

DESCRIPTION

TITLE OF INVENTION:

FLANGE TIGHTENING MANAGEMENT METHOD, FLANGE TIGHTENING MANAGEMENT
SYSTEM, FLANGE TIGHTENING MANAGEMENT PROGRAM, AND FLANGE TIGHTENING
5 MANAGEMENT DEVICE

TECHNICAL FIELD

[0001]

The present invention relates to a tightening management
10 technology of a flange that couples piping, a valve, a pump, etc.

BACKGROUND ART

[0002]

A flange joint is used for coupling of piping and connection
of a pump, etc. to the piping. A gasket is interposed between
15 flanges of the flange joint, the flanges being tightened by bolts
and nuts arranged at a plurality of points. For this tightening,
not only a manual tool such as a torque wrench but also an
electrically-powered screw tightening device can be used.

[0003]

20 It has been known, in relation to pressure acting on the gasket
between the flanges tightened by tightening the bolts and the nuts,
that this pressure is measured by a pressure sensor so that the
flange tightening force is determined by the measurement value (e.g.
Patent Literature 1).

25 CITATION LIST

PATENT LITERATURE

[0004]

Patent Literature 1: JP2007-292628A

SUMMARY OF INVENTION

30 TECHNICAL PROBLEM

[0005]

However, there are a wide variety of flanges and gaskets as
objects, making it indispensable to select a gasket fitting with
a flange. In addition, the tightening procedure of a plurality of

bolts has not yet been established and, even when using a fixed specific tightening tool, a skilled worker is desired for highly reliable tightening. Training and experience are required for proficiency, so that a burden on the worker becomes excessive,
5 rendering the flange tightening management essential.

[0006]

Thus, in view of the above problem, an object of the present invention is to consistently manage gaskets and tightening conditions from selection up to execution in association with
10 flanges, to thereby achieve highly reliable flange tightening management and relieve the worker's burden.

SOLUTION TO PROBLEM

[0007]

In order to achieve the above object, according to an aspect
15 of a flange tightening management method of the present invention, the flange tightening management method uses a computer for management of tightening that tightens flanges sandwiching a gasket therebetween by a plurality of bolts and nuts and comprises the steps of acquiring tightening condition information associated with
20 the flanges, acquiring flange information from a first information tag on the flange side, acquiring gasket information from a second information tag on the gasket side, collating gasket information contained in the flange information with the gasket information acquired from the second information tag, selecting a tightening
25 condition from the tightening condition information on condition that the gasket fits with the flanges, and acquiring on-tightening or post-tightening tightening information to evaluate whether this tightening information conforms to the tightening condition.

To attain the above object, according to an aspect of a flange
30 tightening management method of the present invention, the flange tightening management method uses a computer for management of tightening that tightens flanges sandwiching a gasket therebetween by a plurality of bolts and nuts and comprises the steps of acquiring tightening condition information associated with the flanges,

acquiring flange information containing gasket information fitting with the flanges from a flange tag, acquiring gasket information from a gasket tag, collating the gasket information contained in the flange information with the gasket information acquired from the gasket tag, selecting a tightening condition from the tightening condition information provided that the gasket fits with the flanges, acquiring on-tightening or post-tightening tightening information from a sensor attached to the bolt to evaluate whether tightening conforms to the tightening condition, and presenting tightening result information containing at least the tightening condition and the evaluation result, in association with the flanges.

[0008]

The flange tightening management method may further comprise the step of, at the time of collation of the gasket information, outputting presentation information indicative of whether the gasket fits with the flanges.

[0009]

The flange tightening management method may further comprise the steps of determining whether the tightening condition is satisfied during tightening of the flanges, and presenting a result of the determination.

[0010]

The flange tightening management method may further comprise the steps of acquiring worker information from a worker tag, and presenting the flange, the tightening condition, and the evaluation result, in association with the worker information.

[0011]

In the flange tightening management method, the flange information may contain at least gasket information fitting with the flanges and information indicative of a tightening procedure.

[0012]

In the flange tightening management method, the tightening condition information may contain the flange information and the gasket information.

[0013]

The flange tightening management method may further comprise the steps of forming a gasket from a gasket material, and attaching the gasket tag containing the gasket information, to the gasket.

5 [0014]

In order to accomplish the above object, according to an aspect of a flange tightening management system of the present invention, the flange tightening management system is used for management of tightening that tightens flanges sandwiching a gasket therebetween
10 by a plurality of bolts and nuts and comprises a sensor detecting tightening information and a server connected wiredly or wirelessly to the sensor, wherein the server acquires tightening condition information associated with the flanges, acquires flange information from a first information tag on the flange side,
15 acquires gasket information from a second information tag on the gasket side, collates gasket information contained in the flange information with the gasket information acquired from the second information tag, selects a tightening condition from the tightening condition information on condition that the gasket fits with the
20 flanges, and acquires on-tightening or post-tightening tightening information from the sensor, to evaluate whether tightening of the flanges conforms to the tightening condition.

In order to accomplish the above object, according to an aspect of a flange tightening management system of the present invention,
25 the flange tightening management system is used for management of tightening that tightens flanges sandwiching a gasket therebetween by a plurality of bolts and nuts and comprises a sensor attached to the bolt for detecting tightening information and a server connected wiredly or wirelessly to the sensor, wherein the server
30 acquires tightening condition information associated with the flanges, acquires flange information containing gasket information fitting with the flanges from a flange tag, acquires gasket information from a gasket tag, collates the gasket information

contained in the flange information with the gasket information acquired from the gasket tag, selects a tightening condition from the tightening condition information provided that the gasket fits with the flanges, acquires on-tightening or post-tightening

5 tightening information from the sensor to evaluate whether tightening of the flanges conforms to the tightening condition, and presents tightening result information containing at least the tightening condition and the evaluation result in association with the flanges.

10 [0015]

In order to achieve the above object, according to an aspect of a flange tightening management program of the present invention, the flange tightening management program is run by a computer used for management of tightening that tightens flanges sandwiching a
15 gasket therebetween by a plurality of bolts and nuts and drives the computer to execute the functions of acquiring tightening condition information associated with the flanges, acquiring flange information from a first information tag on the flange side, acquiring gasket information from a second information tag on the
20 gasket side, collating gasket information contained in the flange information with the gasket information acquired from the second information tag, selecting a tightening condition from the tightening condition information on condition that the gasket fits with the flanges, and acquiring on-tightening or post-tightening
25 tightening information to evaluate whether tightening conforms to the tightening condition.

In order to achieve the above object, according to an aspect of a flange tightening management program of the present invention, the flange tightening management program is run by a computer used
30 for management of tightening that tightens flanges sandwiching a gasket therebetween by a plurality of bolts and nuts and drives the computer to execute the functions of acquiring tightening condition information associated with the flanges, acquiring flange information containing gasket information fitting with the flanges from a flange tag,
35 acquiring gasket information from a gasket tag,

collating the gasket information contained in the flange information with the gasket information acquired from the gasket tag, selecting a tightening condition from the tightening condition information, provided that the gasket fits with the flanges, acquiring on-tightening or post-tightening tightening information from a sensor attached to the bolt to evaluate whether tightening conforms to the tightening condition, and presenting the tightening result information containing at least the tightening condition and the evaluation result in association with the flanges.

10 [0016]

In order to attain the above object, according to an aspect of a flange tightening management device of the present invention, the flange tightening management device is used for management of tightening that tightens flanges sandwiching a gasket therebetween by a plurality of bolts and nuts and comprises an information acquiring unit that acquires tightening condition information associated with the flanges, acquires flange information from a first information tag on the flange side, acquires gasket information from a second information tag on the gasket side, and acquires on-tightening or post-tightening tightening information; and a processing unit that collates gasket information contained in the flange information with the gasket information acquired from the second information tag and selects a tightening condition from the tightening condition information on condition that the gasket fits with the flanges, to evaluate whether tightening of the flange conforms to the tightening condition.

In order to attain the above object, according to an aspect of a flange tightening management device of the present invention, the flange tightening management device is used for management of tightening that tightens flanges sandwiching a gasket therebetween by a plurality of bolts and nuts and comprises an information acquiring unit that acquires tightening condition information associated with the flanges, acquires flange information containing gasket information fitting with the flanges from a flange

tag, acquires gasket information from a gasket tag, and acquires on-tightening or post-tightening tightening information from a sensor attached to the bolt; a processing unit that collates the gasket information contained in the flange information with the gasket information acquired from the gasket tag and selects a tightening condition from the tightening condition information provided that the gasket fits with the flanges, to evaluate whether tightening of the flanges conforms to the tightening condition; and an information presenting unit that presents tightening result information containing at least the tightening condition and the evaluation result in association with the flanges.

ADVANTAGEOUS EFFECTS OF INVENTION

[0017]

According to the present invention, the following effects can be obtained.

[0018]

(1) By use of a computer having a flange tightening monitoring function, there can be implemented consistent management of multi-function processing including flange and gasket selection, tightening condition setting, tightening status evaluation, tightening result recording, and its information presentation, thus achieving flange tightening management not relying on the worker's experience and intuition.

[0019]

(2) As a result of acquiring tightening information from a sensor disposed on the bolt to thereby evaluate the conformation to the tightening condition, the status of the flange or gasket to be tightened can be grasped so that highly reliable flange tightening management can be implemented.

[0020]

(3) Since it is evaluated based on the tightening result whether the tightening status conforms to the tightening condition, the degree of dependence on the worker is reduced so that tightening with a smaller error can be implemented.

[0021]

(4) Since tightening result information containing the tightening condition and the tightening evaluation result is presented, the tightening status can be checked from the information.

[0022]

Other objects, features, and advantages of the present invention will be more apparent by referring to the accompanying drawings and embodiments.

10 BRIEF DESCRIPTION OF DRAWINGS

[0023]

Fig. 1 is a diagram showing a flange tightening management system according to one embodiment.

Fig. 2 is a sequence diagram showing an example of processing of the flange tightening management system.

Fig. 3 is a diagram showing a configuration example of a server.

Fig. 4 is a diagram showing a bolt with a strain gauge.

Fig. 5 is a diagram showing a worker information table, a worker tag, and worker tag information.

Fig. 6 is a diagram showing a tightening condition table.

Fig. 7 is a diagram showing flange information and a flange tag.

Fig. 8 is a diagram showing gasket information and a gasket tag.

Fig. 9 is a diagram showing tightening result information and a first log information table.

Fig. 10 is a diagram showing a second log information table.

Fig. 11 is a flowchart showing a flange tightening procedure.

Fig. 12 is a flowchart showing a server processing procedure.

Fig. 13 is a flowchart showing a server processing procedure after tightening.

Fig. 14 is a diagram showing an example of a flange tightening management system according to Example 2.

Fig. 15 is a diagram showing a configuration example of a controller.

Fig. 16 is a diagram showing working and sorting of a gasket according to Example 3.

5 Fig. 17 is a diagram showing a sorting example of the gasket.

DESCRIPTION OF EMBODIMENTS

[0024]

[One Embodiment]

[0025]

10 <Flange Tightening Management System>

[0026]

Fig. 1 shows a flange tightening management system according to one embodiment.

The configuration shown in Fig. 1 is an example and the present
15 invention is not limited to such a configuration.

[0027]

This flange tightening management system 2 comprises a sensor group (hereinafter, referred to simply as "sensor") 4 detecting a flange tightening force, and a server computer (hereinafter,
20 referred to simply as "server") 6.

[0028]

In a flange tightening portion 8 as a tightening object, a gasket 12 is interposed between confronting faces of flanges 10-1 and 10-2, with a plurality of bolts 14 and nuts 16 being attached
25 thereto for tightening the flanges 10-1 and 10-2 together. The worker uses a tightening tool 18 to apply a torque T to each of the nuts 16. By tightening the nut 16 to the bolt 14 in this manner, a tightening force is applied to the gasket 12 interposed between the flanges 10-1 and 10-2. This tightening tool 18 can be for
30 example a manual tool such as a ratchet torque wrench, a digital torque wrench, a bolt tensioner, a ratchet wrench, a spanner, an offset wrench, and a slogging wrench, or an electrically powered tool. Bolts 14-1, 14-2, ..., and 14-8 generate an axial force F in the Z-axis direction of the diagram, which axial force F acts as

a tightening force on the gasket 12.

[0029]

The sensor 4 is an example of means for detecting a tightening force in the flange tightening portion 8, with sensors 4-1, 4-2, ..., and 4-N being disposed corresponding to the bolts 14-1, 14-2, ..., and 14-N (N is a natural number). The sensors 4-1, 4-2, ..., and 4-N may be a sensor that outputs the axial force F as an electric signal, and can be any one of a pressure sensor, a strain gauge, displacement meter, a load cell, etc. or may be a sensor that directly detects the tightening force of the gasket 12.

[0030]

The sensor 4 is connected wiredly or wirelessly to the server 6 so that the detected tightening force is imported into the server 6. This tightening force detected by the sensor 4 is an example of tightening information that is the flange tightening result. The sensor 4, e.g. the sensors 4-1, 4-2, ..., and 4-N may have a function to perform wireless communication with the server 6, respectively, or may comprise, between the sensor 4 and the server 6, a data accumulating unit 20 that compiles detection data and performs transmission management. This data accumulating unit 20 is a computer, etc. having a data processing function and a communication function and may be a data logger, for example.

[0031]

The server 6 is an example of the flange tightening management device and is configured from a personal computer (PC) or a tightening management computer. The server 6 comprises, for example, a processing unit 22, a monitor 24, and an input operation unit 26.

[0032]

For example, this server 6 executes processes such as:

- a) acquisition of tightening condition information in association with the flange 10;
- b) acquisition of flange information of the flange 10;
- c) acquisition of gasket information of the gasket 12;

d) collation of gasket information contained in the flange information with gasket information acquired from the gasket 12;

e) selection of a tightening condition from the tightening condition information if the flange 10 fits with the gasket 12;

5 f) acquisition of on-tightening or post-tightening tightening information from the sensor 4 and evaluation of whether the tightening conforms to the tightening condition; and

g) presentation of tightening information containing at least the tightening condition and the evaluation result, in association
10 with the flange 10.

[0033]

The server 6 may acquire detection information detected by the sensor 4 at the time of completion of tightening or during the tightening. Data transmission from the sensor 4 to the server 6
15 may be performed at timings of detection of the sensors 4-1, 4-2, ..., and 4-N or in a predetermined order.

[0034]

<Flange Tightening Management Processing Procedure>

[0035]

20 Fig. 2 shows a processing sequence of the flange tightening management using the sensor 4 and the server 6. In these processing processes, the processes are designated by steps (Step:S) and numbers. The processing content and processing procedure shown in Fig. 2 are an example and the present invention is not limited to
25 such content. This flange tightening management is an example of the flange tightening management method and the flange tightening management program of this disclosure.

[0036]

A flange tag 30 is attached to a pre-tightening flange 10 for
30 example and indicates flange information including gasket information. This flange tag 30 is an example of a first information tag. A gasket tag 32 is attached to a pre-tightening gasket 12 for example and indicates gasket information. The gasket tag 32 is an example of a second information tag.

[0037]

The server 6 comprises a management function unit 34 performing tightening management processing of the flange 10 for example, and a storage/display function unit 36 including a function of storing database containing tightening conditions, etc. and log information and a function of displaying them. In the case of executing the tightening management processing, the server 6 reads out the above tightening condition information associated with the flange 10, from the storage/display function unit 36 (step S101).

10 [0038]

The management function unit 34 acquires flange information from the flange tag 30 (step S102). This flange information contains gasket information indicative of a gasket fitting a flange with the flange tag 30.

15 [0039]

The management function unit 34 acquires gasket information from the gasket tag 32 (step S103) and collates gasket information contained the flange information with gasket information acquired from the gasket tag 32 (step S104).

20 [0040]

If the gasket 12 fits the flange 10 (step S105;Yes), the management function unit 34 selects a conforming tightening condition from the tightening condition information (step S106). [0041]

25 If the gasket 12 does not fit the flange 10 (step S105;No), the management function unit 34 provides an error indication (step S107), urging the worker to replace the gasket 12 with a fitting gasket 12.

[0042]

30 When the selection of the tightening condition is completed, the management function unit 34 starts the tightening processing by the tightening tool 18. The sensor 4 detects as on-tightening or post-tightening tightening information the axial force F applied to the bolt 14 (step S108).

[0043]

The management function unit 34 of the server 6 acquires on-tightening or post-tightening tightening information from the sensor 4 (step S109) and evaluates whether tightening of the flange 10 conforms to the tightening condition (step S110).

[0044]

The management function unit 34 creates tightening result information containing at least the tightening condition and the evaluation result, to notify the storage/display function unit 36 of the tightening result information (step S111). The storage/display function unit 36 displays the provided tightening result information on the monitor 24 (step S112).

[0045]

The relationships between the above processes a) to g) and steps according to this processing procedure are as follows.

a) acquisition of tightening condition information associated with the flange 10: S101

b) acquisition of flange information of the flange 10: S102

c) acquisition of gasket information of the gasket 12: S103

d) collation of gasket information contained in the flange information with the gasket information acquired from the gasket 12: S104

e) if the flange 10 and the gasket 12 match each other, selection of a tightening condition from the tightening condition information: S105 and S106

f) acquisition of on-tightening or post-tightening tightening information from the sensor 4 and evaluation of whether the tightening conforms to the tightening condition: S109 and S110

g) presentation of tightening result information containing at least the tightening condition and the evaluation result, in association with the flange 10: S111 and S112

[0046]

<Effect of One Embodiment>

[0047]

(1) The server 6 selects a tightening condition applying to the flange 10 and the gasket 12 from the tightening condition information stored and evaluates the tightening information detected by the sensor 4, based on such a tightening condition, thereby making it possible to monitor whether or not proper tightening is carried out, avoid a tightening mistake, and implement proper tightening irrespective of the amount of worker's experience.

[0048]

(2) The flange information acquired from the flange tag 30 contains gasket information indicative of a fitting gasket 12 so that it is determined based on collation of the gasket information with gasket information acquired from the gasket tag 32 whether the gasket fits with the flange, thereby making it possible to prevent a selection mistake of the gasket for a specified flange, to implement consistent management of the flange, gasket, and tightening condition. As a result, highly reliable flange tightening management can be implemented.

[0049]

(3) The selection of the tightening condition cannot be performed if a selected gasket 12 does not fit with the flange 10 to be tightened, thereby making it possible to prevent a worker's selection mistake or tightening condition setting mistake and achieve the enhanced tightening reliability as well as the worker's relieved burden.

[0050]

(4) It is evaluated whether the tightening status conforms to the tightening condition, based on the on-tightening or post-tightening tightening information detected from the bolt 14, thereby making it to reduce the degree of dependence on the worker to avoid or alleviate the tightening error.

[0051]

(5) The tightening result information containing the tightening condition and the tightening evaluation result can be

recorded and presented, whereby monitoring or checking of the tightening status in course of tightening is easy and the past tightening status can also be checked from the recorded tightening information.

5 [0052]

[Example 1]

[0053]

<Server>

[0054]

10 Fig. 3 shows an example of the server 6. The server 6 is an example of the flange tightening management device and is configured from a computer. The server 6 may have a function of storing the tightening condition information or a function of presenting the tightening evaluation result and the log information.

15 [0055]

As shown in Fig. 3A, the server 6 comprises a processing unit 40, an input operating unit 52, and a displaying unit 54, the processing unit 40 including a processor 42, a storing unit 44, an input/output unit (I/O) 46, and a communicating unit 48.

20 [0056]

The processor 42 performs information processing of an operating system (OS) in the storing unit 44, a flange tightening management program, etc. This information processing includes control of: readout of tightening condition information; selection
25 of a tightening condition; acquisition of tightening result information from the sensor 4; monitoring and evaluation of the tightening status; display of an evaluation result; and output of tightening result information. That is, the processor 42 acts as the above management function unit 34.

30 [0057]

The storing unit 44 is used for the storage of the flange tightening management program, the tightening condition information, the log information, etc. and comprises a read only memory (ROM) and a random access memory (RAM). This storing unit

44 can be a storage device such as a hard disc or a semiconductor memory, capable of holding the storage content. This storing unit 44 configures the above storage/display function unit 36.

[0058]

5 The I/O 46 is controlled by the processor 42 and is used for input/output of control information. The communicating unit 48 is used for connection to, e.g. the sensor 4, the displaying unit 54, a touch panel 56, as well as to external equipment not shown. For example, an external memory 50 may be connected as the external
10 equipment to the I/O 46.

[0059]

 The communicating unit 48 is controlled by the processor 42 and is used for wireless connection to the sensor 4, wireless connection to external equipment not shown, and Internet
15 connection.

[0060]

 The input operating unit 52 is an example of means used for input of input information, exput trigger of output information, mode switching, etc. and can be a keyboard and a mouse for example.

20 [0061]

 The displaying unit 54 is an example of the information presenting unit and the display unit and is used for display of a log information table (Fig. 9B). A screen display portion of the displaying unit 54 may comprise the touch panel 56 so as to perform
25 input of information corresponding to the display information in place of the input operating unit 52.

[0062]

 In addition, a barcode reader not shown or the like is connected as means for reading worker information, flange
30 information, and gasket information for example to the processing unit 40.

[0063]

 As shown in Fig. 3B for example, the storing unit 44 of the server 6 comprises a temporary storage area 44-1 and a storage area

44-2. The temporary storage area 44-1 temporarily stores flange information 60 acquired from the flange 10, gasket information 62 acquired from the gasket 12, and worker information 64 acquired from a worker tag 84 (Fig. 5B) and tightening result information 5 66 for example.

[0064]

A database for a tightening condition table 68, log information tables 70-1 and 70-2, etc. is built in the storage area 44-2. The tightening condition table 68 records tightening 10 condition information associated with the flange 10. The log information tables 70-1 and 70-2 record information such as the tightening result and the tightening determination result.

[0065]

<Sensors 4-1, 4-2, ..., and 4-N>

15 [0066]

Fig. 4 shows an example of the bolt 14 having the sensor 4. This bolt 14 comprises a bolt body 72 that has a strain gauge 74 disposed in the interior thereof. The strain gauge 74 is an example of the sensors 4-1, 4-2, ..., and 4-N of this disclosure and detects 20 a strain occurring in the bolt body 72 by the torque T applied to the bolts 14-1, 14-2, ..., and 14-N by the tightening tool 18. This strain represents the axial force F applied to the bolt 14 by tightening. A cable 76 for example is connected to the strain gauge 74 so that the detection axial force F may be taken out as a sensor 25 output through the cable 76.

[0067]

<Worker Information 64>

[0068]

Fig. 5A shows a worker information table. The worker 30 information table 80 is memorized in the server 6 for example and stores worker information acquired from a worker in charge of tightening. This worker information table 80 contains as an example of the worker information a worker identification (ID), a user, a worker name, etc. The worker ID is identification

information for identifying a worker. The user is a name, etc., of a company to which the worker belongs or of a company of a tightening site. The worker name is a name, etc. of the worker.
[0069]

5 As shown in Fig. 5A, the worker information table 80 includes an ID part 80-1, a company name part 80-2, and a worker name part 80-3. The ID part 80-1 stores a worker ID. The company name part 80-2 stores a name of a company to which the worker belongs. The worker name part 80-3 stores a worker name.

10 [0070]

 The worker information stored in the worker information table 80 may be acquired from the worker tag 84 that the worker 82 wears. The worker tag 84 may use a barcode 86 as worker information indication means so that worker tag information 88 may be read from
15 the barcode 86 by using a barcode reader connected to the server 6. Fig. 5C shows an example of the worker tag information 88. This worker tag information 88 contains the worker ID, the company name, and the worker name to be stored in the worker information table 80.

20 [0071]

 This worker information is acquired from the worker tag 84 at the time of start of tightening, to form the worker information table 80, which becomes a piece of information making up the tightening record, by being associated with the above flange
25 information.

 [0072]

 <Tightening Condition Table 68>

 [0073]

 Fig. 6 shows an example of the tightening condition table 68.
30 This tightening condition table 68 stores tightening condition information. This tightening condition table 68 is stored in the storing unit 44 of the server 6 for example and is read out for use in the case of performing the tightening management processing. This tightening condition table 68 contains, as an example of the

tightening condition information, applied point information, the flange information 60, the gasket information 62, the tightening information, and the tightening condition information. The applied point information is information such as working line for placing a gasket. The flange information 60 is individual information for use in identification of the flange 10. The gasket information 62 is individual information for use in identification of the gasket 12. The tightening information is information such as the number of bolts in the flange tightening portion 8. The tightening condition information includes tightening condition identification information and the number of rounds in tightening. [0074]

The tightening condition table 68 may be acquired not only from the storing unit 44 of the server 6 for example but also from an externally connected storage medium or a network. [0075]

This tightening condition table 68 includes, as shown in Fig. 6, a line information part 68-1, a flange information part 68-2, a gasket information part 68-3, a bolt information part 68-4, and a tightening condition information part 68-5 [0076]

The line information part 68-1 stores identification information of a tightening site such as piping lines such as Line A, Line B, etc. as line name. The flange information part 68-2 stores a flange number, flange dimensions, etc. identifying the flange 10. The gasket information part 68-3 stores a gasket part No. gasket dimensions, etc. identifying the gasket 12. The bolt information part 68-4 stores the number of bolts. The tightening condition information part 68-5 stores e.g. tightening condition number (No.) for identifying the tightening condition, and Pass 1, Pass 2, ..., Pass 13, etc. representing the number of rounds. [0077]

By utilizing the tightening condition table 68 as the tightening condition information, the server 6 can grasp required

tightening condition information on tightening.

[0078]

<Flange Information 60>

[0079]

5 Fig. 7A shows an example of the flange 10 and the flange tag
30. In this example, the flange tag 30 is hung to the flange 10
by a lead 89.

[0080]

10 This flange tag 30 has a barcode 90 as an example of information
indication means so that flange information 92 can be acquired by
reading the barcode 90 by a barcode reader.

[0081]

15 This flange tag information 92 is an example of the flange
information and includes flange information and relevant
information stored in the above tightening condition table 69.
This relevant information includes line information and gasket
information.

[0082]

20 The flange tag information 92 includes, as shown in Fig. 7B,
the applied point information, the flange identification
information, the gasket information, and the tightening condition
information. A line name 92-1 as an example of the line information
part stores identification information of a tightening point such
as a piping line such as Line A, Line B, ..., etc. A flange information
25 92-2 stores e.g. a flange number and flange dimensions identifying
the flange 10. A gasket information 92-3 stores a gasket part No.
identifying the gasket 12. A tightening condition number 92-4
stores, as an example of tightening procedure information, a
tightening condition number for identifying the tightening
30 condition.

[0083]

 Since the flange tag information 92 contains the gasket
information having a close relationship with the flange 10 in this
manner, a fitting gasket 12 can automatically be specified by

selecting the flange 10. Then, by collating the gasket information contained in the flange tag information 92 with gasket information obtained from the gasket tag 32, it can promptly be determined whether the gasket 12 fits the flange 10, ensuring a high reliable fitness determination.

[0084]

<Gasket Information 62>

[0085]

Fig. 8A shows a gasket case and the gasket tag 32. The gasket case 100 is for example a synthetic resin case that comprises a case body 102 capable of accommodating the gasket 12 and an openable/closable lid 104 disposed on the case body 102. The lid 104 has a transparent window 106. The gasket 12 can visually be checked through the transparent window 106.

[0086]

The gasket case 100 is provided with the gasket tag 32 having a barcode 108 so that gasket tag information 110 can be acquired by reading the barcode 108 by reading means such as the barcode reader.

[0087]

This gasket tag information 110 contains the gasket information 62. This gasket tag information 110 stores, as shown in Fig. 8B, a gasket part No. and dimensions.

[0088]

<Tightening Result Information 120>

[0089]

Fig. 9A shows an example of the tightening result information 66. This tightening result information 120 contains a tightening condition 120-1, an execution date and time 120-2, an error determination result 120-3, a first tightening result 120-4, and a second tightening result 120-5.

[0090]

The tightening result information 120 is specified by e.g. Line A as the tightening condition 120-1 and the applied point

information. Individual bolt tightening conditions are stored therein. The execution date and time 120-2 indicates the tightening date and time or time zone. The error determination result 120-3 indicates the determination result of whether the tightening status conforms to the tightening condition. The first tightening result 120-4 indicates a measurement value of a tightening torque of the bolt 14 for example. This tightening torque may be calculated e.g. from the axial force F detected by the sensor 4 and the nominal diameters of the bolt 14 and nuts 16 used. The second tightening result 120-5 indicates a nut rotation angle.

[0091]

This tightening result information 120 indicates both the result information in the log information table 70-1 (Fig. 3B) as shown in Fig. 9B as the tightening result acquired from the sensor 4 and the result information in the log information table 70-2 (Fig. 3B) having relevant information such as the working date and time added thereto.

[0092]

As shown in Fig. 9B, the log information table 70-1 contains, not only the applied point information, the flange information 60, the gasket information 62, the tightening portion information, and the tightening condition information, similarly to the tightening condition information (Fig. 6) but also a tightening result associated therewith. The tightening result is tightening result information such as the axial force F acquired from the sensor 4 or the tightening torque calculated from this axial force F .

[0093]

This log information table 70-1 includes a line information part 70-11, a flange information part 70-12, a gasket information part 70-13, a bolt information part 70-14, a tightening condition information part 70-15, a tightening result information part 70-16, and a worker ID part 70-17.

[0094]

As shown in Fig. 10, the log information table 70-2 includes a line information part 70-21, a flange information part 70-22, a gasket information part 70-23, a tightening condition information part 70-25, and a worker ID part 70-27 similarly to the log information table 70-1 (Fig. 9B), and further includes an execution date and time part 70-28, an error determination part 70-29, a first pass tightening result part 70-30, a last pass tightening result part 70-31, and a pass number-of-times part 70-32. The worker ID part 70-27 stores a worker ID similar to that in the worker ID part 70-17. This allows the worker to be identified in association with the flange 10. The log information table 70-2 does not include the bolt information part 70-14, different from the log information table 70-1.

[0095]

The execution date and time part 70-28 stores the tightening date and time. This allows the tightening date to be specified in association with the flange 10. The error determination part 70-29 indicates a determination result of whether the tightening status conforms to the tightening condition, with "OK" representing conformity and "NG" representing inconformity. The first pass tightening result part 70-30 indicates a first pass tightening result (torque) of round pattern tightening of a plurality of bolts 14 on the flange 10. The last pass tightening result part 70-31 indicates a last pass tightening result (the axial force F or torque) of the round pattern tightening of the plurality of bolts 14. The pass number-of-times part 70-32 indicates the number of times of round.

[0096]

<Tightening Procedure>

[0097]

Fig. 11 shows a tightening procedure of the flange tightening management system 2 (Fig. 1) according to Example 1.

[0098]

In this procedure, as shown in Fig. 11, the worker information

64 is acquired at the time of start of tightening (step S201). For the acquisition of the worker information 64, the worker information 64 may be read from the barcode 86 on the worker tag 84 by use of the reading means such as the barcode reader.

5 [0099]

After this process, the server 6 determines whether the worker information 64 is read (step S202). If the worker information 64 is not read (step S202;No), an error indication is provided on the displaying unit 54 (step S203), and for example a red lamp may be
10 lit as an warning indication. This urges the worker 82 to reread the worker information 64 so that the barcode 86 can again be read by the barcode reader. As a result, if the worker information 64 can be acquired, the warning indication is cancelled and for example a green lamp is lit as a properness determination identification,
15 indicating the acquisition of the worker information 64.

[0100]

If the worker information 64 is read (step S202;Yes), the flange information 60 is acquired (step S204). For the acquisition of this flange information 60, similarly, the flange tag information
20 92 (Fig. 7B) may be read from the flange tag 30 by use of the barcode reader or the like. Although in this example, it is not determined whether read of the flange information is performed, the read error may be determined similar to the above worker information 64.

[0101]

25 After the read of this flange information 60, acquisition of the gasket information 62 is performed (step S205). For the acquisition of this gasket information 62, the gasket tag information 110 may be read from the barcode 108 on the gasket tag 32 by use of the barcode reader or the like.

30 [0102]

After the acquisition of the worker information 64, the flange information 60, and the gasket information 62, it is determined whether the gasket 12 fits with the flange 10 (step S206). More specifically, it is determined whether the gasket information 62

acquired from the gasket 12 conforms to the gasket information contained in the flange information 60.

[0103]

If not the gasket 12 fitting with the flange 10 (step S206;No),
5 an error indication is provided on the displaying unit 54 (step S207). This error indication is provided by lighting a red lamp for example. This urges the worker 82 to reselect a fitting gasket 12. As a result, if the fitting gasket 12 is selected, the red lamp is turned off, lighting a green lamp.

10 [0104]

In consequence, the gasket 12 conforming to the worker information 64 and the flange information 60 is selected so that tightening prerequisites are satisfied. At this time, the tightening condition is automatically selected from the tightening
15 condition information (step S208).

[0105]

When the tightening condition is set, tightening of the nut 16 is executed using the tightening tool 18 (step S209). The server 6 acquires the tightening result information from the sensor 4 (step
20 S210). This result information contains the tightening result such as the axial force F described above.

[0106]

The server 6 determines from the acquired result information whether the tightening result conforms to the tightening condition
25 (step S211). If the tightening result does not conform to the tightening condition (step S211;No), an error indication is provided (step S212). The error indication is provided by lighting the red lamp, informing the worker 82 that the tightening result conforming to the tightening condition has not yet been obtained.

30 [0107]

The server 6 then records the tightening result containing an error determination (step S213). The tightening result is recorded in the log information table 70-1 (step S214), bringing this processing to completion.

[0108]

The record information can be output to the external memory 50 for storage. The server 6 can cause the monitor 24 to display the above log information table 70-2 on the monitor 24.

5 [0109]

<Processing Procedure from Preparation for Tightening up to Execution of Tightening>

[0110]

Fig. 12 shows a processing procedure from the preparation for
10 tightening up to the execution of tightening. Executed previous to the tightening of the flange are the acquisition of the worker information 64 from the worker tag 84 (step S301), then the acquisition of the flange information 60 from the flange tag 30 (step S302), then the acquisition of the gasket information 62 from
15 the gasket tag 32 (step S303), and thereafter the collation of gasket information contained in the flange information 60 with the gasket information representative of the actual gasket 12 and determination (step S304). In this collation and determination (S304), it is determined whether the gasket 12 fits with the flange
20 10 (step S305). As a result, it is determined whether the gasket 12 fits with the flange 10 to be tightened.

[0111]

If the gasket 12 does not fit with the flange 10 (step S305;No), the red lamp or the like is lit as notification of the error
25 determination (step S306), returning to S303. That is, the worker is informed by the lighting of the red lamp that the gasket 12 does not fit, and is urged to replace the gasket 12.

[0112]

If a gasket 12 is reselected, the gasket information 62 is
30 acquired from the gasket tag 32 on the gasket 12 (step S303) and then the collation and determination are again performed (step S304). As a result, if the gasket 12 fits with the flange 10 (step S305;Yes), the green lamp is lit as the notification of the proper determination (S307), enabling selection of the tightening condition (step S308).

This means that if the green lamp is not lit, selection of the tightening condition is blocked.

[0113]

In the selection of the tightening condition, the tightening
5 condition table 68 in the storing unit 44 is referred to so that the tightening condition number is selected from this tightening condition table 68 (step S308).

[0114]

After the selection of this tightening condition number,
10 tightening is executed (step S309). This execution of tightening is performed by the worker 82 using the tightening tool 18.

[0115]

<Processing Procedure after Tightening up to Output of Log Information>

15 [0116]

Fig. 13 shows a processing procedure after tightening up to the output of the log information. The tightening result is acquired from the sensor 4 (step S401) and is temporarily stored in the temporary storage area 44-1 of the storing unit 44. This
20 tightening result contains the detection axial force F of the strain gauge 74. The log information table 70-1 is created from this tightening result.

[0117]

For this tightening result, the tightening condition number
25 X of the tightening condition table 68 is referred to so that this tightening condition is determined (step S402). In this determination, it is determined that the tightening result conforms to the tightening condition (step S403).

[0118]

30 If the tightening result conforms to the tightening condition (step S403;Yes), the green lamp is lit as notification of properness determination (S404), whereas if the tightening result does not conform to the tightening condition (step S403;No), the red lamp is lit as notification of error determination (step S407).

[0119]

The log information table 70-1 is created from the tightening result so that this log information is organized and processed to create the log information table 70-2 (step S405).

5 [0120]

Then, this log information table 70-2 is written into the external memory 50 and further output through the displaying unit 54 (step S406).

[0121]

10 <Effect of Example 1>

[0122]

(1) At the time of tightening of the flange, the server 6 reads out the tightening condition information to determine whether the tightening result detected from the sensor 4 is proper or not, thereby enhancing the reliability in the execution of tightening.

15 [0123]

(2) After the selection of the flange 10, the gasket 12 is selected and the gasket information obtained from the gasket 12 is collated with the gasket information lying in the flange information to determine the propriety, thereby making it possible to select a gasket 12 fitting with the flange 10.

20 [0124]

(3) If the gasket 12 does not fit, the worker can be urged to replace the gasket 12 by being notified of warning determination, thereby making it possible to select a fitting gasket 12.

25 [0125]

(4) If it cannot be confirmed whether the gasket 12 fits through the collation of the gasket 12, the shift to the tightening condition providing stage is blocked and, after the decision of the flange 10 and the gasket 12, the tightening condition is selected, thereby making it possible to realize the consistent management of the flange 10, the gasket 12, and the tightening condition.

30 [0126]

(5) Since through the condition of (4), a conforming

tightening condition is automatically selected from the tightening condition information, there is no need to force the worker to manage the tightening condition, rendering it possible to relieve the worker's burden arising from the tightening condition setting.

5 Setting of the tightening condition relying on the worker's experience and intuition can be avoided and automated and cumbersome work by written instructions or input mistake or tightening mistake by written instructions can be prevented. High-accuracy torque management provided by the tightening condition information is
10 feasible and tightening by the axial force F different for each of bolts to be tightened can efficiently be carried out. By presenting the tightening result by the sensor 4 to the worker, there can be implemented high-accuracy flange tightening management far exceeding the management relying on the worker's experience
15 and intuition.

[0127]

(6) Since the flange information is acquired from the flange tag 30 attached to the flange 10 and the gasket information is acquired from the gasket tag 32 attached to the gasket 12, the
20 reliability of the flange information and of the gasket information can be enhanced and various information acquisition work can be reduced.

[0128]

(7) As a result of imparting a barcode or a quick response (QR) (registered trademark) code to the flange tag 30 and the gasket tag 32, use of the reading device such as the barcode reader enables the rapidity and reliability in the information acquisition to be enhanced.

[0129]

30 (8) It can be determined during the tightening of the flange 10 whether the tightening condition is satisfied. The satisfactoriness judgment of the tightening condition during the tightening may include good or bad judgment about member defect or defective work, such as tightening defect, defective bolt 14

or nut 16, occurrence of defectiveness arising from tightening, improper double tightening of the same bolt, erroneous tightening order, and forgotten tightening. As a result of these satisfactoriness judgments, the propriety (OK/NG) of the tightening result can be determined and recorded as the tightening result in the log information. These judgment and recording are carried in synchronism with and concurrently with the tightening of the flange, so that highly reliable work result can be obtained without impairing the work efficiency.

10 [0130]

(9) The tightening result containing such propriety information is provided from the sensor 4 to the server 6, for recording. The server 6 can organize the tightening result and excerpt and edit required information in addition to all information, to create the log information.

15

[0131]

(10) This tightening result information can be compiled into the log information tables 70-1 and 70-2 and transferred from the server 6 to the external memory 50. By dismounting this external memory 50 from the server 6 and mounting it on an external computer, the log information 70-2 can be presented.

20

[0132]

(11) By expanding the log information table 70-2, the manager can easily know whether the tightening result conforming to the tightening condition is obtained. From the log information table 70-2, the error determination result can be known as the propriety information in the tightening result associated with the flange. Details of the work result can easily be known since the tightening result contains detailed relevant information such as the work date associated with the flange.

25

30

[0133]

(12) By virtue of the acquisition of the worker information associated with the flange, it can easily be known from the work result which worker or which execution company is in charge, in

addition to the date and time. Since the gasket information associated with the flange 10 is subjected to the propriety judgment before tightening, use of nonconforming gasket can be obviated.
[0134]

5 [Example 2]

[0135]

Fig. 14 shows a flange tightening management system according to Example 2. The configuration shown in Fig. 14 is an example and the present invention is not limited to such a configuration. In
10 Fig. 14, the same configuration members as those of Figs. 1 and 3 are designated by the same reference signs.

[0136]

This flange tightening management system 130 comprises the sensor 4 detecting a tightening force of the flange for example;
15 the server 6; and a controller 132.

[0137]

This controller 132 is connected wiredly or wirelessly to the sensor 4. The controller 132 is an example of a flange tightening management device and is configured by a computer for example. The
20 controller 132 may be configured by a terminal device of a portable size, carried by the worker or the manager and comprise a front panel unit 134 having a plurality of input keys 136 and a displaying unit 138 thereon.

[0138]

25 This controller 132 executes processing such as:

a) acquisition of tightening condition information associated with the flange 10;

b) acquisition of flange information of the flange 10;

c) acquisition of gasket information of the gasket 12;

30 d) collation of gasket information contained in the flange information with the gasket information acquired from the gasket 12;

e) if the flange 10 and the gasket 12 fit together, selection of a tightening condition from the tightening condition

information;

f) acquisition of on-tightening or post-tightening tightening information from the sensor 4 and evaluation of whether tightening conforms to the tightening condition; and

5 g) presentation of tightening result information containing at least the tightening condition and the evaluation result, associated with the flange 10.

[0139]

The controller 132 is linked to the server 6 wiredly or
10 wirelessly, as indicated by a broken line 140. In this case, the server 6 supports or manages the controller 132.

[0140]

<Controller 132>

[0141]

15 Fig. 15 shows an example of the controller 132.

[0142]

The controller 132 is configured from a computer and comprises a processor 142, a storing unit 144, an input/output unit (I/O) 146, an input operating unit 148, a communicating unit 150, and
20 a displaying unit 152.

[0143]

The processor 142 performs information processing of e.g. an OS and a flange tightening management program lying in the storing unit 144. This information processing includes control of:

25 acquisition of tightening condition information from the server 6; acquisition of tightening result information from the sensor 4; monitoring and evaluation of the tightening status; display of the evaluation result; output of tightening result information; etc.

30 [0144]

The storing unit 144 is used for the storage of the OS, programs, tightening condition information, detection information, etc. and comprises the ROM and the RAM. This storing unit 144 may have the same configuration areas as the temporary storage area 44-1 and

the storage area 44-2 formed in the server 6 described above. This storing unit 144 can be a storage element capable of holding the storage content.

[0145]

5 The I/O 146 is controlled by the processor 142 and is used for input/output of control information. The communicating unit 150 is used for wireless connection to the server 6. A barcode reader 154 and a removable external memory 156 for example are connected as external equipment to the I/O 146. The external memory
10 156 is a log information exput memory and may be a universal serial bus (USB) for example.

[0146]

 The input operating unit 148 comprises a key switch and a touch sensor and is used for an input trigger of input information, an
15 exput trigger of output information, mode switching, etc.

[0147]

 The communicating unit 150 is controlled by the processor 142 and is used for wireless connection to external equipment such as the sensor 4 and the server 6 and for Internet connection.

20 [0148]

 The displaying unit 152 comprises a green lamp 152-1 and a red lamp 152-2 for example. This displaying unit 152 is controlled by the processor 142 and lights the green lamp 152-1 as the status evaluation result at the normal time but lights the red lamp 152-2
25 at the abnormal time.

[0149]

 In such a configuration, the controller 132 in this flange tightening management system 130 may act as the above management function unit 34 to perform e.g. the collation of the gasket
30 information with the flange information and the evaluation processing between the detection result of the sensor 4 and the tightening condition information. The server 6 then may perform e.g. the provision of the stored tightening condition information to the controller 132 and the storage and display processing of

log information created by the controller 132.

[0150]

<Effect of Example 2>

[0151]

- 5 (1) Since the manager provides the tightening condition from the server 6 to the controller 132, the tightening condition can strictly be managed so that a good traceability can be built.

[0152]

- 10 (2) Since the worker in charge of tightening of the flange 10 is given the controller 132 storing the tightening condition information, the worker' burden can be alleviated together with the facilitated tightening condition management.

[0153]

- 15 (3) Since the tightening condition information is provided from the server 6 to the controller 132 at the time of tightening of the flange, the execution of tightening can be constrained by the tightening condition information lying in the controller 132, leading to an enhanced reliability in the execution of tightening.

[0154]

- 20 (4) By the worker carrying the controller 132 or arranging it at a position in the vicinity of a work site, the fittingness determination of the gasket 12 and the flange 10 can be performed at the position near the work site, achieving improved workability.

[0155]

- 25 (5) By the controller 132 acquiring a tightening result from the sensor 4 to determine the tightening result, the tightening status can rapidly be grasped at the work site, leading to improved workability and improved rapidness of work such as retightening.

[0156]

- 30 [Example 3]

[0157]

Fig. 16 shows processing processes of the gasket 12 from formation to sorting. For formation of the gasket 12, there are used, as shown in Fig. 16A, plural types of gasket material plates

160-1, 160-2, ..., and 160-N as raw materials of the gasket 12.

[0158]

As an example of forming processing of gaskets 12-11, 12-12, ..., 12-1N, 12-21, 12-22, ..., 12-2N, ..., 12-N1, 12-N2, ..., and 12-NN, the gasket material plates 160-1, 160-2, ..., and 160-N are subjected to punching, to create the gaskets 12-11, 12-12, ..., 12-1N, 12-21, 12-22, ..., 12-2N, ..., 12-N1, 12-N2, ..., and 12-NN of predetermined shapes individually fitting with various flanges 10, as shown in Fig. 16B.

[0159]

The gaskets 12-11, 12-12, ..., 12-1N, 12-21, 12-22, ..., 12-2N, ..., 12-N1, 12-N2, ..., and 12-NN are individually stored into the fitting gasket cases 100-1, 100-2, ..., and 100-N as shown in Fig. 16C and thereafter are sorted and stored in a plurality of gasket-only racks 162-1, 162-2, ..., and 162-N. The racks 162-1, 162-2, ..., and 162-N are an example of sorting means.

[0160]

Identifying rack tags 164-1, 164-2, ..., and 164-N are attached to the racks 162-1, 162-2, ..., and 162-N. The racks or the stored gaskets may be identifiable by the rack tags 164-1, 164-2, ..., and 164-N.

[0161]

Fig. 17 shows racks 162 that are sorted on a line-by-line basis. In this example, there are disposed a line A rack 162-A, a line B rack 162-B, a line C rack 162-C, and a line D rack 162-D that are set as a plurality of dedicated racks on a line-by-line basis. The line A rack 162-A is used for the line A and is distinguished from the other line use and similarly the line B rack 162-B to the line D rack 162-D are used for lines B to D and are distinguished from the other line use.

[0162]

Each of the racks 162-A to 162-D houses the gasket cases 100 each containing the gasket 12 that is used on a corresponding line.

[0163]

<Effect of Example 3>

[0164]

(1) The racks 162-1, 162-2, ..., and 162-N can sort and house the gaskets 12-11, 12-12, ..., 12-1N, 12-21, 12-22, ..., 12-2N, ..., 12-N1, 5 12-N2, ..., and 12-NN and can for example house a predetermined number of gaskets so that the consumed number or the refilled number can be managed.

[0165]

(2) The line A rack 162-A, the line B rack 162-B, the line 10 C rack 162-C, and the line D rack 162-D can sort and house the gaskets 12 needed for each of the lines. This can prevent line-to-line mixing of the gaskets 12, achieving highly reliable tightening management.

[0166]

(3) Rack tags 164 are attached to the racks 162-1, 162-2, ..., 15 and 162-N and the line A rack 162-A, line B rack 162-B, line C rack 162-C, and line D rack 162-D so that the use destination and the gasket 12 to be housed can be identified by these rack tags 164.

[0167]

(4) The racks 162-1, 162-2, ..., and 162-N and the line A rack 20 162-A, line B rack 162-B, line C rack 162-C, and line D rack 162-D are recyclable and can provide the gaskets 12 and the numerical quantity thereof required to the execution site neither too much nor too little.

25 [0168]

(5) The racks 162-1, 162-2, ..., and 162-N and the line A rack 162-A, line B rack 162-B, line C rack 162-C, and line D rack 162-D housing a required number of gaskets 12 become empty as a result of execution of tightening, so that forgetting to refill the gaskets 30 12 can be prevented.

[0169]

[Other Embodiment]

[0170]

(1) Although in the above embodiment and Examples the case

has been described where the tightening management is carried out using as the tightening information the detection result of the sensor 4 fitted to the bolt 14 executed, the present invention is not limited thereto. The tightening management may be performed
5 using tightening information detected by e.g. a torque sensor having the tightening tool 18, combined with the tightening information obtained by the sensor 4. Consequently, the tightening condition of the bolt 14 and the gasket 12 tightened together can be grasped and the detection result of torque T applied from the tightening
10 side, i.e. the tightening tool 18 can also be utilized for the tightening management, thereby rendering it to grasp the tightening status of the flange 10 in detail and achieve improved accuracy of the tightening processing and stabilized tightening work.
[0171]

15 (2) Although in the tightening management processing, it has been shown that the gasket information, flange information, and worker information are acquired for e.g. collation of the tightening condition, information used for the tightening management is not limited thereto. In the tightening management, the tightening
20 condition information may contain for example: information indicative of the type and dimensions of the bolt 14 and the nut 16, associated with the flange information and gasket information; and information of the tightening tool 18 fitting with the nut 16. Then, the collation with information attached to the bolt 14, nut
25 16, and tightening tool 18 used is performed for the tightening management.
[0172]

(3) The information contained in the tightening management may include elapsed time information from the last tightening work.
30 The server 6 and the controller 132 may comprise a timer as timing means in the interior thereof or may acquire date and time information or time information from external timing means. Then, the server 6 may store the elapsed time information from information of the execution date and time part 70-28 stored in the log

information table 70-2 for example and from the current date and time information. As a result of storing such elapsed time information, it may be utilized for, e.g. the life management of the gasket 12 or notification of time for replacement.

5 (4) Although the sensor 4 is exemplified as means for acquiring on-tightening or post-tightening tightening information, this sensor 4 may be sensor means that acquires tightening information from a point other than the bolt.

10 (5) Although the above system comprises the monitor 24 as an example of the displaying means, it may comprise information presenting means equivalent to the monitor 24 on external equipment connected to the server 6 so that the tightening result information indicative of the tightening condition and the evaluation result is presented to the information presenting means.

15 [0173]

As set forth hereinabove, the most preferred embodiments, etc. of the flange tightening management method, tightening management system, tightening management program, and tightening management device have been described. The present invention is not limited
20 to the above descriptions. Various modification or changes would be feasible by those skilled in the art, based on the gist of the present invention defined in claims or disclosed in description of embodiments. It is natural that such modifications or changes be encompassed within the scope of the present invention.

25 INDUSTRIAL APPLICABILITY

[0174]

According to the flange tightening management method, tightening management system, tightening management program, and tightening management device of the present invention, the
30 tightening result indicative of the tightening status from the flange tightening portion is acquired by the sensor, thereby rendering it possible to implement consistent management of the multi-function processing, such as flange and gasket selection, tightening condition setting, tightening status determination,

tightening result recording, and information presentation thereof,
thus enabling the flange tightening management not relying on the
worker's experience and intuition to be advantageously achieved.

REFERENCE SIGNS LIST

5	[0175]	
	2, 130	flange tightening management system
	4, 4-1, 4-2, ..., 4-N	sensor
	6	server
	8	flange tightening portion
10	10, 10-1, 10-2	flange
	12	gasket
	14, 14-1, 14-2, ..., 14-N	bolt
	16	nut
	18	tightening tool
15	20	data accumulating unit
	22	processing unit
	24	monitor
	26	input operating unit
	30	flange tag
20	32	gasket tag
	34	management function unit
	36	storage/display function unit
	40	processing unit
	42, 142	processor
25	44, 144	storing unit
	46, 146	input/output unit (I/O)
	48, 150	communicating unit
	50, 156	external memory
	52, 148	input operating unit
30	54, 152	displaying unit
	56	touch panel
	60	flange information
	62	gasket information
	64	worker information

	66	tightening result information
	68	tightening condition table
	68-1	line information part
	68-2	flange information part
5	68-3	gasket information part
	68-4	bolt information part
	68-5	tightening condition information part
	70, 70-1, 70-2	log information table
	70-11, 70-21	line information part
10	70-12, 70-22	flange information part
	70-13, 70-23	gasket information part
	70-14	bolt information part
	70-15, 70-25	tightening condition information part
	70-16, 70-26	tightening result information part
15	70-17, 70-27	worker ID part
	70-28	tightening date and time part
	70-29	error determination part
	70-30	first pass tightening result part
	70-31	last pass tightening result part
20	70-32	pass number-of-times part
	72	bolt body
	74	strain gauge
	76	cable
	80	worker information table
25	80-1	ID part
	80-2	company name part
	80-3	worker name part
	82	worker
	84	worker tag
30	86	barcode
	88	worker tag information
	89	lead
	90	barcode
	92	flange tag information

	92-1	line name
	92-2	flange information
	92-3	gasket information
	92-4	tightening condition number
5	100	gasket case
	102	case body
	104	lid
	106	transparent window
	108	barcode
10	110	gasket tag information
	120	tightening result information
	120-1	tightening condition number
	120-2	execution date and time
	120-3	error determination result
15	120-4	first tightening result
	120-5	second tightening result
	132	controller
	134	front panel unit
	136	input key
20	138	displaying unit
	140	broken line
	152-1	green lamp
	152-2	red lamp
	154	barcode reader
25	160-1, 160-2, ..., 160-N	gasket material plate
	162-1, 162-2, ..., 162-N	rack
	162-A	line A rack
	162-B	line B rack
	162-C	line C rack
30	162-D	line D rack
	164	rack tag

CLAIMS

1. A flange tightening management method using a computer for management of tightening that tightens flanges sandwiching a gasket therebetween by a plurality of bolts and nuts, comprising the steps of:

acquiring tightening condition information associated with the flanges, the tightening condition information including numbers of rounds in round pattern tightening of the plurality of bolts and including axial forces or torques that are on the numbers of rounds respectively;

acquiring flange information from a first information tag on the flange side;

acquiring gasket information from a second information tag on the gasket side;

collating gasket information contained in the flange information with the gasket information acquired from the second information tag;

selecting a tightening condition from the tightening condition information, on condition that the gasket fits with the flanges; and

detecting axial forces that are applied to the plurality of bolts respectively for each round of the round pattern tightening and after the round pattern tightening, by a sensor attached to the plurality of bolts, calculating a torque from each of the axial forces, and acquiring a tightening result of the flanges from the axial forces and the torque for each round of the round pattern tightening and after the round pattern tightening, to evaluate whether this tightening result conforms to the tightening condition.

2. A flange tightening management method using a computer for management of tightening that tightens flanges sandwiching a gasket therebetween by a plurality of bolts and nuts, comprising the steps of:

acquiring tightening condition information associated with the flanges, the tightening condition information including numbers of rounds in round pattern tightening of the plurality of bolts and including axial forces or torques that are on the numbers of rounds respectively;

acquiring flange information containing gasket information fitting with the flanges, from a flange tag;

acquiring gasket information from a gasket tag;

collating the gasket information contained in the flange information with the gasket information acquired from the gasket tag;

selecting a tightening condition from the tightening condition information, provided that the gasket fits with the

flanges;

detecting axial forces that are applied to the plurality of bolts respectively for each round of the round pattern tightening and after the round pattern tightening, by a sensor attached to the plurality of bolts, calculating a torque from each of the axial forces, and acquiring a tightening result of the flanges from the axial forces and the torque for each round of the round pattern tightening and after the round pattern tightening, to evaluate whether the tightening result conforms to the tightening condition; and

presenting tightening result information containing at least the tightening condition and the evaluation result, in association with the flanges.

3. The flange tightening management method of claim 1 or 2, further comprising the step of:

at the time of collation of the gasket information, outputting presentation information indicative of whether the gasket fits with the flanges.

4. The flange tightening management method of any one of claims 1 to 3, further comprising the steps of:

determining whether the tightening condition is satisfied, during tightening of the flanges; and

presenting a result of the determination.

5. The flange tightening management method of any one of claims 1 to 4, further comprising the steps of:

acquiring worker information from a worker tag; and

presenting the flange, and the tightening condition, in association with the worker information.

6. The flange tightening management method of any one of claims 1 to 5, wherein

the flange information contains at least gasket information fitting with the flanges and information indicative of a tightening procedure.

7. The flange tightening management method of any one of claims 1 to 6, wherein

the tightening condition information contains the flange information and the gasket information.

8. The flange tightening management method of claim 2, further comprising the steps of:

forming a gasket from a gasket material; and

attaching the gasket tag containing the gasket information, to the gasket.

9. A flange tightening management system used for management of tightening that tightens flanges sandwiching a gasket therebetween by a plurality of bolts and nuts, comprising:

a sensor attached to the plurality of bolts to detect axial forces that are applied to the plurality of bolts respectively; and

a server connected wiredly or wirelessly to the sensor, wherein

the server

acquires tightening condition information associated with the flanges, the tightening condition information including numbers of rounds in round pattern tightening of the plurality of bolts and including axial forces or torques that are on the numbers of rounds respectively;

acquires flange information from a first information tag on the flange side;

acquires gasket information from a second information tag on the gasket side;

collates gasket information contained in the flange information with the gasket information acquired from the second information tag;

selects a tightening condition from the tightening condition information, on condition that the gasket fits with the flanges; and

acquires a tightening result of the flanges for each round of the round pattern tightening and after the round pattern tightening on the basis of axial forces that are applied to the plurality of bolts respectively and are detected for each round of the round pattern tightening and after the round pattern tightening by the sensor and a torque calculated from each of the axial forces, to evaluate whether the tightening result of the flanges conforms to the tightening condition.

10. A flange tightening management system used for management of tightening that tightens flanges sandwiching a gasket therebetween

by a plurality of bolts and nuts, comprising:

a sensor attached to the plurality of bolts to detect axial forces that are applied to the plurality of bolts respectively; and

5 a server connected wiredly or wirelessly to the sensor, wherein

the server

10 acquires tightening condition information associated with the flanges, the tightening condition information including numbers of rounds in round pattern tightening of the plurality of bolts and including axial forces or torques that are on the numbers of rounds respectively;

acquires flange information containing gasket information fitting with the flanges, from a flange tag;

15 acquires gasket information from a gasket tag;

collates the gasket information contained in the flange information with the gasket information acquired from the gasket tag;

20 selects a tightening condition from the tightening condition information, provided that the gasket fits with the flanges;

acquires a tightening result of the flanges for each round of the round pattern tightening and after the round pattern tightening on the basis of axial forces that are applied to the plurality of bolts respectively and are detected for each round of the round pattern tightening and after the round pattern tightening by the sensor and a torque calculated from each of the axial forces, to evaluate whether the tightening result of the flanges conforms to the tightening condition; and

25 presents tightening result information containing at least the tightening condition and the evaluation result, in association with the flanges.

35 11.A flange tightening management program run by a computer used for management of tightening that tightens flanges sandwiching a gasket therebetween by a plurality of bolts and nuts, the program driving the computer to execute the functions of:

acquiring tightening condition information associated with the flanges, the tightening condition information including numbers of rounds in round pattern tightening of the plurality of bolts and including axial forces or torques that are on the numbers of rounds respectively;

40 acquiring flange information from a first information tag on the flange side;

45 acquiring gasket information from a second information tag on the gasket side;

collating gasket information contained in the flange information with the gasket information acquired from the second

information tag;

selecting a tightening condition from the tightening condition information, on condition that the gasket fits with the flanges; and

5 detecting axial forces that are applied to the plurality of bolts respectively for each round of the round pattern tightening and after the round pattern tightening, by a sensor attached to the plurality of bolts, calculating a torque from each of the axial forces, and acquiring a tightening result of the flanges
10 from the axial forces and the torque for each round of the round pattern tightening and after the round pattern tightening, to evaluate whether the tightening result conforms to the tightening condition.

15 12.A flange tightening management program run by a computer used for management of tightening that tightens flanges sandwiching a gasket therebetween by a plurality of bolts and nuts, the program driving the computer to execute the functions of:

acquiring tightening condition information associated with the
20 flanges, the tightening condition information including numbers of rounds in round pattern tightening of the plurality of bolts and including axial forces or torques that are on the numbers of rounds respectively;

acquiring flange information containing gasket information
25 fitting with the flanges, from a flange tag;

acquiring gasket information from a gasket tag;

collating the gasket information contained in the flange information with the gasket information acquired from the gasket tag;

30 selecting a tightening condition from the tightening condition information, provided that the gasket fits with the flanges;

detecting axial forces that are applied to the plurality of bolts respectively for each round of the round pattern tightening and after the round pattern tightening, by a sensor attached to the plurality of bolts, calculating a torque from each of the
35 axial forces, and acquiring a tightening result of the flanges from the axial forces and the torque for each round of the round pattern tightening and after the round pattern tightening, to evaluate whether the tightening result conforms to the tightening condition; and
40

presenting the tightening result information containing at least the tightening condition and the evaluation result, in association with the flanges.

45 13.A flange tightening management device used for management of tightening that tightens flanges sandwiching a gasket therebetween by a plurality of bolts and nuts, comprising:

an information acquiring unit that

acquires tightening condition information associated with the

flanges, the tightening condition information including numbers of rounds in round pattern tightening of the plurality of bolts and including axial forces or torques that are on the numbers of rounds respectively,

5 acquires flange

information from a first information tag on the flange side,
 acquires gasket information from a second information tag on
 the gasket side, and

5 detects axial forces that are applied to the plurality of
 bolts respectively for each round of the round pattern tightening
 and after the round pattern tightening, by a sensor attached to
 the plurality of bolts, calculates a torque from each of the
 axial forces, and acquires a tightening result of the flanges
 from the axial forces and the torque for each round of the round
 10 pattern tightening and after the round pattern tightening; and
 a processing unit that collates gasket information contained
 in the flange information with the gasket information acquired
 from the second information tag and selects a tightening
 condition from the tightening condition information, on condition
 15 that the gasket fits with the flanges, to evaluate whether the
 tightening result of the flanges conforms to the tightening
 condition.

14. A flange tightening management device used for management of
 20 tightening that tightens flanges sandwiching a gasket
 therebetween by a plurality of bolts and nuts, comprising:

an information acquiring unit that
 acquires tightening condition information associated with the
 flanges, the tightening condition information including numbers
 25 of rounds in round pattern tightening of the plurality of bolts
 and including axial forces or torques that are on the numbers of
 rounds respectively,

acquires flange information containing gasket information
 fitting with the flanges, from a flange tag,

30 acquires gasket information from a gasket tag, and
 detects axial forces that are applied to the plurality of
 bolts respectively for each round of the round pattern tightening
 and after the round pattern tightening, by a sensor attached to
 the plurality of bolts, calculates a torque from each of the
 35 axial forces, and acquires a tightening result of the flanges
 from the axial forces and the torque for each round of the round
 pattern tightening and after the round pattern tightening;

a processing unit that
 collates the gasket information contained in the flange
 40 information with the gasket information acquired from the gasket
 tag, and

selects a tightening condition from the tightening condition
 information, provided that the gasket fits with the flanges, to
 evaluate whether the tightening result of the flanges conforms to
 45 the tightening condition; and

an information presenting unit that presents tightening result
 information containing at least the tightening condition and the
 evaluation result, in association with the flanges.