges heat in the heat source device 110. This allows the air conditioner 120 connected to the heat source device 110 to perform indoor heating. On the other hand, the medium cooled by the heat exchange in the heat source device 110 is fed again to the heat exchanger 4 and circulated. In the heat exchanger 4, heat is exchanged between the cooled medium and the ground water flowing inside the well-side pipe 3, so that the ground water is cooled. The cooled ground water is injected into the cold water well 22 through the well-side pipe 3, so that cold water heat storage is performed.

[0027]

In addition, in winter (or at night) when the outside air temperature is low, the geothermal heat utilization system 1 can perform cold water heat storage in the cold water well 22 by cooling the ground water in a state where a heating operation is not performed.

When the geothermal heat utilization system 1 performs the cold water heat storage, the heat storage mode can be switched between a first heat storage mode including heat storage by the cooling tower 130 and a second heat storage mode including heat storage by the chiller 150.

The geothermal heat utilization system 1 performs the cold water heat storage in one of the first heat storage mode and the second heat storage mode under control of the control device 300 described below.

[0028]

Configuration of First Heat Storage Mode

As illustrated in FIG. 5, in the first heat storage mode, the cooling water cooled by heat of vaporization when being brought into contact with the atmosphere and vaporized in the cooling tower 130 is fed to the second heat exchanger 140. In the second heat exchanger 140, heat is exchanged between the cooling water and the medium of the refrigerant circuit 101. That is, the second heat exchanger 140 cools the medium of the refrigerant circuit 101 using the cooling water cooled by the cooling tower 130. The cooled medium is fed to the heat exchanger 4 and exchanges heat with the ground water in the well-side pipe 3. In this case, the pump 31 of the hot water well 21 pumps the ground water (hot water) and feeds the ground water to the heat exchanger 4. As a result, the ground water in the well-side pipe 3 is cooled and injected into the cold water well 22, so that cold water heat storage is performed.

[0029]

Configuration of Second Heat Storage Mode

As illustrated in FIG. 6, in the second heat storage mode, the cooling tower 130 and the heat source device 110 are used as the chiller 150. In this case, the pump 31 of the hot water well 21 pumps the ground water (hot water) and feeds the ground water to the heat exchanger 4. On the auxiliary heat storage facility 100 side, the medium is fed from the second heat exchanger 140 side to the heat source device 110. The heat source device 110 cools the medium (cold water) fed from the heat exchanger 4 side by heat exchange. The medium (cold water) cooled by the heat exchange in the heat source device 110 is fed to the heat exchanger 4. In the heat exchanger 4, heat is exchanged between the cooled medium and the ground water flowing inside the well-side pipe 3, so that the ground water is cooled. The cooled ground water is injected into the cold water well 22 through the well-side pipe 3, so that cold water heat storage is performed. On the other hand, the medium (cooling water) having a temperature increased by the heat exchange in the heat source device 110 with the medium (cold water) on the heat exchanger 4 side is fed to the second heat exchanger 140. The second heat exchanger 140 cools the medium fed from the heat source device 110 by heat exchange with the cooling water cooled by the cooling tower 130.

[0030]

Configuration of Computation Device

As illustrated in FIG. 2, the computation device 200 determines a heat storage mode when heat storage is performed in the geothermal heat utilization system 1.

When cold water heat storage is performed in the geothermal heat utilization system 1, the computation device 200 performs simulation computation in advance to determine which of the first heat storage mode and the second heat storage mode is appropriate to perform the cold water heat storage. The computation device 200 determines one of the first heat storage mode and the second heat storage mode based on a result of the simulation computation.

[0031]

In the present embodiment, the computation device 200 is provided in the geothermal heat utilization system 1. That is, the computation device 200 is provided at the installation position of the geothermal heat utilization system 1.

The computation device 200 may be provided together with the control device 300, for example.

The computation device 200 may be incorporated in the control device 300 as a partial configuration of the control device 300.

In addition, the computation device 200 may be provided at a position different from the installation position of the geothermal heat utilization system 1.

For example, the computation device 200 may be provided so as to be able to perform data communication with the control device 300 via a wired or wireless external network.

[0032]

The computation device 200 functionally includes an acquisition unit 210, a first calculation unit 220, a second calculation unit 230, a temperature calculation unit 240, and a determination unit 250.

[0033]

The acquisition unit 210 acquires a simulation condition.

The acquisition unit 210 acquires the simulation condition serving as a premise of the simulation computation performed for determination of the heat storage mode.

Examples of the acquired simulation condition include an outside air condition.

Examples of the outside air condition may include at least one of an outside air temperature or an outside air humidity.

The outside air condition may include both of the outside air temperature and the outside air humidity.

In the present embodiment, examples of the outside air condition include an outside air temperature (range) and an outside air humidity (range) assumed in a place (area) where the geothermal heat utilization system 1 is installed.

The simulation condition acquired by the acquisition unit 210 may include a pumped water temperature and an upper limit injected water temperature. The pumped water temperature is a temperature of the ground water that can be pumped in the hot water well 21. The upper limit injected water temperature is an upper limit value of the injected water temperature of the ground water injected into the cold water well 22 when cold water heat storage is performed in the cold water well 22. The upper limit injected water temperature is, for example, an upper limit value of the injected water temperature at which the temperature increase of the ground water in the cold water well 22 is suppressed when the ground water is injected into the cold water well 22.

The acquisition unit 210 acquires the outside air temperature and the outside air humidity as virtual outside air conditions for performing the simulation.

[0034]

The acquisition unit 210 may include specifications of devices constituting the heat source well facility 10 and the auxiliary heat storage facility 100 as the simulation conditions.

5 Examples of the specifications of the devices may include specifications of the pumps 31 of the heat source well facility 10, the heat source device 110 of the auxiliary heat storage facility 100, the cooling tower 130, a pump (not illustrated) provided at the refrigerant circuit 101, the medium on the auxiliary heat storage facility 100 side, and the like.

10 [0035]

The acquisition unit 210 may acquire the simulation conditions by, for example, an operator receiving input of numerical values or the like of the respective simulation conditions.

15 The acquisition unit 210 may acquire the simulation condition from, for example, a database or the like that stores the specifications of the devices constituting the heat source well facility 10 and the auxiliary heat storage facility 100.

[0036]

20 The first calculation unit 220 performs the simulation computation of the first heat storage mode including heat storage by the cooling tower 130 based on the simulation condition acquired by the acquisition unit 210.

25 Based on the simulation condition, the first calculation unit 220 performs the simulation computation in a case where an operation is performed in the first heat storage mode including heat storage using the cooling tower 130 as illustrated in FIG. 5.

The first calculation unit 220 performs the simulation computation in a case where cold water heat storage is performed in the cold water well 22 by cooling the medium using the cooling tower 130.

30 The first calculation unit 220 performs the simulation computation a plurality of times by variously changing the temperature and the humidity within the range of the virtual outside air temperature and the virtual outside air humidity acquired as the virtual outside air conditions.

The first calculation unit 220 calculates (outputs) a first simulation result which is a result obtained by the simulation computation.

35 The first calculation unit 220 may include at least one of an injected water temperature, a heat storage amount, or power as the first simulation result obtained by the simulation computation. The injected water temperature is a temperature of the ground water injected into the cold water well 22 from the

well-side pipe 3 that has exchanged heat with the refrigerant circuit 101. The heat storage amount is an energy amount obtained by injecting the water into the cold water well 22 from the well-side pipe 3 that has exchanged heat with the refrigerant circuit 101. The power required for heat storage is power for
5 operating the pumps 31 on the heat source well facility 10 side, various pumps (not illustrated) provided at the refrigerant circuit 101 of the auxiliary heat storage facility 100, and the cooling tower 130, which are required for heat storage in the first heat storage mode.

[0037]

10 The second calculation unit 230 performs the simulation computation of the second heat storage mode including heat storage by the chiller 150 (the heat source device 110 and the cooling tower 130) based on the simulation condition acquired by the acquisition unit 210.

Based on the simulation condition, the second calculation unit 230
15 performs the simulation computation in a case where an operation is performed in the second heat storage mode including heat storage using the chiller 150 as illustrated in FIG. 6.

The second calculation unit 230 performs the simulation computation in a case where cold water heat storage is performed in the cold water well 22 by
20 cooling the medium using the chiller 150.

The second calculation unit 230 performs the simulation computation a plurality of times by changing the temperature and the humidity within ranges of the virtual outside air temperature and the virtual outside air humidity acquired as the virtual outside air conditions.

25 The second calculation unit 230 calculates (outputs) a second simulation result which is a result obtained by the simulation computation.

The second calculation unit 230 may include at least one of the injected water temperature, the heat storage amount, or the power as the calculated second simulation result.

30 The second calculation unit 230 may calculate the second simulation result such that the heat storage amount in the second heat storage mode becomes the same as the heat storage amount in the first heat storage mode.

The power calculated by the second calculation unit 230 is power for operating the pumps 31 on the heat source well facility 10 side, various pumps
35 (not illustrated) provided on the refrigerant circuit 101 side of the auxiliary heat storage facility 100, the cooling tower 130, and the heat source device 110.

[0038]

In the first heat storage mode, the temperature calculation unit 240 calculates the limit outside air temperature at which the injected water temperature of the ground water injected into the cold water well 22 from the well-side pipe 3 that has exchanged heat with the refrigerant circuit 101

5 becomes the upper limit injected water temperature.

[0039]

The determination unit 250 determines one of the first heat storage mode and the second heat storage mode based on the first simulation result calculated by the first calculation unit 220 and the second simulation result calculated by
10 the second calculation unit 230.

For example, the determination unit 250 may compare the injected water temperatures, the heat storage amounts, and the powers included in the first simulation result and the second simulation result.

For example, as a result of the comparison between the first simulation
15 result and the second simulation result, the determination unit 250 determines that, for example, one of the first heat storage mode and the second heat storage mode in which the injected water temperature is lower is the heat storage mode.

When the simulation is performed such that the heat storage amount in the second heat storage mode becomes the same as the heat storage amount in
20 the first heat storage mode, the determination unit 250 may determine that one of the first heat storage mode and the second heat storage mode in which the injected water temperature is lower is the heat storage mode.

For example, as a result of the comparison between the first simulation result and the second simulation result, the determination unit 250 determines
25 that, for example, one of the first heat storage mode and the second heat storage mode in which the heat storage amount is larger is the heat storage mode.

For example, based on the comparison result between the first simulation result and the second simulation result, such as a comparison result between the power required for heat storage in the first heat storage mode and
30 the power required for heat storage in the second heat storage mode, the determination unit 250 determines that one of the first heat storage mode and the second heat storage mode in which the power is smaller is the heat storage mode.

When the simulation is performed such that the heat storage amount in
35 the second heat storage mode becomes the same as the heat storage amount in the first heat storage mode, the determination unit 250 may determine, based on the comparison result between the power required for heat storage in the first heat storage mode and the power required for heat storage in the second heat

storage mode, that one of the first heat storage mode and the second heat storage mode in which the power is smaller is the heat storage mode.

[0040]

In addition, the determination unit 250 selects the second heat storage mode as the heat storage mode under the condition of the virtual outside air temperature equal to or higher than the limit outside air temperature calculated by the temperature calculation unit 240. This is because, in the first heat storage mode in which the cooling tower 130 is used, cooling by the cooling tower 130 may not be sufficiently performed when the outside air temperature is high, and the injected water temperature may become equal to or higher than the upper limit injected water temperature.

The determination unit 250 may compare a predetermined target cold water heat storage amount (for example, cold water heat storage is performed such that the cold water heat storage amount and the hot water heat storage amount are predicted to become the same) with the current cold water heat storage amount, and determine that the second heat storage mode enabling a larger amount of cold water heat storage is the heat storage mode. This is because a sufficient cold water heat storage amount cannot be obtained in the first heat storage mode in which the cooling tower 130 is used.

[0041]

As a result of the comparison between the first simulation result and the second simulation result, the determination unit 250 generates heat storage mode information associated with the determined one of the first heat storage mode and the second heat storage mode for each virtual outside air condition when the simulation computation has been performed.

The determination unit 250 may generate heat storage mode information in which the determined heat storage mode is associated with the virtual outside air temperature (for example, every 1 °C) at which the simulation computation has been performed.

The determination unit 250 may generate heat storage mode information in which the determined heat storage mode is associated with the virtual outside air humidity (for example, every 5%) at which the simulation computation has been performed.

The determination unit 250 may generate heat storage mode information in which the determined heat storage mode is associated with each combination of the virtual outside air temperature and the virtual outside air humidity at which the simulation computation has been performed.

The determination unit 250 outputs the generated heat storage mode information to the control device 300 described below.

[0042]

5 An operation of the computation device 200 of the present embodiment will be described below.

The operation of the computation device 200 corresponds to an embodiment of the computation method.

The computation device 200 performs each step illustrated in FIG. 7.

[0043]

10 First, the acquisition unit 210 acquires a simulation condition (ST01: a step of acquiring a simulation condition). The acquisition unit 210 acquires an outside air condition (outside air temperature and outside air humidity) as the simulation condition.

15 For example, a pumped water temperature and an upper limit injected water temperature may be further acquired as the simulation conditions.

For example, the acquisition unit 210 may further acquire, as the simulation conditions, specifications of the pumps 31 of the heat source well facility 10, the heat source device 110 of the auxiliary heat storage facility 100, the cooling tower 130, a pump (not illustrated) provided at the refrigerant circuit 101, the medium on the auxiliary heat storage facility 100 side, and the like.

[0044]

25 After ST01 is performed, the first calculation unit 220 performs, based on the simulation condition acquired by the acquisition unit 210, simulation computation of the first heat storage mode including heat storage by the cooling tower 130 and obtains a first simulation result (ST02: a step of performing simulation computation in the first heat storage mode).

[0045]

30 After ST02 is performed, the second calculation unit 230 performs, based on the simulation condition acquired by the acquisition unit 210, simulation computation of the second heat storage mode including heat storage by the chiller 150 and obtains a second simulation result (ST03: a step of performing simulation computation in the second heat storage mode).

[0046]

35 After ST03 is performed, the determination unit 250 compares power required for heat storage in the first heat storage mode with power required for heat storage in the second heat storage mode based on the first simulation result obtained in ST02 and the second simulation result obtained in ST03 (ST04: a

step of comparing power in the first heat storage mode with power in the second heat storage mode).

[0047]

Further, after ST02 is performed, the temperature calculation unit 240
5 calculates a limit outside air temperature at which the temperature of injected water to the cold water well 22 becomes the upper limit injected water temperature when heat storage is performed in the first heat storage mode (ST05: a step of calculating a limit outside air temperature in the first heat storage mode). Regarding ST05, ST04 and ST05 may be performed in parallel,
10 or ST05 may be performed before or after ST03 and ST04.

[0048]

After ST04 and ST05 complete, the determination unit 250 determines one of the first heat storage mode and the second heat storage mode based on the first simulation result calculated by the first calculation unit 220 and the
15 second simulation result calculated by the second calculation unit 230 (ST06: a step of determining a heat storage mode). The determination unit 250 may compare the injected water temperatures, the heat storage amounts, and the powers included in the first simulation result and the second simulation result and determine the heat storage mode, for example, so as to enhance energy
20 conservation.

The determination unit 250 may select the second heat storage mode as the heat storage mode, for example, at a virtual outside air temperature equal to or higher than the limit outside air temperature so that the temperature of the injected water to the cold water well 22 does not exceed the upper limit
25 injected water temperature.

[0049]

After ST06 is performed, the determination unit 250 generates heat storage mode information associated with the determined heat storage mode for each virtual outside air condition (ST07: a step of generating heat storage mode
30 information). The determination unit 250 outputs the generated heat storage mode information to the control device 300.

[0050]

Configuration of Control Device

As illustrated in FIG. 2, the control device 300 controls an operation of
35 the geothermal heat utilization system 1.

The control device 300 controls an operation of each unit of the geothermal heat utilization system 1 in each of the cooling operation mode, the

heating operation mode, the first heat storage mode, and the second heat storage mode.

When cold water heat storage is performed, the control device 300 operates in the heat storage mode determined by the computation device 200.

5 The control device 300 operates, based on the actual outside air condition during operation, the geothermal heat utilization system 1 in the heat storage mode corresponding to the actual outside air condition.
[0051]

10 The control device 300 includes a mode information storage unit 310, an outside air condition acquisition unit 320, and an operation control unit 330.
[0052]

The mode information storage unit 310 stores the heat storage mode information output from the computation device 200.

15 The mode information storage unit 310 stores the heat storage mode information associated with the heat storage mode determined for each computation device 200 and each virtual outside air condition.
[0053]

The outside air condition acquisition unit 320 acquires an actual outside air condition.

20 The outside air condition acquisition unit 320 acquires at least one of an actual outside air temperature or an actual outside air humidity as the actual outside air condition.

25 The outside air condition acquisition unit 320 may acquire both the actual outside air temperature and the actual outside air humidity as the actual outside air conditions.

30 For example, the outside air condition acquisition unit 320 may acquire, as the actual outside air conditions, detection values of the actual outside air temperature and the actual outside air humidity at a place where the geothermal heat utilization system 1 is provided, which are obtained by a thermometer, a hygrometer, and the like.

For example, the outside air condition acquisition unit 320 may acquire numerical values of the actual outside air temperature and the actual outside air humidity input by the operator.

35 The outside air condition acquisition unit 320 may acquire data of the actual outside air temperature and the actual outside air humidity via an external network.

[0054]

The operation control unit 330 operates the geothermal heat utilization system 1 based on the heat storage mode information stored in the mode information storage unit 310.

5 The operation control unit 330 operates the geothermal heat utilization system 1 in one of the first heat storage mode and the second heat storage mode based on the heat storage mode information stored in the mode information storage unit 310 and the actual outside air condition.

10 The operation control unit 330 acquires the heat storage mode associated with the virtual outside air condition corresponding to the acquired actual outside air condition with reference to the heat storage mode information stored in the mode information storage unit 310.

The operation control unit 330 controls each unit of the heat source well facility 10 and the auxiliary heat storage facility 100 in the acquired heat storage mode to perform cold water heat storage operation.

15 [0055]

An operation of the control device 300 of the present embodiment will be described below.

The operation of the control device 300 corresponds to an embodiment of the control method.

20 The control device 300 performs each step illustrated in FIG. 8.
[0056]

First, the outside air condition acquisition unit 320 acquires an actual outside air condition (ST11: a step of acquiring an actual outside air condition).
[0057]

25 After ST11 is performed, the operation control unit 330 acquires the heat storage mode associated with the virtual outside air condition corresponding to the acquired actual outside air condition with reference to the heat storage mode information stored in the mode information storage unit 310 (ST12: a step of acquiring information about the heat storage mode corresponding to the
30 actual outside air condition). The operation control unit 330 acquires one of the first heat storage mode and the second heat storage mode that is determined to be appropriate by the computation device 200 as a result of the comparison under the actual outside air condition at that time.
[0058]

35 After ST12 is performed, the operation control unit 330 operates the geothermal heat utilization system 1 based on the acquired heat storage mode (ST13: a step of operating the geothermal heat utilization system in the acquired heat storage mode).

When acquiring the first heat storage mode so as to correspond to the actual outside air condition, the operation control unit 330 performs cold water heat storage in the first heat storage mode.

When acquiring the second heat storage mode so as to correspond to the actual outside air condition, the operation control unit 330 performs cold water heat storage in the second heat storage mode.

[0059]

Operational Effects

According to the present embodiment, the computation device 200 determines the heat storage mode based on the first simulation result in a case where the first heat storage mode including heat storage by the cooling tower 130 is performed and the second simulation result in a case where the second heat storage mode including heat storage by the chiller 150 is performed.

Accordingly, the computation device 200 can determine the heat storage mode suitable for the environmental condition with high accuracy based on the simulation. As a result, the geothermal heat utilization system 1 can operate in the heat storage mode suitable for the environmental condition.

[0060]

Further, according to an example of the present embodiment, each of the first simulation result and the second simulation result includes at least one of the injected water temperature, the heat storage amount, or the power.

Accordingly, the determination unit 250 can appropriately determine the heat storage mode by comparing at least one of the injected water temperature, the heat storage amount, or the power between the first heat storage mode including heat storage by the cooling tower 130 and the second heat storage mode including heat storage by the chiller 150.

[0061]

Further, according to an example of the present embodiment, the determination unit 250 compares the power required for heat storage in the first heat storage mode with the power required for heat storage in the second heat storage mode. This allows the determination unit 250 to select the heat storage mode that requires less power and that achieves enhanced energy conservation.

[0062]

In addition, according to an example of the present embodiment, the second calculation unit 230 calculates the second simulation result such that the heat storage amount in the second heat storage mode becomes the same as the heat storage amount in the first heat storage mode. Accordingly, the determination unit 250 can select an appropriate heat storage mode by

comparing the first heat storage mode and the second heat storage mode in a state in which the heat storage amounts are the same in the first heat storage mode and the second heat storage mode.

[0063]

- 5 In addition, according to an example of the present embodiment, the determination unit 250 determines one of the first heat storage mode and the second heat storage mode in association with each of the plurality of virtual outside air conditions. By determining the heat storage mode in association with the virtual outside air condition in this way, the geothermal heat utilization
10 system 1 can operate in an appropriate heat storage mode according to the actual outside air condition during operation.

[0064]

- According to an example of the present embodiment, the virtual outside air condition includes at least one of the virtual outside air temperature or the
15 virtual outside air humidity.

 Thus, the geothermal heat utilization system 1 can operate in an appropriate heat storage mode according to the actual outside air temperature and the actual outside air humidity during operation.

[0065]

- 20 According to an example of the present embodiment, the determination unit 250 selects the second heat storage mode as the heat storage mode at the virtual outside air temperature equal to or higher than the limit outside air temperature.

- Accordingly, when the actual outside air temperature is high and cooling
25 by the cooling tower 130 increases the injected water temperature, the geothermal heat utilization system 1 does not perform the cooling by the cooling tower 130 and performs heat storage using the chiller 150, which can suppress an increase in the injected water temperature.

[0066]

- 30 According to the computation method of the present embodiment, by determining the heat storage mode based on the first simulation result and the second simulation result, it is possible to determine the heat storage mode suitable for the environmental condition based on the simulation with high accuracy. As a result, the geothermal heat utilization system 1 can operate in
35 the heat storage mode suitable for the environmental condition.

[0067]

 According to the present embodiment, the control device 300 includes the mode information storage unit 310 storing the heat storage mode

information related to the heat storage mode determined by the computation device 200, and the operation control unit 330 operating the geothermal heat utilization system 1 based on the heat storage mode information stored in the mode information storage unit 310.

5 As a result, the geothermal heat utilization system 1 can operate in the heat storage mode that is determined with high accuracy based on the simulation by the computation device 200 and that is suitable for the environmental condition.

[0068]

10 According to an example of the present embodiment, the operation control unit 330 operates the geothermal heat utilization system 1 based on the heat storage mode associated with the actual outside air condition acquired by the outside air condition acquisition unit 320.

 Accordingly, it is possible to operate the geothermal heat utilization
15 system 1 in the heat storage mode that is determined with high accuracy based on the simulation by the computation device 200 and that is suitable for the environmental condition. As a result, the geothermal heat utilization system 1 can operate in the heat storage mode suitable for the environmental condition.

[0069]

20 According to the control method of the present embodiment, it is possible to operate the geothermal heat utilization system 1 in the heat storage mode that is determined with high accuracy based on the simulation by the computation device 200 and that is suitable for the environmental condition. As a result, the geothermal heat utilization system 1 can operate in the heat storage
25 mode suitable for the environmental condition.

[0070]

Modifications

 Note that in the above-described embodiment, a program for achieving various functions of each of the computation device 200 and the control device
30 300 is recorded in a computer-readable recording medium, and various types of processing are performed by a computer system such as a microcomputer reading and executing the program recorded in the recording medium. Here, the procedure of the various processing of the CPU of the computer system is stored in the computer-readable recording medium in the form of a program,
35 and the various processing is performed by reading and executing that program by the computer. In addition, the computer-readable recording medium is a magnetic disc, a magneto-optical disc, a CD-ROM, a DVD-ROM, a semiconductor memory, and the like. In addition, this computer program may

be distributed to a computer through a communication line, and the computer receiving this distribution may execute the program.

[0071]

In the above-described embodiment, an exemplary hardware
5 configuration of a computer 190 that executes the program for achieving various functions of each of the computation device 200 and the control device 300 will be described below.

[0072]

As illustrated in FIG. 9, the computer 190 included in each of the
10 computation device 200 and the control device 300 includes a processor 195, a memory 196, a storage/reproduction device 197, an input output interface (hereinafter referred to as an "IO I/F") 198, and a communication interface (hereinafter referred to as a "communication I/F") 199.

[0073]

15 For example, the processor 195 may be a CPU.

For example, the memory 196 may be a medium such as a random access memory (hereinafter referred to as a "RAM") for temporarily storing data and the like used in the program executed by each of the computation device 200 and the control device 300.

20 For example, the storage/reproduction device 197 may be a device for storing data and the like in an external medium such as a CD-ROM, a DVD, and a flash memory, and/or reproducing data and the like of the external medium.

For example, the IO I/F 198 may be an interface for inputting and
25 outputting information and the like between each of the computation device 200 and the control device 300 and another device.

For example, the communication I/F 199 may be an interface for performing communication between each of the computation device 200 and the control device 300 and another device through a communication line such
30 as the Internet and a dedicated communication line.

[0074]

Other Embodiments

While the embodiments of the present disclosure are described above, the embodiments are examples, and are not intended to limit the scope of the
35 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

variations thereof are included in the scope of the present disclosure and equivalents thereof as well as in the scope and gist of the present disclosure.

[0075]

Supplementary Notes

- 5 The computation device 200, the computation method, the program, the control device 300, the control method, and the control program according to the embodiment are understood as follows, for example.

[0076]

- 10 (1) A computation device 200 according to a first aspect is a computation device 200 determining a heat storage mode when heat storage is performed in a geothermal heat utilization system 1, the geothermal heat utilization system 1 including a heat source well facility 10 and an auxiliary heat storage facility 100, the heat source well facility 10 including a hot water well 21, a cold water well 22, a well-side pipe 3 connecting the hot water well 21 and the cold water well 22, and a pump 31 provided at the well-side pipe 3, the auxiliary heat storage facility 100 including a cooling tower 130, a chiller 150, and a refrigerant circuit 101 connected to at least one of the cooling tower 130 or the chiller 150, the refrigerant circuit 101 being capable of exchanging heat with the well-side pipe 3, the computation device 200 including an acquisition unit 210 acquiring a simulation condition, a first calculation unit 220 calculating a first simulation result based on the simulation condition, the first simulation result being a result of a simulation in a first heat storage mode including heat storage by the cooling tower 130, a second calculation unit 230 calculating a second simulation result based on the simulation condition, the second simulation result being a result of a simulation in a second heat storage mode including heat storage by the chiller 150, and a determination unit 250 determining one of the first heat storage mode and the second heat storage mode based on the first simulation result and the second simulation result.

[0077]

- 30 The computation device 200 determines the heat storage mode based on the first simulation result in a case where the first heat storage mode including heat storage by the cooling tower 130 is performed and the second simulation result in a case where the second heat storage mode including heat storage by the chiller 150 is performed. Accordingly, the computation device 200 can determine the heat storage mode suitable for the environmental condition with high accuracy based on the simulation. As a result, the geothermal heat utilization system 1 can operate in the heat storage mode suitable for the environmental condition.

[0078]

(2) A computation device 200 according to a second aspect is the computation device 200 according to (1), in which the first simulation result and the second simulation result each may include at least one of a temperature of injected water to the cold water well 22 from the well-side pipe 3 having exchanged heat with the refrigerant circuit 101, a heat storage amount on a side of the heat source well facility 10, or power required for heat storage.

[0079]

Accordingly, the determination unit 250 can appropriately determine the heat storage mode by comparing at least one of the injected water temperature, the heat storage amount, or the power between the first heat storage mode including heat storage by the cooling tower 130 and the second heat storage mode including heat storage by the chiller 150.

[0080]

(3) A computation device 200 according to a third aspect is the computation device 200 according to (1) or (2), in which the determination unit 250 may determine the heat storage mode based on a comparison result between power required for heat storage in the first heat storage mode and power required for heat storage in the second heat storage mode.

[0081]

Thus, by comparing the power required for heat storage in the first heat storage mode and the power required for heat storage in the second heat storage mode, the determination unit 250 can select a heat storage mode achieving more enhanced energy conservation.

[0082]

(4) A computation device 200 according to a fourth aspect is the computation device 200 according to any one of (1) to (3), in which the second calculation unit 230 may calculate the second simulation result such that the heat storage amount in the second heat storage mode becomes the same as the heat storage amount in the first heat storage mode.

[0083]

Accordingly, the determination unit 250 can select an appropriate heat storage mode by comparing the first heat storage mode and the second heat storage mode in a state in which the heat storage amounts are the same in the first heat storage mode and the second heat storage mode.

[0084]

(5) A computation device 200 according to a fifth aspect is the computation device 200 according to any one of (1) to (4), in which the

determination unit 250 may determine one of the first heat storage mode and the second heat storage mode in association with an individual virtual outside air condition of a plurality of virtual outside air conditions.

[0085]

5 Thus, by determining the heat storage mode in association with the virtual outside air condition, the geothermal heat utilization system 1 can operate in an appropriate heat storage mode according to the actual outside air condition during operation.

[0086]

10 (6) A computation device 200 according to a sixth aspect is the computation device 200 according to (5), in which the plurality of virtual outside air conditions each may include at least one of a virtual outside air temperature or a virtual outside air humidity.

[0087]

15 Thus, the geothermal heat utilization system 1 can operate in an appropriate heat storage mode according to the actual outside air temperature and the actual outside air humidity during operation.

[0088]

20 (7) A computation device 200 according to a seventh aspect is the computation device 200 according to (6) that may further include a temperature calculation unit 240 calculating, in the first heat storage mode, a limit outside air temperature at which a temperature of injected water to the cold water well 22 from the well-side pipe 3 having exchanged heat with the refrigerant circuit 101 becomes an upper limit injected water temperature, in which the
25 determination unit 250 may select the second heat storage mode as the heat storage mode at the virtual outside air temperature equal to or higher than the limit outside air temperature.

[0089]

30 Accordingly, by selecting the second heat storage mode as the heat storage mode at the virtual outside air temperature at which the injected water temperature becomes equal to or higher than the upper limit injected water temperature, the geothermal heat utilization system 1 can suppress an increase in the injected water temperature by performing heat storage using the chiller 150 without performing cooling by the cooling tower 130 when the actual
35 outside air temperature is high and the cooling by the cooling tower 130 increases the injected water temperature.

[0090]

(8) A computation method according to an eighth aspect is a computation method of determining a heat storage mode when heat storage is performed in a geothermal heat utilization system 1, the geothermal heat utilization system 1 including a heat source well facility 10 and an auxiliary heat storage facility 100, the heat source well facility 10 including a hot water well 21, a cold water well 22, a well-side pipe 3 connecting the hot water well 21 and the cold water well 22, and a pump 31 provided at the well-side pipe 3, the auxiliary heat storage facility 100 including a cooling tower 130, a chiller 150, and a refrigerant circuit 101 connected to at least one of the cooling tower 130 or the chiller 150, the refrigerant circuit 101 being capable of exchanging heat with the well-side pipe 3, the computation method including acquiring a simulation condition, calculating a first simulation result based on the simulation condition, the first simulation result being a result of a simulation in a first heat storage mode including heat storage by the cooling tower 130, calculating a second simulation result based on the simulation condition, the second simulation result being a result of a simulation in a second heat storage mode including heat storage by the chiller 150, and determining one of the first heat storage mode and the second heat storage mode based on the first simulation result and the second simulation result.

[0091]

Thus, by determining the heat storage mode based on the first simulation result and the second simulation result, it is possible to determine the heat storage mode suitable for the environmental condition with high accuracy based on the simulation. As a result, the geothermal heat utilization system 1 can operate in the heat storage mode suitable for the environmental condition.

[0092]

(9) A program according to a ninth aspect causes a computer to perform a method of determining a heat storage mode when heat storage is performed in a geothermal heat utilization system 1, the geothermal heat utilization system 1 including a heat source well facility 10 and an auxiliary heat storage facility 100, the heat source well facility 10 including a hot water well 21, a cold water well 22, a well-side pipe 3 connecting the hot water well 21 and the cold water well 22, and a pump 31 provided at the well-side pipe 3, the auxiliary heat storage facility 100 including a cooling tower 130, a chiller 150, and a refrigerant circuit 101 connected to at least one of the cooling tower 130 or the chiller 150, the refrigerant circuit 101 being capable of exchanging heat with the well-side pipe 3, the method including acquiring a simulation condition, calculating a first simulation result based on the simulation condition, the first

simulation result being a result of a simulation in a first heat storage mode including heat storage by the cooling tower 130, calculating a second simulation result based on the simulation condition, the second simulation result being a result of a simulation in a second heat storage mode including heat storage by the chiller 150, and determining one of the first heat storage mode and the second heat storage mode based on the first simulation result and the second simulation result.

[0093]

Thus, by determining the heat storage mode based on the first simulation result and the second simulation result, it is possible to determine the heat storage mode suitable for the environmental condition with high accuracy based on the simulation. As a result, the geothermal heat utilization system 1 can operate in the heat storage mode suitable for the environmental condition.

[0094]

(10) A control device 300 according to a tenth aspect includes a mode information storage unit 310 storing heat storage mode information related to the heat storage mode determined by the computation device 200 according to any one of (1) to (7), and an operation control unit 330 operating the geothermal heat utilization system 1 based on the heat storage mode information stored in the mode information storage unit 310.

[0095]

As a result, the geothermal heat utilization system 1 can operate in the heat storage mode that is determined with high accuracy based on the simulation by the computation device 200 and that is suitable for the environmental condition.

[0096]

(11) A control device 300 according to an eleventh aspect is the control device 300 according to (10) that may further include an outside air condition acquisition unit 320 acquiring an actual outside air condition, in which the operation control unit 330 may operate the geothermal heat utilization system 1 based on the heat storage mode associated with the actual outside air condition acquired by the outside air condition acquisition unit 320.

[0097]

Accordingly, it is possible to operate the geothermal heat utilization system 1 in the heat storage mode that is determined with high accuracy based on the simulation by the computation device 200 and that is suitable for the environmental condition. As a result, the geothermal heat utilization system 1 can operate in the heat storage mode suitable for the environmental condition.

[0098]

(12) A control method according to a twelfth aspect including storing heat storage mode information related to the heat storage mode determined by the computation device 200 according to any one of (1) to (7), and operating the geothermal heat utilization system 1 based on the heat storage mode information stored.

[0099]

Accordingly, it is possible to operate the geothermal heat utilization system 1 in the heat storage mode that is determined with high accuracy based on the simulation by the computation device 200 and that is suitable for the environmental condition. As a result, the geothermal heat utilization system 1 can operate in the heat storage mode suitable for the environmental condition.

[0100]

(13) A control program according to a thirteenth aspect causes a computer to perform a method including storing heat storage mode information related to the heat storage mode determined by the computation device 200 according to any one of (1) to (7), and operating the geothermal heat utilization system 1 based on the heat storage mode information stored.

[0101]

Accordingly, it is possible to operate the geothermal heat utilization system 1 in the heat storage mode that is determined with high accuracy based on the simulation by the computation device 200 and that is suitable for the environmental condition. As a result, the geothermal heat utilization system 1 can operate in the heat storage mode suitable for the environmental condition.

25

Reference Signs List

[0102]

- 1 Geothermal heat utilization system
- 2 Well
- 30 3 Well-side Pipe
- 4 Heat exchanger
- 10 Heat source well facility
- 21 Hot water well
- 22 Cold water well
- 35 31 Pump
- 100 Auxiliary heat storage facility
- 101 Refrigerant circuit
- 110 Heat source device

- 120 Air conditioner
- 130 Cooling tower
- 140 Second heat exchanger
- 150 Chiller
- 5 190 Computer
 - 195 Processor
 - 196 Memory
 - 197 Storage/reproduction device
 - 198 IO I/F
- 10 199 Communication I/F
 - 200 Computation device
 - 210 Acquisition unit
 - 220 First calculation unit
 - 230 Second calculation unit
- 15 240 Temperature calculation unit
 - 250 Determination unit
 - 300 Control device
 - 310 Mode information storage unit
 - 320 Outside air condition acquisition unit
- 20 330 Operation control unit
 - ST01 Step of acquiring a simulation condition
 - ST02 Step of performing simulation computation in the first heat storage mode
 - ST03 Step of performing simulation computation in the second heat storage mode
- 25 ST04 Step of comparing power in the first heat storage mode with power in the second heat storage mode
 - ST05 Step of calculating a limit outside air temperature in the first heat storage mode
 - ST06 Step of determining a heat storage mode
- 30 ST07 Step of generating heat storage mode information
 - ST11 Step of acquiring an actual outside air condition
 - ST12 Step of acquiring a heat storage mode corresponding to the actual outside air condition
 - ST13 Step of operating the geothermal heat utilization system in the acquired
- 35 heat storage mode

Claims

[Claim 1]

A computation device that determines a heat storage mode when heat storage is performed in a geothermal heat utilization system, the geothermal heat utilization system including:

- a heat source well facility including a hot water well, a cold water well, a well-side pipe connecting the hot water well and the cold water well, and a pump provided at the well-side pipe; and

- an auxiliary heat storage facility including a cooling tower, a chiller, and a refrigerant circuit connected to at least one of the cooling tower or the chiller and configured to exchange heat with the well-side pipe,

- the computation device comprising:

- an acquisition unit configured to acquire a simulation condition;

- a first calculation unit configured to calculate, based on the simulation condition, a first simulation result being a result of a simulation in a first heat storage mode in which heat storage by the cooling tower is included;

- a second calculation unit configured to calculate, based on the simulation condition, a second simulation result being a result of a simulation in a second heat storage mode in which heat storage by the chiller is included;
- and

- a determination unit configured to determine one of the first heat storage mode and the second heat storage mode based on the first simulation result and the second simulation result.

[Claim 2]

The computation device according to claim 1, wherein

- the first simulation result and the second simulation result each include at least one of a temperature of injected water to the cold water well from the well-side pipe having exchanged heat with the refrigerant circuit, a heat storage amount in the heat source well facility, or power required for heat storage.

[Claim 3]

The computation device according to claim 1 or 2, wherein

- the determination unit determines the heat storage mode based on a comparison result between power required for heat storage in the first heat storage mode and power required for heat storage in the second heat storage mode.

[Claim 4]

The computation device according to any one of claims 1 to 3, wherein the second calculation unit calculates the second simulation result such that a heat storage amount in the second heat storage mode becomes a same as a heat storage amount in the first heat storage mode.

[Claim 5]

The computation device according to any one of claims 1 to 4, wherein the determination unit determines any one of the first heat storage mode and the second heat storage mode in association with an individual virtual outside air condition of a plurality of virtual outside air conditions.

[Claim 6]

The computation device according to claim 5, wherein the plurality of virtual outside air conditions each include at least one of a virtual outside air temperature or a virtual outside air humidity.

[Claim 7]

The computation device according to claim 6, further comprising:
a temperature calculation unit configured to calculate, in the first heat storage mode, a limit outside air temperature at which a temperature of injected water to the cold water well from the well-side pipe having exchanged heat with the refrigerant circuit becomes an upper limit injected water temperature, wherein

the determination unit selects the second heat storage mode as the heat storage mode at the virtual outside air temperature equal to or higher than the limit outside air temperature.

[Claim 8]

A computation method of determining a heat storage mode when heat storage is performed in a geothermal heat utilization system, the geothermal heat utilization system including:

a heat source well facility including a hot water well, a cold water well, a well-side pipe connecting the hot water well and the cold water well, and a pump provided at the well-side pipe; and

an auxiliary heat storage facility including a cooling tower, a chiller, and a refrigerant circuit connected to at least one of the cooling tower or the chiller and configured to exchange heat with the well-side pipe,

the computation method comprising:

acquiring a simulation condition;

calculating a first simulation result based on the simulation condition, a first simulation result being a result of a simulation in a first heat storage mode in which heat storage by the cooling tower is included;

calculating a second simulation result, based on the simulation condition, the second simulation result being a result of a simulation in a second heat storage mode in which heat storage by the chiller is included; and

determining one of the first heat storage mode and the second heat storage mode based on the first simulation result and the second simulation result.

[Claim 9]

A program for causing a computer to perform a method of determining a heat storage mode when heat storage is performed in a geothermal heat utilization system, the geothermal heat utilization system including:

a heat source well facility including a hot water well, a cold water well, a well-side pipe connecting the hot water well and the cold water well, and a pump provided at the well-side pipe; and

an auxiliary heat storage facility including a cooling tower, a chiller, and a refrigerant circuit connected to at least one of the cooling tower or the chiller and configured to exchange heat with the well-side pipe,

the method comprising:

acquiring a simulation condition;

calculating a first simulation result, based on the simulation condition, a first simulation result being a result of a simulation in a first heat storage mode in which heat storage by the cooling tower is included;

calculating a second simulation result, based on the simulation condition, the second simulation result being a result of a simulation in a second heat storage mode in which heat storage by the chiller is included; and

determining one of the first heat storage mode and the second heat storage mode based on the first simulation result and the second simulation result.

[Claim 10]

A control device comprising:

a mode information storage unit configured to store heat storage mode information related to the heat storage mode determined by the computation device described in any one of claims 1 to 7; and

an operation control unit configured to operate the geothermal heat utilization system based on the heat storage mode information stored in the mode information storage unit.

[Claim 11]

The control device according to claim 10, further comprising:

an outside air condition acquisition unit configured to acquire an actual outside air condition, wherein

the operation control unit operates the geothermal heat utilization system based on the heat storage mode associated with the actual outside air condition acquired by the outside air condition acquisition unit.

[Claim 12]

A control method comprising:

storing heat storage mode information related to the heat storage mode determined by the computation device described in any one of claims 1 to 7; and

operating the geothermal heat utilization system based on the heat storage mode information stored.

[Claim 13]

A control program for causing a computer to perform a method comprising:

storing heat storage mode information related to the heat storage mode determined by the computation device described in any one of claims 1 to 7; and

operating the geothermal heat utilization system based on the heat storage mode information stored.