the seal handling, when an accuracy of a handling result is low, thereby leading to a problem in that a required sealing accuracy cannot be realized.

The present inventors have obtained the findings that in such seal handling, a surface-to-surface distance of flanges whose surfaces face each other is quantitatively perceived by measuring the surface-to-surface distance and a result of the measurement is confirmed, thereby allowing reliability of the seal handling to be enhanced.

Patent Literatures 1 to 3 neither disclose nor suggest any things as to the above-mentioned problem, and the above-mentioned problem cannot be solved by the configurations disclosed in these Patent Literatures 1 to 3.

[0005] Therefore, in view of the above-mentioned problem, an object of the present invention is to facilitation of determination of a state of seal handling and enhancement of reliability of the seal handling and handling skills based on findings required for the seal handling.

Solution to Problem

Summary

[0005a] In an aspect, the present disclosure refers to a seal handling determination system which determines a handling result by a surface-to-surface distance between flanges which are tightened by bolts and nuts, with a gasket being interposed between the flanges, the seal handling determination system comprising: a seal handling part which includes the flanges being tightened by the bolts and the nuts, with the gasket being interposed between the flanges; a surface-to-surface distance measurement part which measures a surface-to-surface distance between the flanges; a processing

part which takes in measured values of the surface-to-surface distance from the surface-to-surface distance measurement part in a plurality of stages from start of tightening of the bolts up to completion of the tightening, calculates a difference between a maximum value and a minimum value of the measured values, and determines a skill level by comparing the difference and a determination reference; and an information presentation part which presents any or all of calculation information and a calculation result, the calculation information and the calculation result being processed by the processing part.

[0005b] In another aspect, the present disclosure refers to a program which causes a computer to realize: a function to take in measured values of a surface-to-surface distance between flanges being tightened by bolts and nuts with a gasket being interposed between the flanges, in a plurality of stages from start of tightening of the bolts of a seal handling part including the flanges up to completion of the tightening; a function to calculate a difference between a maximum value and a minimum value of the measured values and to determine a skill level by comparing the difference and a determination reference; and a function to generate any or all of calculation information and a calculation result as a piece or pieces of presentation information, the calculation information and the calculation result being processed by a processing part.

[0005c] In another aspect, the present disclosure refers to a seal handling determination method for determining a handling result by a surface-to-surface distance between flanges being tightened by bolts and nuts with a gasket being interposed between the flanges, the method comprising: a step of measuring the surface-to-surface distance between the flanges in a seal handling part, the seal handling part including the flanges being tightened by the bolts and the

nuts with the gasket being interposed between the flanges; and a step of, in a plurality of stages from start of tightening of the bolts up to completion of the tightening, taking in measured values of the surface-to-surface distance, calculating a difference between a maximum value and a minimum value of the measured values, and determining a skill level by comparing the difference and a determination reference.

[0005d] In another aspect, the present disclosure refers to a seal handling learning system for learning seal handling by using a surface-to-surface distance between flanges being tightened by bolts and nuts with a gasket being interposed between the flanges, the system comprising: a seal handling part which includes the flanges being tightened by the bolts and the nuts, with the gasket being interposed between the flanges; a surface-to-surface distance measurement part which measures the surface-to-surface distance between the flanges; a processing part which takes in measured values of the surface-to-surface distance from the surface-to-surface distance measurement part in a plurality of stages from start of tightening of the bolts up to completion of the tightening, calculates a difference between a maximum value and a minimum value of the measured values, and determines a skill level by comparing the difference and a determination reference; and an information presentation part which presents any or all of calculation information and a calculation result, the calculation information and the calculation result being processed by the processing part.

[0006] In order to achieve the above-mentioned object, according to one example of a seal handling determination system of the present disclosure, the seal handling determination system determines a handling result by a surface-to-surface distance between flanges which are tightened by bolts and nuts, with a gasket being interposed between the flanges, and the seal handling determination

system includes: a seal handling part which includes the flanges being tightened by the bolts and the nuts, with the gasket being interposed between the flanges; a surface-to-surface distance measurement part which measures a surface-to-surface distance between the flanges; a processing part which takes in measured values of the surface-to-surface distance from the surface-to-surface distance measurement part in a

determination reference.

In this seal handling determination system, the processing part may employ any or two or more of a measurement portion on the flanges where the surface-to-surface distance is measured and a tightening time as a piece or pieces of identification information and may perform information processing in a manner associated with the piece or the pieces of the identification information.

[0007] In order to achieve the above-mentioned object, according to one example of a program of the present disclosure, the program causes a computer to realize: a function to take in measured values of a surface-to-surface distance between flanges being tightened by bolts and nuts with a gasket being interposed between the flanges in a plurality of stages from start of tightening of the bolts of a seal handling part including the flanges up to completion of the tightening; a function to calculate a difference between a maximum value and a minimum value of the measured values and to determine a skill level by comparing the difference and a determination reference; and a function to generate any or all of calculation information and a calculation result as a piece or pieces of presentation information, the calculation information and the calculation result being processed by a processing part.

The program may further cause the computer to realize: a function to take in measured values of axial forces of the bolts in the plurality of stages from the start of the tightening of the bolts up to the completion of the tightening; a function to calculate an average value of the measured values and to determine a skill level by comparing the average value and a determination reference; and a function to generate any or all of calculation information and a calculation result as a piece or pieces of presentation information, the calculation information and the calculation

result being processed by the processing part.

This program may further cause the computer to realize: a function to take in measured values of axial forces of the bolts in the plurality of stages from the start of the tightening of the bolts up to the completion of the tightening; a function to calculate a difference between a maximum value and a minimum value of the measured values and to determine a skill level by comparing the difference and a determination reference; and a function to generate any or all of calculation information and a calculation result as a piece or pieces of presentation information, the calculation information and the calculation result being processed by the processing part.

The program may further cause the computer to realize: a function to calculate an amount of deviation of the difference with respect to a reference value and to determine a skill level by comparing the amount of deviation and a determination reference.

[0008] In order to achieve the above-mentioned object, according to one example of a seal handling determination method of the present disclosure, the seal handling determination method for determining a handling result by a surface-to-surface distance between flanges being tightened by bolts and nuts with a gasket being interposed between the flanges includes: a step of measuring the surface-to-surface distance between the flanges in a seal handling part, the seal handling part including the flanges being tightened by the bolts and the nuts with the gasket being interposed between the flanges; and a step of, in a plurality of stages from start of tightening of the bolts up to completion of the tightening, taking in measured values of the surface-to-surface distance, calculating

a difference between a maximum value and a minimum value of the measured values, and determining a skill level by comparing the difference and a determination reference.

The seal handling determination method may further include: a step of measuring axial forces being exerted from the bolts on the flanges; and a step of, in the plurality of stages from the start of the tightening of the bolts up to the completion of the tightening, taking in measured values of the axial forces from the bolts, calculating an average value of the measured values, and determining a skill level by comparing the average value and a determination reference.

The seal handling determination method may further include: a step of measuring axial forces being exerted from the bolts on the flanges; and a step of, in the plurality of stages from the start of the tightening of the bolts up to the completion of the tightening, taking in measured values of the axial forces from the bolts, calculating a difference between a maximum value and a minimum value of the measured values, and determining a skill level by comparing the difference and a determination reference.

The seal handling determination method may further include: a step of calculating an amount of deviation of the difference with respect to a reference value and determining a skill level by comparing the amount of deviation and a determination reference.

[0009] In order to achieve the above-mentioned object, according to one example of a seal handling learning system of the present disclosure, the seal handling learning system for learning seal handling by using a surface-to-surface distance between flanges being tightened by bolts and nuts with a gasket being interposed between the flanges includes: a seal handling part which includes the flanges being tightened by the bolts and the nuts, with the gasket being interposed between the flanges; a surface-to-surface distance measurement

part which measures the surface-to-surface distance between the flanges; a processing part which takes in measured values of the surface-to-surface distance from the surface-to-surface distance measurement part in a plurality of stages from start of tightening of the bolts up to completion of the tightening, calculates a difference between a maximum value and a minimum value of the measured values, and determines a skill level by comparing the difference and a determination reference; and an information presentation part which presents any or all of calculation information and a calculation result, the calculation information and the calculation result being processed by the processing part.

The seal handling learning system may further include an axial force measurement part which measures axial forces being exerted from the bolts on the flanges, the processing part may take in measured values from the axial force measurement part in the plurality of stages from the start of the tightening of the bolts up to the completion of the tightening, may calculate an average value of the measured values, and may determine a skill level by comparing the average value and a determination reference, and the information presentation part may present any or all of calculation information and a calculation result, the calculation information and the calculation result being processed by the processing part.

The seal handling learning system may further include an axial force measurement part which measures axial forces being exerted from the bolts on the flanges, the processing part may take in measured values from the axial force measurement part in the plurality of stages from the start of the tightening of the bolts up to the completion of the tightening, may calculate a difference between a maximum value and a minimum value of the measured values, and may determine a skill level by comparing the difference and a determination reference, and

level La is fair (= handling failure), and

these are pieces of skill level information indicating the skill level of a handler.

f) The information presentation process

The processing part 8 generates and presentation information to be presented on the information presentation part 12 and provides the presentation information for the information presentation part 12. The presentation information includes: the measured values of the surface-to-surface distance D; the calculation result of the measured values; transition information of the difference between the maximum value and the minimum value of the measured values; the determination result of the skill level La; and the like.

[0022] <Seal Handling Determination File 26-1>

Fig. 3 shows one example of a first seal handling determination file 26-1 stored in the storage part 10. In this seal handling determination file 26-1, a number part 28, an identification information part 30, a surface-to-surface distance part 32, and a skill level part 34 are stored.

In the number part 28, numbers for identifying storage information in the seal handling determination file 26-1 are stored.

In the identification information part 30, pieces of identification information for identifying the surface-to-surface distances D are stored. This identification information part 30 includes, for example, a measurement portion part 30-1 and a tightening time part 30-2. In the measurement portion part 30-1, information indicating measurement portions Sn is stored. In the tightening time part 30-2, information indicating tightening time Tn is stored.

The surface-to-surface distance part 32 includes a temporary tightening measured value part 32-1, a final tightening measured value part 32-2, a maximum value part 32-3, a minimum value part 32-4, a difference part 32-5,

and the final tightening to completing of the handling by the seal handling part 4, the measurement part 6 measures the surface-to-surface distances D in measurement positions which are previously set (S101). The processing part 8 executes taking-in of the measured values dk and dh of the surface-to-surface distances D (S102). The processing part 8 stores the taken-in measured values dk and dh together with the pieces of identification information in the storage part 10 (S103). The measured values dk and dh are stored together with the pieces of identification information in the seal handling determination file 26-1.

[0024] The processing part 8 extracts the maximum values dkmax and dhmax and the minimum values dkmin and dhmin from the measured values dk and dh (S104). These maximum values dkmax and dhmax and minimum values dkmin and dhmin are stored in the seal handling determination file 26-1.

The processing part 8 calculates the difference Δdk between the maximum value dkmax and the minimum value dkmin and the difference Δdh between the maximum value dhmax and the minimum value dhmin (S105).

The processing part 8 determines the skill level La by comparing the differences Δdk and Δdh and the reference values Δdkref and Δdhref using these (S106).

After this determination, the processing part 8 generates, for example, the seal handling determination file 26-1 as presentation information and performs output thereof to the information presentation part 12 (S107). The information presentation part 12 which has received this presents the provided presentation information (S108).

[0025] <Effects of First Embodiment>

According to this first embodiment, the following effects can be obtained.

(1) Since elastic interaction and uneven tightening which occur between the flanges 16-1 and 16-2 appear on the surface-

(S124) and stores the average values fkave and fhave in the seal handling determination file 26-2 (Fig. 6). As to these average values fkave and fhave, based on whether the average value fkave is within the range fkref of the target axial forces and whether the average value fhave is within the range fhref of the target axial forces, the skill level Lb-1 (the skill level of axial forces F) is determined (S125).

After this determination, the processing part 8 generates, for example, the seal handling determination file 26-2 as presentation information and performs output thereof to the information presentation part 12 (S126). The information presentation part 12 which has received this presents the provided presentation information (S127).

[0035] <Effects of Second Embodiment>

According to this second embodiment, the following effects can be obtained.

(1) Based on whether or not the seal handling is implemented at a proper tightening surface pressure and whether elastic interaction and uneven tightening occurring between the flanges 16-1 and 16-2 appear on the average value of the measured values of the axial forces F, the skill level Lb-1 of the seal handling can be evaluated.

(2) A seal handler can recognize handling skills with the skill level Lb-1 as an evaluation index and with reference to a level which is an evaluation result of the handling skills, can effectively enhance the handling skills.

(3) Since the seal handler can implement the seal handling at the proper seal surface pressure and can avoid the elastic interaction and the uneven tightening, reliability of the seal handling can be enhanced.

[0036] [Third Embodiment]

A seal handling determination system 2 according to a third embodiment, as in the second embodiment (Fig. 5), includes measurement parts 6 and 36, and from the measurement

Δfhref using these (S211).

After this determination, the processing part 8 generates, for example, the seal handling determination files 26-1 and 26-3 as presentation information and outputs the seal handling determination files 26-1 and 26-3 to the information presentation part 12 (S212). The information presentation part 12 which has received these presents the provided presentation information (S213).

Based on whether numbers of skill levels La and Lb-2 are large or small, the processing part 8 performs overall determination in consideration of the skill levels La and Lb-2, generates presentation information indicating this overall determination results, stores this presentation information in the overall determination part 45 of the seal handling determination file 26-3, and presents the presentation information to the information presentation part 12.

[0051] <Modified Example of Processing Sequence by Seal Handling Determination System 2>

In the processing sequence shown in Fig. 9, for example, an arithmetic mean of the skill levels La and Lb-2 may be taken and a skill level Lc-1 with both of the skill levels La and Lb-2 taken into consideration may be calculated and presented. In addition, instead of the simple arithmetic mean of the skill levels La and Lb-2, the skill levels La and Lb-2 may be weighted and a degree of evaluation may be thereby adjusted.

[0052] <Effects of Third Embodiment>

According to this third embodiment, the following effects can be obtained.

(1) Elastic interaction and uneven tightening which occur between the flanges 16-1 and 16-2 appear on the surface-to-surface distances D, and this can be recognized as the skill level La, a situation of the axial forces F at this time can be recognized as the skill level Lb-2, and the seal handling

same components as those shown in Fig. 1 are denoted by the same reference signs.

The seal handling determination system 2 of this exemplary embodiment is installed in a seal handling training center or the like and is used for training and learning of seal handling, handling simulation, or the like.

In this seal handling determination system 2, a seal handling part 4 is fixed on a floor 46 inside a building. The seal handling part 4 is provided with a long piping 14-2, and a fixed flange 48 which is attached on a lower end of this piping 14-2 is firmly fixed on the floor 46. In this exemplary embodiment, the already-described piping 14-1 is omitted, and heights of flanges 16-1 and 16-2 are set in such a way that a seal handler can perform handling by the piping 14-2. In the flanges 16-1 and 16-2, the already-described bolts 20-1, 20-2,..., and 20-8 are attached.

[0056] A measurement part 6 for measuring surface-to-surface distances D of the flanges 16-1 and 16-2 is configured to be movable. This measurement part 6 includes a measurement function part 50 and a communication part 52. The measurement function part 50 measures the surface-to-surface distances D and outputs the measured values d. Outputted measurements which indicate the measured values d obtained by the measurement function part 50 are transmitted by the communication part 52 to a side of a processing part 8. For this signal transmission, any of wireless transmission or wired transmission may be used.

Each of the bolts 20-1, 20-2,..., and 20-8 in the flanges 16-1 and 16-2 is provided with a measurement part 36 which measures an axial force F of each of the bolts. The measurement part 36 is provided with axial force sensors 36-1, 36-2,..., and 36-8 (Fig. 11) in such a way as to correspond to the bolts 20-1, 20-2,..., and 20-8.

[0057] A management table 54 for managing seal handling

16-1, 16-2 Flange joint
18 Gasket
20-1, 20-2,..., 20-N Bolts
22 Nuts
24 Tightening tool
26-1 First seal handling determination file
26-2 Second seal handling determination file
28 Number information part
30 Identification information part
30-1 Measurement portion part
30-2 Tightening time part
32 Surface-to-surface distance part
32-1 Temporary tightening measured value part
32-2 Final tightening measured value part
32-3, 42-2 Maximum value part
32-4, 42-3 Minimum value part
32-5 Difference part
32-6, 42-5 Reference value part
34, 35 Skill level part
36 Axial force measurement part
36-1, 36-2,..., 36-8 Axial force sensors
39, 40 Axial force part
46 Floor
48 Fixed flange
50 Measurement function part
52 Communication part
54 Management table
56 Casters
58 PC
60 Data logger
62 Monitor
64 Cable
66 Screen
68 Touch panel