Process Control) and determines whether or not there is an abnormality through comparison between the statistic and a threshold (see, for example, Patent Document 1).

CITATION LIST

PATENT DOCUMENT

[0003] Patent Document 1: Japanese Laid-Open Patent Publication No. 2012-138044

SUMMARY OF THE INVENTION

PROBLEM TO BE SOLVED BY THE INVENTION

[0004] Abnormalities in the water treatment process can include a severe abnormality that adversely affects a reaction system of a water treatment plant, and a minor abnormality that does not hinder normal progress of the water treatment process. An operator preferentially copes with a severe abnormality. In this regard, with the process state monitoring device of Patent Document 1, an operator can know occurrence of an abnormality without monitoring multiple measurement values, but cannot know the severity of the occurring abnormality. Patent Document 1 also discloses that abnormality detection may be performed using, as a trigger, an important variable that an operator recognizes sufficiently well, whereby only an abnormality sign that the operator desires to know may be detected. However, the index of the abnormality degree in the water treatment process and the severity of the abnormality are not always in a simple proportional relationship, and it is not easy to accurately find an important variable that corresponds to an abnormality of which the severity is great.

[0005] The present disclosure has been made to solve the above problem, and an object of the present disclosure is to provide an abnormality diagnosis system for a water treatment plant and an abnormality diagnosis method for a water treatment plant that can detect occurrence of an abnormality in a water treatment process and performs diagnosis for the severity of the detected abnormality.

MEANS TO SOLVE THE PROBLEM

[0006] According to a first aspect of the present disclosure, there is provided an abnormality diagnosis system for a water treatment plant, which performs diagnosis for an abnormality of the water treatment plant which is a monitoring target, the abnormality diagnosis system including: a measurement value collection unit which collects a plurality of kinds of measurement values in a water treatment process performed by the water treatment plant; a measurement value storage unit in which the measurement values collected by the measurement value collection unit are accumulated; an abnormality detection unit which determines

whether or not an abnormality has occurred in the water treatment plant, on the basis of an abnormality degree calculated from the measurement values; a contribution factor calculation unit which calculates, for each of the measurement values, a contribution degree indicating a degree of an influence caused to variation in the abnormality degree; an abnormality mode determination information storage unit which stores abnormality mode determination information indicating a relationship between the abnormality degree and an abnormality mode; an abnormality mode determination unit which, in a case where it is determined that the abnormality has occurred, compares the abnormality degree calculated by the abnormality detection unit with the abnormality mode determination information, to determine the abnormality mode of the occurring abnormality; and a diagnosis result display unit which displays a result of the determination. The abnormality mode is associated with a severity for the water treatment plant, and the abnormality mode determination unit narrows down the abnormality modes on the basis of the contribution degrees, before the determination based on comparison between the abnormality degree and the abnormality mode determination information.

[0006a] According to a second aspect of the present disclosure, there is provided an abnormality diagnosis system for a water treatment plant, which performs diagnosis for an abnormality of the water treatment plant which is a monitoring target, the abnormality diagnosis system including: a measurement value collection unit which collects a plurality of kinds of measurement values in a water treatment process performed by the water treatment plant; a measurement value storage unit in which the measurement values collected by the measurement value collection unit are accumulated; an abnormality detection unit which determines whether or not an abnormality has occurred in the water treatment plant, on the basis of an abnormality degree calculated from the measurement values; an abnormality mode determination information storage unit which stores abnormality mode determination information indicating a relationship between the abnormality degree and an abnormality mode; an abnormality mode determination unit which, in a case where it is determined that the abnormality has occurred, compares the abnormality degree calculated by the abnormality detection unit with the abnormality mode determination information, to determine the abnormality mode of the occurring abnormality; a diagnosis result display unit which displays a result of the determination; a past abnormality storage unit in which data of the measurement values when abnormalities occurred in past are accumulated; a water quality simulator unit which virtually reproduces an abnormality that actually occurred or an abnormality that can

occur; a past abnormality degree calculation unit which calculates the abnormality degree as a past abnormality degree using data of the abnormality virtually reproduced by the water quality simulator unit and the measurement values accumulated in the past abnormality storage unit; and
a past abnormality clustering unit which performs clustering through machine learning for the past abnormality degree, to associate the past abnormality degree and the abnormality mode with each other, thus generating determination clustering information, wherein the abnormality mode is associated with a severity for the water treatment plant, and the abnormality mode determination unit determines the abnormality mode of the abnormality occurring at present, using the determination clustering information generated in advance, as the abnormality mode determination information.

[0007] According to a third aspect of the present disclosure, there is provided an abnormality diagnosis method for a water treatment plant, which performs diagnosis for an abnormality of the water treatment plant which is a monitoring target, the abnormality diagnosis method including: a measurement value collection step of collecting a plurality of kinds of measurement values in a water treatment process performed by the water treatment plant; a measurement value accumulation step of accumulating the measurement values collected in the measurement value collection step; an abnormality detection step of determining whether or not an abnormality has occurred in the water treatment plant, on the basis of an abnormality degree calculated from the measurement values; a contribution factor calculation step of calculating, for each of the measurement values, a contribution degree indicating a degree of an influence caused to variation in the abnormality degree; an abnormality mode determination step of, in a case where it is determined that the abnormality has occurred, comparing the abnormality degree calculated in the abnormality detection step with abnormality mode determination information indicating a relationship between the abnormality degree and an abnormality mode, to determine the abnormality mode of the occurring abnormality; and a diagnosis result display step of displaying a result of the determination. The abnormality mode is associated with a severity for the water treatment plant, and in the abnormality mode determination step, the abnormality modes are narrowed down on the basis of the contribution degrees, before the determination based on comparison between the abnormality degree and the abnormality mode determination information.

[0007a] According to a fourth aspect of the present disclosure, there is provided an abnormality diagnosis method for a water treatment plant, which performs diagnosis for an abnormality of the water treatment plant which is a

monitoring target, the abnormality diagnosis method including: a measurement value collection step of collecting a plurality of kinds of measurement values in a water treatment process performed by the water treatment plant; a measurement value accumulation step of accumulating the measurement values collected in the measurement value collection step; an abnormality detection step of determining whether or not an abnormality has occurred in the water treatment plant, on the basis of an abnormality degree calculated from the measurement values; an abnormality mode determination step of, in a case where it is determined that the abnormality has occurred, comparing the abnormality degree calculated in the abnormality detection step with abnormality mode determination information indicating a relationship between the abnormality degree and an abnormality mode, to determine the abnormality mode of the occurring abnormality; a diagnosis result display step of displaying a result of the determination; a past abnormality data accumulation step of accumulating data of the measurement values when abnormalities occurred in past; a water quality simulation step of virtually reproducing an abnormality that actually occurred or an abnormality that can occur; a past abnormality degree calculation step of calculating the abnormality degree as a past abnormality degree using a simulation result of the water quality simulation step and the measurement values accumulated in the past abnormality data accumulation step; and a past abnormality clustering step of performing clustering through machine learning for the past abnormality degree, to associate the past abnormality degree and the abnormality mode with each other, thus generating determination clustering information, wherein the abnormality mode is associated with a severity for the water treatment plant, and in the abnormality mode determination step, the abnormality mode of the abnormality occurring at present is determined, using the determination clustering information generated in advance, as the abnormality mode determination information.

EFFECT OF THE INVENTION

[0008] The abnormality diagnosis system for the water treatment plant and the abnormality diagnosis method for the water treatment plant according to embodiments of the present disclosure can detect occurrence of an abnormality in a water treatment process and performs diagnosis for the severity of the detected abnormality.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] [FIG. 1] FIG. 1 is a block diagram showing a

described above, and may be other values uniquely calculated in accordance with a purpose.

[0026] The abnormality occurrence determination unit 1036 determines whether or not an abnormality has occurred, on the basis of a relationship between the abnormality degree WD and the threshold Th at the present time, calculated from the data set DS* at the present time (the data set DS* constituted of measurement value data D of which the measurement time is the present time). Specifically, in a case where one of the T^2 value and the Q value at the present time has exceeded the threshold Th, i.e., one of (T^2 value at present time) > (threshold Th_T^2 for T^2 value) and (Q value at present time) > (threshold Th_Q for Q value) is satisfied, the abnormality occurrence determination unit 1036 determines that an abnormality has occurred. That is, the abnormality occurrence determination unit 1036 determines whether or not an abnormality has occurred, by comparing the abnormality degree WD and the threshold Th. The abnormality occurrence determination unit 1036 outputs the principal component axis information PA which is a result of principal component analysis, the calculated abnormality degree WD, and a result of abnormality occurrence determination, collectively as an abnormality presence/absence determination result W. That is, the abnormality presence/absence determination result W includes the principal component axis

(step ST2013: preprocessing step). The preprocessing for the data set DS_P is as described above.

[0075] Next, PCA analysis is performed on the data set DS_P* (step ST2014: principal component analysis step). The PCA analysis is as described above, and regarding data when abnormalities occurred in the past, principal component axis information PA_P which is information about each principal component axis is obtained.

[0076] Next, past abnormality degrees are calculated using the principal component axis information PA_P and the data set DS_P* which is the original data for calculating past abnormality degrees (step ST2015: past abnormality degree calculation step). The past abnormality degree is as described above. In embodiment 2, for data when abnormalities occurred in the past, the T^2 values and the Q values are calculated, and data of the calculated T^2 values and Q values are used as the past abnormality degrees WD_P.

[0077] Next, on the basis of the past abnormality degrees WD_P, data when abnormalities occurred in the past are classified by a method of clustering, to generate determination clustering information CLM_P (step ST2016: past abnormality clustering step). The clustering in the past abnormality clustering step is as described above, and by performing machine learning, e.g., unsupervised learning such as a k-means method or supervised learning such as decision