

SYSTEM AND METHOD FOR AUDITING WASTEWATER TREATMENT PLANT PARAMETERS

TECHNICAL FIELD

5 **[0001]** The present invention relates to a system and method for auditing wastewater treatment plant parameters.

BACKGROUND

10 **[0002]** The following discussion of the background to the invention is intended to facilitate understanding of the present invention. However, it should be appreciated that the discussion is not an acknowledgment or admission that any of the material referred to was published, known or a part of the common general knowledge in any jurisdiction as at the priority date of the application.

15 **[0003]** There currently exists numerous monitoring and control systems associated with wastewater treatment plants. An example is the inCTRL™ system which provide for a monitoring and control platform that supplements an existing supervisory control and data acquisition (SCADA) platform to provide for check, analyse and provide on-line or real time status updates on the sensors, actuators and processes.

20 **[0004]** However, existing systems do not provide adequate remote support to the monitoring platform. In particular, there exist a need for better integration between monitoring and audit checks on various process performance of the wastewater treatment plant. There also exists a need for better integration of data collected from different sources such as SCADA, lab and manual measurement systems into a common monitoring and automated
25 checking platform.

SUMMARY

[0005] The present disclosure seeks to meet the aforementioned needs at least in part.

5 **[0006]** A technical solution seeks to provide an audit platform suitable for deployment with a wastewater treatment plant. The audit platform may be integrated with the wastewater treatment plant and may include checks for one or more of the following: - sensor failure(s); effluent parameter levels; effluent quality; water and mass balance. The audit platform may include one or more audit modules arranged to receive input dataset from each of the
10 plurality of sensors. Data from each of the plurality of sensors may be received continuously or at pre-determined intervals.

[0007] Alternatively, the audit platform may be implemented as a standalone device or system arranged to receive data from one or more sensors of a wastewater treatment plant. The data may be received remotely.

15 **[0008]** In some embodiments, the audit platform may be an integrated platform which allows data from different sources to be used to perform automated, real-time checks on the wastewater treatment plant. The audit platform may be used with existing control and monitoring solutions for wastewater treatment plants.

20 **[0009]** Through the use of computer and wireless communications technology, the audit platform can be deployed as a remote monitoring tool for monitoring and checks on de-centralized wastewater/water treatment systems.

25 **BRIEF DESCRIPTION OF THE DRAWINGS**

[0010] The present disclosure will now be described, by way of example only, with reference to the accompanying drawings, in which:

[0011] Fig. 1a shows a block diagram of a system and an audit device for

auditing one or more wastewater treatment plant parameters according to some embodiments; Fig. 1b shows a block diagram of an audit platform arranged in communication with a wastewater treatment plant;

5 **[0012]** Fig. 2 is a logic flow chart of an exemplary faulty sensor audit algorithm for measurement sensors installed in the vicinity of a wastewater treatment plant;

[0013] Fig. 3 is a logic flow chart of an exemplary faulty sensor audit algorithm for status sensors installed in the vicinity of a wastewater treatment plant;

10 **[0014]** Fig. 4 shows examples of checks performed on multiple effluent parameters and effluent quality; and

[0015] Fig. 5 and Fig. 6 show exemplary calculations of a water balance and mass balance of a wastewater treatment plant.

DETAILED DESCRIPTION

15 **[0016]** Particular embodiments of the present invention will now be described with reference to the accompanying drawings. The terminology used herein is for the purpose of describing particular embodiments only and is not intended to limit the scope of the present invention. Additionally, unless defined otherwise, all technical and scientific terms used herein have the
20 same meanings as commonly understood by one of ordinary skill in the art to which the present invention belongs. Where possible, the same reference numerals are used throughout the figures for clarity and consistency.

[0017] In the context of the description, the term 'parameter(s)' may be construed broadly to include constant, variables, calculated or derived values.
25 In relation to a wastewater treatment plant, parameter(s) may include influent parameters and effluent parameters. The parameter(s) may also include system parameters such as temperature, pressure etc.

[0018] Throughout the specification, unless otherwise stated, the term

'wastewater treatment plant' include aerobic wastewater treatment plant, anaerobic wastewater treatment plant, and combination of aerobic and anaerobic wastewater treatment modules. Wastewater treatment may also include physicochemical treatment processes. It is appreciable that the wastewater treatment plant may be adapted for different industries, for example, battery manufacturing, electric power plants, food, iron and steel, mines and quarries, nuclear, petroleum, pulp and paper, textile, wood, chemical etc. It is appreciable that the disclosure may also be adapted for a domestic wastewater treatment device/process.

10 **[0019]** Throughout the specification, unless otherwise stated, the term 'sensor(s)' include hardware sensor(s) and soft sensor(s). The term 'sensor(s)' also include intelligent or smart sensor(s) capable of data communication with at least one remote server.

15 **[0020]** Throughout the specification, unless otherwise stated, the term 'computer networks' include centralized computer networks, decentralized computer networks, and/or distributed computer networks.

[0021] Referring to Fig. 1a and 1b there is an audit platform or server 10 suitable for deployment at a wastewater treatment plant 30. The audit server 10 may include one or more computer processors. The computer processors may be part of one or more computer networks arranged in data communication with the wastewater treatment plant 30. The computer processors may include general purpose computers and/or application-specific processors which can include one or more ASIC (application-specific integrated circuit).

25 **[0022]** The audit server 10 is configured in signal or data communication with one or more sensors 40, actuators and/or measurement devices positioned in the vicinity of a wastewater treatment plant 30 to obtain data related to various parameters of the wastewater treatment plants. The parameters include influent and effluent wastewater parameters. In some embodiments, the audit server 10 comprises four modules: - a sensor fault

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detection module 120; an effluent parameter module 140; an effluent quality module 160 and an operation reconciliation module 180. The operation reconciliation module 180 may in turn include a water and mass balance module. Each of the modules 120, 140, 160 and 180 is operable to perform
5 checks on the various components and/or parameters within the wastewater treatment plant 30. One or more of the modules 120, 140, 160 and 180 may include an input interface for receiving input data or dataset, processor(s) for implementing audit logic (see Fig. 2 to Fig. 6), and an output interface for providing a result. The result may be sent to one or more users arranged in
10 data or electronic signal communication with the audit server 10. The modules 120, 140, 160, 180 may be used to determine an integrity indicator of the wastewater treatment plant 30.

[0023] In some embodiments, authorized users may be equipped with computer devices, such as mobile smart phones and/or tablet PCs to interface
15 with the audit server 10. The computer devices may be configured to receive notifications and alerts from the audit server 10. Such notifications and alerts may include electronic notifications such as email notifications, short messaging, and notifications facilitated by push/pull APIs.

[0024] The audit platform 10 may be configured to work with one or more
20 other modules for monitoring and control of a wastewater treatment plant. Examples of one or more other modules include a wastewater treatment parameter prediction module and a wastewater treatment optimization module. Data generated from these modules may be input into the audit platform 10. Alternatively, data generated from the audit platform 10 may be
25 input to the wastewater treatment parameter prediction module and/or a wastewater treatment optimization module.

[0025] The sensor fault detection module 120 may be installed at the wastewater treatment plant and configured to check and determine whether various sensors are operating within normal operating conditions, which may
30 include checks on whether each of the sensors are connected properly. The

sensor fault detection module 120 may operate to generate electronic alerts when there are one or more sensor malfunctions. Such malfunction(s) may include one or more of the following situations: - when successive measurements indicate that one or more sensor(s) are stagnant, when
5 measurements obtained indicate that the one or more sensors produce unexpected results, such as negative or zero readings, when measurements of the one or more sensors indicate sudden spikes, when the one or more sensors drifting away from an expected trend and out of normal range.

[0026] The effluent parameter module 140 is operable to perform checks on
10 selected wastewater effluent (i.e. treated wastewater) parameters. The wastewater effluent parameters may include parameters such as effluent chemical oxygen demand (COD), and/or effluent total phosphorus (TP). In some embodiments, the effluent parameter module 140 may be programmed or configured to compare the actual values of the parameters measured on-
15 site with parameters obtained from lab measurements. For example, the COD and TP data obtained from lab measurements may be compared with the actual parameters obtained on-site, with checks for consistency with corresponding sensors or removal system efficiency. The effluent parameter module 140 is also configured to detect abnormal situation(s) whereby
20 erroneous data may have been reported based on errors made during lab measurement or improper sample collection.

[0027] In some embodiments, the effluent parameter module 140 may include a pre-determined set of constraints. At least one constraint may be in the form of a statistical range, such that any data falling outside the statistical
25 range is flagged as an abnormal data point requiring further analysis. In some embodiments, the statistical range may be in the form of an upper or lower limit.

[0028] The effluent quality module 160 operates to perform checks on the effluent quality of the wastewater treatment plant. This function utilizes both
30 sensor-recorded and lab measured effluent quality for comparison. The

effluent quality module 160 provides remote monitoring and real-time checks on the effluent quality of the wastewater treatment plant. Such remote monitoring may be achieved via hard or soft sensors disposed at suitable positions in the vicinity, such as around or within, the wastewater treatment plant.

[0029] The hard or soft sensors may be equipped with wireless communications transceiver for transmission of data between the plurality of sensors and the effluent parameter module 140 and/or the effluent quality module 160.

10 **[0030]** The effluent quality module 160 may be arranged in data communication with one or more historical databases (not shown). The historical database(s) may be used to derive statistical data such as 'average', 'mean', 'standard deviation', 'mode' etc. The statistical data may be utilized as basis of comparison between collected dataset and historical data.

15 **[0031]** The water and mass balance module 180 periodically collect and utilize data from the wastewater treatment plant to check if various balances, such as mass or material balance, at the wastewater plant is maintained within a permissible range or level.

20 **[0032]** The plurality of sensors in the wastewater treatment process (WWTP) plant are employed or deployed for monitoring process performance and condition. The proper operation of the deployed sensors is therefore crucial to the monitoring of WWTP and any adjustments of the parameters. Sensor validation is therefore a factor to the success of process monitoring. Besides monitoring of wastewater parameters, the
25 sensors may be used for automatic control (e.g. feedback and feedforward control) of plant performance. In order for the control system of the WWTP plant to work efficiently, the sensor used in a control law has to be reliable. If a sensor reads a wrong value, too much resources (e.g. energy for aeration) may be used or the resultant treatment may
30 deviate from the desired results. In other words, faulty sensors that are

either completely or partially failing (hard fault or soft fault) provide incorrect information for monitoring and control. This can be detrimental to decision schemes that are based on, or supported by, on-line measurements. A complete sensor failure disables access to the relevant measurement. Monitoring or control based on the measurement is then infeasible.

[0033] In view of the above, degradation in bias, drift or precision of a sensor signal and/or partial failure of the sensor can cause the accuracy and reliability of the sensor measurement to decrease. Such decrease in accuracy and reliability may result in erroneous control actions and false perception of the performance of the monitored system or component. Therefore, prompt detection of the occurrence and correct identification of the location of sensor faults and reliable reconstruction (or recovery) of faulty sensors is of primary importance for efficient operation.

[0034] In a WWTP process, data of hundreds of sensors may be collected from the SCADA for process monitoring and control. In a particular example, there may comprise two types of sensors (a first sensor type and a second sensor type) in the SCADA system.

[0035] The first type of sensor (i.e. first sensor type) include 'status sensors' deployed to obtain statuses of a device, such as a pump. Such statuses can depend on the number of operating modes associated with the device. For example, the statuses of a pump can include an 'open' status and a 'closed' status. The statuses can be assigned the values of 0 or 1 respectively. It is appreciable that statuses may involve more than an 'on' and an 'off' state. Some equipment/devices may include other statuses such as 'increasing speed/force', 'constant speed/force', etc.

[0036] The second type of sensor (i.e. a second sensor type) relates to measurement devices which are deployed to obtain measurements of wastewater treatment parameters, such as flowrate, pH, temperature, pressure etc. Some of these sensors may be deployed to measure and

obtain continuous readings. It is appreciable that measurements for both influent and effluent wastewater parameters may be obtained.

[0037] Fig. 2 shows an exemplary faulty sensor audit flowchart for measurement sensors. Regarding the measurement sensors, the steps
5 for auditing sensors are described as follows.

[0038] In an example, data may be collected from each measurement sensor at a pre-determined interval. Different measurement sensors may be associated with different pre-determined intervals. The collection frequency associated with each deployed measurement sensor (also referred to as
10 online sensor), can be based on a pre-determined time, for example, every 5 minutes interval per data collection.

[0039] The online sensor dataset collected is sent (remotely or otherwise) to the sensor fault detection module 120 via an input interface. The data is processed by a fault sensor analysis algorithm, which is installed in the sensor
15 fault detection module 120. In some embodiments, the most recent data point (from a collected dataset) obtained from a sensor may be checked by the fault sensor analysis algorithm. In other embodiments, a subset of the collected dataset (comprising a number of data points) may be checked.

[0040] The sensor dataset is checked for any sensor faults. Such checks
20 may include, but are not limited to, detecting or checking: -

- (i.) whether a sensor or a group of sensors are properly deployed around the vicinity or connected to the supposed location(s) of the wastewater treatment plant or are faulty;
- (ii.) whether a sensor or a group of sensors are reading one or more
25 wrong value(s); and/or
- (iii.) whether a sensor or a group of sensors are out of range.

[0041] The faulty sensor detection logic shown in Fig. 2 includes the following detection and check steps.

(a.) Sensor failure or disconnection (see Step 1) – This may be based on detection of a sensor signal transmitted from a sensor to the sensor fault detection module 120. The sensor signal may be in the form of an electrical signal having 4 to 20 milliamperes (mA) transmitted from the sensor to the sensor fault detection module 120. Such sensor signals function like regular ‘heartbeat signal(s)’. If a sensor signal has previously been received by the fault detection module 120 but is subsequently not received for a period of time, absence of such heartbeat signal could indicate a data transmission issue or a sensor failure or disconnection. For example, further checks may be performed via database check(s) to ascertain whether a data connection link associated with a particular sensor is broken. In this regard, a constant data entry with no updates for a period of time may indicate a data transmission issue (i.e. constant heartbeat signals over a prolonged period), while a zero-value associated with the data received (and entered into a database) may indicate sensor failure (see step 3).

(b.) Negative faulty sensor (see Step 2) – Detection and checks may be performed to detect if a sensor or a selected group of sensors measure(s) a negative value. Any negative value transmitted by such sensor(s) may indicate a fault on such sensors, which are supposed to transmit non-negative values (i.e. ≥ 0). Exceptions are created for certain sensors, such as Oxidation-Reduction Potential (ORP) sensors, as such ORP sensors can obtain negative-value measurements.

(c.) Zero faulty sensor (see Step 3) – The detection and checks may be performed to detect if a sensor or a selected group of sensors sense a zero value for a pre-determined period. Any zero-value transmitted by such sensor(s) for the pre-determined period may indicate a fault on such sensors, as sensor(s) typically provide non-zeros readings under normal operation conditions. Exceptions are created for certain sensors, such as flow sensors, as such flow sensors can obtain zero-valued measurements.

(d.) Constant number fault (see Step 4) - The detection and checks

may be performed to detect if a sensor or a selected group of sensors sense a constant value for a pre-determined period. Any constant value transmitted by such sensor(s) for the pre-determined period may indicate a fault on the data connection of such sensors, as sensor readings typically fluctuates under normal operation conditions. Exceptions are created for certain sensors, such as flow sensors, as such flow sensors can obtain constant value measurements.

(e.) Sensor drift fault (see Step 5) - Accuracy of a sensor could be compromised over time due to a variety of reasons, such as impurities build-up, or wear-and-tear, for example. Such a phenomenon is known as sensor-drift. Sensor drift faults can be detected via a number of ways, such as constantly increasing or constantly decreasing measurements. Such faults indicate that the sensor(s) need to undergo repairs, maintenance, or replacements.

(f.) Out of range fault (see Step 6) - A sensor will typically operate within certain range and therefore any measurements/readings obtained from the sensor will typically be between a minimum and a maximum value. Detection and checks on this fault are aimed to detect measurements outside of the minimum and maximum range which may indicate a sensor fault or operational issue (such as unauthorized tempering in the form of addition of purified water in the wastewater treatment plant).

(g.) Sensor spike fault (see Step 7) - A sensor spike may occur when there are interferences which can affect the readings, such as electromagnetic interferences. In addition, unauthorized tempering such as the unauthorized addition of purified water in the wastewater treatment plant may also result in sensor spike readings. While not all sensor spikes are faults, all sensor spikes are flagged for further investigation(s) and/or analysis.

[0042] It is to be appreciated that steps 1 to 3 are process steps configured to check the most recent data point associated with the particular sensor. For example, a heartbeat signal not obtained from a particular sensor can indicate

sensor failure or disconnection.

[0043] Step 4 checks the latest pre-set or pre-determined data points, for example 20, where 20 is the default number and can be adjusted for different wastewater applications.

5 **[0044]** In some embodiments associated with the checks for sensor drift, i.e. Step 5, a linear fit (based on linear regression or otherwise) of the latest one-day data (over 24 hours) is performed to obtain a predication of various values, which may then be used to calculate an R squared value (R^2). If the absolute R^2 value is greater or equal to a pre-set value (for example $R^2 \geq$
10 0.7), the data shows drift. The threshold 0.7 can be adjustable depending on applications.

[0045] In some embodiments associated with checks for sensor spike, i.e. Step 7, the one day data points may be extracted to calculate its mean value, and if the latest mean value is more than or equal to a pre-set or pre-
15 determined number or less than or equal to (i.e. ≥ 3 times the mean value or $\leq 1/3$ times the mean value), it is identified as spike, where 3 and $1/3$ can be adjustable depending on applications.

[0046] In relation to the 'status sensors', such as a pump, the following steps with the details depicted in Fig. 3 are proposed to identify the faulty
20 sensors for pump related sensors:

[0047] In some embodiments, data collection frequency for the status sensors may be performed every predetermined interval, such as 5 minutes.

[0048] Each deployed status sensor data is checked by the fault sensor analysis function. The first step s302 checks if a pump status (either 1 or 0) is
25 obtained. If there is no pump status, an alarm is generated and reported.

[0049] If a pump status is ascertained to be present based on step s302 but is not 1 or 0, an invalid pump status is detected. An alarm will be generated and reported (step s304).

[0050] If a valid pump status is obtained, the algorithm performs other checks on the pump (step s306).

[0051] In some embodiments, the status sensors provide a value of 1 and 0 for the indication of on/off. In other embodiments, there may be additional statuses (2, 3, etc.) associated with different modes of operating the sensors.

[0052] In some embodiments, the statuses of the pump sensors may be provided separately.

Effluent parameter module

[0053] The effluent parameter module 140 operates to perform audit of one or more effluent wastewater parameters. Such effluent wastewater parameters may include parameters such as the effluent chemical oxygen demand (COD) and/or the effluent total phosphorus (TP) level of the treated effluent wastewater. The collected data are analysed by the effluent parameter module 140 to perform checks on the reliability of laboratory measured Chemical Oxygen Demand (COD) and Total Phosphorus (TP) measurements. The specific mechanism of each audit parameter check depends on the configuration and measurement points available at the wastewater treatment facility but the generic basis for performing checks is as shown in Fig. 4. Statistical relationship between a first wastewater parameter and a second parameter may be derived.

[0054] In some embodiments, the first wastewater parameter and second wastewater parameter may be effluent parameters. In some embodiments, the first wastewater parameter may be an influent parameter and the second wastewater parameter may be an effluent parameter. In some embodiments, the first wastewater parameter may be an effluent parameter and the second wastewater parameter may be an influent parameter. In some embodiments, the first wastewater parameter and second wastewater parameter may be influent parameters.

[0055] In the example shown in Fig. 4, two or more effluent parameters may

be calculated as part of the analysis process. Statistical relationship between an effluent parameter and an influent parameter or a system parameter such as temperature, pressure and/or other environmental parameters may also be calculated. In some embodiments, the system parameters may include
5 derived parameters such as intermediate removal efficiency, statistical variants or differences between sensor measurements etc.

[0056] Fig. 4 shows a two-step process of determining the reliability of the effluent wastewater parameter(s). In particular, after the effluent wastewater parameters are checked or calculated, and various statistical
10 relationship between effluent COD and influent COD and selected influent parameters and system parameters are calculated or derived. Decision tables are then used to determine if a lab measured COD or TP value is reliable.

[0057] In some embodiments, a ratio between two effluent parameters
15 may be calculated. The ratio between the two effluent parameters may be calculated at periodic intervals to provide an indication of the wastewater treatment reliability. For example, in relation to the effluent parameter COD, the change in COD/TOD (total organic carbon) ratio is calculated. The differences in COD quantity over time can also be calculated.

[0058] In some embodiments, ratios of removed influent parameters and/or
20 removed effluent parameters with respect to other parameters may be derived and calculated. For example, in relation to the parameter TP, the ratio of quantity of TP removed with respect to the quantity of Polyferric Chloride- (PFCs) may be derived or calculated. In addition, the difference in conductivity
25 of the wastewater; differences in TP removal efficiency; lab vs analyzer data; difference in COD quantity; COD removal efficiency; may also be calculated or derived.

[0059] In some embodiments, once the effluent parameters (i.e. COD and TP) are calculated, statistical relationships between the effluent parameters
30 and other effluent parameters or influent parameters can be derived or

calculated. The effluent parameter module 140 operates to determine whether the calculated or derived statistical value CX (where X is a positive integer 1, 2, 3, 4, ...) of the effluent parameter is within a particular range (e.g. 20%). For example, if the test date COD/TOC is lower than the averaged past 30 days average TOC/COD ratio by 20%, then a flag FX (where X is a positive integer 1, 2, 3, 4, ...) will be assigned a value of 1. Otherwise, the flag is assigned a value of 0. In the table shown in Fig. 4, where the test data obtained on a particular date associated with the ratio of effluent COD/TOC is lower than the averaged past 30 days average TOC/COD ratio by 20%, i.e. $C3 < 20\%$.

Effluent quality module

[0060] The effluent quality module 160 is operable to continuously provide remote monitoring of the wastewater treatment plant. In some embodiments, the effluent quality module 160 utilizes both lab measured and sensor measured data to perform automated monitoring of a wastewater plant's adherence to regulatory policies. The effluent quality module 160 operates to compare the real-time value of the effluent quality measurement (based on sensor values) and sample value (obtained from lab) against the regulatory requirement.

Water and mass balance module (Water Balance calculation)

[0061] Fig. 5 illustrates a calculation of a water balance of a wastewater treatment plant. In the water balance audit point, the daily wastewater treatment plant influent inflow vs wastewater effluent outflow and tank accumulation is computed. Email alerts/events are created when the difference exceeds a predefined specification. In the example shown in Fig. 5 the influent water should be within the range of $\pm 5\%$ of the sum of the effluent water and the tank accumulation. Otherwise, an alert will be generated.

Water and mass balance module (Mass Balance calculation)

[0062] Fig. 6 illustrates a calculation of a mass balance of a wastewater treatment plant. In the mass balance audit point, the monthly sludge disposal is compared against the sludge generation from removal of COD, TP and non-biodegradable total suspended solids (TSS). The total sludge disposed (taking into account sludge moisture removal) is calculated and compared with the generated COD, TP and TSS. Email alerts/events are created when difference exceeds a predefined specification. In the example shown in Fig. 6, the total summation of COD, TP and TSS in the influent wastewater should be within the range of $\pm 20\%$ of the sum of the effluent COD, TP and TSS, taking into account sludge moisture. Otherwise, an alert will be generated.

[0063] In the mass balance audit point, the monthly sludge disposal is compared against the sludge generation from COD, TP removal and non-biodegradable TSS in the influent.

[0064] In some embodiments, output from each audit modules may provide an indication of the integrity of the wastewater treatment plant. Examples include deriving an average or weighted sum average of a number of sensor failures/abnormality for a specific time, overall drop in wastewater treatment efficiency/reliability etc.

[0065] In some embodiments, historical databases of past results may be used for the derivation or calculation of the statistical relationships, statistical data between parameters.

[0066] The present disclosure or invention seeks to provide an integrated system to monitor the quality of treated effluent water using various sensors (pH, temperature, etc.). The integrated system may provide a centralized monitoring module and centralized platform. For multiple plant operator, one-stop monitoring, alarm setting, triggering of alarm.

[0067] In some embodiments, the auditor device of the present invention

may be utilized in conjunction with the system disclosed in WO2017/184077A1. In particular, the present disclosure may be used as a pre-processing device to achieve at least a reasonable level of quality of input dataset used for the prediction of one or more parameters of wastewater treatment process.

[0068] For example, the sensor fault detection module 120 operates to identify failure of sensors and reduces impact of erroneous sensor data on the performance of the predictor or prediction system as disclosed in WO2017/184077A1. The effluent parameter module 140 operates to identify errors in any laboratory measurements.

[0069] In some embodiments, the effluent quality module 160 may include an abnormality closure mechanism to collect operator-related action(s) during effluent abnormalities. Such operator action may be compiled as data and used in the derivation of usage-related statistics for troubleshooting in the troubleshooting module disclosed in WO2017/184077A1.

[0070] The operation reconciliation module 180 operates to provide one or more indications on whether the wastewater treatment plant is operated in a manner consistent with standard operating conditions.

[0071] In another aspect, at least part of the audit platform 10 may be implemented as software codes on one or more non-transitory computer readable medium within the processor(s). When executed, the software codes may generate a method for auditing one or more wastewater treatment plant parameters including the steps of:- receiving an input dataset from an input interface, the input dataset associated with at least a first sensor type and a second sensor type; determining, by a processor, whether the first sensor type and the second sensor type is within normal operating condition; and determining, by the processor, at least one of (a.) a statistical relationship between a first wastewater parameter and a second wastewater parameter; and (b.) an operation analysis of the wastewater treatment plant. The input dataset includes a status of the first sensor type, and a measurement value of

the second sensor type.

[0072] It will be apparent that various other modifications and adaptations of the invention will be apparent to the person skilled in the art after reading the foregoing disclosure without departing from the spirit and scope of the invention.

[0073] It is intended that all such modifications and adaptations come within the scope of the appended claims.

[0074] Further, it is to be appreciated that features from various embodiment(s), may be combined to form one or more additional embodiments.

CLAIMS

1. A system for auditing one or more wastewater treatment plant parameters including
 - 5 an input interface configured to receive an input dataset associated with at least a first sensor type and a second sensor type;
a processor configured to determine whether each of the first sensor type and the second sensor type is within normal operating condition;
wherein the input dataset includes a measurement value of the second
 - 10 sensor type, and a status of the first sensor type; and
wherein the processor is further configured to determine at least one of (a.) a statistical relationship between a first wastewater parameter and a second wastewater parameter; and (b.) an operation analysis of the wastewater treatment plant.
- 15 2. The system of claim 1, wherein the processor includes a sensor fault detection module; a wastewater effluent parameter module; a wastewater effluent quality check module; and an operation reconciliation module.
- 20 3. The system of claim 2, wherein the sensor fault detection module is operative to determine at least one of the following sensor fault scenarios: - sensor failure or disconnection fault; negative fault; zero fault; constant number fault; sensor drift fault; out of range fault; sensor spike fault; and status fault.
- 25 4. The system of claim 3, wherein the status fault includes checking if the second sensor is connected, and if the status of the second sensor is an approved status.
- 30 5. The system of claim 2, wherein the wastewater effluent parameter check module is operative to determine a ratio between the first wastewater parameter and the second wastewater parameter.

6. The system of claim 5, wherein the first wastewater parameter is an effluent parameter and the second wastewater parameter is an influent parameter.

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7. The system of claim 5, wherein the first wastewater parameter is a first effluent parameter and the second wastewater parameter is a second effluent parameter.

10 8. The system of claim 2, wherein the wastewater effluent quality check module is operative to compare at least one of a real-time measurement of an effluent quality value and a lab value of the effluent quality value, with a control value.

15 9. The system of claim 2, wherein the operation reconciliation module is operative to compute a water balance and a mass balance of the wastewater treatment plant over a predetermined period.

20 10. A method for auditing one or more wastewater treatment plant parameters including

receiving an input dataset from an input interface, the input dataset associated with at least a first sensor type and a second sensor type;

determining, by a processor, whether the first sensor type and the second sensor type is within normal operating condition; and

25 determining, by the processor, at least one of (a.) a statistical relationship between a first wastewater parameter and a second wastewater parameter; and (b.) an operation analysis of the wastewater treatment plant;

wherein the input dataset includes a measurement value of the second sensor type, and a status of the first sensor type.

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11. The method of claim 10, wherein the step of determining at least one of a statistical relationship between a first wastewater parameter and a second

wastewater parameter includes determining a ratio between the first wastewater parameter and the second wastewater parameter.

12. The method of claim 11, wherein the first wastewater parameter is an effluent parameter and the second wastewater parameter is an influent parameter.

13. The method of claim 11, wherein the first wastewater parameter is a first effluent parameter and the second wastewater parameter is a second effluent parameter.

14. An auditor device for use with a wastewater treatment plant, the auditor device arranged to receive an input dataset associated with at least a first sensor type and a second sensor type;

15 wherein the auditor device includes a processor configured to determine whether each of the first sensor type and the second sensor type is within normal operating condition; and

wherein the processor is further configured to determine at least one of (a.) a statistical relationship between a first wastewater parameter and (b.) a second wastewater parameter; and an operation analysis of the wastewater treatment plant.

15. The auditor device of claim 14, wherein the input dataset includes a measurement value of the second sensor type, and a status of the first sensor type.

16. The auditor device of claim 14 or 15, wherein the processor includes a sensor fault detection module; a wastewater effluent parameter module; a wastewater effluent quality check module; and an operation reconciliation module.