

DESCRIPTION

REMOTE MONITORING AND CONTROLLING SYSTEM AND METHOD OF OPERATING SAME

Technical Field

[0001]

The present invention relates to a remote monitoring and controlling system and a method of operating the same related to heat source equipment of facilities, which need cold heat or hot heat, such as a building, a factory, a data center, a regional cooling and heating, etc.

Background Art

[0002]

Air conditioning equipment produces cold heat or hot heat by a centrifugal chiller, an absorption cold/hot water generator, or the like to perform cooling or heating on a load side. A heat source device for producing cold heat or hot heat controls the cooling capacity or the heating capacity, in response to an increase or decrease in a load and transfers a heat medium by a pump to the load side.

Background Art Document

Patent Document

[0003]

Patent Document 1: JP 2003-299161 A

Patent Document 2: JP 2006-275323 A

Patent Document 3: JP 2005-114295 A

SUMMARY OF THE INVENTION

Problems to be Solved by the Invention

[0004]

There is a case that chillers are operated with a low operation efficiency or the energy of pumps is wasted unless, depending on a variation in a load or the conditions of external atmospheric air, the operation of heat source devices is operated or stopped depending on the type or the number of heat source devices for efficient operation or the flow rate necessary for a transfer system is controlled. Accordingly, an operation method is necessary for a system including devices, considering the characteristics of the system upon a variation in the loads of the devices or the conditions of external atmospheric air.

[0005]

On the other hand, there is a case that, a pipe pressure loss caused by aging deterioration of heat source devices and a piping system or actual construction is different from a designed value having been set at the designing.

Further, if heat source equipment is operated with a constant flow rate and temperature condition, the energy of heat source devices and pumps is wasteful when partial loads are applied.

[0006]

In the above-described situation, an object of the present invention is to provide a remote monitoring and controlling system and a method of operating the same that enable reduction in the energy consumption amount and appropriate adjustment at the time of introduction and maintenance or management.

Means for Solving the Problems

[0007]

Claim 1 has a remote monitoring and controlling system for controlling air-conditioning equipment by controlling a flow rate or a temperature of a heat medium having a cold heat or a hot heat obtained by heat exchange with a heat source, the remote monitoring and controlling system including: an adjusting parameter identification means for identifying an adjusting parameter for controlling the air-conditioning

equipment; a device characteristic storage section for storing characteristic of a device of the air-conditioning equipment; an air-conditioning equipment simulator for simulating an energy consumption amount of the air-conditioning equipment; and a managing-adjusting computer including an optimization computing means for performing optimization computation, based on the simulation of the energy consumption amount of the air-conditioning equipment, wherein the managing-adjusting computer computes optimization control data for controlling the air-conditioning equipment by the air-conditioning equipment simulator and the optimization computing means for an evaluation function related to energy consumption to come to a desired value, in response to environmental condition of the air-conditioning equipment, and based on characteristic of at least one of a heat source device for producing the cold heat or the hot heat and a heat exchanger for heat exchange with the heat source, and characteristic of a transfer system for transferring the heat medium.

[0008]

Claim 10 has a method of operating the remote monitoring and controlling system according to any one of claims 1 to 5 , the remote monitoring and controlling system including, in the air-conditioning equipment, at least one heat source device, heat exchanger, heat source medium pump, and cold or hot medium pump, a piping system for a heat source medium and a cold or hot medium to flow therethrough, a heat amount measuring means for measuring a heat amount of a load on the air-conditioning equipment, a flow rate control means for controlling flow rates of the heat source medium and the cold or hot medium to predetermined flow rates, and a temperature control means for controlling temperatures of the cold or hot medium and the heat source medium to predetermined temperatures, the operation method including: controlling at least one of a number of operated devices provided in the air-conditioning equipment, and temperature or flow rate of the heat source medium or the cold or hot medium, according to the optimization control data.

Advantages of the Invention

[0009]

According to the present invention, it is possible to realize a remote monitoring and controlling system and a method of the same that enable reduction in the energy consumption amount, and appropriate adjustment at the time of introduction and maintenance or management.

Brief description of the Drawings

[0010]

FIG. 1 is a diagram of conceptual configuration showing a remote monitoring and controlling system in Embodiment 1 according to the present invention;

FIG. 2 is a diagram of conceptual configuration showing a remote monitoring and controlling system in Embodiment 2 according to the present invention;

FIG. 3 is a diagram of conceptual configuration showing a remote monitoring and controlling system in Embodiment 3 according to the present invention;

FIG. 4 is a diagram of conceptual configuration showing a heat source system in Embodiments 1 to 3;

FIG. 5 is a diagram of conceptual configuration showing a remote monitoring and controlling system in Embodiment 4 according to the present invention;

FIG. 6A is a diagram showing the relationship between the flow rate and the total pressure of a pump, FIG. 6B is a diagram showing the relationship between the flow rate and the power consumption, and FIG. 6C is a diagram showing the relationship between the flow rate and the inverter frequency; and

FIG. 7 is a diagram showing table data for optimization control of the rotational speed ratio of a cooling water pump.

Embodiments for Carrying Out the Invention

[0011]

Embodiments according to the present invention will be described below with reference to the attached drawings.

<Embodiment 1>

FIG. 1 is a diagram of conceptual configuration showing a remote monitoring and controlling system in Embodiment 1 according to the present invention.

A remote monitoring and controlling system S1 in Embodiment 1 is a system that monitors and controls, by a managing-adjusting computer c1, a piece or pieces of air-conditioning equipment e11, ... (the equipment side 1, equipment side 2, ... in FIG. 1), which are objects of remote control.

[0012]

The remote monitoring and controlling system S1 assigns one or more out of the total energy consumption, the produced CO₂ amount, and the used primary energy amount of each piece of remote heat source equipment (air-conditioning equipment e11, ...) to an evaluation function/functions. The system S1 has at least one of the flow rate and temperature of a used refrigerant (heat medium) and the type and the number of operated heat source devices (see a chiller 1 in FIG. 4) be an optimization parameter/parameters. The system S1 seeks an optimization value/values so that the evaluation function/functions are minimized, using a result of computation of the energy consumption amount of each piece of heat source equipment, the amount being computed by an air-conditioning equipment simulator c14 and an optimization computing means c15 and based on a change in the external atmospheric air condition, the load condition, and the control condition of the temperature/flow rate of cold water/cooling water. Optimization computation is performed on various combinations of external atmospheric air wet-bulb temperature and load to create optimization control data. Further, the remote monitoring and controlling system S1 gives the optimization control data to control target values, and issues the instructions to the monitoring and controlling devices

e1 of the respective pieces of heat source equipment (the air-conditioning equipment e11,...).

[0013]

The managing-adjusting computer c1 on the management side timely computes optimization control data, based on operation data of the monitoring and controlling devices e1, the pieces of air-conditioning equipment e11, ... collected from the monitoring and controlling devices e1 of the respective equipment sides, and updates the optimization control data of the respective equipment sides to thereby make adjustments.

[0014]

The remote monitoring and controlling system S1 includes monitoring and controlling devices e1 for monitoring and controlling pieces of air-conditioning equipment e11, as objects of control, provided on the respective equipment sides 1, 2, 3, ..., and further includes the managing-adjusting computer c1 provided on the management side to manage and adjust the respective monitoring and controlling devices e1 on the equipment sides 1, 2, 3, As the equipment side 2, the equipment side 3, ... are configured similarly to the equipment side 1, description will be made only on the equipment side 1.

[0015]

The managing-adjusting computer c1 on the management side includes a data communication means c11, an adjusting parameter identification means c12, a device characteristic database c13, an air-conditioning simulator c14, an optimization computing means c15, and an optimization control data creating means c16.

The data communication means c11 communicates with data communication means e12 on the respective equipment sides 1, 2, 3,

[0016]

The adjusting parameter identification means c12 identifies adjusting parameters for controlling the equipment sides 1, 2, 3, ... from data collected from the equipment sides 1, 2, 3, ..., respectively .

The characteristics of devices (a chiller 1, a cooling water pump 2, a cold/hot water pump 3, etc. in FIG. 4) provided in the respective air-conditioning equipments e11, ... on the equipment sides 1, 2, 3, ... are stored in the device characteristic database c13, and data is updated by the adjusting parameter identification means c12. For example, the device characteristic database c13 includes the characteristics of pressure loss with respect to the flow rate through a pipe, the characteristics of the flow rates with respect to the total pressure and the electrical power of a pump, and the heat exchange characteristics of a cooling tower, and the like, wherein, in case that the numeric values of the characteristics of devices after actual operation and the numerical values of design data are different from each other, the numerical values of the design data are corrected to values that approximate to values in an actual operation state. For example, the energy consumption amount of a chiller may be corrected by linear approximation, using a value by simulation and a value by actual operation.

[0017]

From the data collected from the equipment sides 1, 2, 3, ... and information of the device characteristic database c13, the air-conditioning simulator c14, the optimization computing means c15, and the optimization control data creating means c16 perform simulation and optimization computation to minimize the evaluation functions, and thereby create optimization data for the respective equipment sides 1, 2, 3,

[0018]

The system S1 includes, on the equipment side 1, the monitoring and controlling device e1 for monitoring and controlling of a piece of air-conditioning equipment e11 as a control object.

The air-conditioning equipment e11 performs cooling and heating of a building, a factory, a data center, a region, or the like.

The monitoring and controlling device e1 includes a data communication means e12 for communication with the managing-adjusting computer c1, a storage section e13 for optimization control data, an optimization instruction value computing means e14, a communication

means e15 for communication with the air-conditioning equipment e11, and a data collection-storage means e16.

[0019]

The storage section e13 for optimization control data stores optimization control data transmitted from the managing-adjusting computer c1 on the management side.

The data collection-storage means e16 collects and stores data of the air-conditioning equipment e11 from the air-conditioning equipment e11 via the communication means e15.

The optimization instruction value computing means e14 seeks control target values used for control instruction values used in the PID control and the sequence control of the air-conditioning equipment e11 from the transmitted optimization control data and information in the data collection-storage means e16.

[0020]

The flow of control of the remote monitoring and controlling system S1 will be described below.

The air-conditioning equipment e11 as an object of control by the remote monitoring and controlling system S1 is automatically controlled by a control means, not shown, for PID control and the like so that a user set temperature and the like are obtained. This automatic control performs control of the temperature by the air-conditioning equipment e11 and the flow rate control of a used heat medium, and sequence control of operation, stoppage, etc. of a chiller, a hot heat source device, a pump, and the like.

[0021]

The optimization instruction value computing means e14 reads operation information data of the air-conditioning equipment e11 from the data collection-storage means e16, obtains control target values by seeking optimization control data corresponding to the operation state and the installation environment from the storage section e13 for optimization control data, and issues an instruction via the communication means e15 to the control means (not shown) of the air-conditioning equipment e11.

[0022]

The actual operation data of the air-conditioning equipment e11 and the collected data for the control target values of the air-conditioning equipment e11 are transmitted to the managing-adjusting computer c1 on the management side by the data communication means e12. The adjusting parameter identification means c12 of the managing-adjusting computer c1 identifies adjusting parameters for control of the air-conditioning equipment e11 from collected data and updates the device characteristic data in the device characteristic database c13.

[0023]

Then, the air-conditioning simulator c14 and the optimization computing means c15 perform simulation and optimization computation that minimize evaluation functions for the air-conditioning equipment e11, using information in the device characteristic database c13 and the collected data. The optimization control data creating means c16 creates optimization control data from a result of optimization computation of optimization parameters corresponding to combinations of the external atmospheric air wet-bulb temperature and load, and updates the optimization control data on the equipment side 1.

On each of one or more equipment sides 1, 2, ... , the monitoring and controlling device e1 is connected to the air-conditioning equipment e11 of the heat source equipment, and optimization control data used for control of the air-conditioning equipment e11 is transmitted from the managing-adjusting computer c1 to update the storage section e13 for storing optimization control data.

[0024]

By the above-described configuration, based on the actual operation data of a piece of air-conditioning equipment e11 and the collected data of the control target values of the air-conditioning equipment e11, simulation and optimization computation are performed to minimize evaluation functions such as the total consumption energy, which creates new optimization control data matching the characteristics of actual equipment

for controlling the air-conditioning equipment e11. Accordingly, each piece of air-conditioning equipment e11 is enabled to be controlled with a high efficiency.

Thus, the configuration enables energy consumption to be decreased, and emission of CO₂ to be reduced.

[0025]

<Embodiment 2>

FIG. 2 is a diagram of conceptual configuration showing a remote monitoring and controlling system in Embodiment 2 according to the present invention.

In a remote monitoring and controlling system S2 in Embodiment 2, the optimization control data in Embodiment 1 includes optimization control table data and adjusting parameters.

As the configuration in Embodiment 2 is similar to that in Embodiment 1 in other points, reference symbols of numbers in twenties are assigned to elements which are similar to elements in Embodiment 1, and detailed description of these elements will be omitted.

[0026]

The adjusting parameters shown in the remote monitoring and controlling system S2 in Embodiment 2 are numerical values related to the update cycle of control target values of optimization control by a monitoring and controlling device e2, and numerical values related to automatic control of a piece of air-conditioning equipment e21 of the heat source equipment, such as a change speed.

The adjusting parameters include, for example, the average number of processing data pieces, the output interval of optimization instruction values, the output interval of output signals, default set values during operation of a chiller on an equipment side.

The optimization control table data is specific detailed data of control target values for optimization control.

[0027]

FIG. 7 shows the rotation speed ratios of a cooling water pump, as an example of optimization control table data.

The optimization control table data include, for example, rotation speed ratios of the cooling water pump 2 shown in FIG. 4 on the equipment side with respect to the external atmospheric air wet-bulb temperature(°C) and the load ratio (%). In FIG. 7, a rotation speed ratio is represented by anm (n, m: natural numbers), and a rotation speed ratio is represented by the ratio (%) of a rotation speed to a rated (maximum) rotation speed.

A load ratio (%) refers to the load ratio (%) of the chiller 1. The load ratio (%) of the chiller 1 refers to the load ratio (%) allocated to the chiller 1 from the load ratio (%) (the ratio to the maximum load) of the actual air-conditioning load. For example, in case that a single chiller 1 is used, the load ratio (%) of the actual air-conditioning load itself is the load ratio of the chiller 1. In case that two chillers 1 are used, and the load ratio (%) of the actual air-conditioning load is 80% and equally allocated, the both load ratios are 40%. If the load ratio (%) of one chiller 1 is 30%, the load ratio (%) of the other chiller 1 is 50%. The intervals of external atmospheric air wet-bulb temperatures and the intervals of load ratios are shown as an example, and the volume of data can be reduced by making the intervals larger.

[0028]

The managing-adjusting computer c2 on the management side in Embodiment 2 includes an adjusting parameter creating means c26a and an optimization control table creating means c26b, substituting for the optimization control data creating means c16 (see FIG. 1) in Embodiment 1.

The adjusting parameter creating means c26a creates adjusting parameters, based on optimization computation by an optimization computing means c25. The adjusting parameter creating means c26a creates set values, such as the temperature, the flow rate, and the inverter frequency during rated operation, using values in a device characteristic database c23, and computes the number of data pieces in an optimization control table from a computation result by the optimization computing means c25 to create data.

The optimization control table creating means c26b creates table data (see FIG. 7) being specific detailed data of optimization control target values, based on optimization computation by the optimization computing means c25. The table data is a table data group including the temperature of cold water, the temperature of cooling water, the number of operated devices, in other words, the number of devices to be operated. A single optimization instruction value is applied to a single table.

[0029]

Further, the monitoring and controlling device e2 on the equipment side in Embodiment 2 includes a storage section e23a for storing adjusting parameters and a storage section e23b for storing optimization control table data, substituting for the storage section e13 for storing optimization control data in Embodiment 1.

The storage section e23a for storing adjusting parameters has adjusting parameters transmitted from the managing-adjusting computer c2, which are stored for updating.

The storage section e23b for storing optimization control table data has optimization control table data transmitted from the managing-adjusting computer c2, which are stored for updating.

[0030]

Regarding the monitoring and controlling device e2, descriptions will be made below on a case of using the inlet temperature of cooling water of the chiller on the equipment side and the like, which are optimization control table data transmitted from the managing-adjusting computer c2, the optimization control table data being created with respect to the wet-bulb temperature (°C) and the load ratio (%) of the external atmospheric air.

An optimization instruction value computing means e24 obtains, from a data collection-storage means e26, input of the external atmospheric air temperature and the external atmospheric air relative humidity on the equipment side, the cold/hot water incoming temperature to the chiller and the cold/hot water outgoing temperature from the chiller, and the cold/hot

water flow rate, to compute the external atmospheric air wet-bulb temperature and the cooling load ratio of the chiller.

[0031]

Then, the data collection-storage means e26 obtains respective output values including an inlet temperature of cooling water of the chiller on the equipment side, a flow rate ratio of cold/hot water of the chiller, a flow rate ratio of cooling water of the chiller, a temperature of cold/hot water at the outlet of the chiller, from table data including the inlet temperatures of cooling water of the chiller, the flow rate ratios of cold/hot water of the chiller (to the rated maximum flow rate), the flow rate ratios of cooling water of the chiller (to the rated maximum flow rate), the temperatures of cold/hot water at the outlet of the chiller, with respect to the wet-bulb temperature ($^{\circ}\text{C}$) and the load ratio (%). The data collection-storage means e26 outputs the respective obtained output values to a control means, not shown, of the air-conditioning equipment e21 together with adjusting parameters related to automatic control.

[0032]

By the above-described configuration, the device characteristics are corrected, based on actual operation data of the air-conditioning equipment e21 and collected data of the control target values of the air-conditioning equipment e21. Simulation and optimization computation are performed to minimize the evaluation functions such as the total consumption energy, which creates new optimization control table data and adjusting parameters for controlling the air-conditioning equipment e21. Consequently, it is possible to control the air-conditioning equipment e21, with a high efficiency.

Accordingly, the configuration enables the energy consumption to be decreased and emission of CO_2 to be reduced.

[0033]

<Embodiment 3>

FIG. 3 is a diagram of conceptual configuration showing a remote monitoring and controlling system in Embodiment 3 according to the present invention.

A remote monitoring and controlling system S3 in Embodiment 3 includes means for transmitting/receiving data via the Internet 11, as a communication method between communication means.

As the configuration is similar to that in Embodiment 2 in other points, reference symbols of numbers in thirties are assigned to elements which are similar to elements in Embodiment 2, and detailed description of these elements will be omitted.

[0034]

The remote monitoring and controlling system S3 includes an Internet connection means c3i on the managing-adjusting computer c3 side and an internet connection means e3i on the equipment side, as means for transmitting/receiving data via the Internet 11.

In this system, communication is possible, without installing a line with a long distance, by sharing the Internet 11 on existing lines without using a dedicated line. In case of using a mobile line, wired equipment is unnecessary.

[0035]

FIG. 4 is a diagram of conceptual configuration showing a heat source system used in Embodiments 1 to 3.

A heat source system N1 performs optimization control by any one of the remote monitoring and controlling systems S1 to S3 in Embodiments 1 to 3.

The heat source system N1 includes a cold heat source device 1 (a chiller 1 in case of FIG. 4), such as a centrifugal chiller, an absorption cold/hot water device, or the like, a cooling water (heat source water) pump 2, a cold/hot water pump 3, a cooling tower 4 for heat exchange with external atmospheric air, and a control means 6 for controlling the heat source system N1. The heat source system N1 is configured to supply cold/hot water to a load 5.

[0036]

For example, inverter controls are performed on the cooling water (heat source water) pump 2 and the cold/hot water pump 3, respectively.

The cooling tower (heat exchanger) 4 performs heat exchange with external atmospheric air to produce cooling water (heat source medium, heat medium) having a predetermined temperature. As the heat source of the cooling tower 4, external atmospheric air, sea water, river water, groundwater, or the like is used. However, the heat source is not limited thereto.

The cooling water produced in the cooling tower 4 circulates in the chiller 1 of the cold heat source device as shown in FIG. 4 by alternate long and short dash lines by the cooling water (heat source water) pump 2.

[0037]

The chiller 1 produces cold/hot water (cold/hot medium, heat medium) for cooling at a load 5, using the cold heat of cooling water, and the cold/hot water circulates through the load 5 by the cold/hot water pump 3 to perform cooling.

A single cold/hot water system or plural cold/hot water systems is/are provided, each including a chiller 1, a cold/hot water pump 3, and a load 5.

Detection signals are input to the control means 6 from a temperature sensor t1 for measuring the temperature of external atmospheric air and a humidity sensor h1 for measuring the humidity of the external atmospheric air, respectively.

[0038]

Further, detection signals are input to the control means 6 from a temperature sensor t2 for measuring the temperature of cooling water at the outlet of the cooling tower 4, a temperature sensor t3 for measuring the temperature of the cold/hot water at the outlet of the chiller 1, temperature sensors t4, t5 for measuring the temperatures of the cold/hot water at the inlet/outlet of the load 5 of the air-conditioning equipment, respectively.

Further, a detection signal is input to the control means 6 from a flow rate sensor f1 for measuring the flow rate of cold/hot water at the outlet of the load 5 of the air-conditioning equipment. Still further, a flow rate sensor for measuring the flow rate of cooling water produced by the cooling

tower 4 and sensors for measuring the electrical power amount and the energy consumption amount of gas of all devices may be arranged to input detection signals so that the accuracy of correction is improved.

[0039]

Control of the heat source system N1 will be described below.

A load ratio (%) to the maximum load of the load 5 in air conditioning is obtained from temperatures detected by the temperature sensors t4, t5 and a flow rate detected by the flow rate sensor f1.

The load ratio (%) of the load 5 is allocated to the chiller 1. In case that plural chillers 1 are used, the allocation of load ratios (%) is determined by adjusting the flow rates of cold/hot water flowing through the respective chillers 1.

[0040]

In the heat source system N1, the type and number of chillers 1 as the heat source device, the number of cold/hot water pumps 3 and cooling water pumps 2, and the temperatures/the flow rates of cold/hot water and heat source water (cooling water) are given to parameters. Optimization control table data is computed in advance by computation of the optimization parameters to minimize at least one of the energy consumption amount, the operation cost, and the CO₂ generation amount, based on a computation result by air-conditioning equipment simulators (c14 to c34). The optimization control table data as a result of optimization computation is searched with the wet-bulb temperature of external atmospheric air and measured values of the load states of the devices of the air-conditioning equipment, and the control target values of the respective devices of the heat source system N1 are updated to numerical values in this table data.

[0041]

In case of performing heating at the load 5 of the air-conditioning equipment, the cold heat device 1 serves as a hot heat source, and a heating tower (heat exchanger) with a heat source of, for example, external atmospheric air is used instead of the cooling tower 4. In heating, cooling water turns into heating water (heat source medium), and cold/hot water

turns into hot water (cold/hot medium). A heating tower may be used both for heating and cooling.

[0042]

By the above-described configuration, based on actual operation data of the heat source system N1 and collected data of the control target values of the heat source system N1, simulation and optimization computation are performed to minimize the evaluation functions such as the total consumption energy, which creates new optimization control table data and adjusting parameters for controlling the heat source system N1. Consequently, it is possible to control the heat source system N1, with a high efficiency.

Accordingly, the configuration enables the energy consumption to be decreased and emission of CO₂ to be reduced.

[0043]

<Embodiment 4>

FIG. 5 is a diagram of conceptual configuration showing a remote monitoring and controlling system in Embodiment 4 according to the present invention.

A remote monitoring and controlling system S4 in Embodiment 4 is an example of a cold heat source.

The remote monitoring and controlling system S4 is configured similarly to the remote monitoring and controlling system S3 in FIG. 3.

Reference symbols of numbers in forties are assigned to elements, of the remote monitoring and controlling system S4, which are similar to elements of the remote monitoring and controlling system S3 in Embodiment 3, and detailed description of these elements will be omitted.

[0044]

The remote monitoring and controlling system S4 includes a router c4i as an Internet connection means of the managing-adjusting computer c4, and includes a router e4i as an Internet connection means of the monitoring and controlling device e4.

The remote monitoring and controlling system S4 includes a parameter updating history storage section c47a for storing adjusting parameters created by an adjusting parameter creating means c46a, and a table updating history storage section c47b for storing optimization control table data created by an optimization control table creating means c46b.
[0045]

The adjusting parameters, created by the adjusting parameter creating means c46a of the remote monitoring and controlling system S4, and the optimization control table data, created by the optimization control table creating means c46b, are stored as equipment-specific transmission data c58 individually for respective pieces of equipment.

The equipment-specific transmission data c58 is used for an equipment determination means c59 to determine a piece of equipment corresponding to equipment-specific transmission data c58, and is transmitted to the monitoring and controlling device e4 of the corresponding the piece of equipment by the data communication means c41.
[0046]

The remote monitoring and controlling system S4 has a piece of air-conditioning equipment e41 as an object of control which is assumed to be the heat source system N1 in FIG. 4. The system S4 has a monitoring and controlling device e4 on the equipment side and a managing-adjusting computer c4 on the management side into which the process of optimization control is separated.

The remote monitoring and controlling system S4 has the air-conditioning equipment e41 as an object of control on the equipment side. The air-conditioning equipment e41 has cold heat source devices 1, such as a centrifugal chiller or an absorption cold/hot water device, disposed in parallel with each other or serially to perform cooling. The absorption cold/hot water device is an absorption chiller that produces cold/hot water, using lithium bromide, ammonia, etc.
[0047]

<Control of Air-conditioning Equipment e41>

For control of the air-conditioning equipment e41 of the remote monitoring and controlling system S4, control means 6 (see FIG. 4) performs feedback control, such as control for constant temperatures of devices incorporated in the chiller 1 and the like, control for constant temperature of the cooling water outlet of the cooling tower (4), and the like.

The control target values by the control means 6 (see FIG. 4) and the operation state of the air-conditioning equipment e41 are stored by a data collection/storage means e46 (see FIG. 5) into a PC (personal computer) or a PLC (programmable logic controller).

[0048]

The operation state of the heat source system N1 of the air-conditioning equipment includes the operation/stoppage states of devices, the respective temperatures of external atmospheric air, cooling water (heat medium), and cold/hot water, the respective flow rates of cooling water and cold/hot water, the respective inverter frequencies of the cold/hot water pump 3 and the cooling water pump 2.

An optimization instruction value computing means e44 may perform filtering processing of moment data. The means e44 performs averaging processing in which failures and abnormal data of various sensors are deleted. The means e44 switches, upon detection of a failure, the control target values for optimization control to control target values for a time of failure occurrence, and stores the failure state and the average values.

[0049]

Then, the optimization instruction value computing means e44 computes a wet-bulb temperature from a dry-bulb temperature measured by the temperature sensor t1 for external atmospheric air and a relative humidity measured by a humidity sensor h1. The means e44 computes the load of cooling from the difference between outgoing temperature and returning temperature of cold/hot water (heat medium) on the load 5 side.

Further, the means e44 seeks an optimum instruction value from a table data having optimum instruction values corresponding to input values of external atmospheric air wet-bulb temperature and the load of cooling.

Regarding a change in an instruction value, the means e44 sets a limit on the instruction value so that the instruction value is within a range satisfying conditions of the operation range of a device, for example, the change amount per unit time in flow rate and the change amount per unit time in temperature, and satisfying the range of an upper and lower limit, and thus outputs an instruction value to the control means 6.

[0050]

The optimization instruction value computing means e44 computes the rotation speed ratios of the cold/hot water pump 3 and the cooling water pump 2 from sought and obtained values of flow rate ratios in the optimization control table data, based on the relationships between the rotation speeds and the flow rate ratios of the cold/hot water pump 3 and the cooling water pump 2, and outputs the computed rotation speed ratios. For example, in case of controlling the rotation speed ratio of the cold/hot water pump 3 or the cooling water pump 2 by an inverter, the value of the rated ratio of the inverter frequency multiplied by a rotation speed ratio, letting the rated ratio of the inverter frequency be 100, is output to the inverter.

The adjusting parameters have the maximum capacity of a device, the optimization operation cycle, the coefficient of the relationship between the pump rotation speed ratio (inverter frequency ratio) and the flow rate, and the like, which are updated as parameters for performing adjustment of the monitoring control device e4.

[0051]

<Transmission/Reception of Data Between Monitoring and Controlling Device e4 on Equipment Side and Managing-Adjusting Computer c4 on Management Side>

The monitoring and controlling device e4 on the equipment side and the managing-adjusting computer c4 on the management side transmit and receive data therebetween.

The monitoring and controlling device e4 on the equipment side is configured with a PC or a PLC and is connected to the Internet 11 via the

router e4i. An existing VPN (Virtual Private Network) device is used in Internet connection so as to decrease the possibility of leakage of information and data.

[0052]

The managing-adjusting computer c4 transmits/receives data similarly to/from monitoring and controlling devices e4 on plural equipment sides as objects of data transmission/reception. Data is transmitted and received, based on an existing protocol, such as FTP (File Transfer Protocol), HTTP (Hypertext Transfer Protocol), HTTPS (Hypertext Transfer Protocol over Secure Socket Layer), or the like.

[0053]

Data of operation information is stored individually for the respective pieces of equipment by an equipment determination means c59 of the managing-adjusting computer c4 on the management side. Data transmitted/received by the data communication means c41 includes only numerical values, and is stored in association with item names corresponding to the order of the numeric values by the managing-adjusting computer c4 on the management side. This method is capable of making it difficult to identify data in data communication.

For example, equipment determination means c59 stores operation data and optimization control data, separating the respective storage areas from each other, and the monitoring and controlling device e4 on an equipment side transmits and receives data in a storage area corresponding to the equipment side.

[0054]

<Managing-Adjusting Computer c4>

The managing-adjusting computer c4 compares deterioration in the resistance characteristics of the piping system and devices of the air-conditioning equipment e41, according to the operation data of the air-conditioning equipment e41, with a simulation result obtained the time of planning, and identifies adjusting parameters. For example, in case that the absorption cold/hot water device (the chiller 1 is shown as an example in

FIG. 4) has a larger energy consumption amount (gas consumption amount) under the same conditions of load and cooling water temperature using an air-conditioning equipment simulator c44 and device characteristics adjusted at the time of introduction, the computer c4 determines that deterioration has occurred and the energy consumption amount is corrected. Further, the system for performing simulation of the heat source equipment is configured to store data, which correspond to the respective equipment sides 1, 2, 3, ..., in a device characteristic database c43, the air-conditioning equipment simulator c44, or the like. The air-conditioning equipment simulator c44 calls a system configuration and device characteristics corresponding to the equipment side and simulates the energy consumption amount. The system configuration is constituted with a cooling tower, a chiller, pumps and cold water pipes, and cooling water pipes, and is a configuration of a combination of devices implemented with energy conservation and mass conservation, including device types, the number of devices, capacities, a method of controlling temperature and flow rate.

[0055]

Further, when a pump power has become larger with respect to the inverter frequency n_i of the pump, the coefficient 'a' of the pipe resistance is corrected. For example,

$$(\text{pipe resistance}) \Delta P = a \times Q^b + C \quad (1)$$

represents the correction. Herein, C represents the actual head, and 'b' is a constant, 2 for example.

[0056]

The pipe resistance ΔP is substantially proportional to the square of the flow rate Q , according to Equation (1). Assuming that the actual head C is constant, and that the flow rate Q is proportional to the inverter frequency n_i (see FIG. 6C), based on the relationship between the flow rate Q and the total pressure P of the pump (see FIG. 6A) and the relationship between the flow rate Q and the consumption power E (see FIG. 6B). The pump total pressure P is obtained, based on the electric power (kW) and the

inverter frequency n_i and using FIGS. 6A and 6B, and the relationship between the flow rate Q and the pipe resistance ΔP is thereby obtained.

In other words, a and C in Equation (1) are obtained.

[0057]

Assuming that the actual head is small and the total pressure of the pump can be approximated by quadratic expression of a flow rate, the flow rate Q can be represented by the following Equation (2), based on the relationship represented by Equation (1) and using the inverter frequency n_i .

$$(\text{Flow rate}) Q = d \times (n_i - e) \quad (2).$$

The coefficients d and e can be obtained from Equation (1) and Equation (2) by measuring at least two points.

In case that a flow meter is provided, the relationship between the flow rate Q and the pipe resistance ΔP is estimated from the relationship between the flow rate Q and the inverter frequency n_i .

[0058]

A flow rate may be obtained from the differential pressure in the heat exchanger of the chiller 1, and in case of the chiller 1 having the external output, the value may be used as operation data. Using a signal from a device provided on the air-conditioning equipment e41 reduces the number of sensors fitted to the air-conditioning equipment e41 at the site.

Based on a result of identifying adjusting parameters, information in the device characteristic database c43 is updated. Optimization control instruction values obtained by the air-conditioning equipment simulator c44 and an optimization computing means c45 form an optimization control table data by an optimization control table creating means c46b. Adjusting parameters formed of the change cycle, the change speed, etc. of the optimization control instructions are converted into data for transmission by the adjusting parameter creating means c46a.

[0059]

<Optimization Control Table Data>

FIG. 7 shows optimization control table data of the rotation speed ratios of the cooling water pump.

The optimization control table data includes data of, for example, rotation speed ratios, cooling water temperatures, cold/hot water temperatures of the cooling water pump 2, rotation speed ratios of the cold/hot water pump 3, operation patterns of chillers 1 (the number and the types of devices), corresponding to combinations of external atmospheric air wet-bulb temperatures and load ratios. Herein, optimization parameters and optimization control tables may be stored in the parameter updating history storage section c47a, c47b. Updated points of data can be confirmed by comparison with old data by a person (user). Confirming a significant change in a value or confirming operation by simulation before a transmitting table data improves reliability.

[0060]

Adjusting parameters and optimization control table data are transmitted via the data communication means c41 to the monitoring and controlling device e4 on an equipment side so that the adjusting parameters and the optimization control table data are transmitted to a corresponding piece of equipment and are stored in a storage area (e43a, e43b). As initial values, a control table data using the characteristics of the devices and the piping system of a piece of air-conditioning equipment e41 obtained from design data is stored, and can be updated, as necessary, at the time of adjustment in introducing the air-conditioning equipment e41. After the adjustment in introducing the air-conditioning equipment e41, the optimization control table data is normally updated once a month or a year, and the update cycle is shortened in the event of a failure of the air-conditioning equipment e41.

[0061]

It is practical that, during writing data of the monitoring and controlling device e4, the control target values of an operation mode are set, for example, to rated settings for performing operation, and optimization control starts after the writing is completed.

Updating of adjusting parameters and optimization control table data is also performed for other equipment side 2, equipment side 3, ... ,

using operation data corresponding to respective air-conditioning equipments e41, and is available with even a single managing-adjusting computer c4 provided on the management side. Sharing backup data and managing-adjusting computers c4 at plural base points on the management side enables management on plural management with the plural managing-adjusting computers c4, which thereby improves the convenience to the management.

[0062]

The equipment determination means c59 is included to identify pieces of equipment and update optimization table data and adjusting parameters, corresponding to the respective pieces of equipment.

Centralized management of pieces of equipment prevents occurrence of control errors, which facilitates updating of the air-conditioning equipment simulator c44.

Data communication, which makes it possible to get at a time the state of operation of pieces of equipment, may be implemented by a dedicated signal line without using the Internet, and both the managing-adjusting computer c4 and the monitoring and controlling device e4 may be incorporated in a single PC.

[0063]

In computing a rotation speed ratio of a pump, if the actual head b is small, the relationship between the rotation speed ratio and the flow rate ratio may be linearly approximated to correct the rotation speed ratio, by the two points of the maximum flow rate ratio and the minimum flow rate ratio, which enables reduction in the number of measurements for adjustment.

[0064]

<Optimization Computation>

The managing-adjusting computer c4 performs optimization computation of the temperature and the flow rate of cold/hot water and cooling water to minimize the energy consumption amount of the heat source system N1 predicted from an external atmospheric air state and the

load amount on the load 5 (see FIG. 4) side, a measured value of the temperature of sea water or river water as the heat source, and the characteristics of devices and the pipe resistance of the heat source system N1, which are at the air-conditioning equipment e41 and vary every minute. Thus, the managing-adjusting computer c4 updates the control target values of the cooling water outlet temperature (measured by the temperature sensor t2) of the cooling tower 4, the cold/hot water outlet temperature (measured by the temperature sensor t3) on the high temperature side of the chiller 1, the cold water outlet temperature of the chiller 1, the rotation speed of the cold/hot water pump 3, and the rotation speed of the cooling water pump 2.

[0065]

Details of optimization computation will be described below.

The managing-adjusting computer c4 gives the type and the number of the heat source devices (the chiller 1 in FIG. 4) on the load 5 side to parameters, and computes the load handled by heat source devices (the chiller 1 in FIG. 4) and the load of the heat source device of an exhaust-heat-using heat source that uses the generator exhaust heat of cogeneration. Then, the managing-adjusting computer c4 gives the external atmospheric air wet-bulb temperature, the flow rates and the temperatures of cold/hot water and cooling water to inputs, and computes the energy consumption amounts of respective devices and the total value by the air-conditioning equipment simulator c44, based on operation characteristics of the devices (the heat source devices (chillers 1), the resistance characteristics of the piping system with respect to the flow rates of the cold/hot water pump 3, the heat source water pump (cooling water pump 2), the cooling tower 4, the cold/hot water system (the cold/hot water system in FIG. 4), and the heat source system (the cooling water system in FIG. 4).

[0066]

Regarding the energy consumption amount of the cooling water pump 2 or the cold/hot water pump 3, a pump head is computed from a result of prediction or actual measurement of the relationship of the

pressure loss to the flow rate of the piping system (pipe, valve, heat exchanger, etc.), and a pump power is computed from the relationship between the flow rate and the head.

Further, the relationship between the fan power of the cooling tower 4 (see FIG. 4) and the cooling performance is predicted, using an enthalpy based overall volume transfer coefficient, which is general, of the cooling tower 4. Still further, the total value of the energy consumption amounts of the heat source system N1 is given to an evaluation function W. The types of the heat source devices (the chiller 1 in FIG. 4 and the like) and the number of operated devices and the pump rotation speed ratios/the temperatures of cold/hot water and cooling water are given to optimization variables. Seeking optimization variables that minimize the evaluation function W obtains the optimum values, and the optimum values are assigned to control target values.

[0067]

[Expression 1]

$$W = \sum_{1}^l (E_{refl} \times N_{refl}) + \sum_{1}^m E_{cpm} + \sum_{1}^n E_{cwpm} + \sum_{1}^p E_{ctp} \quad (3)$$

wherein,

E_{refl} : energy consumption amount of heat source device n

N_{refl} : number of heat source devices n

E_{cpm} : energy consumption amount of cold/hot water pump m

E_{cwpm} : energy consumption amount of heat source water pump n, and

E_{ctp} : energy consumption amount of cooling tower p.

[0068]

By the present control method, a chiller 1 is operated such as to minimize the evaluation function W, in other words, to minimize the total value of the energy consumption amounts, compared with a case of operating the chiller 1 at a maximum load (rated load). This operation makes it possible to operate the heat source system N1 in FIG. 4 with a high value of COP (Coefficient Of Performance), and achieves energy conservation.

[0069]

To be specific, a control target value/values of least one of the rotation speed ratio/ratios of a pump/pumps (2, 3), of the heat source equipment, (to the rated (maximum) rotation speed), the fan rotation speed ratio of a cooling tower 4 (to the rated (maximum) rotation speed), the cooling water temperature-cold/hot water temperature of a chiller 1, and the number of devices/type of the heat source device to be operated (chiller 1 in the case of FIG. 4) is/are assigned to an optimization parameter/parameters.

[0070]

Then, the external atmospheric air conditions and load conditions are given to input conditions, and the energy consumption amount of the entire equipment obtained from device characteristics and the CO₂ emission amount or the primary energy to be used are given to evaluation functions. Optimization computation is performed to minimize the evaluation function, and the air-conditioning equipment simulator c44 and the optimization computing means c45 determine optimization parameters. Further, optimum instruction values determined with respect to the external atmospheric air wet-bulb temperature and the load ratio (to the rated load) are given to optimization control table data in advance. The operation conditions are set on the control system and devices, based on measured values of the external atmospheric air and the load conditions. The optimization control method has been described above.

[0071]

<Optimization Control Table Data>

FIG. 7 shows an example of optimization control table data. FIG. 7 shows the rotation speed ratio of the cooling water pump 2 with respect to the external atmospheric air wet-bulb temperature and the load ratio (%) of a chiller 1. The load ratio (%) of the chiller 1 is, as described above, the load ratio (%) of the load 5 of air conditioning allocated to the chiller 1.

In addition, optimization control table data include table data, such as, the cooling water outlet temperature of the cooling tower 4, the cold/hot water flow rate ratio of the chiller 1 (to the rated flow rate of the maximum

flow rate), the cooling water flow rate ratio of the cooling tower 4 (to the rated flow rate of the maximum flow rate), and the cold/hot water temperature at the outlet of the chiller 1, etc.

[0072]

The cooling tower 4 shown in FIG. 4 is controlled by flow rate control that changes the rotation speed of the fan to keep the cooling water outlet temperature measured by the temperature sensor t2 constant. Further, though not shown, a cold/hot water secondary pump is operated by control of the variable flow rate of cold/hot water, in response to the load on the load 5 side. The control of the cold/hot water secondary pump is a known discharge-pressure constant control, end pressure constant control that makes the pressure at the end on the load 5 side be constant, in response to a requirement on the load side, or the like.

[0073]

The external atmospheric air state, as shown in Fig. 4, is got by measuring the external atmospheric air wet-bulb temperature from the temperature sensor t1 and the humidity sensor h1. The cooling load is computed from the cold/hot water flow rate and the difference between the outgoing temperature and the returning temperature of the cold/hot water circulation in the cold/hot water system. The outlet temperature of the chiller 1 may be considered to be the cold/hot outgoing temperature. Further, operation with a constant rotation may be performed, and may be performed by changing settings of a configured system stored in the device characteristic database c43.

[0074]

<Monitoring and Controlling Device e4>

The monitoring and controlling device e4 has received optimization parameters and optimization control table data from the managing-adjusting computer c4. The monitoring and controlling device e4 uses the external atmospheric air wet-bulb temperature measured by the temperature sensor t1 and the load ratio, and seeks optimum values of the type and the number of devices of the chiller 1 to be operated, the

temperatures of cold/hot water and cooling water, and the pump rotation speed ratio from the optimization control table data e43b (see FIG. 5). Then, the monitoring and controlling device e4 gives a sought result to control target values, and updates the set value of the outlet temperature of the chiller 1, the frequency ratios (to the rated inverter frequencies) or the rotation speed ratios (to the rated rotation speed ratios) of the cooling water pump 2 and the cold/hot water pump 3, and the set value of the cooling water outlet temperature of the cooling tower 4. Change of settings is made, following a variation in the external atmospheric air wet-bulb temperature and the cooling load, and is performed, for example, once every ten minutes. [0075]

The cooling tower 4 may be a known open cooling tower or a known closed cooling tower.

The heat pump chiller 1 may be an air cooled type.

The control target values of the number and type of chiller 1, the rotation speed ratio of the cold/hot water pump 3, and the cold water outlet temperature of chiller 1 are updated, using the data of an optimization computation result and corresponding to the external atmospheric air and load conditions, which realizes energy conservation.

[0076]

The chiller 1 may be an inverter chiller that performs control of rotation speed of the compressor of the chiller 1, which improves the efficiency of a partial load, compared with a case of constant speed control.

In the optimization computation, the flow rate and the temperature of cooling water may be kept to be a constant value, which reduces the cost of the inverter of a pump or the inverter of a cooling tower fan.

[0077]

Optimum instruction values instead of optimization control table data may be directly transmitted to the monitoring and controlling device e4 side of the remote monitoring and controlling system S4. This direct transmission decreases the data storage capacity and the computation performance of the monitoring and controlling device e4 side.

Although, in the foregoing description, a chiller 1 was taken as an example of a heat source device, the heat source device may be a heat pump hot water generator. Refrigerant (heat medium) may not be water but existing flowable latent-heat medium or brine water.

[0078]

In summary of the above, the air-conditioning equipment e41 starts to be operated with default control target values at the start of operating. Then, the managing-adjusting computer c4 collects the operation data of the air-conditioning equipment e41 and the monitoring and controlling device e4 timely, for example, once a year or once a month. The managing-adjusting computer c4 performs simulation and optimization computation to create optimization control data, and transmits the optimization control data to the monitoring and controlling device e4. The monitoring and controlling device e4 obtains control target values from the control table data of the optimization control data, and the control means 6 operates the air-conditioning equipment e41 with these control target values.

[0079]

Accordingly, the system S4 is capable of setting control target values to monitoring and controlling devices e4 of pieces of air-conditioning equipment e41 at plural sites which are remote from the managing-adjusting computer c4 at a single place, respectively. That is, the system S4 transmits data by communication, without providing simulators at respective sites with a piece of air-conditioning equipment e41. Accordingly, for version up of a simulator, it is only necessary to update the version of the air-conditioning equipment simulator c44 of the managing-adjusting computer c4 at a single place, which enables easy setting of new control target values for the pieces of air-conditioning equipment e41 at plural remote sites, respectively.

[0080]

Although a piece of air-conditioning equipment e41 changes in performance with use and aged deterioration, the managing-adjusting computer c4 collects the operation data of the air-conditioning equipment

e41 and the monitoring and controlling device e4 to perform simulation for making the operation state newly become optimum. The monitoring and controlling device e4 transmits the optimum control target values to the monitoring and controlling device e4. The monitoring and controlling device e4 enables the air-conditioning equipment e41 to be operated with the optimum control target values then.

[0081]

<Modified Embodiment 1>

The configuration of chillers 1 may be arranged in a serial disposition for tandem operation. The load allocation of the chillers 1 is added to the optimization variables, and consumption powers of the cooling water pump 2 and the cold/hot water pump 3 are added to the evaluation functions, thus creating optimized instruction values used as optimization control table data. The optimization control table data is, for example, the set value of the outlet temperature of the chiller 1 connected to the return side of cold/hot water.

This configuration prevents drop in the partial load efficiency of the tandem operation of the chillers 1.

[0082]

<Modified Embodiment 2>

A chiller 1 may be used as a heat exchanger or a heat source device for producing cold water at the cooling tower 4 to control the cold/hot water pump 3 and the cooling water pump 2.

[0083]

<Modified Embodiment 3>

A heat source device for producing cold water and hot water by solar heat may be included, and the heat source water pump may be a hot water transfer pump of a cooling tower for performing heat exchange with air or a solar heat collector. Thus, energy conservation of a system that uses renewable energy is enabled.

[0084]

<Modified Embodiment 4>

A system including a cold/hot water producer using exhaust heat of cogeneration may be configured. Thus, optimization operation of a heat source device using exhaust heat is also possible.

[0085]

<Modified Embodiment 5>

The flow rate with respect to the pump frequency (pump rotation speed) may be measured by a method that measures the constant frequency and the flow rate of the maximum flow rate in case of a small actual head. Setting the numerical value to be larger is capable of preventing the flow rate from dropping. Reducing the number of measurement data at the initial adjustment allows the adjustment time to be shortened.

[0086]

<Modified Embodiment 6>

Automatic tuning may be applied. In this case, determination is made with a defined change range (for example, $\pm 10\%$ for cooling water flow rate) applied at the time of updating an automatic control table and adjusting parameters. If transmission is possible, data is transmitted to the data communication means e12 to e42 on the equipment sides.

[0087]

<Modified Embodiment 7>

The characteristics of a heat exchanger on the load side and the load may be used to perform optimization operation including the cold/hot water temperature. When including pumps and air-conditioner fans of the load side increases the number of items of optimization parameters to increase the cold water temperature, the operation efficiency of a chiller is improved, which achieves energy conservation.

[0088]

<Modified Embodiment 8>

Instead of cooling described in the above-described embodiments, heating devices may be used. In case of heat pump heaters, the efficiency is increased by decreasing the temperature of refrigerant, and energy conservation is thereby achieved.

[0089]

<Modified Embodiment 9>

A display means displaying operation data and an optimization control table is preferably provided. An updating means for a user to visually determine and confirm and manually update control target values may be provided. Thus, control is assisted.

[0090]

<Modified Embodiment 10>

Instead of using communication means such as the Internet 11 as described in the above-described embodiments, a storage device may be connected to rewrite data on the equipment side. Thus, the initial stage is enabled to be carried out even without communication means.

[0091]

<Modified Embodiment 11>

The external atmospheric air wet-bulb temperature used for optimization may be a dry-bulb temperature or a specific enthalpy of the external atmospheric air, and the wet-bulb temperature may be approximately computed from a measured value, letting the relative humidity be constant. Although the accuracy of optimization decreases, the number of sensors is reduced as the physical amount to be measured decreases.

[0092]

<Modified Embodiment 12>

Adjusting parameters may include parameters for PID control. Thus, adjustment of the feedback control system of the control means 6 is possible.

[0093]

<Modified Embodiment 13>

The upper and lower limits of the pump rotation speed ratio or the inverter frequency ratio corresponding to the upper and lower limits of the pump flow rate ratio to the rated flow rate are obtained from designed values or actually measured values. The pump flow rate ratio may be

converted into a rotation speed ratio or an inverter frequency ratio as an instruction value for optimization control. Despite an error in the flow rate, in case of a small actual head, the flow rate ratio and the pump rotation speed ratio is enabled to be adjusted with data at two points by linear approximation, as represented by Equation (2). Further, the pump flow rate may be measured by a differential pressure or flow meter to come to a design value by use of a feedback control.

[0094]

When the inner side of a pipe becomes thin by clogging or the like, the flow rate changes even with the same control frequency, it is possible to respond to change in the performance or deterioration in the device performance by, periodically or as necessary, customizing the operation with the optimization control table data and setting a frequency that satisfies a necessary flow rate.

For example, in case that operation data collected by the managing-adjusting computers c1 to c4 are the rotation speeds and the flow rates of pumps (the cooling water pump 2 and the cold/hot water pump 3) provided on the transfer system of a heat medium, the managing-adjusting computers c1 to c4 create optimization control data, based on the rotation speeds and the flow rates of the pumps in the operation data of the pieces of air-conditioning equipment e11 to e41 to update the optimization control data in the monitoring and controlling devices e1 to e4 on the equipment sides. The monitoring and controlling devices e1 to e4 obtain control target values from the optimization control data to issue instructions to the control means 6 for controlling these pumps.

[0095]

<Modified Embodiment 14>

On the monitoring and controlling devices e1 to e4 having a heat accumulation operation schedule, the heat accumulation operation schedule may be changed. Data replacement is enabled to be carried out from a remote site.

[0096]

<Other Embodiments>

In the above-described embodiments, a case was described as an example, where adjusting parameters and optimization control tables are transmitted, as optimization control data, to the monitoring and controlling devices e1 to e4, and the pieces of air-conditioning equipment e11 to e41 are thereby controlled. However, the arrangement may be made such that adjusting parameters or optimization control tables are transmitted to the monitoring and controlling devices e1 to e4, and the pieces of air-conditioning equipment e11 to e41 are controlled.

Further, in the above-described embodiments, a database is described as an example of a storage section, any storage section capable of storing information may be used without being limited to these embodiments.

[0097]

In the above-described embodiments, a case was described as an example, where optimization control data and collection data of the pieces of air-conditioning equipment e11 to e14 are transmitted online. However, optimization control data and the collection data may be stored in a storage medium, and data may be exchanged offline between the monitoring and controlling devices e1 to e4 and the managing-adjusting computers c1 to c4.

[0098]

Although various embodiments according to the invention have been described above, the description is not limiting and is aimed at being typical description. Accordingly, modifications and variations of the embodiments can be made within the scope of the invention. That is, the embodiments can be arbitrarily varied within a scope that does not change the spirit of the invention.

Description of Reference Symbols

[0099]

1 chiller (heat source device, device)

2 cooling water pump (device, pump, heat source medium pump, and cold/hot medium pump)

3 cold/hot water pump (device, pump)

4 cooling tower (heat exchanger, device)

6 control means (equipment control means, temperature control means, flow rate control means)

c1, c2, c3, c4 managing-adjusting computer

c11, c21, c31, c41 data communication means

c12, c22, c32, c42 adjusting parameter identification means

c13, c23, c33, c43 device characteristic database (device characteristic storage section)

c14, c24, c34, c44 air-conditioning simulator

c15, c25, c35, c45 optimization computing means

e1, e2, e3, e4 monitoring and controlling device

e11, e21, e31, e41 air-conditioning equipment

e13 storage section of optimization control data

e23a, e33a storage section of adjusting parameters

e43a storage area of adjusting parameters

e23b, e33b storage section for storing optimization control table data

e43b optimization control table data in storage area

Ectp energy consumption amount of cooling tower (energy consumption amount)

Ecpm energy consumption amount of cold/hot water pump (energy consumption amount)

Ecwpn energy consumption amount of heat source water pump (energy consumption amount)

Erefl energy consumption amount of heat source device (energy consumption amount)

S1, S2, S3, S4 remote monitoring and controlling system

t4, t5 temperature sensor (heat amount measuring means)

W evaluation function

CLAIMS

1. A remote monitoring and controlling system for controlling air-conditioning equipment by controlling a flow rate or a temperature of a heat medium having a cold heat or a hot heat obtained by heat exchange with a heat source, comprising:

- a managing-adjusting computer including
 - an adjusting parameter identification means for identifying an adjusting parameter for controlling the air-conditioning equipment;
 - a device characteristic storage section for storing characteristic of a device of the air-conditioning equipment;
 - an air-conditioning equipment simulator for simulating an energy consumption amount of the air-conditioning equipment; and
 - an optimization computing means for performing optimization computation, based on the simulation of the energy consumption amount of the air-conditioning equipment,
- wherein the managing-adjusting computer computes optimization control data for controlling the air-conditioning equipment by the air-conditioning equipment simulator and the optimization computing means for an evaluation function related to energy consumption to come to a desired value, in response to environmental condition of the air-conditioning equipment, and based on characteristic of at least one of a heat source device for producing the cold heat or the hot heat and a heat exchanger for heat exchange with the heat source, and characteristic of a transfer system for transferring the heat medium.

2. The remote monitoring and controlling system according to claim 1, comprising:

- an equipment control means for controlling the air-conditioning equipment; and
- a monitoring and controlling device for obtaining a control target value from the optimization control data to issue an instruction to the

equipment control means and for collecting operation data of the air-conditioning equipment.

3. The remote monitoring and controlling system according to claim 2, wherein the managing-adjusting computer creates new optimization control data for updating, based on the operation data of the air-conditioning equipment.

4. The remote monitoring and controlling system according to claim 2, wherein the operation data includes a rotation speed and a flow rate of a pump provided in the transfer system, and wherein the managing-adjusting computer creates new optimization control data for updating, based on the rotation speed and the flow rate of the pump of the air-conditioning equipment.

5. The remote monitoring and controlling system according to claim 3, wherein the operation data includes a rotation speed and a flow rate of a pump provided in the transfer system, and wherein the managing-adjusting computer creates new optimization control data for updating, based on the rotation speed and the flow rate of the pump of the air-conditioning equipment.

6. The remote monitoring and controlling system according to claim 4 or 5, wherein the monitoring and controlling device determines a control target value from updated optimization control data, and instructs the equipment control means to control the pump.

7. The remote monitoring and controlling system according to any one of claims 1 to 3, wherein the optimization control data includes at least one of optimization control table data and an adjusting parameter.

8. The remote monitoring and controlling system according to claim 7, wherein the managing-adjusting computer creates, from operation data collected from the equipment side, at least one of an adjusting parameter and an optimization control table having the optimization control table data to update either the adjusting parameter or the optimization control table.

9. The remote monitoring and controlling system according to any one of claims 1 to 3, comprising:

a communication means for performing transmission and reception of data, using the Internet.

10. A method of operating the remote monitoring and controlling system according to any one of claims 1 to 5,

the remote monitoring and controlling system including, in the air-conditioning equipment, at least one heat source device, heat exchanger, heat source medium pump, and cold or hot medium pump, a piping system for a heat source medium and a cold or hot medium to flow therethrough, a heat amount measuring means for measuring a heat amount of a load on the air-conditioning equipment, a flow rate control means for controlling flow rates of the heat source medium and the cold or hot medium to predetermined flow rates, and a temperature control means for controlling temperatures of the cold or hot medium and the heat source medium to predetermined temperatures,

the operation method comprising:

controlling at least one of a number of operated devices provided in the air-conditioning equipment, and temperature or flow rate of the heat source medium or the cold or hot medium, according to the optimization control data.