

DESCRIPTION

Title of Invention

OPERATION ASSISTANCE DEVICE, OPERATION ASSISTANCE METHOD,
OPERATION ASSISTANCE PROGRAM, AND PLANT MANAGEMENT SYSTEM

Technical Field

[0001]

The present disclosure relates to an operation support device, an operation support method, an operation support program, and a plant management system.

Background Art

[0002]

In the related art, a technique for detecting an abnormality in a plant is known. For example, PTL 1 discloses a technique in which, when receiving an alarm and abnormality information of a failure precursor monitoring system, an artificial intelligence platform searches for past events highly correlated with an event, which is a cause of the precursor, from an event database and outputs search results. However, in the technique disclosed in PTL 1, it is not possible to sufficiently support the operation of the plant.

Citation List

Patent Literature

[0003]

[PTL 1] Japanese Unexamined Patent Publication No.

2020-201764

Summary of Invention

Technical Problem

[0004]

An object of the present disclosure is to support an operation of a plant.

Solution to Problem

[0005]

According to an aspect of the present disclosure, there is provided an operation support device that supports an operation of a plant, the operation support device including: an acquisition unit that acquires target data based on a measured value related to at least any one of a temperature, a pressure, and a flow rate related to one or more parts where a heat transfer medium flows in the plant; and an output unit that outputs support information related to a flow failure of the heat transfer medium or a precursor of the flow failure in the one or more parts, based on the target data and one or more reference data

items when the plant is operated in a normal state, the one or more reference data items being based on a measured value corresponding to the target data.

[0006]

According to another aspect of the present disclosure, there is provided an operation support method for supporting an operation of a plant, the operation support method causing a computer to execute: a step of acquiring target data based on a measured value related to at least any one of a temperature, a pressure, and a flow rate related to one or more parts in which a heat transfer medium flows in the plant; and a step of outputting support information related to a flow failure of the heat transfer medium or a precursor of the flow failure in the one or more parts, based on the target data and one or more reference data items when the plant is operated in a normal state, the one or more reference data items being based on a measured value corresponding to the target data.

[0007]

According to still another aspect of the present disclosure, there is provided an operation support program that supports an operation of a plant, the operation support program causing a computer to function as: acquisition means for acquiring target data based on a measured value related to at least any one of a

temperature, a pressure, and a flow rate related to one or more parts in which a heat transfer medium flows in the plant; and output means for outputting support information related to a flow failure of the heat transfer medium or a precursor of the flow failure in the one or more parts, based on the target data and one or more reference data items when the plant is operated in a normal state, the one or more reference data items being based on a measured value corresponding to the target data.

[0008]

According to yet another aspect of the present disclosure, there is provided a plant management system including: a plant; and an operation support device that supports an operation of the plant, in which the operation support device includes an acquisition unit that acquires target data based on a measured value related to at least any one of a temperature, a pressure, and a flow rate related to one or more parts in which a heat transfer medium flows in the plant, and an output unit that outputs support information related to a flow failure of the heat transfer medium or a precursor of the flow failure in the one or more parts, based on the target data and one or more reference data items when the plant is operated in a normal state, the one or more reference data items being based on a measured value corresponding to the target data.

Advantageous Effects of Invention

[0009]

According to the present disclosure, it is possible to support an operation of a plant.

Brief Description of Drawings

[0010]

FIG. 1 is a diagram showing an outline of a plant management system 1.

FIG. 2 is a diagram showing an example of an overall configuration of the plant management system 1.

FIG. 3 is a diagram showing an example of a functional configuration of an operation support device 4.

FIG. 4 is a diagram showing an example of an operation of the operation support device 4.

FIG. 5 is a diagram showing an example of the operation of the operation support device 4.

FIG. 6 is a diagram showing an example of the operation of the operation support device 4.

FIG. 7 is a diagram showing an example of a display screen of the operation support device 4.

FIG. 8 is a diagram showing an example of hardware of the operation support device 4.

FIG. 9 is a diagram showing another example of the

operation of the operation support device 4.

Description of Embodiments

[0011]

<1. Outline>

In recent years, steam power generation facilities using biomass have been rapidly increasing under a feed-in tariff (FIT) system. Materials, such as construction waste wood, wood chips, wood pellets, and palm kernel shells (PKSs), are used as the biomass. However, since biomass fuel contains a large amount of alkali substances such as sodium and potassium, the biomass fuel can cause agglomeration of a circulating material which is a heat transfer medium of a circulating fluidized bed (CFB) boiler or the like. When the heat transfer medium agglomerates in a furnace, a flow failure of the heat transfer medium may occur, which may lead to a plant shutdown. In addition, the biomass fuel varies in shape and components. When the biomass fuel is supplied to the furnace, the biomass fuel may temporarily increase an alkali concentration in the heat transfer medium, thereby increasing the risk of a plant shutdown.

[0012]

In order to detect the occurrence of the flow failure or a precursor of the flow failure, for example, a method

of analyzing the alkali concentration in the circulating material obtained by an alkali purge is considered.

However, in this method, it takes a lot of time to evaluate an operation state of a plant. In addition, an operator of the plant requires a high level of expertise in order to detect the occurrence of the flow failure based on time-series data or a scatter diagram of operation data.

[0013]

A plant management system 1 according to the present disclosure makes it possible to efficiently support the operation of the plant. FIG. 1 is a diagram showing an outline of the plant management system 1. The plant management system 1 includes a plant 2 and an operation support device 4. A heat transfer medium flows in a boiler of the plant 2. The operation support device 4 acquires, as the operation data to be determined, measured values of temperature, pressure, flow rate, and the like related to the boiler from sensors installed in the plant 2 (S1). Then, the operation support device 4 compares operation data acquired during a normal operation of the plant 2 (for example, when the plant 2 is operated normally without any failure) with the operation data to be determined (S2). When the operation support device 4 compares the operation data during the normal operation with the operation data to be determined to detect the flow failure or the precursor

of the flow failure in the boiler, the operation support device 4 outputs the fact to the operator of the plant 2 (S3).

[0014]

The plant management system 1 makes it possible for even non-expert operators to easily detect the flow failure or the precursor of the flow failure. In addition, since the plant management system 1 can detect the flow failure and the precursor of the flow failure based on the operation data obtained from the sensors already provided in the plant 2, it is not necessary to increase the number of instruments, and it is easy to introduce the plant management system 1. In addition, the plant management system 1 can detect the flow failure and the precursor of the flow failure regardless of the type of fuel.

[0015]

In the present disclosure, a "part of the plant 2" may be any one of a device and a facility constituting the plant 2 or a part thereof. Examples of the part of the plant 2 are a boiler, a furnace, a separator, a substance supply device, a substance storage device, an exhaust facility, a liquid discharge facility, and the like. Other examples of the part are an upper wall surface of the furnace, a middle wall surface of the furnace, a lower wall surface of the furnace, an exhaust port of the furnace, an

air inlet of the furnace, and the like.

[0016]

In the present disclosure, the "heat transfer medium" includes a substance that flows together with the fuel in the boiler. The heat transfer medium can also be referred to as a fluid medium or a circulating material. The heat transfer medium is, for example, silica sand or the like.

[0017]

In the present disclosure, the "heat transfer medium flows through one or more parts of the plant 2" includes that the heat transfer medium circulates or passes through the one or more parts.

[0018]

In the present disclosure, a "state in which the plant 2 is operated in a normal state" includes a state in which there are no flow failures and precursors thereof in the plant 2. The "normal state" can also be referred to as a state in which an alert related to the flow failure of the plant 2 is not issued. The "normal state" can also be referred to as a state in which there are no abnormalities in the plant 2. In the present disclosure, the "abnormalities" are not limited to abnormalities that can stop the operation of the plant 2 and include a state in which the plant 2 can continue to operate, but has deviated from an ideal operation state.

[0019]

In the present disclosure, the "state in which the flow failure has occurred" includes a state in which the operation efficiency of the plant 2 (including the efficiency of a combustion process, the efficiency of the boiler, and the safety of the plant 2) is reduced due to the flow failure. In addition, in the present disclosure, the "state in which the precursor of the flow failure has occurred" includes a state in which there is a high probability that the operation efficiency of the plant 2 may be reduced due to the flow failure in the future.

[0020]

<2. Configuration>

An example of a configuration of the plant management system 1 will be described with reference to FIGS. 2 to 3.

[0021]

FIG. 2 is a diagram showing an overall configuration of the plant management system 1. The plant management system 1 includes the plant 2, a discrete control system (DCS) 2, the operation support device 4, and a communication network 5.

[0022]

The plant 2 includes a CFB boiler. As shown in FIG. 2, the CFB boiler includes a fuel bunker, a drum, a furnace, a separator, a wall seal, an air heater, a

superheater, a main steam outlet, a water supply inlet, a dust collector, a chimney, an induced draft fan, a forced draft fan, a bottom ash cooler, a bottom ash discharge path, a fly ash discharge path, an ash tank connection path, and the like. These devices and facilities are provided with sensors that measure temperature, pressure, flow rate, and the like.

[0023]

The operation support device 4 acquires the operation data of the plant 2 from various sensors provided in the plant 2 via the DCS 2 and the communication network 5. The operation support device 4 detects the flow failure of the heat transfer medium or the precursor of the flow failure of the heat transfer medium in the plant 2 based on the acquired operation data, and outputs support information for supporting the operation of the plant 2 to the operator of the plant 2. The operation support device 4 may include output devices, such as a display and a speaker, and input devices, such as a keyboard, a touch panel, and a mouse.

[0024]

[Operation Support Device 4]

FIG. 3 is a diagram showing an example of a configuration of the operation support device 4. The operation support device 4 includes a control unit 10, a storage unit 12, a network interface unit 14, and a bus 16.

The control unit 10, the storage unit 12, and the network interface unit 14 are electrically connected to each other via the bus 16.

[0025]

(Control unit 10)

The control unit 10 executes various programs stored in the storage unit 12, which will be described below, to function as an acquisition unit 100, a generation unit 102, a determination unit 104, an estimation unit 106, and an output unit 108.

[0026]

-Acquisition Unit 100-

The acquisition unit 100 acquires operation data based on the measured values related to at least one of the temperature, the pressure, and the flow rate related to one or more parts in which the heat transfer medium flows in the plant 2.

[0027]

~Definition of Measured Values Related to Parts~

The measured value related to the temperature of a predetermined part of the plant 2 may be any of the temperature of a wall surface of the predetermined part, the temperature of gas in the predetermined part, the temperature of the substance (that is, the heat transfer medium or the fuel) flowing in the predetermined part, and

the like.

[0028]

The measured value related to the pressure of the predetermined part of the plant 2 may be any of the pressure of gas in the predetermined part, the force of the substance (that is, the heat transfer medium or the fuel) flowing in the predetermined part which acts on the wall surface of the predetermined part, and the like.

[0029]

The measured value related to the flow rate in the predetermined part of the plant 2 may be any of the flow rate of gas in the predetermined part, the flow rate of the substance (that is, the heat transfer medium or the fuel) flowing in the predetermined part, an opening degree (for example, a valve opening degree of an inlet port, a valve opening degree of an outlet port, a damper opening degree, and the like) of a flow control valve connected to the part, and the like. In addition, typically, since the opening degree of the flow control valve is automatically controlled according to the measured value related to the flow rate in the predetermined part, the opening degree can be information indirectly indicating the measured value related to the flow rate in the predetermined part.

Further, the measured value related to the flow rate in the predetermined part may include a measured value related to

a flow velocity in the predetermined part.

[0030]

~Reference Data and Target Data~

In one embodiment, the acquisition unit 100 includes a reference data acquisition unit 100a, a target data acquisition unit 100b, and an operating load information acquisition unit 100c.

[0031]

The reference data acquisition unit 100a acquires reference data which is operation data related to the predetermined part when the plant 2 is operated in the normal state. The reference data is data that serves as a reference when it is determined whether or not a flow failure or a precursor of the flow failure has occurred in the plant 2.

[0032]

The target data acquisition unit 100b acquires target data which is operation data related to the predetermined part in a determination target period. In one embodiment, the determination target period is a period after the reference data acquisition unit 100a acquires the reference data. In one embodiment, the determination target period is a period after the generation unit 102, which will be described below, generates a learning model. Further, in one embodiment, the target data acquisition unit 100b

continuously acquires the target data at predetermined time intervals (for example, 1-minute intervals, 10-second intervals, or the like).

[0033]

The reference data is based on the measured values corresponding to the target data. That is, the reference data includes the measured value that can be compared with the target data. The reference data and the target data may include the measured values of a common part and a common physical quantity.

[0034]

~Measured Values of Predetermined Part~

In one embodiment, the target data is the measured value related to at least one of the temperature, the pressure, and the flow rate related to the predetermined part of the plant 2. The target data is, for example, the "temperature of the upper wall surface of the furnace" or the like.

[0035]

In one embodiment, the reference data is the measured value corresponding to the target data of the predetermined part when the plant 2 is operated in the normal state. For example, when the target data is the "temperature of the upper wall surface of the furnace", an example of the reference data is the "temperature of the upper wall

surface of the furnace when the plant 2 is operated in the normal state".

[0036]

~Measured Values of Two Parts~

In one embodiment, the target data is generated by comparing the measured values related to at least one of the temperature, the pressure, and the flow rate of each of a first part and a second part of the plant 2. The target data is, for example, a "temperature difference between the temperature of the upper wall surface of the furnace (corresponding to the temperature of the first part) and the temperature of the lower wall surface of the furnace (corresponding to the temperature of the second part)".

[0037]

In one embodiment, the reference data is generated by comparing the measured values which are related to each of the first part and the second part when the plant 2 is operated in the normal state and which correspond to the target data. For example, when the target data is the "temperature difference between the temperature of the upper wall surface of the furnace and the temperature of the lower wall surface of the furnace", an example of the reference data is the "temperature difference between the temperature of the upper wall surface of the furnace and the temperature of the lower wall surface of the furnace

when the plant 2 is operated in the normal state".

[0038]

~Measured Values of Plurality of Combinations~

In one embodiment, when a plurality of combinations including at least two parts are present in one or more parts of the plant 2, the target data may include (1) first target data generated by comparing the measured values related to at least one of the temperature, the pressure, and the flow rate related to each of the parts included in a first combination and (2) second target data generated by comparing the measured values related to at least one of the temperature, the pressure, and the flow rate related to each of the parts included in a second combination.

[0039]

For example, when there are three parts, that is, a part A, a part B, and a part C, in the plant 2, the target data may include (1) a temperature difference (corresponding to the first target data) between the part A and the part B (corresponding to the first combination), and (2) a pressure difference (corresponding to the second target data) between the part B and the part C (corresponding to the second combination).

[0040]

In one embodiment, when a plurality of combinations of at least two parts are present in one or more parts of the

plant 2, the reference data may include (1) first reference data obtained by comparing the measured values which are related to each of the parts included in the first combination when the plant 2 is operated in the normal state and which correspond to the first target data and (2) second reference data obtained by comparing the measured values which are related to each of the parts included in the second combination when the plant 2 is operated in the normal state and which correspond to the second target data.

[0041]

For example, when the target data includes the temperature difference between the part A and the part B and the pressure difference between the part B and the part C, the reference data may include (1) the temperature difference (corresponding to the first reference data) between the part A and the part B (corresponding to the first combination) when the plant 2 is operated in the normal state and (2) the pressure difference (corresponding to the second reference data) between the part B and the part C (corresponding to the second combination) when the plant 2 is operated in the normal state.

[0042]

The operating load information acquisition unit 100c acquires information related to the operating load of the

plant 2 when the operation data is acquired. Specifically, when the reference data acquisition unit 100a acquires the reference data, the operating load information acquisition unit 100c acquires information related to the operating load of the plant 2 when the reference data is acquired. In addition, when the target data acquisition unit 100b acquires the target data, the operating load information acquisition unit 100c acquires information related to the operating load of the plant 2 when the target data is acquired. Further, an example of the operating load of the plant 2 is the ratio of an actual evaporation amount to a rated evaporation amount in the boiler of the plant 2 or the like.

[0043]

Furthermore, in the present disclosure, "acquiring information" includes bringing the information into a state in which the information can be processed by the control unit 10. Acquiring information may be any of the reception of the information by another device, the reading of the information from the storage unit 12, and the obtaining of the information as a result of some calculation in the control unit 10.

[0044]

-Generation Unit 102-

The generation unit 102 generates a learning model

that has been trained using the reference data acquired by the reference data acquisition unit 100a as training data. The generation unit 102 may generate the learning model using supervised learning or may generate the learning model using unsupervised learning.

[0045]

The learning model generated by the generation unit 102 using supervised learning may be either a regression model or a classification model. The regression model includes, for example, a learning model based on simple regression analysis, multiple regression analysis, or the like. The classification model includes a learning model based on Support Vector Machine (SVM), a decision tree, a k-nearest neighbor method, logistic regression, or the like.

[0046]

The learning model generated by the generation unit 102 using unsupervised learning may be any of a learning model based on a probability distribution, a learning model based on clustering, a learning model based on association analysis, and the like. The learning model based on the probability distribution may be intended for detecting outliers and change points.

[0047]

The learning model generated by the generation unit

102 may be a learning model including a neural network. The learning model including the neural network may include a Deep Neural Network (DNN), a Convolutional Neural Network (CNN), a Recurrent Neural Network (RNN), a Generative Adversarial Network (GAN), and the like.

[0048]

In one embodiment, the generation unit 102 generates a learning model that has been trained by associating one or more reference data items with each of a plurality of operating loads related to the plant 2. That is, the generation unit 102 may generate a learning model that has been trained with the value or range of operation data that is considered to be appropriate for each of the operating loads of the plant 2.

[0049]

-Determination Unit 104-

The determination unit 104 determines whether or not there is a flow failure of the heat transfer medium or a precursor of the flow failure, based on the target data acquired by the target data acquisition unit 100b and the reference data acquired by the reference data acquisition unit 100a. In one embodiment, the determination unit 104 compares the target data with the reference data to determine whether or not there is a flow failure of the heat transfer medium or a precursor of the flow failure.

[0050]

The determination of whether or not there is a flow failure of the heat transfer medium or a precursor of the flow failure by the determination unit 104 includes the outputting of a possibility of the flow failure of the heat transfer medium or the precursor of the flow failure. That is, the output by the determination unit 104 is not limited to a Boolean value and may be a continuous value based on levels, scores, or the like.

[0051]

In one embodiment, the determination unit 104 inputs the target data as determination data to the learning model generated by the generation unit 102 to determine whether or not there is a flow failure of the heat transfer medium or a precursor of the flow failure. In addition, the inputting of the target data to the learning model that has been trained with the reference data is an aspect of comparing the target data with the reference data.

[0052]

In one embodiment, when the generation unit 102 generates a learning model that has been trained by associating one or more reference data items with each of a plurality of operating loads related to the plant 2, the determination unit 104 inputs the target data and information related to the operating load of the plant 2

when the target data is acquired to the learning model to determine whether or not there is a flow failure of the heat transfer medium or a precursor of the flow failure.

[0053]

-Estimation Unit 106-

The estimation unit 106 estimates the cause of the flow failure of the heat transfer medium or the precursor of the flow failure in the predetermined part of the plant 2 based on the relationship between the target data and the reference data. The following patterns are considered for the cause of the flow failure or the precursor of the flow failure and the relationship between the target data and the reference data.

[0054]

(1) When a flow failure occurs due to agglomeration of the heat transfer medium in the boiler, the temperature in the boiler may be higher than normal. The reason is that, when the heat transfer medium agglomerates, thermal energy that should be stored in the heat transfer medium is stored in other substances (for example, gas and fuel) in the boiler. When an agglomerate of the heat transfer medium is deposited near the temperature sensor, the agglomerate may hinder accurate measurement by the temperature sensor. As a result, the measured value of the temperature in the boiler may be lower than normal.

[0055]

(2) When a flow failure occurs due to accumulation of combustion ash in the boiler, the measured value of the temperature in the boiler tends to be lower than normal. The reason is that the combustion ash covers the temperature sensor, which prevents the temperature in the boiler from being accurately measured.

[0056]

(3) When a flow failure occurs due to the entry of foreign matter into the boiler through fuel or the like, the temperature and pressure in the boiler tend to be non-uniform. The reason is that the flow of the heat transfer medium and the fuel is hindered by the entry of the foreign matter into the boiler.

[0057]

As described in (1) to (3), since there is a close correlation between the relationship between the target data and the reference data and the cause of the flow failure or the precursor of the flow failure, it is possible to estimate the cause of the flow failure of the heat transfer medium or the precursor of the flow failure in the predetermined part of the plant 2, based on the relationship between the target data and the reference data. In addition, the cause of the flow failure or the precursor of the flow failure and the relationship between

the target data and the reference data are not limited to (1) to (3).

[0058]

In one embodiment, with reference to information in which the cause is associated with each of one or more conditions, the estimation unit 106 estimates the cause of the flow failure of the heat transfer medium or the precursor of the flow failure in the predetermined part of the plant 2, based on whether or not the relationship between the target data and the reference data satisfies any of the one or more conditions.

[0059]

-Output Unit 108-

The output unit 108 outputs support information related to the flow failure of the heat transfer medium or the precursor of the flow failure based on the target data and the reference data. The support information may include figures, characters, numerical values, colors, graphs (for example, scatter diagrams and time-series data), and the like. In addition, the support information may be audio.

[0060]

In one embodiment, the support information includes the determination result by the determination unit 104. For example, when the determination unit 104 determines that a flow failure of the heat transfer medium has occurred, the

output unit 108 may display a warning mark and text saying "a flow failure has occurred" as the support information on the display screen. In addition, in one embodiment, the determination result by the determination unit 104 includes an output obtained when the target data is input to the learning model generated by the generation unit 102.

[0061]

In one embodiment, the support information includes information obtained by comparing the target data with the reference data. For example, the output unit 108 may output, as the support information, a graph obtained by plotting the reference data and the target data on a common scatter diagram in a superimposed manner.

[0062]

In one embodiment, the support information includes information obtained by comparing the first target data with the first reference data and information obtained by comparing the second target data with the second reference data. For example, the output unit 108 may output, as the support information, a first graph obtained by plotting the temperature difference between the part A and the part B (corresponding to the first reference data) when the plant 2 is operated in the normal state and the temperature difference between the part A and the part B (corresponding to the first target data) in the determination target

period on a common scatter diagram in a superimposed manner and a second graph obtained by plotting the pressure difference between the part B and the part C (corresponding to the second reference data) when the plant 2 is operated in the normal state and the pressure difference between the part B and the part C (corresponding to the second target data) in the determination target period on a common scatter diagram in a superimposed manner.

[0063]

In one embodiment, the support information includes information related to the cause estimated by the estimation unit 106. For example, when the estimation unit 106 estimates that the flow failure caused by the agglomeration of the heat transfer medium has occurred in the part A, the output unit 108 may display, as the support information, text saying "there is a possibility of the heat transfer medium agglomerating in the part A" on the display screen.

[0064]

Further, in the present disclosure, the expression "the support information includes predetermined information" may mean that the support information includes the predetermined information as it is or that the support information includes information obtained by appropriately processing the predetermined information.

[0065]

(Storage Unit 12)

The storage unit 12 stores various programs executed by the control unit 10. In addition, the storage unit 12 stores various types of information necessary for the operation of the operation support device 4, such as the target data and the reference data acquired by the acquisition unit 100 and the learning model generated by the generation unit 102.

[0066]

(Network Interface Unit 14)

The network interface unit 14 implements communication with another device via the communication network 5.

[0067]

<3. Operation>

Examples of the operation of the plant management system 1 and the display screen will be described with reference to FIGS. 4 to 7.

[0068]

FIG. 4 is a conceptual diagram showing the boiler of the plant 2 in an example which will be described below. The heat transfer medium flows inside the boiler. The boiler has the part A, the part B, and the part C, and temperature sensors and pressure sensors are provided in each of the parts.

[0069]

[Acquisition of Reference Data to Generation of Learning Model]

FIG. 5 is a flowchart showing an operation of the operation support device 4 from the acquisition of the reference data to the generation of the learning model.

[0070]

First, the operation support device 4 acquires the reference data (S100). In this example, the reference data acquired by the operation support device 4 is the temperature difference between the part A and the part B when the plant 2 is operated in the normal state. Then, the operation support device 4 acquires information related to the operating load of the boiler when the reference data is acquired (S102).

[0071]

Then, the operation support device 4 determines whether or not a sufficient number of reference data items to generate the learning model are acquired (S104). When the sufficient number of reference data items to generate the learning model are not acquired (NO in S104), the operation support device 4 acquires the reference data and the information related to the operating load of the boiler when the reference data is acquired again (S102 to S104).

[0072]

On the other hand, when the sufficient number of reference data items to generate the learning model are acquired (YES in S104), the operation support device 4 associates the reference data with the operating load of the boiler to train the learning model (S106). Specifically, the operation support device 4 determines a mathematical formula indicating the relationship between the operating load of the boiler and the reference data using simple regression analysis (S106a). That is, the operation support device 4 determines a mathematical formula indicating the relationship between the operating load of the boiler and the temperature difference between the part A and the part B when the plant 2 is operated in the normal state.

[0073]

The operation support device 4 further determines a mathematical formula indicating the relationship between the operating load of the boiler and an upper limit of the operation data capable of being used to determine that the flow failure and the precursor of the flow failure have not occurred in the plant 2, based on the mathematical formula determined in S106a (S106b). Similarly, the operation support device 4 determines a mathematical formula indicating the relationship between the operating load of the boiler and a lower limit of the operation data capable

of being used to determine that the flow failure and the precursor of the flow failure have not occurred in the plant 2, based on the mathematical formula determined in S106a (S106c). That is, the operation support device 4 determines a mathematical formula indicating the relationship between the operating load of the boiler and the upper and lower limits of the temperature difference between the part A and the part B capable of being used to determine that the flow failure and the precursor of the flow failure have not occurred in the plant 2.

[0074]

In this example, the mathematical formula determined by the simple regression analysis in S106a is expressed as " $y = f(x)$ " using a function f . In addition, " x " is the operating load of the boiler, and " y " is the temperature difference between the part A and the part B when the plant 2 is operated in the normal state. In this case, the mathematical formula determined in S106b and the mathematical formula determined in S106c may be expressed as " $y = f(x) + \alpha/2$ " and " $y = f(x) - \alpha/2$ ", respectively. Here, " α " is a constant corresponding to a width that is allowed as the temperature difference between the part A and the part B.

[0075]

Hereinafter, lines drawn on a graph based on the

mathematical formulas determined in S106a to S106c are referred to as a "reference line", an "upper limit threshold line", and a "lower limit threshold line", respectively. In addition, hereinafter, when the upper limit threshold line and the lower limit threshold line are not particularly distinguished from each other, the upper limit threshold line and the lower limit threshold line are collectively referred to as a "threshold line". Specific examples of the reference line and the threshold line will be described with reference to an example of a display screen shown in FIG. 7 which will be described below.

[0076]

[Acquisition of Target Data to Output of Support Information]

FIG. 6 is a flowchart showing an operation of the operation support device 4 from the acquisition of the target data to the output of the support information.

[0077]

First, the operation support device 4 acquires the target data (S200). In this example, the target data acquired by the operation support device 4 is the temperature difference between the part A and the part B. Then, the operation support device 4 acquires information related to the operating load of the boiler when the target data is acquired (S202).

[0078]

Then, the operation support device 4 inputs the target data and the information related to the operating load when the target data is acquired to the learning model generated in S106. Then, the operation support device 4 determines whether or not the target data is within the range of the upper limit and the lower limit of the operation data capable of being used to determine that the flow failure and the precursor of the flow failure have not occurred in the plant 2 (S206). When the target data is within the range of the upper limit and the lower limit (YES in S206), the operation support device 4 ends the process. On the other hand, when the target data is outside the range (NO in S206), the operation support device 4 estimates the cause of the flow failure or the precursor of the flow failure based on the relationship between the reference data learned in S106 and the target data acquired in S200 (S208) and outputs an alert and the cause estimated in S208 as the support information (S210).

[0079]

In addition, for the pressure difference between the part A and the part C, the operation support device 4 generates a learning model that has learned the reference data and inputs the target data to the learning model, using the same method as the method described in S100 to

S106 and S200 to S210.

[0080]

FIG. 7 is a diagram showing an example of a display screen in the operation support device 4. The operator of the plant 2 can visually recognize the example of the display screen. In the example of the display screen shown in FIG. 7, a plot legend d100, a line legend d102, a graph display region d104, a graph display region d106, an alert d108, a text d110, and a switching button d112 are displayed.

[0081]

The plot legend d100 and the line legend d102 show the legends of the graphs displayed in the graph display region d104 and the graph display region d106, respectively. Specifically, the plot legend d100 indicates that a circular plot on the graph corresponds to the reference data and a square plot corresponds to the target data. In addition, the line legend d102 indicates that a solid line on the graph corresponds to the reference line and a dotted line corresponds to the threshold line. That is, the fact that all the square plots are present between two dotted lines corresponds to the fact that the target data is within the range of the upper limit and the lower limit of the operation data capable of being used to determine that the flow failure and the precursor of the flow failure have

not occurred in the plant 2. On the other hand, the fact that at least some of the square plots are present outside two dotted lines corresponds to the fact that the target data is outside the range of the upper limit and the lower limit of the operation data capable of being used to determine that the flow failure and the precursor of the flow failure have not occurred in the plant 2 (that is, within the range in which it is determined that the flow failure or the precursor of the flow failure has occurred).

[0082]

In the graph display region d104, a scatter diagram showing the relationship between the operating load of the boiler, and the reference data and the target data is displayed for the temperature difference between the part A and the part B. In addition, the reference line and the threshold line determined in S106a to S106c are displayed in the graph display region d104. In this example, all the target data is included between the upper limit threshold line and the lower limit threshold line. Therefore, no alert is displayed for the temperature difference between the part A and the part B (see YES in S206).

[0083]

In the graph display region d106, a scatter diagram showing the relationship between the operating load of the boiler, and the reference data and the target data is

displayed for the pressure difference between the part A and the part C. In addition, the reference line and the threshold line determined by the same method as that in S106a to S106c are displayed in the graph display region d106. In this example, there is target data that is located above the upper limit threshold line. Therefore, for the pressure difference between the part A and the part C, the alert d108 is displayed, and the text d110 indicating the cause estimated as the flow failure or the precursor of the flow failure is displayed. "There is a possibility of foreign matter being present between the part A and the part C" is displayed as the text d110. In addition, each of the graph display region d104, the graph display region d106, the alert d108, and the text d110 is an aspect of the support information.

[0084]

The switching button d112 is a button that can be selected or pressed by the operator of the plant 2 to switch the data displayed in the graph display region d104 and the graph display region d106. The operator of the plant 2 can press the switching button d112 to display, for example, data related to the temperature difference between the part A and the part C, the pressure difference between the part B and the part C, the pressure difference between the part A and the part C, and the like in the graph

display region d104 and the graph display region d106.

[0085]

<4. Effects>

According to an aspect of the present disclosure, there is provided the operation support device 4 that supports an operation of the plant 2 and includes: an acquisition unit (target data acquisition unit 100b) that acquires target data based on a measured value related to at least one of a temperature, a pressure, and a flow rate related to one or more parts in which a heat transfer medium flows in the plant 2; and the output unit 108 that outputs support information related to a flow failure of the heat transfer medium or a precursor of the flow failure in the one or more parts, based on the target data and one or more reference data items when the plant 2 is operated in a normal state, the one or more reference data items being based on a measured value corresponding to the target data.

[0086]

As described above, according to the plant management system 1 including the operation support device 4, even a non-expert operator can easily detect the flow failure or the precursor of the flow failure. In addition, since the plant management system 1 can detect the flow failure or the precursor of the flow failure based on the operation

data obtained from the sensors that have already been provided in the plant 2, it is not necessary to increase the number of instruments, and it is easy to introduce the plant management system 1. Further, the plant management system 1 can detect the flow failure or the precursor of the flow failure regardless of the type of fuel.

[0087]

The operation support device 4 according to the embodiment further includes the determination unit 104 that determines whether or not there is the flow failure of the heat transfer medium or the precursor of the flow failure in the one or more parts, based on the target data and the one or more reference data items, in which the support information includes a determination result by the determination unit 104.

[0088]

According to this configuration, since the operator of the plant 2 can understand the determination result by the operation support device 4, it is possible to more easily recognize the flow failure or the precursor of the flow failure in the plant 2.

[0089]

In one embodiment, the determination unit 104 inputs the target data as determination data to a learning model, which has been trained with the one or more reference data

items as training data, to determine whether or not there is the flow failure of the heat transfer medium or the precursor of the flow failure in the one or more parts.

[0090]

According to this configuration, it is possible to more easily compare the reference data with the target data. Therefore, the accuracy of the determination result is also improved.

[0091]

In one embodiment, the learning model learns the one or more reference data items in association with each of a plurality of operating loads related to the plant 2, the target data acquisition unit 100b further acquires information related to the operating load when the target data is acquired, and the determination unit 104 inputs the target data and the information related to the operating load when the target data is acquired to the learning model to determine whether or not there is the flow failure of the heat transfer medium or the precursor of the flow failure in the one or more parts.

[0092]

In general, the range of the operation data in which it is determined that the flow failure and the precursor of the flow failure have not occurred varies depending on the operating load. According to this configuration, since the

determination is performed in consideration of this tendency, the accuracy of the determination result is improved.

[0093]

In one embodiment, the one or more parts include a first part and a second part different from the first part, the target data is generated by comparing measured values related to at least one of the temperature, the pressure, and the flow rate related to each of the first part and the second part, each of the one or more reference data items is generated by comparing measured values which are related to each of the first part and the second part when the plant 2 is operated in the normal state and which correspond to the target data, and the support information includes information obtained by comparing the target data with the one or more reference data items.

[0094]

In order to detect the flow failure or the precursor of the flow failure, it is effective to use the operation data obtained by comparing the measured values of a plurality of parts as the reference data and the target data. This is because an abnormality in the flow of the heat transfer medium tends to appear as non-uniformity in temperature, pressure, or the like. According to this configuration, since it is possible to capture the non-

uniformity, the accuracy of the determination result is improved.

[0095]

The operation support device 4 according to the embodiment further includes the storage unit 12 that stores a plurality of combinations of at least two parts in the one or more parts, in which the plurality of combinations stored in the storage unit 12 include a first combination and a second combination, the target data includes first target data generated by comparing measured values related to at least one of the temperature, the pressure, and the flow rate related to each of the parts included in the first combination and second target data generated by comparing measured values related to at least one of the temperature, the pressure, and the flow rate related to each of the parts included in the second combination, the one or more reference data items include one or more first reference data items generated by comparing measured values which are related to each of the parts included in the first combination when the plant 2 is operated in the normal state and which correspond to the first target data and one or more second reference data items generated by comparing measured values which are related to each of the parts included in the second combination when the plant 2 is operated in the normal state and which correspond to the

second target data, and the support information includes information obtained by comparing the first target data with the one or more first reference data items and information obtained by comparing the second target data with the one or more second reference data items.

[0096]

For example, even when the flow failure and the precursor of the flow failure cannot be detected from the difference between the measured values of the respective parts included in the first combination, the flow failure or the precursor of the flow failure may be detected from the difference between the measured values of the respective parts included in the second combination. According to this configuration, it is possible to comprehensively detect the flow failure or the precursor of the flow failure based on the combinations of the plurality of parts.

[0097]

In one embodiment, the target data acquisition unit 100b may continuously acquire the target data at a predetermined time interval.

[0098]

According to this configuration, it is possible to continuously monitor the occurrence of the flow failure or the precursor of the flow failure. As a result, the

operator of the plant 2 can take measures at an early stage.

[0099]

The operation support device 4 according to the embodiment may further include the estimation unit 106 that estimates a cause of the flow failure of the heat transfer medium or the precursor of the flow failure in the one or more parts, based on a relationship between the target data and the one or more reference data items, in which the support information may include information related to the cause estimated by the estimation unit 106.

[0100]

According to this configuration, the operator of the plant 2 can easily understand the cause of the flow failure or the precursor of the flow failure.

[0101]

The above-described effects are merely examples and do not limit the applicable scope of the present disclosure.

[0102]

<5. Hardware Configuration>

An example of a hardware configuration when the operation support device 4 is implemented by a computer 70 will be described with reference to FIG. 8. In addition, the functions of each device can be distributed across a plurality of devices.

[0103]

As shown in FIG. 8, the computer 70 includes a processor 700, a storage device 702, an input I/F 704, a data I/F 706, a communication I/F 708, and a display device 710.

[0104]

The processor 700 executes a program stored in the storage device 702 to control various processes in the computer 70. For example, the processor 700 executes the program stored in the storage device 702 to implement each functional unit and the like included in the control unit 10 of the operation support device 4.

[0105]

The storage device 702 is a storage medium such as a random access memory (RAM). The RAM temporarily stores a program code of a program executed by the processor 700 and data required to execute the program.

[0106]

The storage device 702 is also, for example, a non-volatile storage medium such as a hard disk drive (HDD) or a flash memory. The storage device 702 stores an operating system and various programs for implementing each of the above-described configurations. The storage medium storing the various programs may be a non-transitory computer readable storage medium. In addition, the storage device

702 can also store a table for registering various types of information and a DB for managing the table. This program or data is loaded into the storage device 702 as necessary and is referred to by the processor 700.

[0107]

The input I/F 704 is a device for receiving an input from a user. Specific examples of the input I/F 704 include a camera, a button, a microphone, a keyboard, a mouse, a touch panel, various sensors, a wearable device, and the like. The input I/F 704 may be connected to the computer 70 via an interface such as a universal serial bus (USB).

[0108]

The data I/F 706 is a device for inputting data from the outside of the computer 70. A specific example of the data I/F 706 is a drive device for reading data stored in various storage media or the like. It is also considered that the data I/F 706 is provided outside the computer 70. In this case, the data I/F 706 is connected to the computer 70 via, for example, an interface such as a USB.

[0109]

The communication I/F 708 is a device for performing wired or wireless data communication with a device outside the computer 70 via the communication network 5. It is also considered that the communication I/F 708 is provided outside the computer 70. In this case, the communication

I/F 708 is connected to the computer 70 via an interface such as a USB.

[0110]

The display device 710 is a device for displaying various types of information. Specific examples of the display device 710 include, for example, a liquid crystal display, an organic electro-luminescence (EL) display, displays of wearable devices, and the like. The display device 710 may be provided outside the computer 70. In this case, the display device 710 is connected to the computer 70 via, for example, a display cable or the like. In addition, when a touch panel is adopted as the input I/F 704, the display device 710 can be configured to be integrated with the input I/F 704.

[0111]

In addition, the components included in the various devices of the operation support device 4 described in the embodiment are implemented by the execution of the program stored in the storage device 702 by the processor 700, and a predetermined process is implemented in cooperation with other hardware. Further, in other words, these components are also assumed as software or firmware, or corresponding hardware, are also described as "functions", "means", "portions", "processing circuits", "units", "modules", or the like in both concepts, and can be read as them.

[0112]

<6. Modification Examples>

In the above-described embodiment, an example in which the learning model based on simple regression analysis is mainly used has been described. However, the present disclosure is not limited thereto. The learning model may include a neural network shown in FIG. 9. Specifically, the learning model may include a neural network including (1) nodes of an input layer that receives the input of the operating load related to the plant 2, the temperature of the first part, the pressure of the first part, the flow rate of the first part, ..., the temperature of an N-th part, the pressure of the N-th part, and the flow rate of the N-th part (where N is a natural number), (2) nodes of a plurality of intermediate layers, and (3) nodes of an output layer that outputs values corresponding to each of normality, agglomeration occurrence, and the entry of foreign matter. According to the learning model including the neural network, it is possible to detect a flow failure or a precursor of the flow failure, taking the measured values in a plurality of parts into comprehensive consideration. In addition, an output value obtained from the node corresponding to "normality" may correspond to the degree of possibility of the flow failure or the precursor of the flow failure, an output value obtained from the node

corresponding to "agglomeration occurrence" may correspond to the degree of possibility of the flow failure or the precursor of the flow failure occurring due to the agglomeration of the heat transfer medium, and an output value obtained from the node corresponding to "entry of foreign matter" may correspond to the degree of possibility of the flow failure or the precursor of the flow failure occurring due to the entry of the foreign matter.

[0113]

In the above-described embodiment, the description has been mainly made on the premise that the CFB boiler is used. However, the application of the present disclosure is not limited thereto. The present disclosure can be applied to any device using a heat transfer medium that may cause a flow failure.

[0114]

In the above-described embodiment, the plant 2 that mainly uses biomass fuel as the fuel has been described. However, the application of the present disclosure is not limited thereto. The present disclosure can also be applied to, for example, the plant 2 that uses waste-derived fuel.

[0115]

In the above-described embodiment, an example in which the operation support device 4 outputs the support information to the display screen of the operation support

device 4 has been described. However, the present disclosure is not limited thereto. The operation support device 4 may transmit the support information to a terminal device owned by the operator of the plant 2.

[0116]

<7. Embodiments of Present Disclosure>

The present disclosure includes, for example, the following embodiments. In addition, the correspondence with the above-described embodiment is shown in parentheses.

[0117]

[Supplementary Note 1]

According to an aspect of the present disclosure, there is provided an operation support device 4 that supports an operation of a plant 2 and includes: an acquisition unit (target data acquisition unit 100b) that acquires target data based on a measured value related to at least one of a temperature, a pressure, and a flow rate related to one or more parts in which a heat transfer medium flows in the plant 2; and an output unit 108 that outputs support information related to a flow failure of the heat transfer medium or a precursor of the flow failure in the one or more parts, based on the target data and one or more reference data items when the plant 2 is operated in a normal state, the one or more reference data items being based on a measured value corresponding to the target

data.

[0118]

[Supplementary Note 2]

The operation support device 4 according to Supplementary Note 1 may further include a determination unit 104 that determines whether or not there is the flow failure of the heat transfer medium or the precursor of the flow failure in the one or more parts, based on the target data and the one or more reference data items, in which the support information may include a determination result by the determination unit 104.

[0119]

[Supplementary Note 3]

In the operation support device 4 according to Supplementary Note 2, the determination unit 104 may input the target data as determination data to a learning model, which has been trained with the one or more reference data items as training data, to determine whether or not there is the flow failure of the heat transfer medium or the precursor of the flow failure in the one or more parts.

[0120]

[Supplementary Note 4]

In the operation support device 4 according to Supplementary Note 3, the learning model may learn the one or more reference data items in association with each of a

plurality of operating loads related to the plant 2, the acquisition unit (target data acquisition unit 100b) may further acquire information related to the operating load when the target data is acquired, and the determination unit 104 may input the target data and the information related to the operating load when the target data is acquired to the learning model to determine whether or not there is the flow failure of the heat transfer medium or the precursor of the flow failure in the one or more parts.

[0121]

[Supplementary Note 5]

In the operation support device 4 according to any one of Supplementary Notes 1 to 4, the one or more parts may include a first part and a second part different from the first part, the target data may be generated by comparing measured values related to at least one of a temperature, a pressure, and a flow rate related to each of the first part and the second part, each of the one or more reference data items may be generated by comparing measured values which are related to each of the first part and the second part when the plant 2 is operated in the normal state and which correspond to the target data, and the support information may include information obtained by comparing the target data with the one or more reference data items.

[0122]

[Supplementary Note 6]

The operation support device 4 according to any one of Supplementary Notes 1 to 5 may further include a storage unit 12 that stores a plurality of combinations of at least two parts in the one or more parts, in which the plurality of combinations stored in the storage unit 12 may include a first combination and a second combination, the target data may include first target data generated by comparing measured values related to at least one of a temperature, a pressure, and a flow rate related to each of the parts included in the first combination and second target data generated by comparing measured values related to at least one of a temperature, a pressure, and a flow rate related to each of the parts included in the second combination, the one or more reference data items may include one or more first reference data items generated by comparing measured values which are related to each of the parts included in the first combination when the plant 2 is operated in the normal state and which correspond to the first target data and one or more second reference data items generated by comparing measured values which are related to each of the parts included in the second combination when the plant is operated in the normal state and which correspond to the second target data, and the support information may include information obtained by

comparing the first target data with the one or more first reference data items and information obtained by comparing the second target data with the one or more second reference data items.

[0123]

[Supplementary Note 7]

In the operation support device 4 according to any one of Supplementary Notes 1 to 6, the acquisition unit (target data acquisition unit 100b) may continuously acquire the target data at a predetermined time interval.

[0124]

[Supplementary Note 8]

The operation support device 4 according to any one of Supplementary Notes 1 to 7 may further include an estimation unit 106 that estimates a cause of the flow failure of the heat transfer medium or the precursor of the flow failure in the one or more parts, based on a relationship between the target data and the one or more reference data items, in which the support information may include information related to the cause estimated by the estimation unit 106.

[0125]

[Supplementary Note 9]

According to another aspect of the present disclosure, there is provided an operation support method for

supporting an operation of a plant 2, the operation support method causing a computer to execute: a step of acquiring target data based on a measured value related to at least one of a temperature, a pressure, and a flow rate related to one or more parts in which a heat transfer medium flows in the plant 2; and a step of outputting support information related to a flow failure of the heat transfer medium or a precursor of the flow failure in the one or more parts, based on the target data and one or more reference data items when the plant 2 is operated in a normal state, the one or more reference data items being based on a measured value corresponding to the target data.

[0126]

[Supplementary Note 10]

According to still another aspect of the present disclosure, there is provided an operation support program that supports an operation of a plant 2, the operation support program causing a computer to function as:
acquisition means for acquiring target data based on a measured value related to at least one of a temperature, a pressure, and a flow rate related to one or more parts in which a heat transfer medium flows in the plant 2; and
output means for outputting support information related to a flow failure of the heat transfer medium or a precursor of the flow failure in the one or more parts, based on the

target data and one or more reference data items when the plant 2 is operated in a normal state, the one or more reference data items being based on a measured value corresponding to the target data.

[0127]

[Supplementary Note 11]

According to yet another aspect of the present disclosure, there is provided a plant management system 1 including: a plant 2; and an operation support device 4 that supports an operation of the plant 2, in which the operation support device 4 includes an acquisition unit (target data acquisition unit 100b) that acquires target data based on a measured value related to at least one of a temperature, a pressure, and a flow rate related to one or more parts in which a heat transfer medium flows in the plant 2, and an output unit 108 that outputs support information related to a flow failure of the heat transfer medium or a precursor of the flow failure in the one or more parts, based on the target data and one or more reference data items when the plant 2 is operated in a normal state, the one or more reference data items being based on a measured value corresponding to the target data.

Reference Signs List

[0128]

- 1 Plant management system
- 2 Plant
- 3 DCS
- 4 Operation support device
- 5 Communication network
- 10 Control unit
- 12 Storage unit
- 14 Network interface unit
- 70 Computer
- 100 Acquisition unit
 - 100a Reference data acquisition unit
 - 100b Target data acquisition unit
 - 100c Operating load information acquisition unit
- 102 Generation unit
- 104 Determination unit
- 106 Estimation unit
- 108 Output unit

CLAIMS

1. An operation support device that supports an operation of a plant, the operation support device comprising:

an acquisition unit that acquires target data based on a measured value related to at least one of a temperature, a pressure, and a flow rate related to one or more parts in which a heat transfer medium flows in the plant; and

an output unit that outputs support information related to a flow failure of the heat transfer medium or a precursor of the flow failure in the one or more parts, based on the target data and one or more reference data items when the plant is operated in a normal state, the one or more reference data items being based on a measured value corresponding to the target data.

2. The operation support device according to claim 1, further comprising:

a determination unit that determines whether or not there is the flow failure of the heat transfer medium or the precursor of the flow failure in the one or more parts, based on the target data and the one or more reference data items,

wherein the support information includes a

determination result by the determination unit.

3. The operation support device according to claim 2, wherein the determination unit inputs the target data as determination data to a learning model, which has been trained with the one or more reference data items as training data, to determine whether or not there is the flow failure of the heat transfer medium or the precursor of the flow failure in the one or more parts.

4. The operation support device according to claim 3, wherein the learning model learns the one or more reference data items in association with each of a plurality of operating loads related to the plant,

the acquisition unit further acquires information related to the operating load when the target data is acquired, and

the determination unit inputs the target data and the information related to the operating load when the target data is acquired to the learning model to determine whether or not there is the flow failure of the heat transfer medium or the precursor of the flow failure in the one or more parts.

5. The operation support device according to claim 1,

wherein the one or more parts include a first part and a second part different from the first part,

the target data is generated by comparing measured values related to at least one of a temperature, a pressure, and a flow rate related to each of the first part and the second part,

each of the one or more reference data items is generated by comparing measured values which are related to each of the first part and the second part when the plant is operated in the normal state and which correspond to the target data, and

the support information includes information obtained by comparing the target data with the one or more reference data items.

6. The operation support device according to claim 1, further comprising:

a storage unit that stores a plurality of combinations of at least two parts in the one or more parts,

wherein the plurality of combinations stored in the storage unit include a first combination and a second combination,

the target data includes

first target data generated by comparing measured values related to at least one of a temperature, a

pressure, and a flow rate related to each of the parts included in the first combination, and

second target data generated by comparing measured values related to at least one of a temperature, a pressure, and a flow rate related to each of the parts included in the second combination,

the one or more reference data items include

one or more first reference data items generated by comparing measured values which are related to each of the parts included in the first combination when the plant is operated in the normal state and which correspond to the first target data, and

one or more second reference data items generated by comparing measured values which are related to each of the parts included in the second combination when the plant is operated in the normal state and which correspond to the second target data, and

the support information includes information obtained by comparing the first target data with the one or more first reference data items and information obtained by comparing the second target data with the one or more second reference data items.

7. The operation support device according to claim 1, wherein the acquisition unit continuously acquires the

target data at a predetermined time interval.

8. The operation support device according to claim 1, further comprising:

an estimation unit that estimates a cause of the flow failure of the heat transfer medium or the precursor of the flow failure in the one or more parts, based on a relationship between the target data and the one or more reference data items,

wherein the support information includes information related to the cause estimated by the estimation unit.

9. An operation support method for supporting an operation of a plant, the operation support method causing a computer to execute:

a step of acquiring target data based on a measured value related to at least one of a temperature, a pressure, and a flow rate related to one or more parts in which a heat transfer medium flows in the plant; and

a step of outputting support information related to a flow failure of the heat transfer medium or a precursor of the flow failure in the one or more parts, based on the target data and one or more reference data items when the plant is operated in a normal state, the one or more reference data items being based on a measured value

corresponding to the target data.

10. An operation support program that supports an operation of a plant, the operation support program causing a computer to function as:

acquisition means for acquiring target data based on a measured value related to at least one of a temperature, a pressure, and a flow rate related to one or more parts in which a heat transfer medium flows in the plant; and

output means for outputting support information related to a flow failure of the heat transfer medium or a precursor of the flow failure in the one or more parts, based on the target data and one or more reference data items when the plant is operated in a normal state, the one or more reference data items being based on a measured value corresponding to the target data.

11. A plant management system comprising:

a plant; and

an operation support device that supports an operation of the plant,

wherein the operation support device includes

an acquisition unit that acquires target data based on a measured value related to at least one of a temperature, a pressure, and a flow rate related to one or more parts in

which a heat transfer medium flows in the plant; and

an output unit that outputs support information related to a flow failure of the heat transfer medium or a precursor of the flow failure in the one or more parts, based on the target data and one or more reference data items when the plant is operated in a normal state, the one or more reference data items being based on a measured value corresponding to the target data.