Claims

[Claim 1]

A control system configured to control a geothermal heat utilization system including a heat source well facility including a hot water well and a cold water well, and an auxiliary heat storage facility including a cooling tower and a heat source device, the control system comprising:

an operation control unit configured to switch a mode of the geothermal heat utilization system between

a first cold energy storage mode in which hot heat stored in the hot water well is supplied to the cooling tower without going through the heat source device, and cold energy obtained from the cooling tower is stored in the cold water well without going through the heat source device,

a second cold energy storage mode in which the hot heat stored in the hot water well is supplied to the cooling tower via the heat source device, and the cold energy obtained from the cooling tower is stored in the cold water well via the heat source device,

a first cold energy discharge mode in which the cold energy stored in the cold water well is supplied to a device without going through the heat source device, and

a second cold energy discharge mode in which the cold energy stored in the cold water well is supplied to the device via the heat source device;

a calculation unit configured to calculate a cumulative cold energy storage amount being a cold energy storage amount stored in the cold water well;

a prediction unit configured to predict a required cold energy storage amount being a cold energy storage amount required for cooling the device; and

a mode determination unit configured to determine whether to perform control in the first cold energy storage mode or in the second cold energy storage mode, based on the cumulative cold energy storage amount and the required cold energy storage amount,

wherein the operation control unit reduces a cold energy storage amount in the cold water well when the first cold energy storage mode or the second cold energy storage mode is executed and the cumulative cold energy storage amount is larger than the required cold energy storage amount.

[Claim 2]

A control system configured to control a geothermal heat utilization system including a heat source well facility including a hot water well and a cold water well,

and an auxiliary heat storage facility including a cooling tower and a heat source device, the control system comprising:

an operation control unit configured to switch a mode of the geothermal heat utilization system between

a first cold energy storage mode in which hot heat stored in the hot water well is supplied to the cooling tower without going through the heat source device, and cold energy obtained from the cooling tower is stored in the cold water well without going through the heat source device,

a second cold energy storage mode in which the hot heat stored in the hot water well is supplied to the cooling tower via the heat source device, and the cold energy obtained from the cooling tower is stored in the cold water well via the heat source device,

a first cold energy discharge mode in which the cold energy stored in the cold water well is supplied to a device without going through the heat source device, and

a second cold energy discharge mode in which the cold energy stored in the cold water well is supplied to the device via the heat source device;

a calculation unit configured to calculate a cumulative cold energy storage amount being a cold energy storage amount stored in the cold water well;

a prediction unit configured to predict a required cold energy storage amount being a cold energy storage amount required for cooling the device,

a mode determination unit configured to determine whether to perform control in the first cold energy storage mode or in the second cold energy storage mode, based on the cumulative cold energy storage amount and the required cold energy storage amount; and

a cold water temperature acquisition unit configured to acquire a pumped water temperature of the cold water well,

wherein the mode determination unit determines, when the pumped water temperature is equal to or less than a reference temperature, to perform control in the first cold energy discharge mode and determines, when the acquired pumped water temperature is higher than the reference temperature to perform control in the second cold energy discharge mode.

[Claim 3]

A control system configured to control a geothermal heat utilization system including a heat source well facility including a hot water well and a cold water well, and an auxiliary heat storage facility including a cooling tower and a heat source device, the control system comprising:

an operation control unit configured to switch a mode of the geothermal heat utilization system between

a first cold energy storage mode in which hot heat stored in the hot water well is supplied to the cooling tower without going through the heat source device, and cold energy obtained from the cooling tower is stored in the cold water well without going through the heat source device,

a second cold energy storage mode in which the hot heat stored in the hot water well is supplied to the cooling tower via the heat source device, and the cold energy obtained from the cooling tower is stored in the cold water well via the heat source device,

a first cold energy discharge mode in which the cold energy stored in the cold water well is supplied to a device without going through the heat source device, and

a second cold energy discharge mode in which the cold energy stored in the cold water well is supplied to the device via the heat source device;

a calculation unit configured to calculate a cumulative cold energy storage amount being a cold energy storage amount stored in the cold water well;

a prediction unit configured to predict a required cold energy storage amount being a cold energy storage amount required for cooling the device,

a mode determination unit configured to determine whether to perform control in the first cold energy storage mode or in the second cold energy storage mode, based on the cumulative cold energy storage amount and the required cold energy storage amount; and

a cold water temperature acquisition unit configured to acquire a pumped water temperature of the cold water well,

wherein the mode determination unit determines, when a demand cut is required, whether to perform control in the first cold energy discharge mode or in the second cold energy discharge mode, based on the pumped water temperature.

[Claim 4]

The control system according to any one of claims 1 to 3, further comprising an outside air temperature acquisition unit configured to acquire an outside air temperature,

wherein the mode determination unit determines, when the cold energy is stored in the cold water well, whether to perform control in the first cold energy storage mode or in the second cold energy storage mode, based on the outside air temperature.

[Claim 5]

The control system according to claim 1, further comprising a cold water temperature acquisition unit configured to acquire a pumped water temperature of the cold water well,

wherein the mode determination unit determines, when the cold energy is stored in the cold water well, whether to perform the first cold energy storage mode or the second cold energy storage mode, based on the cumulative cold energy storage amount and the pumped water temperature of the cold water well.

[Claim 6]

The control system according to claim 1, further comprising a cold water temperature acquisition unit configured to acquire a pumped water temperature of the cold water well,

wherein the mode determination unit determines, when the cold energy stored in the cold water well is supplied to the device, whether to perform control in the first cold energy discharge mode or in the second cold energy discharge mode, based on the pumped water temperature of the cold water well.

[Claim 7]

The control system according to any one of claims 1 to 3,

wherein the prediction unit predict a predicted value of the amount of power to be peak-cut among an amount of power required for an air conditioning facility including the geothermal heat utilization system and the device,

the operation control unit reduces a cold energy storage amount in the cold water well when the first cold energy storage mode or the second cold energy storage mode is executed and the cumulative cold energy storage amount is larger than the predicted value of the amount of power to be peak-cut.

[Claim 8]

The control system according to any one of claims 1 to 3, wherein the cold energy is constantly supplied to the device when the first cold energy discharge mode or the second cold energy discharge mode is executed.

[Claim 9]

A geothermal heat utilization system comprising:

the control system according to any one of claims 1 to 3;

the heat source well facility; and

the auxiliary heat storage facility.

[Claim 10]

A control method comprising:

calculating a cumulative cold energy storage amount being a cold energy storage amount stored in a cold water well of a geothermal heat utilization system including a heat source well facility including a hot water well and the cold water well, and an auxiliary heat storage facility including a cooling tower and a heat source device, the geothermal heat utilization system having a mode switchable between a first cold energy storage mode in which hot heat stored in the hot water well is supplied to the cooling tower without going through the heat source device and cold energy obtained from the cooling tower is stored in the cold water well without going through the heat source device, a second cold energy storage mode in which the hot heat stored in the hot water well is supplied to the cooling tower via the heat source device and the cold energy obtained from the cooling tower is stored in the cold water well via the heat source device, a first cold energy discharge mode in which the cold energy stored in the cold water well is supplied to a device without going through the heat source device, and a second cold energy discharge mode in which the cold energy stored in the cold water well is supplied to the device via the heat source device;

predicting a required cold energy storage amount being a cold energy storage amount required for cooling the device; and

determining whether to perform control in the first cold energy storage mode or in the second cold energy storage mode, based on the cumulative cold energy storage amount and the required cold energy storage amount,

wherein a cold energy storage amount in the cold water well is reduced when the first cold energy storage mode or the second cold energy storage mode is executed and the cumulative cold energy storage amount is larger than the required cold energy storage amount.

[Claim 11]

A control method comprising:

calculating a cumulative cold energy storage amount being a cold energy storage amount stored in a cold water well of a geothermal heat utilization system including a heat source well facility including a hot water well and the cold water well, and an auxiliary heat storage facility including a cooling tower and a heat source

device, the geothermal heat utilization system having a mode switchable between a first cold energy storage mode in which hot heat stored in the hot water well is supplied to the cooling tower without going through the heat source device and cold energy obtained from the cooling tower is stored in the cold water well without going through the heat source device, a second cold energy storage mode in which the hot heat stored in the hot water well is supplied to the cooling tower via the heat source device and the cold energy obtained from the cooling tower is stored in the cold water well via the heat source device, a first cold energy discharge mode in which the cold energy stored in the cold water well is supplied to a device without going through the heat source device, and a second cold energy discharge mode in which the cold energy stored in the cold water well is supplied to the device via the heat source device;

predicting a required cold energy storage amount being a cold energy storage amount required for cooling the device,

determining whether to perform control in the first cold energy storage mode or in the second cold energy storage mode, based on the cumulative cold energy storage amount and the required cold energy storage amount; and

acquiring a pumped water temperature of the cold water well,

wherein it is determined, when the pumped water temperature is equal to or less than a reference temperature, to perform control in the first cold energy discharge mode and it is determined, when the acquired pumped water temperature is higher than the reference temperature, to perform control in the second cold energy discharge mode.

[Claim 12]

A control method comprising:

calculating a cumulative cold energy storage amount being a cold energy storage amount stored in a cold water well of a geothermal heat utilization system including a heat source well facility including a hot water well and the cold water well, and an auxiliary heat storage facility including a cooling tower and a heat source device, the geothermal heat utilization system having a mode switchable between a first cold energy storage mode in which hot heat stored in the hot water well is supplied to the cooling tower without going through the heat source device and cold energy obtained from the cooling tower is stored in the cold water well without going through the heat source device, a second cold energy storage mode in which the hot heat stored in the hot water well is supplied to the cooling tower via the heat source device and the cold energy obtained from the cooling tower is stored in the cold water well via the heat source device, a first cold energy discharge mode in which the cold energy stored in the cold water well is supplied to a device without going through the

heat source device, and a second cold energy discharge mode in which the cold energy stored in the cold water well is supplied to the device via the heat source device;

predicting a required cold energy storage amount being a cold energy storage amount required for cooling the device,

determining whether to perform control in the first cold energy storage mode or in the second cold energy storage mode, based on the cumulative cold energy storage amount and the required cold energy storage amount; and

acquiring a pumped water temperature of the cold water well,

wherein it is determined, when a demand cut is required, whether to perform control in the first cold energy discharge mode or in the second cold energy discharge mode, based on the pumped water temperature.

[Claim 13]

A program comprising processing executable by a computer of a geothermal heat utilization system including a heat source well facility including a hot water well and a cold water well, and an auxiliary heat storage facility including a cooling tower and a heat source device, the geothermal heat utilization system having a mode switchable between a first cold energy storage mode in which hot heat stored in the hot water well is supplied to the cooling tower without going through the heat source device and cold energy obtained from the cooling tower is stored in the cold water well without going through the heat source device, a second cold energy storage mode in which the hot heat stored in the hot water well is supplied to the cooling tower via the heat source device and the cold energy obtained from the cooling tower is stored in the cold water well via the heat source device, a first cold energy discharge mode in which the cold energy stored in the cold water well is supplied to a device without going through the heat source device, and a second cold energy discharge mode in which the cold energy stored in the cold water well is supplied to the device via the heat source device, the program causing the computer to execute the processing comprising:

calculating a cumulative cold energy storage amount being a cold energy storage amount stored in the cold water well;

predicting a required cold energy storage amount being a cold energy storage amount required for cooling the device; and

determining whether to perform control in the first cold energy storage mode or in the second cold energy storage mode, based on the cumulative cold energy storage amount and the required cold energy storage amount,

wherein a cold energy storage amount in the cold water well is reduced when the first cold energy storage mode or the second cold energy storage mode is executed and the cumulative cold energy storage amount is larger than the required cold energy storage amount.

[Claim 14]

A program comprising processing executable by a computer of a geothermal heat utilization system including a heat source well facility including a hot water well and a cold water well, and an auxiliary heat storage facility including a cooling tower and a heat source device, the geothermal heat utilization system having a mode switchable between a first cold energy storage mode in which hot heat stored in the hot water well is supplied to the cooling tower without going through the heat source device and cold energy obtained from the cooling tower is stored in the cold water well without going through the heat source device, a second cold energy storage mode in which the hot heat stored in the hot water well is supplied to the cooling tower via the heat source device and the cold energy obtained from the cooling tower is stored in the cold water well via the heat source device, a first cold energy discharge mode in which the cold energy stored in the cold water well is supplied to a device without going through the heat source device, and a second cold energy discharge mode in which the cold energy stored in the cold water well is supplied to the device via the heat source device, the program causing the computer to execute the processing comprising:

calculating a cumulative cold energy storage amount being a cold energy storage amount stored in the cold water well;

predicting a required cold energy storage amount being a cold energy storage amount required for cooling the device,

determining whether to perform control in the first cold energy storage mode or in the second cold energy storage mode, based on the cumulative cold energy storage amount and the required cold energy storage amount; and

acquiring a pumped water temperature of the cold water well,

wherein it is determined, when the pumped water temperature is equal to or less than a reference temperature, to perform control in the first cold energy discharge mode and it is determined, when the acquired pumped water temperature is higher than the reference temperature, to perform control in the second cold energy discharge mode.

[Claim 15]

A program comprising processing executable by a computer of a geothermal heat utilization system including a heat source well facility including a hot water well and a cold water well, and an auxiliary heat storage facility including a cooling tower and a heat source device, the geothermal heat utilization system having a mode switchable between a first cold energy storage mode in which hot heat stored in the hot water well is supplied to the cooling tower without going through the heat source device and cold energy obtained from the cooling tower is stored in the cold water well without going through the heat source device, a second cold energy storage mode in which the hot heat stored in the hot water well is supplied to the cooling tower via the heat source device and the cold energy obtained from the cooling tower is stored in the cold water well via the heat source device, a first cold energy discharge mode in which the cold energy stored in the cold water well is supplied to a device without going through the heat source device, and a second cold energy discharge mode in which the cold energy stored in the cold water well is supplied to the device via the heat source device, the program causing the computer to execute the processing comprising:

calculating a cumulative cold energy storage amount being a cold energy storage amount stored in the cold water well;

predicting a required cold energy storage amount being a cold energy storage amount required for cooling the device,

determining whether to perform control in the first cold energy storage mode or in the second cold energy storage mode, based on the cumulative cold energy storage amount and the required cold energy storage amount; and

acquiring a pumped water temperature of the cold water well,

wherein it is determined, when a demand cut is required, whether to perform control in the first cold energy discharge mode or in the second cold energy discharge mode, based on the pumped water temperature.