

## CONTROL SYSTEM FOR MACHINERY AND EQUIPMENT

## TECHNICAL FIELD

[0001]

5           The invention relates to a control system which controls information on machinery and equipment.

## BACKGROUND ART

[0002]

10           Compressors are used in a wide range of fields such as in chemical plants, for manufacturing electronic devices and for food processing, and is essential to an industry. Especially, in fields such as the electronic devices and the food processing in which oil mixture is not desired, demands for  
15 oil-free screw compressors without use of oil in a compression process are getting higher.

          Further, since performance of compressors remarkably affects productivity for products, there are demands by which users can recognize state of the compressors properly.

20 [0003]

          For example, Patent document 1 discloses an abnormality prediction/longevity control system. Facilities of customers are connected via communication lines with a remote monitoring system and diagnosis information and decision information on  
25 the facilities are notified to the monitoring system.

          With the technology disclosed in Patent document 1, specialists check each part for operation state of the facilities set in remote places and inform production plants whether an abnormality is found and how to deal with the  
30 abnormality for maintenance.

## PRIOR ART DOCUMENT

## PATENT DOCUMENT

[0004]

35           Patent Document 1: JP2003-50617 A

## SUMMARY OF THE INVENTION

## PROBLEMS TO BE SOLVED BY THE INVENTION

[0005]

With the technology disclosed in Patent document 1, the  
5 specialists inform the production plants of the discovery of  
the abnormality and the content of measures, but the more the  
number of customers (that is, the number of machinery and  
equipment as maintenance objects) increases, the more difficult  
only the specialists handle all countermeasures.

10 In other words, a system is desired, by which the state  
of each of the machinery and equipment can be grasped properly,  
while a large amount of information acquired from the machinery  
and equipment via a network is processed.

[0006]

15 Embodiments of the invention seek to provide a control  
system for machinery and equipment by which a state of the  
machinery and equipment can be grasped properly.

## MEANS TO SOLVE THE PROBLEMS

20 [0007]

According to an aspect, there is provided a control  
system for machinery and equipment comprising: a working  
information storage device in which working information at  
every moment of one or a plurality of machinery and equipment  
25 is acquired via a network and is associated with identification  
information of the machinery and equipment to be stored; and an  
information processing device that analyzes an operation  
tendency of the machinery and equipment in a predetermined  
period based on the working information read out from the  
30 working information storage device and associates an analyzed  
result with the identification information of the machinery and  
equipment to store in an operation information storage device,  
wherein the machinery and equipment is a compressor, the  
working information includes information that indicates which  
35 operation

between a load operation and an unload operation is executed by the compressor, and in case that a ratio of the unload operation is equal to or above a predetermined value as an operation tendency of the compressor in a predetermined period, the information processing device decides a setting value that makes the ratio of the unload operation smaller than the predetermined value based on an analysis of the working information and sends the setting value to a user computer corresponding to the compressor via the network.

According to another aspect, there is provided A control system for machinery and equipment comprising: a working information storage device in which working information at every moment of one or a plurality of machinery and equipment is acquired via a network and is associated with identification information of the machinery and equipment to be stored; and an information processing device that analyzes an operation tendency of the machinery and equipment in a predetermined period based on the working information read out from the working information storage device and associates an analyzed result with the identification information of the machinery and equipment to store in an operation information storage device, wherein the machinery and equipment is a compressor, a specification information storage device that stores specification information on the compressor is provided, the working information includes a discharge pressure of the compressor, and in case that an average value of the discharge pressure is larger than a target discharge pressure by a predetermined value or more as an operation tendency of the compressor in a predetermined period, the information processing device searches a compressor candidate of which discharge pressure is closer to the target discharge pressure than the discharge pressure of the compressor in the specification information storage device and sends the compressor candidate to a user computer corresponding to the compressor via the network, and wherein the working information

includes an electric current value supplied to the compressor, and in case that an average value of a load ratio calculated based on the electric current value is below a predetermined value as an operation tendency of the compressor in a

5 predetermined period, the information processing device decides a setting value which makes the load ratio be equal to or be above the predetermined value based on an analysis on the working information and sends the setting value to a user computer corresponding to the compressor via the network.

10 According to a third aspect, there is provided a control system for machinery and equipment comprising: a working information storage device in which working information at every moment of one or a plurality of machinery and equipment is acquired via a network and is associated with identification  
15 information of the machinery and equipment to be stored; and an information processing device that analyzes an operation tendency of the machinery and equipment in a predetermined period based on the working information read out from the working information storage device and associates an analyzed  
20 result with the identification information of the machinery and equipment to store in an operation information storage device, wherein the machinery and equipment is a compressor, the working information includes an electric current value supplied to the compressor, and in case that an average value of a load  
25 ratio calculated based on the electric current value is below a predetermined value as an operation tendency of the compressor in a predetermined period, the information processing device decides a setting value which makes the load ratio be equal to or be above the predetermined value based on an analysis on the  
30 working information and sends the setting value to a user computer corresponding to the compressor via the network.

#### EFFECT OF THE INVENTION

[0008]

Embodiments of the invention may provide a control system for machinery and equipment by which a state of the machinery and equipment can be grasped properly.

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#### BRIEF DESCRIPTION OF THE DRAWINGS

[0009]

FIG. 1 is a schematic block diagram showing a control system according to one embodiment of the invention;

10        FIG. 2 is a block diagram showing a structure of a compressor;

FIG. 3 is a graph showing a discharge pressure change of the compressor;

15        FIG. 4 is a block diagram showing a structure of an integrated control center;

FIG. 5 is a sequence diagram showing operations of acquisition/disclosure processes for working information;

20        FIG. 6A is a display example of a log-in screen of a user personal computer and FIG. 6B is a display example of a selection screen displayed after logging in;

FIG. 7A is a display example of a working information screen and FIG. 7B is a display example of a setting information screen;

25        FIG. 8 is a sequence diagram showing operations of an acquisition process for failure/maintenance information;

FIG. 9 is a sequence diagram showing operations of a disclosure process for the failure/maintenance information;

30        FIG. 10A is a display example of a failure/maintenance information screen and FIG. 10B is a display example of a failure information screen when sensor abnormality occurs;

FIG. 11 is a sequence diagram showing operations of acquisition/disclosure processes for operation information;

35        FIG. 12A is a screen display example showing a change in an unload time, FIG. 12B is a screen display example showing change in a total unload frequency and FIG. 12C is a screen

display example showing a discharge pressure change, of an operation information screen;

FIG. 13 is a sequence diagram showing operations of an acquisition/disclosure processes for device information; and

FIG. 14A is a graph showing the discharge pressure change of a plurality of compressors, FIG. 14B is a graph showing a change of an electric current value supplied to the compressors and a load ratio, and FIG. 14C is a graph showing a change of the electric current value supplied to the compressors.

#### EMBODIMENTS FOR CARRYING OUT THE INVENTION

[0010]

An embodiment of the invention will be explained in detail with reference to the accompanying drawings. In the drawings, a common portion will be labeled with the same numeral and the explanation thereof will be omitted.

[0011]

<<Embodiment>>

<Structure of a control system>

FIG. 1 is a schematic block diagram showing a control system according to one embodiment of the invention. A control system A according to the invention is a cloud computing system with which users can use service provided by server groups on a network without becoming aware of the server groups (such as an integrated control center 1).

[0012]

The control system A has the integrated control center 1, plant bases 21, 22, 23, a user PC (personal computer) 3, a research and development center 4, a service center 5 and an authentication server 6.

[0013]

The integrated control center 1 acquires working information sent from the respective plant bases 21, 22, 23 via a network N1 and device information on compressors sent from the user PC 3, and controls the information correctively.

Further, the integrated control center 1 provides various pieces of information on the compressors to the user PC 3 via a network N2.

The integrated control center 1 is, for example, operated by a manufacturer of the compressors or a maintenance company. A detail of the integrated control center 1 will be explained later.

[0014]

The plant bases 21, 22, 23 shown in FIG. 1 are set in different areas, respectively. Each plant base includes one or more compressors. The plant bases 21, 22, 23 are operated by a corporation or a local government possessing the compressors.

The plant base 21 includes compressors 211a, 211b, interfaces 212a, 212b, and a communication device 213.

[0015]

The compressor 211a is, for example, an oil-free screw compressor and is driven by a controller 18 (see FIG. 2) based on a pre-set program.

The controller 18 sends the working information on the compressor 211a at every moment (such as every second) to the integrated control center 1 via the communication device 213 and the network N1. The word, "every moment" may be every 0.1 seconds or several seconds.

The same explanation can be applied to the compressor 211b and the interface 212b, and the explanation thereof will be omitted. Further, the plant bases 22, 23 which are provided in different areas from the plant base 21 can be applied with the same explanation above, and the explanation thereof will be omitted. A structure and control of each compressor will be explained later.

[0016]

Information sent from communication devices 213, 223, 233 in plant bases is encrypted and is sent to the integrated control center 1 via the network N1. A communication device 101 (see FIG. 4) provided in the integrated control center 1

has a structure which decrypts the encrypted information sent from respective communication devices 213, 223, 233 and can identify which compressor sent the information.

[0017]

5           The user PC 3 is, for example, provided in a central control room (not shown) of each plant base and can communicate with the integrated control center 1 via the network N2. After the user PC 3 is authorized by the authentication server 6, various pieces of information is sent from the integrated  
10 control center 1 to the user PC 3. The "user" indicates, for example, an administrator of each plant base.

          Further, one user PC 3 is shown in FIG. 1 (and FIG. 4). However, there are a plurality of user PCs 3 in practice such as personal computers set in the central control room of each  
15 plant base and personal computers used with wireless communication cards outside the central control rooms.

[0018]

          The research and development center 4 acquires information stored in each storage device 104 to 108 (see FIG.  
20 4) in the integrated control center 1, and researches and develops a higher control system by analyzing the information. Further, the research and development center 4 updates and upgrades various applications used in the integrated control center 1 via a network N3.

25 [0019]

          The service center 5 includes a service PC 51 and a control PC 52.

          For example, when a service person inputs a user ID via an input device (not shown), the service PC 51 can display the  
30 same images as the images (for example, images shown in FIGS. 7A and 7B) which are displayed on the user PC 3 of the user.

          The service person operating the service PC 51 browses the images when a compressor breaks down or the like, and communicates with the user via mails and telephones to deal  
35 with the failure.

[0020]

The control PC 52 is set in a control room of the service center 5 or the like, and can acquire the information stored in each storage device 104 to 108 in the integrated control center 5 1 via the network N3 and a communication device 118 (see FIG. 4). An administrator of the service center 5 always monitors the information on each compressor displayed on a monitor of the control PC 52.

[0021]

10 The authentication server 6 authorizes a user ID as user's identifier specifies the user uniquely and a password corresponding to the user ID, and confirms user validity. For example, the authentication server 6 executes an authentication process with a public key and a private key.

15 [0022]

<Structure of the compressor>

FIG. 2 is a block diagram showing a structure of the compressor. The compressor 211a set in the plant base 21 will be explained below, but the other compressors 211b, 221, 231 20 (see FIG. 1) have the same structure.

The compressor 211a includes a compressor main body 11, an induction motor 12, a cooler 15, a blowoff valve 16, the controller 18, and a startup board or an inverter board 19.

The compressor main body 11 is, for example, an oil-free 25 screw compressor and has a pair of male and female screw rotors (not shown) whose rotating shafts are arranged in parallel. The screw rotors are accommodated in a casing (not shown).

[0023]

Further, a pinion gear (not shown) is provided on a shaft 30 end of the female screw rotor (not shown) and the pinion gear meshes with a helical gear provided on a rotating shaft of the induction motor 12. Further, timing gears (not shown) are attached on the male screw rotor and the female screw rotor respectively, and the timing gears mesh with each other to make

the male screw rotor and the female screw rotor rotate synchronously.

[0024]

An intake side of the compressor main body 11 is  
5 connected to an intake port via a capacity regulating valve 13  
and an intake filter 14. A discharge side of the compressor  
main body 11 is connected to a discharge port via the cooler 15.  
Cooling water supplied from an inflow port flows in the cooler  
15 via a pipe a5. The cooling water executes heat exchange  
10 with a high temperature and high pressure gas discharged from  
the compressor main body 11 in the cooler 15, and flows out  
from an outflow port via a pipe a6.

Further, the blowoff valve 16 and a blowoff silencer 17  
are connected sequentially in a pipe a4 which branches from a  
15 pipe a3. The blowoff valve 16 is opened at an unload operation  
(non-loaded operation) described later and is closed at a load  
operation (loaded operation). A device structure of the  
compressor may change based on a customer's specification.

[0025]

20 Further, an intake pressure sensor P1 which detects a  
pressure of gas flowing into the compressor main body 11 and an  
intake temperature sensor T1 which detects temperature of the  
gas are provided on a pipe a1 which is connected to the intake  
side of the compressor main body 11.

25 Still further, a discharge pressure sensor P2 which  
detects a pressure of the gas discharged from the compressor  
main body 11 and cooled in the cooler 15, and a discharge  
temperature sensor T2 which detects a temperature of the gas  
are provided on the pipe a3 which communicates with the  
30 compressor main body 11 and the discharge port.

Moreover, a cooling water inflow temperature sensor T3  
which detects a temperature of the cooling water flowing in the  
cooler 15 is provided on a pipe a5, and a cooling water outflow  
temperature sensor T4 which detects the temperature of the  
35 cooling water flowing out from the cooler 15 is provided on a

pipe a6. The attachment position of each sensor may change based on the customer's specification.

[0026]

The sensor information at every moment is sent from each  
5 pressure sensor and each temperature sensor to the controller  
18. Shortly, the working information (such as an intake pressure, a discharge pressure, an intake temperature, a discharge temperature and the electric current value) of the compressor 211a is sent to the controller 18 every  
10 predetermined time (for example, every second). The controller 18 controls to drive the compressor 211a integrally based on the sensor information and setting information.

[0027]

The startup board or the inverter board 19 converts AC  
15 power supplied from an AC power source (not shown) to DC power, and further converts to three-phase AC power based on a command signal output from the controller 18 to output to the induction motor 12. The startup board or the inverter board 19 may be set outside the compressor 211a.

20 [0028]

When the three-phase AC power is input from the startup board or the inverter board 19 based on the command signal output from the controller 18 to the induction motor 12, the induction motor 12 rotates at a predetermined speed. With this  
25 operation, the pinion gear (not shown) rotates and the male and the female screw rotors (not shown) rotate simultaneously. As a result, the gas taken in via the intake filter 14 and the capacity regulating valve 13 is compressed by the compressor main body 11 to be discharged as a high temperature and high  
30 pressure gas. Then, the gas is properly cooled in the cooler 15 and is discharged from the discharge port. A load (not shown) which is driven by the compressed gas is connected to the discharge port. Further, the controller 18 may be set outside the compressor 211a.

In the explanation below, an arbitrary compressor (main body) is referred to only as a "compressor" and an arbitrary controller is referred to only as a "controller".

[0029]

5 <Load operation/unload operation>

FIG. 3 is a graph showing a discharge pressure change of the compressor. The compressor 11 executes a load operation (loaded operation) and an unload operation (non-loaded operation) repetitively. When the load operation is executed, the controller 18 drives the compressor 11, adjusts opening of the capacity regulating valve 13, and closes the blowoff valve 16. Accordingly, the high temperature and high pressure gas discharged from the compressor 11 flows through the pipe a2, the cooler 15 and the pipe a3 to the discharge port. The discharge pressure of the compressor 11 tends to increase during the load operation.

[0030]

A target discharge pressure  $P_\alpha$  of the compressor 11, an unload pressure  $P_\beta$  ( $> P_\alpha$ ) and a load pressure  $P_\gamma$  ( $< P_\alpha$ ) shown in FIG. 3 are pre-set. The discharge pressure of the compressor 11 is detected by the discharge pressure sensor P2 (see FIG. 2) and the detected value is input to the controller 18.

[0031]

In case that the discharge pressure of the compressor 11 is equal to or above the unload pressure  $P_\beta$ , the controller 18 drives the compressor 11, opens the blowoff valve 16 and executes the unload operation. Thus, the gas discharged from the compressor 11 also flows to the blowoff valve 16 side via the pipe a4 and is discharged from a blowoff port to an outside of the system. Accordingly, since a part of the high pressure gas is discharged outside the system by opening the blowoff valve 16 in the unload operation, the discharge pressure decreases gradually. The induction motor 12 keeps driving even in the unload operation to avoid ineffectual on/off operation, thereby maintaining high energy efficiency.

[0032]

Then, in case that the discharge pressure of the compressor 11 is equal to or below the load pressure  $P_V$ , the controller 18 switches to the load operation again to increase the discharge pressure. Thus, the discharge pressure  $P$  of the compressor 11 is controlled to vary within a predetermined range (load pressure  $P_V \leq P \leq$  unload pressure  $P_U$ ) centered on the target discharge pressure  $P_A$ .

In the unload operation, the high pressure gas discharged outside the system causes energy loss. Therefore, the operation efficiency of the compressor 11 is improved as a period in the unload operation is shorter.

[0033]

<Structure of the integrated control center>

FIG. 4 is a block diagram showing a structure of the integrated control center. As shown in FIG. 4, the integrated control center 1 includes the communication device 101, a first information control device 102, the various storage devices 104 to 108, an information processing device 109, a front server 115 and a second information control device 116.

[0034]

The communication device 101 decrypts the encrypted information sent from the communication devices 213, 223, 233 (see FIG. 1) provided in the plant bases, 21, 22, 23, respectively.

The first information control device 102 includes a first information acquisition unit 102a and a first information disclosure unit 102b.

[0035]

The first information acquisition unit 102a sends a command signal for acquiring the working information to each controller 18 in each compressor 11 every predetermined time (for example, every second) via the communication device 101 and the network N1. The first information acquisition unit 102a acquires the working information sent from each controller

18 at every moment based on the command signal via the network N1, the communication device 101 and a F/W (firewall) 114a. Then, the working information is stored in the working information storage device 104 per compressor 11.

5           In case of receiving a command signal for acquiring information on each compressor 11 from the user PC 3, the first information disclosure unit 102b reads out the working information and the like corresponding to the command signal from the storage devices 104 to 107 and sends the information  
10 to the user PC 3 via the communication device 112 and the network N2.  
[0036]

          A F/W 103 acts as a security function by which the data stored in each storage device 104 to 108 in the integrated  
15 control center 1 cannot be acquired fraudulently by a third party.

          The working information storage device 104 stores the working information on each compressor 11 in a database format. The "working information" includes command information (such as  
20 an unload operation command and a load operation command) output from the controller 18 to the compressor 11 and sensor information detected by the various sensors. Further, identification information of each compressor 11 is added to the working information sent from each controller 18 to the  
25 integrated control center 1.  
[0037]

          The setting information storage device 105 stores the setting information on each compressor 11 in a database format. The setting information on each compressor 11 is acquired by  
30 the first information acquisition unit 102a every predetermined period and is associated with the identification information of each compressor 11 to be stored in the setting information storage device 105.  
[0038]

The failure/maintenance information storage device 106 stores failure information and maintenance information on each compressor 11 in a database format. The "failure information" is output from the controller 18 in case that, for example, the  
5 discharge temperature of the compressors 11 is beyond the pre-set temperature range or the discharge pressure of the compressors 11 is below a load lower limit pressure, or the like.

Further, the "maintenance information" is input via an  
10 information terminal 7 (see FIG. 8) during repairing work or inspection work by an operator.

[0039]

The operation information storage device 107 stores operation information such as a working time/a working  
15 frequency of each compressor 11 in a database format. The "working time" includes a load operation time, an unload operation time and a stop time for each compressor 11. Further, the "working frequency" includes an unload frequency of each compressor 11 and the ON/OFF frequency of the power source.

20 The information processing device 109 reads out the working information stored in the working information storage device 104 to calculate these pieces of information above.

[0040]

The device information storage device 108 stores a plant  
25 base name, a base code, a compressor name, a compressor code and the like in a database format for each compressor 11.

Further, the device information storage device 108 stores a device name, a device code, type, an operation time, a longevity operation time, a previous inspection date, an  
30 inspection result, a previous replacement date, a next scheduled date for replacement, stock quantity, and the like constituting each compressors 11 in a database format.

The above-mentioned device name, the device code and the type are sent from the user PC 3 to the integrated control  
35 center 1 via the network N2 in advance. These pieces of

information are associated with the respective compressors 11 by a second information acquisition unit 116a and are stored in the device information storage device 108.

[0041]

5       The information processing device 109 is configured to include electronic circuits such as a CPU (Central Processing Unit), a ROM (Read Only Memory), a RAM (Random Access Memory) and various interfaces. The information processing device 109 executes various processes based on the set program.

10       Details of processes by the information processing device 109 will be explained later.

[0042]

      The bus 111 is connected to the first information control device 102, the second information control device 116, each  
15   storage device 104 to 108, the information processing device 109 and a F/W 117, enabling the information explained above to be exchanged.

      The communication device 112 is a communication line used for sending and receiving the information between the user PC 3,  
20   the authentication server 6 and the integrated control center 1 via the network N2. After the user's validity is confirmed by the authentication server 6, the communication device 112 sends and receives the information to/from the front server 115 via a communication line corresponding to the user ID and a F/W 114b.

25   [0043]

      The F/W 114a, 114b have a security function to prevent the third party from interrupting into the integrated control center 1 from the outside to acquire data fraudulently.

      In case that the authentication process by the  
30   authentication server 6 completes, the front server 115 outputs the user ID to the first information disclosure unit 102b and the second information disclosure unit 116b. The user ID is associated with one or a plurality of plant bases at the time of registration. Further, in case that a user who watches an  
35   image displayed on a monitor of the user PC 3 selects by a

predetermined manner with the input device (not shown), the front server 115 outputs the selected information to the first information disclosure unit 102b or the second information disclosure unit 116b.

5           The information provided to the user PC 3 will be explained later.  
[0044]

          The second information control device 116 includes the second information acquisition unit 116a and the second  
10   information disclosure unit 116b.

          The second information acquisition unit 116a acquires the device information from the user PC 3 via the network N2 and the communication device 112 and stores the information in the device information storage device 108 per compressor 11.

15           In case of receiving a command signal which acquires the device information from the user PC 3 of the user, the second information disclosure unit 116b reads out the device information from the device information storage device 108 based on the command signal and sends the device information to  
20   the user PC 3 via the communication device 112 and the network N2.  
[0045]

          The F/W 117 has the security function which prevents the third party from interrupting into the integrated control center 1  
25   from the outside to acquire data fraudulently.

          The communication device 118 is a communication line to communicate with the research and development center 4 via the network N3.  
[0046]

30   <Process of information disclosure service>

          Hereinafter, acquisition/disclosure of information on the compressors set in the plant base 21 will be explained as one example.

[0047]

35   (1. Working information)

FIG. 5 is a sequence diagram showing operations on acquisition/disclosure processes for the working information.

In step S101, the first information acquisition unit 102a (see FIG. 4) sends a transmission command signal for the  
5 working information to the controller 18 (see FIG. 2) in the compressor 11 via the communication device 101, the network N1 and the communication device 213 (see FIG. 1). Next, in step S102, the controller 18 sends the working information corresponding to the above transmission command signal for the  
10 working information to the first information acquisition unit 102a. The content of the working information is explained above and the explanation thereof will be omitted.  
[0048]

In step S103, the first information acquisition unit 102a  
15 stores the working information on the compressor 11 received from the controller 18 in the working information storage device 104. The processes of above steps S101 to S103 are repeated at a predetermined time (for example, every second).

It is noted that the process of step S101 may be omitted  
20 and the controller 18 may send the working information automatically to the first information acquisition unit 102a.  
[0049]

In step S104 in FIG. 5, the user who controls the plant base 21 operates the input device (not shown) of the user PC 3  
25 and accesses a site of a compressor remote monitoring service provided by the integrated control center 1. Then, for example, a log-in screen G1 shown in FIG. 6A is displayed on the monitor of the user PC 3.  
[0050]

30 The user operates the input device of the user PC 3 to input the user ID in a user ID section G101 and to input a password in a password section G102, and clicks on a log-in button G103. Thus, the user ID and the password are sent to the authentication server 6 via the network N2.

Next, in step S105, the authentication server 6 processes the authentication explained above. When the authentication server 6 confirms the user's validity, a screen G2 shown in FIG. 6B is displayed on the monitor of the user PC 3.

5 [0051]

FIG. 6B shows "equipment monitoring service" which enables the user to browse the working information, the setting information, the failure/maintenance information or the operation information on each compressor.

10 Further, FIG. 6B shows "maintenance management service" which enables the user to browse the device information on the compressor.

[0052]

In case that the user browses the working information on the compressor 11, the "equipment monitoring service" G201 shown in FIG. 6B is selected. This operation makes the user PC 3 send an acquisition command signal for the working information to the first information disclosure unit 102b in step S106 in FIG. 5.

20 Then, in step S107, the first information disclosure unit 102b searches the working information on the plant base corresponding to the user ID among the working information stored in the working information storage device 104. Then, the first information disclosure unit 102b acquires the corresponding working information (step S108). Accordingly, in step S109, the first information disclosure unit 102b sends the acquired working information to the user PC 3.

[0053]

Consequently, a working information screen G3 shown in FIG. 7A is displayed on the monitor of the user PC 3. The plant base name (plant base 1) is displayed on a section G301 shown in FIG. 7A. Further, the user can select the compressor which the user wants to browse (for example, the compressor No. 1) by pulling down "compressor No." in a section G302.

35 [0054]

FIG. 7A shows that the intake pressure of the compressor 11 is PPP1kPa and the intake temperature is TTT1°C currently (when the user accesses the integrated control center 1 side) as an example.

5 The information shown in FIG. 7A is preferably displayed on a side of the structure diagram of the compressor shown in FIG. 2 so that the user can browse the information easily.

[0055]

(2. Setting information)

10 Since a sequence for the setting information on the compressor 11 is similar to that (see FIG. 5) for the above-mentioned working information, the explanation thereof will be omitted.

In case that the user's validity is authenticated and the user browses the setting information, for example, a setting information screen G4 shown in FIG. 7B is displayed on the user PC 3. In FIG. 7B, the unload pressure: 880kPa, the load pressure: 830kPa, the load lower limit pressure: 400kPa, the target pressure: 860kPa are displayed as the "setting pressure".

20 [0056]

The "load lower limit pressure" is a lower limit value which is allowed as the discharge pressure of the compressor 11. In case that the discharge pressure detected by the discharge pressure sensor P2 (see FIG. 2) is below the load lower limit pressure, the controller 18 continues to drive the compressor 11 and sends the failure information to the integrated control center 1.

[0057]

(3. Failure/maintenance information)

30 FIG. 8 is a sequence diagram showing operations on acquisition/disclosure processes for the failure/maintenance information.

In step S201, the first information acquisition unit 102a (see FIG. 4) sends a transmission command signal for the failure information to the controller 18 (see FIG. 2) via the

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communication device 101 and the network N1. In step S202, in case that failure corresponding to the command occurs within a predetermined time, the controller 18 associates the failure information with the identification information of the compressor 11 to send to the first information acquisition unit 102a. Next, in step S203, the first information acquisition unit 102a stores the failure information in the failure/maintenance information storage device 106.

[0058]

Next, in step S204, the first information acquisition unit 102a sends the failure information sent from the controller 18 to the control PC 52 (see FIG. 1). Accordingly, the administrator of the service center 5 (see FIG. 1) can recognize the failure approximately at the same time when the failure occurred in the area where the compressor 11 is placed. Therefore, the service person in the service center 5 can communicate with the user in a plant base where the failure occurred via mails and telephones.

[0059]

Then, in step S205, the control PC 52 sends the failure information to the information terminal 7. For example, the information terminal 7 is held by an operator (being around the plant base where the failure occurred) of the service center 5. The processes in the above steps S201 to S205 are executed repetitively per predetermined time (or with the detection of the failure occurrence as a trigger).

The process in step S201 may be omitted, and the failure information may be sent automatically from the controller 18 to the first information acquisition unit 102a at the failure occurrence.

[0060]

Next, in step S206, the operator who repaired the failure (or who performed inspection work) stores the maintenance information in a storage device (not shown) in the information terminal 7. In step S207, the information terminal 7 sends the

maintenance information to the first information acquisition unit 102a with the depression of a send button by the operator as a trigger. The maintenance information includes the identification information on the compressor 11 as a  
5 maintenance object, time information, maintenance contents and a maintenance result.

Next, in step S208, the first information acquisition unit 102a associates the maintenance information sent from the information terminal 7 with the failure information sent in  
10 step S204, and stores in the failure/maintenance information storage device 106.

Each piece of the information above is also stored in the device information storage device 108 corresponding to a device constituting the compressor 11.

15 [0061]

Next, in step S209 in FIG. 9, the user PC 3 sends the user ID and the password to the authentication server 6 via the network N2. In step S210, the authentication server 6 sends an authentication result to the user PC 3. After being  
20 authenticated by the authentication server 6, in step S211, the user PC 3 sends an acquisition command signal for the failure/maintenance information to the first information disclosure unit 102b.

In step S212, the first information disclosure unit 102b  
25 searches the failure/maintenance information in the plant base corresponding to the user ID in the failure/maintenance information storage device 106, and acquires the information (step S213). In step S214, the first information disclosure unit 102b sends the failure/maintenance information to the user  
30 PC 3.

[0062]

Then, a failure/maintenance information screen G8 shown in FIG. 10A is displayed on the monitor of the user PC 3. The failure/maintenance information up to the time when the user  
35 accesses the site of the compressor remote monitoring service

(or the month which the user designates) is displayed on the failure/maintenance information screen G8.

In the example shown in FIG. 10A, occurrence time, messages and recovery time are displayed from left. For example, referring to the failure/maintenance information screen G8, it is shown that sensor abnormality occurred at 18:00 on April 1, 2012 and was recovered at 18:30 on the same day.

[0063]

When the user clicks the above-described "sensor abnormality" section via the input device (not shown), for example, a failure information screen G9 shown in FIG. 10B is displayed. In this example, the abnormality occurred in the intake temperature sensor T1 (see FIG. 2), the compressor 11 and a main motor (induction motor 12) stop, and APC (Active Power Control) setting, PSC (Power Save Control) setting and ASS (Auto Start & Stop) setting are made invalid temporarily. Details of the APC, the PSC and the ASS will be omitted.

Thus, the user can browse the failure/maintenance information on the compressor 11 easily by accessing to the integrated control center 1 via the network N2.

[0064]

#### (4. Operation information)

FIG. 11 is a sequence diagram showing operations on acquisition/disclosure processes for the operation information.

In step S301, the information processing device 109 searches the working information on the compressor 11 in the working information storage device 104, and acquires predetermined working information (step S302). In step S303, the information processing device 109 calculates the working time and the working frequency based on the acquired working information.

As described above, the "working time" indicates, for example, the load operation time, the unload operation time and the stop time of the compressor 11. Further, the "working

frequency" indicates, for example, the unload frequency or the ON/OFF frequency of the compressor 11.

[0065]

The operation information includes the longevity  
5 operation time, the previous replacement date and the like of  
the compressor 11. The longevity operation time and the  
previous replacement date of the compressor 11 are input via  
the information terminal 7 (see FIG. 8) by the operator who  
replaces parts of the compressor 11 and performs the inspection  
10 work.

In step S304, the information processing device 109  
calculates the working time/frequency (that is, the operation  
information) per compressor 11 to store in the operation  
information storage device 107.

15 [0066]

In step S305, the user PC 3 sends the user ID and the  
password to the authentication server 6 via the network N2, and  
the server 6 executes the authentication process in step S306.

After the completion of the authentication process, the  
20 user selects "browsing the operation information" on the  
compressor 11. This operation makes the user PC 3 send an  
acquisition command signal for the operation information to the  
first information disclosure unit 102b in step S307.

[0067]

25 In step S308, the first information disclosure unit 102b  
searches the operation information on the plant base  
corresponding to the user ID in the operation information  
storage device 107, and acquires the operation information  
(step S309). Further, in step S310, the first information  
30 disclosure unit 102b sends the operation information to the  
user PC 3. Accordingly, operation information screens shown in  
FIGS. 12A to 12C are displayed on the monitor of the user PC 3.

[0068]

FIG. 12A is a screen display example showing a change in  
35 the unload time. The horizontal axis in FIG. 12A indicates

dates (in April, 2012), and the vertical axis indicates an amount time (unload time) of the unload operation per date. The user can grasp the change in the unload time easily by browsing the screen G5. A change in the unload time per month or per year may be displayed.

Further, an accumulated value of the unload time or the unload frequency from the time when the compressor 11 is placed to a predetermined date may be displayed on the user PC 3.

[0069]

FIG. 12B is a screen display example showing a change in the unload frequency. The horizontal axis in FIG. 12B indicates dates (in April, 2012), and the vertical axis indicates a switching frequency (unload frequency) from the load operation to the unload operation. The user can grasp the change in the unload frequency per date easily by browsing the screen G6 shown in FIG. 12B.

[0070]

FIG. 12C is a screen display example showing a change in the discharge pressure of the compressor. The horizontal axis in FIG. 12C indicates time (on April 1, 2012), and the vertical axis indicates the discharge pressure of the compressor 11.

In case that working state history of the compressor 11 is browsed, the user selects "browsing the operation information" (not shown) in a selection screen and further selects the "discharge pressure" (not shown) at a particular date in a pull-down menu or the like.

Accordingly, the user can grasp the working state of the compressor 11 at a particular date in a past easily. In FIG. 12C, the change in the discharge pressure at the particular date is shown, but a mean value of the discharge pressure per month or a change in the discharge temperature may be displayed.

[0071]

(5. Device information)

The maintenance control service in the compressor monitoring service will be explained. FIG. 13 is a sequence

diagram showing operations on acquisition/disclosure processes for the device information.

In step S401, the user PC 3 sends the user ID and the password to the authentication server 6 via the network N2, and the authentication server 6 executes the authentication process in step S402. Then, the screen G2 shown in FIG. 6B is displayed on the monitor of the user PC 3.

[0072]

Further, when the user selects a "maintenance control service" section G202 in FIG. 6B, a screen (not shown) is displayed in which the device information can be attached. The user assigns a particular compressor 11, and attaches information such as the device name, the device code, the type, the previous replacement date, a stock quantity and the like of the assigned compressor 11, for example, in a file format to send to the integrated control center 1 (step S403).

This process is executed at the time of a registration process or an update process for the compressor remote monitoring service by the administrator of each plant base.

[0073]

In step S403, the user PC 3 sends the device information to the second information acquisition unit 116a. In step S404, the second information acquisition unit 116a associates the received device information with the compressor 11 which the user selects to store in the device information storage device 108.

[0074]

Further, in case that the user wants to browse the device information of the plant base which the user controls, the user operates the user PC 3 to access the integrated control center 1. In other words, in step S405 in FIG. 13, the user PC 3 sends the user ID and the password to the authentication server 6 via the network N2, and the authentication server 6 executes the authentication process in step S406.

[0075]

In step S407, the user PC 3 sends an acquisition command signal for the device information to the second information disclosure unit 116b. In case that a plurality of compressors 11 are placed in a plant base, the user selects a particular compressor 11 via the input device among the plurality of compressors 11 displayed on a screen (not shown) of the user PC 3.

[0076]

In step S408, the second information disclosure unit 116b searches the device information on the compressor 11 designated by the user among the device information stored in the device information storage device 108 and acquires the target device information (step S409).

In step S410, the second information disclosure unit 116b sends the device information to the user PC 3. Accordingly, a device information screen (not shown) is displayed on the monitor of the user PC 3.

The device information screen displays the device name, the device code, the type, an accumulated operation time, the longevity operation time, failure history, the previous replacement date, the next scheduled date for replacement, the stock quantity and the like.

[0077]

<Analysis process of operation tendency>

(A. Change in setting value)

As described above, the target discharge pressure  $P_\alpha$  (see FIG. 3) of the compressor 11 is pre-set. When the discharge pressure is equal to or above the unload pressure  $P_\beta$  ( $> P_\alpha$ ), the controller 18 opens the blowoff valve 16 (see FIG. 2) and switches to the unload operation (non-loaded operation). Further, when the discharge pressure is equal to or below the load pressure  $P_\gamma$ , the controller 18 closes the blowoff valve 16 and switches to the load operation (loaded operation). In the unload operation, since compressed air is emitted outside the system, the shorter (smaller) the time (ratio) for the unload

operation is, the more the energy efficiency of the compressor 11 grows.

Therefore, the setting of the unload pressure  $P_u$  greatly affects the energy efficiency of the compressor 11.

5 [0078]

In case that the user browsing the monitor of the user PC 3 selects an "energy saving operation" (not shown) via the input device (not shown), the information processing device 109 executes, for example, the following processes.

10 Shortly, the information processing device 109 reads out the working information on the compressor 11 corresponding to the user ID from the working information storage device 104. Information indicating which operation was executed between the loaded operation and the non-loaded operation by the compressor  
15 11 is stored in the working information storage device 104 to correspond to the identification information on the compressor and the time information.

[0079]

The information processing device 109 decides whether the  
20 ratio of the unload time is equal to or above a predetermined value (or the unload frequency is equal to or above a predetermined frequency) as an operation tendency of the compressor 11 in a pre-set given period.

For example, in case that the ratio of the unload time is  
25 equal to or above the predetermined value, the information processing device 109 analyzes the working information on the compressor 11. Further, the information processing device 109 calculates the unload pressure which makes the ratio of the unload time smaller than the predetermined value based on the  
30 analysis. The analysis process may take a method in which the operation of the compressor 11 is simulated once or more using the device information (specification information) stored in the device information storage device 108, and the smallest ratio of the unload time among the simulation results is  
35 selected as the unload pressure. Further, the unload pressure

may be determined by other methods (such as statistical approach and learning processing) using the working information on the compressor 11. The information processing device 109 sends the determined unload pressure to the user PC 3

5 corresponding to the compressor 11 via the network N2.

Setting values other than the unload pressure can be shown to the user by the same method as described above.

[0080]

Further, the setting values such as the unload pressure  
10 may be determined based on a load ratio (ratio of the unload time in a predetermined time) of the compressor 11 and may be sent to the user PC 3. In this case, the information processing device 109 calculates the load ratio based on an electric current value supplied to the compressor 11 in a  
15 predetermined period and associates the load ratio with the identification information of the compressor 11 to store in the working information storage device 104. In case that an average value of the load ratio is below a predetermined value, the information processing device 109 determines a setting  
20 value which makes the load ratio be equal to or be above the predetermined value by the analysis process on the working information, and sends the setting value to the user PC 3 corresponding to the compressor 11 via the network N2.

The above-mentioned analysis process can take various  
25 methods such as the simulation, the statistical approach, the learning processing. Further, the setting values other than the unload pressure can be provided to the user by the same method as described above.

[0081]

30 Still further, the working information on other compressors 11 stored in the working information storage device 104 may be searched and the setting value may be determined based on the search result. In this case, the information processing device 109 searches the predetermined number of  
35 compressors 11 (for example, 100) having the same device name,

device code and type as the compressor 11 controlled by the user in the device information storage device 108. Then, the information processing device 109 searches the compressors 11 which have a similar operation condition as the compressor 11 of the user among the plurality of compressors 11 as compared objects.

[0082]

Yet further, the information processing device 109 searches the compressor 11 having failure frequencies equal to or below a predetermined value and having the shortest unload time (or the fewest unload frequencies). Then, the information processing device 109 sends the unload pressure of the compressor 11 to the user PC 3 via the network N2.

[0083]

In case that the unload pressure value is set as an unload pressure of the compressor 11 controlled by the user, there is a higher possibility that the unload time is shorter than before, and the operation efficiency of the compressor 11 can be increased.

The setting values other than the unload pressure can be presented to the user by the same method as described above.

[0084]

(B. Proposal for next replacement)

FIG. 14A is a graph showing a time change in the discharge pressure of a plurality of compressors. A first compressor (target discharge pressure  $P_A$ ) is driven during time frames  $t_1$  to  $t_2$  and  $t_3$  to  $t_4$ , and a second compressor (target discharge pressure  $P_B > P_A$ ) is driven during a time frame  $t_2$  to  $t_3$ .

Shortly, the two compressors 11 having the different target discharge pressure are driven alternately per predetermined time. The driving of the two compressors 11 alternately in this manner is sent from the user PC 3 to the integrated control center 1 at the time of registration or

update of the compressor remote monitoring service and is stored in the setting information storage device 105.

[0085]

For example, when the information on the compressor 11 provided to the user is prepared, the information processing device 109 executes the processes as follows.

In case that the average value of the discharge pressure is larger than the target discharge pressure by a predetermined value or more as the operation tendency of the compressor 11 in a predetermined period, the information processing device 109 searches one compressor or a plurality of compressors of which the discharge pressure is closer to the target discharge pressure than the compressor 11 in the device information storage device 108.

The device information storage device 108 stores the specification information on all compressors 11 which the service center 5 can correspond to, in addition to the information on the compressor 11 of each user.

[0086]

The information processing device 109 sends the search result to the user PC 3 via the network N2.

The information processing device 109 may provide a combination of the compressors cheaper than the total price of the compressors 11 (the first and the second compressors) currently possessed by the user among the search result. Accordingly, when buying new compressors, the user can select compressors which are cheaper than the currently working compressors 11 and satisfy conditions requested by the user (such as the target discharge pressure).

[0087]

FIG. 14B depicts a graph (upper side) showing a change in the electric current value supplied to the compressor and a graph (lower side) showing a change in the load ratio of the compressor. The working information stored in the working

information storage device 104 includes the electric current value supplied to the compressor 11.

Further, an electric current value  $I_A$  corresponds to the load operation and an electric current value  $I_B$  corresponds to the unload operation among the change in the electric current value shown in the upper graph of FIG. 14B. Further, the load ratio shown in the lower graph of FIG. 14B represents a ratio of the unload time with respect to predetermined time as a reference (100 %), and is calculated successively per predetermined time mentioned above.

[0088]

For example, when the information on the compressor 11 provided to the user is prepared, the information processing device 109 executes the processes as follows.

The information processing device 109 reads out the electric current value of the target compressor 11 and calculates the load ratio in the predetermined period based on the electric current value. Then, the information processing device 109 decides whether the average value of the load ratio in the predetermined period is below a predetermined value as the operation tendency of the compressor 11. In case that the average value of the load ratio is below the predetermined value, the information processing device 109 decides the compressor candidates which makes the load ratio be equal to or be above the predetermined value based on the working information on the other compressors 11 stored in the working information storage device 104.

[0089]

The information processing device 109 selects one or more compressor candidates among the compressors 11 working under the same conditions (such as the target discharge pressure) as the target compressor 11.

Accordingly, when the compressor needs to be replaced, the user who controls the compressor 11 can select a compressor having a higher load ratio (that is, higher operation

efficiency) than the currently working compressor 11 among a plurality of compressor candidates.

[0090]

(C. Abnormality indication decision process)

5           Further, the information processing device 109 in the integrated control center 1 decides whether there is an abnormality indication of the compressor 11 based on the working information stored in the working information storage device 104. In other words, the information processing device  
10 109 decides whether there is the abnormality indication in the compressor 11 based on a change ratio of, for example, at least either one of the intake temperature and the discharge temperature as the operation tendency of the compressor 11 in the predetermined period.

15 [0091]

For example, the information processing device 109 calculates an average change rate (increase rate) of the discharge temperature of the compressor 11 through a year. In case that the average change rate is equal to or above a  
20 predetermined value, the information processing device 109 decides that the compressor 11 has the abnormality indication.

Then, the information processing device 109 sends the information on the abnormality indication to the user PC 3 corresponding to the compressor 11 via the network N2.

25 [0092]

Further, for example, an allowable range for the intake temperature (or the discharge temperature) of the compressor 11 may be pre-set, an abnormality occurrence period of the compressor 11 may be predicted based on the average change rate  
30 of the actual intake temperature (or the discharge temperature) of the compressor 11 in the predetermined period, and the prediction may be sent to the user PC 3.

Therefore, the user can easily recognize the presence/absence of the abnormality indication and the

abnormality occurrence period of the compressor 11 which the user controls.

The presence/absence of the abnormality indication may be decided based on the other working information such as the intake pressure or the discharge pressure of the compressor 11, or the electric current value supplied to the compressor 11, in place of the intake temperature/discharge temperature of the compressor 11. Further, proper combinations thereof may be used for the decision.

10 [0093]

(D. Reminder for maintenance)

FIG. 14C is a graph showing the change in the electric current value supplied to the compressor. An electric current value  $I_c$  shown in FIG. 14C corresponds to the load operation and an electric current value  $I_0$  corresponds to the unload operation.

Some compressors 11 stop automatically (that is, the induction motors 12 stop) when a duration time of the unload operation is beyond a predetermined value  $\Delta t_0$ . Accordingly, the energy saving operation is made, but a malfunction may occur at the next startup if downtime of the compressors 11 continues for a long time.

[0094]

Therefore, in case that the information processing device 109 refers to the working information storage device 104 and there is a compressor 11 of which downtime is longer than a predetermined period, the information processing device 109 sends information which promotes maintenance for the compressor 11 to the user PC 3 corresponding to the compressor 11 via the network N2.

The operation downtime of the compressor 11 can be obtained as follows. For example, when the first information acquisition unit 102a acquires the working information and the stopped state of the compressor 11 is detected, a value of a counter is incremented and the value is associated with the

identification information of the compressor 11 and is stored in the working information storage device 104.

[0095]

The information processing device 109 refers to the working information storage device 104. When the value of the counter indicating the downtime of the compressor 11 is equal to or above a predetermined value, the information processing device 109 sends the information which promotes the maintenance for the compressor 11 to the user PC 3.

Therefore, the user who controls the compressor 11 can easily recognize that the compressor 11 controlled by the user is in the downtime for a long time and needs the maintenance.

[0096]

(E. Calculation of parts replacement date)

As described above, the operation information storage device 107 of the integrated control center 1 stores the longevity operation time and the previous replacement date of the devices (parts) constituting the compressor 11. The information processing device 109 calculates the accumulated operation time per device based on the working information stored in the working information storage device 104. The "accumulated operation time" indicates an accumulated value of the operation time up to the present (at the time of calculation for the accumulated time) with respect to the previous replacement date of a particular device.

[0097]

The information processing device 109 calculates the next scheduled date for replacement per device based on the above-mentioned accumulated operation time, the longevity operation time and the previous replacement date read out from the operation information storage device 107. Then, the next scheduled date for replacement is associated with the identification information of a target device and is stored in the operation information storage device 107.

The information processing device 109 calculates a period to the longevity operation time based on an increase rate of the accumulated operation time, and decides the "next scheduled date for replacement" as a date when the period passes from the previous replacement date.

[0098]

When the next scheduled date for replacement comes closer (for example, one month before), the information processing device 109 sends the information on the next scheduled date for replacement to the user PC 3 via the network N2.

Thus, the user can easily recognize the replacement scheduled date for each part constituting the compressor 11, which allows the user to have less control burden.

[0099]

<Effect>

According to the control system A for the machinery and equipment of the embodiment, the user only needs to prepare a minimum connection environment (such as the user PC 3, the mobile terminal, the browser and the communication devices).

Each compressor 11 can be controlled by the integrated control center 1 integrally. Therefore, the user can acquire the working information and the device information on the compressors 11 without changing each of the present compressors 11 significantly in each plant base.

[0100]

Further, the control system A of the embodiment stores the information on the compressors 11 in each plant base into each storage device 104 to 108 of the integrated control center 1. Therefore, each plant base does not need to have a mass storage device therein, resulting in a lower cost in each plant base.

Further, the user is given with the ID and the password corresponding to the plant base which the user registered. Only with the connection environment for the Internet, the user

can recognize the conditions of the compressors in real time by connecting to the network of a cloud computing.

[0101]

Further, in the embodiment, the setting value (such as the unload pressure) is decided such that the ratio of the unload operation of the compressor 11 is below the predetermined value based on the working information on the other compressors 11 and is sent to the user PC 3 via the network N2.

Thus, the compressor 11 in a stable energy saving operation is searched by use of a large amount of data stored in the storage devices 104 to 108. The setting value of the searched compressor 11 can be presented to the user.

Therefore, the user can modify the setting value of the compressor 11 to an appropriate value within a design range based on the presented information. In other words, the allowable range within which the setting value of the compressor 11 can be changed is pre-set, and the appropriate setting value in the range can be presented to the user.

[0102]

Further, in the embodiment, in case that the average value of the discharge pressure of the compressor 11 is larger than the target discharge pressure by the predetermined value or more, the compressor candidates which make the discharge pressure come close to the target discharge pressure are searched in the device information storage device 108. The search result is sent to the user PC 3 via the network N2.

Further, in case that the average value of the load ratio of the compressor 11 is below the predetermined value, the compressor candidates which make the load ratio be equal to or be above the predetermined value are searched in the device information storage device 108. The search result is sent to the user PC 3 via the network N2.

Therefore, the user can select one compressor or can select one of compressors which can operate more efficiently

than the current working compressor at the time of next replacement of the compressor 11.

[0103]

Further, in the embodiment, the presence/absence of the abnormality indication of the compressor 11 is decided based on at least one of the change rates of the intake temperature and the discharge temperature. The decision result is sent to the user PC 3 via the network N2.

The user needs to grasp a long time change of the working information for detecting the abnormality indication on the compressor 11. A computer to store/deal with such a large amount of data costs too much for each user. In the embodiment, since the integrated control center 1 controls the working information and the like on the compressors 11, processing burden on the user can be decreased and the cost of controlling the compressors 11 can be reduced.

[0104]

Further, in the embodiment, in case that the downtime of the compressor is equal to or above the predetermined period, the information which promotes the maintenance for the compressor 11 is sent to the user PC 3 via the network N2. Therefore, a malfunction due to the downtime for a long time can be prevented at the next startup and the user can think about execution of the maintenance and a maintenance request earlier.

[0105]

Further, there is a need for maintaining the stocks of the devices (parts) constituting the compressor 11 in advance in a plant base in case that the longevity of the compressor 11 comes to an end or in case of replacement due to a failure. Since the longevity of the device varies based on a device type, working history, a fault content and the like, the user needs to have more stocks than actually needed.

On the other hand, in the embodiment, the device information on the compressors 11 is integrally controlled by

the use of the cloud computing system. For example, in case that the device constituting the compressor 11 needs to be replaced, the device information is sent from the integrated control center 1 (or the service center 5) to the user PC 3.

5 Therefore, the control burden on the user needed for the maintenance or the parts replacement of the compressors 11 can be greatly reduced.

[0106]

<<Modification>>

10 In the above embodiment, the oil-free screw compressor is exemplified, but the invention is not limited thereto. The invention can be also applied to other types of compressors (such as a turbo type, a vane type and a diaphragm type). Further, in the above embodiment, the compressors are  
15 exemplified as controlled objects by the integrated control center 1, but the invention is not limited thereto. For example, machinery and equipment in other types such as a power plant, a nuclear plant and a water treatment plant can be controlled objects.

20 Further, only one type (for example, compressors) is controlled by the integrated control center 1 in the embodiment, but a plurality of machinery and equipment types may be controlled. In this case, identification marks which indicate the types of the machinery and equipment are added to the  
25 working information or the like.

[0107]

Further, in the above embodiment, the case in which the authentication server 6 is placed outside the integrated control center 1 is explained, but is not limited thereto.

30 Shortly, the authentication server may be provided in the integrated control center 1.

Further, in the above embodiment, the case in which the integrated control center 1 acquires the working information on the intake/discharge pressure and the intake/discharge  
35 temperatures, but is not limited thereto. Shortly, the working

information may be added with information on an ambient temperature or vibrations of the compressor 11.

Further, in the above embodiment, the case in which the information processing device 109 in the integrated control center 1 executes the analysis process for the operation tendency of the compressor 11, but is not limited thereto. For example, the research and development center 4 may execute the analysis process and may disclose the analysis result from the service center 5 to the user PC 3.

10

#### EXPLANATION OF REFERENCES

[0108]

A control system

1 integrated control center

15 102a first information acquisition unit

102b first information disclosure unit

104 working information storage device (storage device)

105 setting information storage device (storage device)

106 failure/maintenance information storage device (storage

20 device)

107 operation information storage device (storage device)

108 device information storage device (storage device)

109 information processing device

116 second information control device

25 116a second information acquisition device

116b second information disclosure unit

11, 211a, 211b, 221, 231 compressor (machinery and equipment)

3 user PC (computer)

N1, N2, N3 network

30 16 blowoff valve

18 controller

Claims:

1. A control system for machinery and equipment comprising:  
a working information storage device in which working  
5 information at every moment of one or a plurality of machinery  
and equipment is acquired via a network and is associated with  
identification information of the machinery and equipment to be  
stored; and

an information processing device that analyzes an  
10 operation tendency of the machinery and equipment in a  
predetermined period based on the working information read out  
from the working information storage device and associates an  
analyzed result with the identification information of the  
machinery and equipment to store in an operation information  
15 storage device, wherein

the machinery and equipment is a compressor,

the working information includes information that  
indicates which operation between a load operation and an  
unload operation is executed by the compressor, and

20 in case that a ratio of the unload operation is equal to  
or above a predetermined value as an operation tendency of the  
compressor in a predetermined period, the information  
processing device decides a setting value that makes the ratio  
of the unload operation smaller than the predetermined value  
25 based on an analysis of the working information and sends the  
setting value to a user computer corresponding to the  
compressor via the network.

2. The control system for machinery and equipment according  
30 to claim 1, wherein

the working information includes an electric current  
value supplied to the compressor, and

in case that an average value of a load ratio calculated  
based on the electric current value is below a predetermined  
35 value as an operation tendency of the compressor in a

predetermined period, the information processing device decides a setting value which makes the load ratio be equal to or be above the predetermined value based on an analysis on the working information and sends the setting value to the user computer corresponding to the compressor via the network.

3. The control system for machinery and equipment according to claim 1, wherein

the working information includes an intake temperature and a discharge temperature of the compressor, and

in case that an increase rate of at least one of the intake temperature and the discharge temperature is equal to or above a predetermined value as an operation tendency of the compressor in a predetermined period, the information processing device decides that the compressor has an abnormality indication and sends a decision result to the user computer corresponding to the compressor via the network.

4. The control system for machinery and equipment according to claim 1, wherein

the working information includes downtime of the compressor, and

in case that the downtime is equal to or above a predetermined period as an operation tendency of the compressor, the information processing device sends information that promotes maintenance for the compressor to the user computer corresponding to the compressor via the network.

5. The control system for machinery and equipment according to claim 1, wherein

information stored in the operation information storage device includes longevity operation time and a previous replacement date of a device constituting the compressor, and

the information processing device calculates accumulated operation time per device based on the working information

stored in the working information storage device as an operation tendency of the compressor, calculates a next scheduled date for replacement of the device based on the accumulated operation time, the longevity operation time and the previous replacement date, and sends the next scheduled date for replacement to the user computer corresponding to the compressor via the network.

6. The control system for machinery and equipment according to claim 1, wherein

a specification information storage device that stores specification information on the compressor is provided,

the working information includes a discharge pressure of the compressor, and

in case that an average value of the discharge pressure is larger than a target discharge pressure by a predetermined value or more as an operation tendency of the compressor in a predetermined period, the information processing device searches a compressor candidate of which discharge pressure is closer to the target discharge pressure than the discharge pressure of the compressor in the specification information storage device and sends the compressor candidate to the user computer corresponding to the compressor via the network.

7. A control system for machinery and equipment comprising:

a working information storage device in which working information at every moment of one or a plurality of machinery and equipment is acquired via a network and is associated with identification information of the machinery and equipment to be stored; and

an information processing device that analyzes an operation tendency of the machinery and equipment in a predetermined period based on the working information read out from the working information storage device and associates an analyzed result with the identification information of the

machinery and equipment to store in an operation information storage device, wherein

the machinery and equipment is a compressor,

5 a specification information storage device that stores specification information on the compressor is provided,

the working information includes a discharge pressure of the compressor, and

10 in case that an average value of the discharge pressure is larger than a target discharge pressure by a predetermined value or more as an operation tendency of the compressor in a predetermined period, the information processing device searches a compressor candidate of which discharge pressure is closer to the target discharge pressure than the discharge pressure of the compressor in the specification information storage device and sends the compressor candidate to a user computer corresponding to the compressor via the network, and wherein

the working information includes an electric current value supplied to the compressor, and

20 in case that an average value of a load ratio calculated based on the electric current value is below a predetermined value as an operation tendency of the compressor in a predetermined period, the information processing device decides a setting value which makes the load ratio be equal to or be above the predetermined value based on an analysis on the working information and sends the setting value to a user computer corresponding to the compressor via the network.

8. A control system for machinery and equipment comprising:

30 a working information storage device in which working information at every moment of one or a plurality of machinery and equipment is acquired via a network and is associated with identification information of the machinery and equipment to be stored; and

an information processing device that analyzes an operation tendency of the machinery and equipment in a predetermined period based on the working information read out from the working information storage device and associates an analyzed result with the identification information of the machinery and equipment to store in an operation information storage device, wherein

the machinery and equipment is a compressor,

the working information includes an electric current

value supplied to the compressor, and

in case that an average value of a load ratio calculated based on the electric current value is below a predetermined value as an operation tendency of the compressor in a predetermined period, the information processing device decides a setting value which makes the load ratio be equal to or be above the predetermined value based on an analysis on the working information and sends the setting value to a user computer corresponding to the compressor via the network.

9. The control system for machinery and equipment according to claim 8, wherein

the working information includes an intake temperature and a discharge temperature of the compressor, and

in case that an increase rate of at least one of the intake temperature and the discharge temperature is equal to or above a predetermined value as an operation tendency of the compressor in a predetermined period, the information processing device decides that the compressor has an abnormality indication and sends a decision result to the user computer corresponding to the compressor via the network.

10. The control system for machinery and equipment according to claim 8, wherein

the working information includes downtime of the compressor, and

in case that the downtime is equal to or above a predetermined period as an operation tendency of the compressor, the information processing device sends information that promotes maintenance for the compressor to the user computer  
5 corresponding to the compressor via the network.

11. The control system for machinery and equipment according to claim 8, wherein

information stored in the operation information storage  
10 device includes longevity operation time and a previous replacement date of a device constituting the compressor, and  
the information processing device calculates accumulated operation time per device based on the working information stored in the working information storage device as an  
15 operation tendency of the compressor, calculates a next scheduled date for replacement of the device based on the accumulated operation time, the longevity operation time and the previous replacement date, and sends the next scheduled date for replacement to the user computer corresponding to the  
20 compressor via the network.