

Description

Title of Invention

GROUND THERMAL ENERGY SYSTEM, CONTROL DEVICE, CONTROL
METHOD, AND PROGRAM

5

Technical Field

[0001]

The present disclosure relates to a ground thermal energy system, a control device, a control method, and a program.

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This application claims priority based on Japanese Patent Application No. 2021-72635 filed on April 22, 2021, contents of which are incorporated herein by reference.

Background Art

15 [0002]

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

[0003]

For example, PTL 1 discloses a ground thermal energy system that performs heat exchange with the ground water inside the space in the casing.

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Citation List

Patent Literature

[0004]

25 PTL 1: JP 2014-122712 A

Summary of Invention

Technical Problem

[0005]

PTL 1 discloses a ground thermal energy system for performing heat exchange without pumping the ground water to the ground, and also discloses a ground thermal energy system for returning the pumped ground water back into the ground.

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However, when the pumped ground water is exposed to the atmospheric air, the gas component in the ground water may volatilize.

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As such, when the pumped ground water is injected to the well, the gas pressure inside the well may increase due to the volatilized gas.

The increased gas pressure may make water injection difficult, and cause clogging of the well.

[0006]

To solve the above-mentioned problems, an object of the present disclosure is to provide a ground thermal energy system, a control device, a control method, and a program that can suppress increase in gas pressure during water injection into a well.

Solution to Problem

10 [0007]

To solve the above-mentioned problems, a ground thermal energy system according to the present disclosure includes a pumping well, a water injection well, a pipe extending from the pumping well to the water injection well, a heat exchanger provided in the pipe, a pressure sensor configured to detect a pressure inside the water injection well, an opening/closing valve configured to open/close the water injection well with respect to atmospheric air, and a control device configured to control the opening/closing valve to open when the pressure detected is greater than a reference pressure.

[0008]

20 A control device according to the present disclosure includes a pressure data acquiring section configured to acquire a pressure inside a water injection well to which ground water pumped from a pumping well and passed through a heat exchanger is injected, and an opening/closing valve control section configured to control an opening/closing valve to allow an inside of the water injection well to communicate with atmospheric air when the pressure acquired is greater than a predetermined reference pressure.

[0009]

30 A control method according to the present disclosure includes acquiring a pressure inside a water injection well to which ground water pumped from a pumping well and passed through a heat exchanger is injected, and controlling an opening/closing valve to allow an inside of the water injection well to communicate with atmospheric air when the pressure acquired is greater than a predetermined reference pressure.

[0010]

35 A program according to the present disclosure is configured to cause a computer to acquire a pressure inside a water injection well to which ground water pumped from a pumping well and passed through a heat exchanger is injected, and control an opening/closing valve to allow an inside of the water

injection well to communicate with atmospheric air when the pressure acquired is greater than a predetermined reference pressure.

Advantageous Effects of Invention

5 [0011]

With the ground thermal energy system, the control device, the control method, and the program of the present disclosure, it is possible to suppress increase in gas pressure during water injection into a well.

10 Brief Description of Drawings

[0012]

FIG. 1 is a diagram illustrating a schematic configuration of a ground thermal energy system according to an embodiment of the present disclosure.

15 FIG. 2 is a system diagram of the ground thermal energy system according to the embodiment of the present disclosure.

FIG. 3 is a cross-sectional view illustrating an exemplary arrangement of a pressure sensor, an opening/closing valve, and a degassing valve of the ground thermal energy system according to the embodiment of the present disclosure.

20 FIG. 4 is a block diagram of a control device according to the embodiment of the present disclosure.

FIG. 5 is a flowchart illustrating a procedure of a control method according to the embodiment of the present disclosure.

25 FIG. 6 is a diagram illustrating an exemplary hardware configuration of a computer included in a control device according to the embodiment of the present disclosure.

Description of Embodiments

[0013]

30 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.

[0014]

35 Embodiments

An embodiment of a ground thermal energy system according to the present disclosure is described below with reference to FIGS. 1 to 5.

Configuration of Ground Thermal Energy System

As illustrated in FIGS. 1 and 2, a ground thermal energy system 1 mainly includes a plurality of wells 2, a pipe 3, a well lid 6, a heat exchanger 4, and a pressure adjustment system 7 (see FIG. 2).

[0015]

5 Configuration of Wells

The plurality of wells 2 extends from a ground OG into a aquifer LY.

For example, the plurality of wells 2 includes a first well 2A and a second well 2B.

10 The ground thermal energy system 1 pumps the ground water from one of the first well 2A and the second well 2B, performs heat exchange at the heat exchanger 4, and injects the heat-exchanged ground water into the other of the first well 2A and the second well 2B. Specifically, the ground thermal energy system 1 includes two operation modes for when pumping the ground water from the first well 2A and injecting the water to the second well 2B, and when
15 pumping the ground water from the second well 2B and injecting the water to the first well 2A.

In the following description, of the first well 2A and the second well 2B, the one from which the ground water is pumped is referred to as the pumping well 21; and of the first well 2A and the second well 2B, the one to which the
20 ground water is injected is referred to as the water injection well 22. That is, each of the first well 2A and the second well 2B may function as the pumping well 21 and may function as the water injection well 22.

It should be noted that, to simplify the description, the following mainly describes a case where the first well 2A serves as the pumping well 21, the
25 second well 2B serves as the water injection well 22, and heat exchange is performed with the heat exchanger 4.

[0016]

Each well 2 includes a casing 2a embedded in a drilled hole HOL drilled toward the underground from the ground OG to the aquifer LY.

30 The casing 2a has a tubular shape extending in the vertical direction.

[0017]

Each well 2 includes an opening 2c at an upper part.

For example, the opening 2c may be an opening at an upper part of the casing 2a.

35 [0018]

The casing 2a includes a strainer 2b composed of a plurality of slits, for example.

With the strainer 2b, the well 2 is configured to take the ground water of the aquifer LY into the casing 2a, and return the ground water from the inside of the casing 2a back to the aquifer LY.

[0019]

5 The well lid 6 is provided at the opening 2c at the upper part of each well 2.

 The well lid 6 closes the opening 2c.

[0020]

Configuration of Pipe

10 The pipe 3 extends inside the well 2.

 For example, both ends of the pipe 3 may be each immersed in the ground water of a respective one of the pumping well 21 and the water injection well 22 to connect the pumping well 21 and the water injection well 22.

15 For example, one end of the pipe 3 may be provided in the pumping well 21 and the other end of the pipe 3 may be provided at the water injection well 22 so that the ground water pumped by a pump 31 can flow from the pumping well 21 toward the water injection well 22.

[0021]

20 The pipe 3 is provided with the pump 31.

 The pump 31 pumps the water from the well 2 to the pipe 3.

 For example, in the case where the well 2 functions as the pumping well 21, the pump 31 pumps the water from the well 2 to the pipe 3.

25 For example, the pump 31 may pump the ground water inside the well 2 into the pipe 3.

 For example, the pump 31 may be provided at both ends of the pipe 3 and immersed in the ground water in each well 2.

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

30 [0022]

 The pipe 3 is provided with water injection valves 32.

 The water injection valves 32 are each provided at a respective one of both end portions of the pipe 3.

35 The water injection valves 32 may be disposed between the heat exchanger 4 and the pumps 31 at both ends of the pipe 3.

 For example, the water injection valves 32 may be immersed in the ground water in the respective wells 2.

 The water injection valves 32 inject the ground water inside the pipe 3.

For example, in the case where the well 2 functions as the water injection well 22, the water injection valve 32 injects the ground water inside the pipe 3 into the well 2 (the water injection well 22).

When the pressure inside the pipe 3 is greater than a set pressure, the water injection valve 32 is opened, and the ground water inside the pipe 3 is injected to the water injection well 22.

[0023]

As illustrated in FIG. 2, the pipe 3 includes check valves 35a to 35d between the heat exchanger 4, and the pumping well 21 and the water injection well 22.

The check valves 35a to 35d control the flow of the ground water in the pipe 3 such that the ground water flows in the same direction with respect to the heat exchanger 4 regardless of whether the ground water is pumped from the pumping well 21 or the ground water is pumped from the water injection well 22.

[0024]

For example, when the ground water is pumped from the first well 2A, the ground water inside the pipe 3 is sequentially passed from the first well 2A to the check valve 35a, the heat exchanger 4, and the check valve 35b before being injected to the second well 2B. At this time, the pressure inside the pipe 3 is greater on the upstream side (the first well 2A side) of the heat exchanger 4 than on the downstream side, and therefore the water flows through neither the check valve 35c nor the check valve 35d.

Likewise, in the case of pumping from the second well 2B, the ground water inside the pipe 3 is sequentially passed from the second well 2B to the check valve 35c, the heat exchanger 4, and the check valve 35d before being injected to the first well 2A. Also at this time, the pressure inside the pipe 3 is greater on the upstream side (the second well 2B side) of the heat exchanger 4 than on the downstream side, and therefore the water flows through neither the check valve 35a nor the check valve 35b.

[0025]

Configuration of Heat Exchanger

The heat exchanger 4 exchanges heat between the ground water inside the pipe 3 and the medium on a load 100 side.

For example, the heat exchanger 4 exchanges heat between the ground water pumped from the well 2 and flowing inside the pipe 3, and the medium on the load 100 side. The ground water having been subjected to the heat

exchange may flow inside the pipe 3 from the heat exchanger 4 and be injected to the well 2.

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

5 [0026]

Configuration of Pressure Adjustment System

As illustrated in FIGS. 2 and 3, the pressure adjustment system 7 includes a pressure sensor 71, an opening/closing valve 72, and a control device 80.

10 [0027]

The pressure sensor 71 detects the pressure inside the water injection well 22.

For example, the pressure sensor 71 may detect the pressure of the gas retained in an upper space inside the water injection well 22.

15 For example, the pressure sensor 71 is provided at the well lid 6.
[0028]

The opening/closing valve 72 is configured to open/close the water injection well 22 with respect to the atmospheric air.

20 For example, the opening/closing valve 72 may be configured to open/close the water injection well 22 by allowing the atmospheric air to communicate with the inside of the water injection well 22.

For example, the opening/closing valve 72 may be provided at a valve pipe 73 extending through the well lid 6.

25 For example, when brought to the open state, the opening/closing valve 72 may allow the atmospheric air outside the water injection well 22 to communicate with the inside of the water injection well 22 through the valve pipe 73.

[0029]

In addition, the pipe 3 is provided with degassing valves 75.

30 In the case where gas is contained in the ground water flowing inside the pipe 3, the degassing valves 75 discharge the gas to the outside of the pipe 3.

For example, commercially available valves may be used as the degassing valves 75.

35 For example, the degassing valves 75 may include a valve element floating on the ground water inside the pipe 3 introduced into the valve chamber, for example.

For example, the degassing valves 75 may be configured such that, when gas accumulates in the valve chamber, the valve element is brought to an open

state by being pressed to move by the gas inside the valve chamber, and thus the gas inside the valve chamber is discharged.

For example, the degassing valves 75 may be configured such that, after the discharge of the gas, the valve element is brought to a closed state by the buoyancy acting on the valve element due to the ground water, and thus stops the discharge of the gas inside the valve chamber.

[0030]

Configuration of Control Device

The control device 80 controls the opening/closing valve 72 to open when the pressure inside the water injection well 22 detected by the pressure sensor 71 is greater than a predetermined reference pressure.

In the state where water injection is performed from the pipe 3 to the water injection well 22, the control device 80 controls the opening/closing valve 72 to open when the pressure inside the water injection well 22 detected by the pressure sensor 71 is greater than the reference pressure. Specifically, in the state where the well 2 is functioning as the water injection well 22, the control device 80 controls the opening/closing valve 72 to open when the pressure inside the water injection well 22 detected by the pressure sensor 71 is greater than the reference pressure.

For example, from the operation mode of the ground thermal energy system 1, the control device 80 can recognize whether the well 2 is functioning as the water injection well 22.

For example, the control device 80 can recognize the flow direction of the ground water inside the pipe 3 from the operation state of the pump 31, the pressure of the ground water inside the pipe 3, and the like, and can recognize which well 2 is functioning as the water injection well 22 on the basis of the flow direction.

In the state where the well 2 is functioning as the pumping well 21, the control device 80 does not control the opening/closing valve 72 to open when the pressure inside the water injection well 22 detected by the pressure sensor 71 is greater than the reference pressure.

The control device 80 may be separately provided at both of the wells 2 (the first well 2A and the second well 2B).

For example, only a pair of the control devices 80 may be provided for the plurality of wells 2.

[0031]

As illustrated in FIG. 4, the control device 80 includes a pressure data acquiring section 81, and an opening/closing valve control section 82.

The pressure data acquiring section 81 acquires data related to the pressure inside the water injection well 22 detected by the pressure sensor 71.

For example, the pressure data acquiring section 81 may acquire the value of the pressure inside the water injection well 22 to which the ground water pumped from the pumping well 21 and passed through the heat exchanger 4 is injected.

[0032]

When the pressure acquired by the pressure data acquiring section 81 is greater than the predetermined reference pressure, the opening/closing valve control section 82 controls the opening and closing of the opening/closing valve 72 to allow the inside of the water injection well 22 to communicate with the atmospheric air.

For example, when the acquired pressure is greater than the reference pressure, the opening/closing valve control section 82 may control the opening/closing valve 72 to open the opening/closing valve 72 to allow the inside of the water injection well 22 to communicate with the atmospheric air.

For example, when the pressure acquired by the pressure data acquiring section 81 is greater than the predetermined reference pressure, the opening/closing valve control section 82 may control the opening/closing valve 72 to allow the inside of the water injection well 22 to communicate with the atmospheric air.

For example, when the acquired pressure is less than the reference pressure, the opening/closing valve control section 82 may control the opening/closing valve 72 to close.

The opening/closing valve control section 82 may output a command for controlling the opening and closing of the opening/closing valve 72 on the basis of a sequence stored in advance in the control device 80.

[0033]

An operation of the control device 80 of the present embodiment is described below.

The operation of the control device 80 corresponds to an embodiment of the control method.

The control device 80 performs the steps illustrated in FIG. 5.

[0034]

First, the pressure data acquiring section 81 acquires the pressure inside the water injection well 22 detected by the pressure sensor 71 (ST01: a step of acquiring data on the pressure inside the water injection well).

Subsequent to the execution of ST01, the opening/closing valve control section 82 determines whether the acquired pressure inside the water injection well 22 is greater than the reference pressure set in advance (ST02: a step of determining whether the pressure inside the water injection well is not less than the reference pressure).

[0035]

When it is determined, as a result of the determination at ST02, that the acquired pressure inside the water injection well 22 is greater than the reference pressure, the opening/closing valve control section 82 outputs a command for opening the opening/closing valve 72 (ST03: a step of opening the opening/closing valve). This opens the opening/closing valve 72, and the pressure inside the water injection well 22 is discharged to the outside of the water injection well 22 through the valve pipe 73. At this time, when the opening/closing valve 72 is already open immediately before ST03, the opened state of the opening/closing valve 72 is maintained.

When it is determined, as a result of the determination at ST02, that the acquired pressure inside the water injection well 22 is not greater than the reference pressure, the opening/closing valve control section 82 outputs a command for closing the opening/closing valve 72 (ST04: a step of closing the opening/closing valve). At this time, when the opening/closing valve 72 is closed immediately before ST04, the closed state of the opening/closing valve 72 is maintained.

[0036]

Operational Effects

According to the present embodiment, the ground thermal energy system 1 supplies the ground water pumped from the pumping well 21 to the heat exchanger 4 through the pipe 3. By exchanging heat between the ground water and the medium on the load 100 side at the heat exchanger 4, the ground thermal energy system 1 utilizes the geothermal heat. The ground water passed through the heat exchanger 4 is injected to the water injection well 22 through the pipe 3. The pressure inside the water injection well 22 is detected by the pressure sensor 71. When the pressure inside the water injection well 22 detected by the pressure sensor 71 is greater than the reference pressure, the ground thermal energy system 1 controls the opening/closing valve 72 to open by the control device 80. This opens the opening/closing valve 72 to allow the inside of the water injection well 22 to communicate with the atmospheric air. Then, the pressure inside the water injection well 22 that is greater than the reference pressure is discharged to the atmospheric air. As a result, the ground

thermal energy system 1 can suppress increase in gas pressure during water injection into the well 2. In this manner, the ground thermal energy system 1 can suppress hindrance of the water injection into the inside of the water injection well 22 by increase in gas pressure inside the water injection well 22.

5 [0037]

In addition, according to one example of the present embodiment, the pressure sensor 71 and the opening/closing valve 72 are provided at the well lid 6. In this manner, the user can easily access the pressure sensor 71 and the opening/closing valve 72 from the ground OG. Thus, the user can easily
10 monitor the ground thermal energy system 1. In addition, the user can easily perform the maintenance of the ground thermal energy system 1.

[0038]

In addition, according to one example of the present embodiment, in the state where water injection is performed from the pipe 3 to the water injection well 22, the control device 80 controls the opening/closing valve 72 to open
15 when the pressure inside the water injection well 22 detected by the pressure sensor 71 is greater than the reference pressure. That is, only in the state where water injection to the water injection well 22 is performed can the control device 80 open the opening/closing valve 72 to release the pressure inside the
20 water injection well 22 when the pressure inside the water injection well 22 is greater than the reference pressure. Thus, the ground thermal energy system 1 can suppress excessive increase in gas pressure in the well 2 serving as the water injection well 22.

[0039]

25 In addition, according to one example of the present embodiment, the degassing valve 75 that discharges, to the outside of the pipe 3, the gas contained in the ground water flowing inside the pipe 3 is further included.

In this manner, in the case where gas is contained in the ground water flowing inside the pipe 3, the ground thermal energy system 1 can discharge
30 only gas to the outside of the pipe 3 through the degassing valve 75. Thus, the ground thermal energy system 1 can suppress increase in the amount of gas supplied together with the ground water at the water injection well 22. As a result, the ground thermal energy system 1 can suppress increase in pressure inside the water injection well 22.

35 [0040]

In addition, according to one example of the present embodiment, the control device 80 includes the pressure data acquiring section 81 and the opening/closing valve control section 82.

In such a configuration, when the pressure inside the water injection well 22 acquired by the pressure data acquiring section 81 is greater than the reference pressure, the control device 80 opens the opening/closing valve 72 by the opening/closing valve control section 82 to allow the inside of the water injection well 22 to communicate with the atmospheric air. This discharges the pressure inside the water injection well 22 that is greater than the reference pressure to the atmospheric air. As a result, the control device 80 can suppress increase in gas pressure during water injection into the well 2.

[0041]

10 Modifications

Note that in the above-described embodiment, a program for achieving the functions of the control device 80 is recorded in a computer-readable recording medium, and various processing is performed by reading and executing the program recorded in the recording medium by a computer system such as a microcomputer. 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, 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.

[0042]

In the above-described embodiment, an exemplary hardware configuration of a computer 190 that causes the program for achieving the functions of the control device 80 to be executed is described below.

[0043]

As illustrated in FIG. 6, the computer 190 included in the control device 80 includes a processor 195, a memory 196, a storage/reproduction device 197, an input output interface (hereinafter referred to as the "IO I/F") 198, and a communication interface (hereinafter referred to as the "communication I/F") 199.

[0044]

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 the "RAM") for temporarily storing data and the like used in the program executed by the control device 80.

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.

5 For example, the IO I/F 198 may be an interface for inputting and outputting information and the like between the control device 80 and another device.

For example, the communication I/F 199 may be an interface for performing communication between the control device 80 and another device
10 through a communication line such as the Internet and a dedicated communication line.

[0045]

Other Embodiments

While the embodiments of the present disclosure are described above,
15 the embodiments are examples, and are not intended to limit the 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 variations thereof are included in the scope of the present disclosure and
20 equivalents thereof as well as in the scope and gist of the present disclosure.

[0046]

Supplementary Notes

The ground thermal energy system 1, the control device 80, the control method, and the program according to the embodiment are understood as
25 follows, for example.

[0047]

(1) The ground thermal energy system 1 according to a first aspect includes the pumping well 21, the water injection well 22, the pipe 3 extending from the pumping well 21 to the water injection well 22, the heat exchanger 4
30 provided to the pipe 3, the pressure sensor 71 configured to detect the pressure inside the water injection well 22, the opening/closing valve 72 configured to open/close the water injection well 22 with respect to the atmospheric air, and the control device 80 configured to control the opening/closing valve 72 to open when the pressure detected is greater than a reference pressure.

35 [0048]

This ground thermal energy system 1 supplies the ground water pumped from the pumping well 21 to the heat exchanger 4 through the pipe 3. By exchanging heat between the ground water and the medium on the load side at

the heat exchanger 4, the ground thermal energy system 1 utilizes the geothermal heat. The ground water passed through the heat exchanger 4 is injected to the water injection well 22 through the pipe 3. The pressure inside the water injection well 22 is detected by the pressure sensor 71. When the pressure inside the water injection well 22 detected by the pressure sensor 71 is greater than the reference pressure, the ground thermal energy system 1 controls the opening/closing valve 72 to open by the control device 80. This opens the opening/closing valve 72 to allow the inside of the water injection well 22 to communicate with the atmospheric air. Then, the pressure inside the water injection well 22 that is greater than the reference pressure is discharged to the atmospheric air. As a result, the ground thermal energy system 1 can suppress increase in gas pressure during water injection into a well.

[0049]

(2) The ground thermal energy system 1 according to a second aspect is the ground thermal energy system 1 of (1), in which the well lid 6 configured to close the opening 2c at the upper part of the water injection well 22 may be further included, and the pressure sensor 71 and the opening/closing valve 72 may be provided at the well lid 6.

[0050]

In this manner, the user can easily access the pressure sensor 71 and the opening/closing valve 72 from the ground OG. Thus, the user can easily monitor the ground thermal energy system 1. In addition, the user can easily perform the maintenance of the ground thermal energy system 1.

[0051]

(3) The ground thermal energy system 1 according to a third aspect is the ground thermal energy system 1 of (1) or (2), in which, in the state where water injection from the pipe 3 to the water injection well 22 is performed, the control device 80 may control the opening/closing valve 72 to open when the pressure inside the water injection well 22 detected by the pressure sensor 71 is greater than the reference pressure.

[0052]

With such a configuration, in the state where water injection is performed from the pipe 3 to the water injection well 22, the control device 80 controls the opening/closing valve 72 to open when the pressure inside the water injection well 22 detected by the pressure sensor 71 is greater than the reference pressure. That is, only in the state where water injection to the water injection well 22 is performed can the control device 80 open the opening/closing valve 72 to release the pressure inside the water injection well

22 when the pressure inside the water injection well 22 is greater than the reference pressure. Thus, the ground thermal energy system 1 can suppress excessive increase in gas pressure in the well serving as the water injection well 22.

5 [0053]

(4) The ground thermal energy system 1 according to a fourth aspect is the ground thermal energy system 1 of any one of (1) to (3), in which the degassing valve 75 configured to discharge, to the outside of the pipe 3, the gas contained in the ground water flowing inside the pipe 3 may be further

10 included.

[0054]

In this manner, in the case where gas is contained in the ground water flowing inside the pipe 3, the ground thermal energy system 1 can discharge only gas to the outside of the pipe 3 through the degassing valve 75. Thus, the

15 ground thermal energy system 1 can suppress increase in the amount of gas supplied together with the ground water at the water injection well 22. As a result, the ground thermal energy system 1 can suppress increase in pressure inside the water injection well 22.

[0055]

20 (5) The control device 80 according to a fifth aspect includes the pressure data acquiring section 81 configured to acquire the pressure inside the water injection well 22 to which the ground water pumped from the pumping well 21 and passed through the heat exchanger 4 is injected, and the opening/closing valve control section 82 configured to control the

25 opening/closing valve 72 to allow the inside of the water injection well 22 to communicate with the atmospheric air when the pressure acquired is greater than a predetermined reference pressure.

[0056]

In such a configuration, when the pressure inside the water injection

30 well 22 acquired by the pressure data acquiring section 81 is greater than the reference pressure, the control device 80 opens the opening/closing valve 72 by the opening/closing valve control section 82 to allow the inside of the water injection well 22 to communicate with the atmospheric air. This discharges the pressure inside the water injection well 22 that is greater than the reference

35 pressure to the atmospheric air. As a result, the control device 80 can suppress increase in gas pressure during water injection into the well 2.

[0057]

(6) In the control method according to a sixth aspect, the pressure inside the water injection well 22 to which the ground water pumped from the pumping well 21 and passed through the heat exchanger 4 is injected is acquired, and the opening/closing valve 72 is controlled to allow the inside of the water injection well 22 to communicate with the atmospheric air when the pressure acquired is greater than a predetermined reference pressure.

[0058]

This control method can open the opening/closing valve 72 to allow the inside of the water injection well 22 to communicate with the atmospheric air when the pressure inside the water injection well 22 is greater than the reference pressure. This discharges the pressure inside the water injection well 22 that is greater than the reference pressure to the atmospheric air. As a result, the control method can suppress increase in gas pressure during water injection into the well 2.

[0059]

(7) The program according to a seventh aspect causes the computer 190 to acquire the pressure inside the water injection well 22 to which the ground water pumped from the pumping well 21 and passed through the heat exchanger 4 is injected, and control the opening/closing valve 72 to allow the inside of the water injection well 22 to communicate with the atmospheric air when the pressure acquired is greater than a predetermined reference pressure.

[0060]

With such a program, the computer can open the opening/closing valve 72 to allow the inside of the water injection well 22 to communicate with the atmospheric air when the pressure inside the water injection well 22 is greater than the reference pressure. This discharges the pressure inside the water injection well 22 that is greater than the reference pressure to the atmospheric air. As a result, the program can suppress increase in gas pressure during water injection into the well 2.

Reference Signs List

[0061]

1 Ground thermal energy system

2 Well

2A First well

2B Second well

2a Casing

2b Strainer

- 2c Opening
- 3 Pipe
- 4 Heat exchanger
- 6 Well lid
- 5 7 Pressure adjustment system
- 21 Pumping well
- 22 Water injection well
- 31 Pump
- 32 Water injection valve
- 10 35a to 35d Check valve
- 71 Pressure sensor
- 72 Opening/closing valve
- 73 Valve pipe
- 75 Degassing valve
- 15 80 Control device
- 81 Pressure data acquiring section
- 82 Opening/closing valve control section
- 100 Load
- 190 Computer
- 20 195 Processor
- 196 Memory
- 197 Storage/reproduction device
- 198 IO I/F
- 199 Communication I/F
- 25 HOL Drilled hole
- LY Aquifer
- OG Ground
- ST01 Step of acquiring data on pressure inside water injection well
- ST02 Step of determining whether pressure inside water injection well is not
- 30 less than reference pressure
- ST03 Step of opening opening/closing valve
- ST04 Step of closing opening/closing valve

Claims

[Claim 1]

A ground thermal energy system comprising:
a pumping well;
a water injection well;
a pipe extending from the pumping well to the water injection well;
a heat exchanger provided to the pipe;
a pressure sensor configured to detect a pressure inside the water injection well;
an opening/closing valve configured to open/close the water injection well with respect to atmospheric air; and
a control device configured to control the opening/closing valve to open when the pressure detected is greater than a reference pressure.

[Claim 2]

The ground thermal energy system according to claim 1, further comprising
a well lid configured to close an opening at an upper part of the water injection well, wherein
the pressure sensor and the opening/closing valve are provided at the well lid.

[Claim 3]

The ground thermal energy system according to claim 1 or 2, wherein
in a state where water injection from the pipe to the water injection well is performed, the control device controls the opening/closing valve to open when the pressure inside the water injection well detected by the pressure sensor is greater than the reference pressure.

[Claim 4]

The ground thermal energy system according to any one of claims 1 to 3, further comprising
a degassing valve configured to discharge, to an outside of the pipe, gas contained in ground water flowing inside the pipe.

[Claim 5]

A control device comprising:

a pressure data acquiring section configured to acquire a pressure inside a water injection well to which ground water pumped from a pumping well and passed through a heat exchanger is injected; and

an opening/closing valve control section configured to control an opening/closing valve to allow an inside of the water injection well to communicate with atmospheric air when the pressure acquired is greater than a predetermined reference pressure.

[Claim 6]

A control method comprising:

acquiring a pressure inside a water injection well to which ground water pumped from a pumping well and passed through a heat exchanger is injected; and

controlling an opening/closing valve to allow an inside of the water injection well to communicate with atmospheric air when the pressure acquired is greater than a predetermined reference pressure.

[Claim 7]

A program configured to cause a computer to perform a method, the method comprising:

acquiring a pressure inside a water injection well to which ground water pumped from a pumping well and passed through a heat exchanger is injected; and

controlling an opening/closing valve to allow an inside of the water injection well to communicate with atmospheric air when the pressure acquired is greater than a predetermined reference pressure.