METHOD AND SYSTEM FOR AUTOMATED RESPONSIVE ELECTROCOAGULATION WASTEWATER PROCESSING

TECHNICAL FIELD

[0001] The present invention generally relates to wastewater treatment, and more particularly relates to methods and systems for automated responsive electrocoagulation wastewater processing.

BACKGROUND OF THE DISCLOSURE

[0002] Globally, due to various factors, the volume of wastewater generated and contaminant loads produced are increasing. Indeed, the recalcitrant and toxic nature of industrial pollutants renders conventional chemical and biological wastewater treatment methods challenging. Therefore, currently, there is high interest and concern in developing more effective wastewater treatment technologies.

[0003] Electrocoagulation (EC) is an electrochemical water treatment technology that has become increasingly popular owing to its ability to efficiently remove various types of contaminants. The electrocoagulation process is a low cost and environmentally friendly technology for the treatment of water containing different kinds of contaminants such as heavy metals, organic compounds, oil, and suspended solids. Moreover, due to its no requirement of chemicals, its reduced risk of secondary pollution and its low sludge production, the EC process has been seen as an alternative to conventional chemical coagulation processes. Therefore, more research effort is being invested to better understand the process and make the EC process competitive as a reference technology for water treatment.

[0004] During the EC process, coagulant species are produced in-situ by the electro-dissolution of the sacrificial anode. Aluminum and iron electrodes are typically used

resulting in electro-generated ions of Al^{3+} or Fe^{2+}. These ions undergo further hydrolysis reactions producing monomeric and polymeric species that will finally be transformed into solid flocculant particles or flocs. These flocs have the potential for adsorption or entrapment of pollutants. Therefore, the metal ionic species distribution is a determining factor of EC performance. Moreover, after the flocculation, the pollutants can be removed by sedimentation, filtration, or flotation. The bubbles formed due to both oxygen and hydrogen evolution in the electrodes help to increase the efficiency of the removal by flotation.

[0005] Until now, extensive studies have been carried out on parameters that have a significant effect on the operating parameters of a batch EC process. For example, the initial concentration of the pollutant, current density, pH, applied voltage or current, treatment time, temperature, distance between electrodes, electrode arrangement, stirring speed, and support electrolyte are parameters that have been most evaluated. The applicability of the optimized condition obtained from batch experiments is quite complex during a pilot or full-scale application mainly due to variation in the influent wastewater characteristics. In real-time situations, the influent wastewater characteristics, or parameters, especially the organic content (which is related to the chemical oxygen demand (COD)) and total suspended solids, might vary. Thus, the operating conditions are required to be varied based on initial wastewater quality to achieve a target effluent water quality. Conventional EC responsive treatment has focused on reverse polarity i.e., change of polarity with respect to time in-order to reduce the passivation effect of the electrodes. Yet, this is insufficient to respond to varying influent wastewater organic content/COD and total suspended solids characteristics. It becomes imperative to develop a responsive treatment for operating

conditions, especially the current density, pH and HRT based on the wastewater characteristics in-order to achieve the target effluent quality.

[0006] Thus, there is a need to provide a responsive treatment method and system that readily adjusts operating parameters such as current density, retention time with respect to the influent wastewater characteristics or parameters. Furthermore, other desirable features will become apparent from the subsequent detailed description and the appended claims, taken in conjunction with the accompanying drawings and this background of the disclosure.

SUMMARY

[0007] According to at least one aspect of the present embodiments, a method for wastewater treatment is provided. The method includes monitoring water quality parameters of influent wastewater and determining a predicted chemical oxygen demand (COD) in response to the monitored parameters. The method also includes controlling operation of an electrocoagulation reactor for processing the influent wastewater in response to the predicted COD.

[0008] According to another aspect of the present embodiments, a system for responsive treatment of wastewater is provided. The system includes an electrocoagulation (EC) reactor, one or more sensors and a processing means. The EC reactor processes influent waste water while the one or more sensors monitor water quality parameters of the influent waste water. The processing means is coupled to the one or more sensors and determines a predicted chemical oxygen demand (COD) in response to the monitored parameters of the influent wastewater. The processing means is also coupled to the EC reactor for controlling its operation in response to the predicted COD.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] The accompanying figures, where like reference numerals refer to identical or functionally similar elements throughout the separate views and which together with the detailed description below are incorporated in and form part of the specification, serve to illustrate various embodiments and to explain various principles and advantages in accordance with present embodiments.

[0010] FIG. 1 depicts a schematic illustration of a responsive electrocoagulation wastewater treatment system in accordance with present embodiments.

[0011] FIG. 2 depicts a flowchart of a process for responsive electrocoagulation wastewater treatment in accordance with the present embodiments.

[0012] FIG. 3, comprising FIGs. 3A and 3B, depicts graphs of the effects of pH and current density on chemical oxygen demand (COD) removal rate in accordance with the present embodiments, wherein FIG. 3A depicts a graph of COD versus time for various pH levels when current density is 7 mA/cm^2 and FIG. 3B depicts a graph of COD versus time for various current density levels when pH is 9.

[0013] FIG. 4, comprising FIGs. 4A to 4E, depicts graphs of the correlation between pH and COD removal rate using a linear equation for different sources in accordance with the present embodiments, wherein FIG. 4A depicts a graph of the pH and COD correlation rate for commercial laundry wastewater, FIG. 4B depicts a graph of the pH and COD correlation rate for high strength rust cleaning wastewater, FIG. 4C depicts a graph of the pH and COD correlation rate for low strength rust cleaning wastewater, FIG. 4D depicts a graph of the pH and COD correlation rate for a food and beverage outlet wastewater, and FIG. 4E depicts a graph of the pH and COD correlation rate for cooling tower reused water.

[0014] FIG. 5, comprising FIGs. 5A to 5E, depicts graphs of the correlation between current density and COD removal rate using a linear equation for different sources in accordance with the present embodiments, wherein FIG. 5A depicts a graph of the current density and COD correlation rate for commercial laundry wastewater, FIG. 5B depicts a graph of the current density and COD correlation rate for high strength rust cleaning wastewater, FIG. 5C depicts a graph of the current density and COD correlation rate for low strength rust cleaning wastewater, FIG. 5D depicts a graph of the current density and COD correlation rate for a food and beverage outlet wastewater, and FIG. 5E depicts a graph of the current density and COD correlation rate for cooling tower reused water.

[0015] And FIG. 6, comprising FIGs. 6A to 6E, depicts bar graphs of predicted COD versus measured final COD after treatment processes for different sources in accordance with the present embodiments, wherein FIG. 6A depicts a bar graph of the predicted versus the measured final COD for laundry wastewater, FIG. 6B depicts a bar graph of the predicted versus the measured final COD for cooling tower reused water, FIG. 6C depicts a bar graph of the predicted versus the measured final COD for a food and beverage outlet wastewater, FIG. 6D depicts a bar graph of the predicted versus the measured final COD for high strength rust cleaning wastewater, and FIG. 6E depicts a bar graph of the predicted versus the measured final COD for low range rust cleaning wastewater.

[0016] Skilled artisans will appreciate that elements in the figures are illustrated for simplicity and clarity and have not necessarily been depicted to scale nor in full detail.

DETAILED DESCRIPTION

[0017] The following detailed description is merely exemplary in nature and is not intended to limit the invention or the application and uses of the invention. Furthermore, there is no intention to be bound by any theory presented in the preceding background of the invention or the following detailed description. It is the intent of present embodiments to provide systems and methods for responsive treatment of wastewater which adapts to varying operating conditions and influent wastewater characteristics or parameters, including current density, retention time, and pH. The present embodiments present a responsive waste water treatment methods and systems that readily and in real-time adjust operating parameters for efficient and optimal waste water treatment, such as adjusting current density within an electrocoagulation reactor retention time within the reactor in response to influent waste water characteristics. The present embodiments include electrocoagulation-based systems and methods for wastewater treatment which monitor water quality parameters of influent wastewater, determine a predicted chemical oxygen demand (COD) of the influent wastewater in response to the monitored parameters, and control operation of an electrocoagulation reactor processing the wastewater in response to the predicted COD. The operation of the electrocoagulation (EC) reactor may include altering a current density of the EC reactor in response to the predicted COD or varying a wastewater retention time in the EC reactor. The wastewater retention time in the EC reactor may be varied or adjusted and/or the current density of the EC reactor may be altered when the predicted COD of the influent wastewater is less than a COD of the effluent water.

[0018] Wastewater treatment may involve the passage of a contaminated wastewater stream through a system including an electrocoagulation (EC) device. Referring to FIG. 1, a schematic illustration depicts a wastewater treatment system 100 for

responsive electrocoagulation wastewater processing in accordance with present embodiments. The system 100 includes an influent tank 110, an effluent tank 120, an electrocoagulation reactor 130, a pump 140 for moving the wastewater through the system 100 from the influent tank 110 to the effluent tank 120, in-line water quality sensors 150, and a main control panel 160 for controlling the process and responsive treatment of the wastewater. In accordance with the present embodiments, in-line water quality sensors 150 measure various characteristics or parameters of the influent wastewater and include at least a potential of hydrogen (pH) sensor 152, a Total Suspended Solids (TSS) sensor 154 and a Total Dissolved Solids (TDS) sensor 156.

[0019] The electrocoagulation (EC) reactor 130 includes an electrolytic cell with one or more pairs of conductive metal plates arranged in a vertical stacked configuration. Each such pair includes a plate which acts as a cathode electrode and another plate which acts as an anode electrode. The cathode and anode electrodes are submerged in the wastewater to be treated. The anode may be fabricated to include iron, steel, stainless steel, aluminium, titanium, titanium alloy or other valve metal substrates. In accordance with the present embodiments, the anode and cathode electrodes are connected in monopolar configuration to a power supply via the main control panel 160.

[0020] When electric current is applied to the electrolytic cell, the anode material will begin to electrochemically dissolve or erode due to oxidation at the anode surface, while the cathode surface will be subjected to passivation and will not dissolve. The dissolving anode is called a "sacrificial electrode." The sacrificial electrode continuously releases ions, such as aluminium or iron ions, into the water. The released ions destabilize the charge of suspended contaminants in the wastewater stream. This destabilization process initiates a coagulation process by producing aggregates or

flocculant particles that are nucleation sites for the contaminants that then drop out of solution. These flocculant particles or flocs are managed either by flotation or gravitational settling in a chamber or in a bath of an electrolyte.

[0021] The main control panel 160 provides power to the pump 140 to move the wastewater through the system and to the electrocoagulation reactor 130 for operation thereof as described hereafter. A processing means, such as a controller or processor, is coupled to the main control panel 160 and the sensors 150 for selectively providing power to control the electrocoagulation reactor 130 (e.g., by providing varying current levels or current densities to the electrocoagulation reactor 130 for operation in accordance with the present embodiments) and the pump 140 for automated responsive electrocoagulation wastewater processing in accordance with the present embodiments. The processing means can be part of the main control panel 160 or may be coupled to the wastewater treatment system 100 via the main control panel for automated operation of the wastewater treatment system 100 in accordance with the present embodiments (e.g., the processing means may be wirelessly coupled to the main control panel 160 and the sensors 150 for operational control and wastewater monitoring in accordance with the present embodiments).

[0022] High strength food and beverage wastewater was used for validation of a model of the EC reactor 130 and characteristics/parameters of the high strength food and beverage wastewater are summarized in Table 1 where chemical oxygen demand (COD) is the amount of dissolved oxygen that must be present in water to oxidize chemical organic materials and TSS is the total suspended solids. The presence of suspended particles in in the wastewater (or turbidity) is measured in nephelometric turbidity units (NTU) and BOD5 is the level of biodegradability measured as biological oxygen demand over 5 days (BOD5).

Parameters	values
COD (mg/L)	3200
TSS (mg/L)	1180
Turbidity (NTU)	970
pH	6.1
BOD5	2700

TABLE 1

[0023] Chemical oxygen demand (COD) is an important parameter because the COD parameter provides a globally recognized assessment of water quality. The higher the COD value, the higher the organic matter in the water which is essentially oxygen consumed by chemicals. However, in real-time situations, manual monitoring of COD continuously is difficult due to grab sampling and testing duration. There are a multitude of reasons for needing to measure COD continuously. For example, continuous monitoring is often required where there is a lack of resources and manpower to provide routine grab samples. In addition, continuous COD measurement enables efficient detection of spikes or fluctuations in COD thereby improving responsiveness in a wastewater treatment plant, in a process control or in the environment to sudden changes or fluctuations in oxygen demand. In addition, continuous COD monitoring facilitates real-time control and process optimization as the continuous data monitoring can help identify where process conditions are distressed to either aid decision making or automatic control. Further, continuous COD monitoring and optimization of water treatment plants improves performance and conformance making it possible to directly match incoming loads to wastewater treatment plants.

[0024] Referring to FIG. 2, a flowchart 200 depicts an exemplary process performed by the processing means of the wastewater treatment system 100 in accordance with the present embodiments for continuous COD monitoring to provide real-time automated control of the electrocoagulation reactor 130 for robust and optimal operation of the wastewater treatment system 100 and responsive electrocoagulation wastewater treatment in accordance with the present embodiments. The process begins by using water quality measurements 202 taken before the process to create a model 204 to predict initial COD. Two datasets 206 are used to train the model 208, the two datasets including (a) COD versus time in different pH levels at a constant current density (an example at a constant current density of 7 mA/cm^2 is seen in the graph of FIG. 3A) and (b) COD versus time in different current density levels at a constant pH (an example at a constant pH level of 9 is seen in the graph of FIG. 3B). Then the data is fit 210 to the requisite functions.

[0025] Next, initial water quality parameter values are inputted 212 including an initial COD level, a source water pH, a target COD, target retention time, a source water TSS and a bias value corresponding to the source water. The water quality is then monitored 214 during the wastewater treatment by the sensors 150 and a model is generated 216 for COD prediction from continuous monitoring of values of the initial water quality parameters during the wastewater treatment. For example, COD may be predicted from the TSS parameter through a correlation developed based on batch experiments for specific types of wastewater as discussed hereinafter. Using the predicted COD from the model 216 optimizes responsive wastewater treatment in accordance with the present embodiments, and the COD is predicted 216 during the wastewater treatment process utilizing real-time monitoring of water quality during the treatment process. Then, after some processing, the measured COD values are

compared to the predicted target COD level 218 by the processing means to determine whether to use the predicted target COD from the model 216. If the measured COD is greater than or equal to the target COD 218, a difference between the measured COD and the predicted target COD is calculated 220 and, since the predicted COD value is used to provide operational control signals to the EC reactor 130, the current density of the EC reactor 130 is adjusted 222 in response to the calculated difference 220 and/or another operating parameter of the EC reactor 130 is altered (e.g., retention time of the wastewater in the EC reactor 130). If the measured COD is less than the target COD 218, the process is continued and a user-determined time is set 224 before rechecking the predicted COD.

[0026] The COD prediction function 216 is used 226 and the adjusted current density and/or retention time 222 or the initial current density and/or retention time 212 are outputted 228 from the processing means to the EC reactor 130 for operational control thereof depending on the relation of the measured COD value and the predicted target COD value 218. The EC reactor 130 operating condition variation mainly includes current variation to adjust current density in the EC reactor and/or retention time as well as potentially any other adjustable variable. The processing means controls operation of the EC reactor 130 for automated responsive wastewater treatment in accordance with the present embodiments and the operating condition for the automated responsive wastewater treatment as seen from the flowchart 200 is obtained based on a first order rate constant determined based on batch experiments from the datasets inputted at step 206. The operating condition is then predicted by making use of the current prediction function 226 and water quality after the process. Retention time can also be predicted with the use of a different function, and the predicted current density or retention time will automatically change the system and update the process due to decision step 218

and adjustments 222 such that the systems and methods in accordance with the present embodiments enable the water quality level to meet the target COD even if the wastewater quality parameters may change (within a reasonable range). Thus, the systems and methods in accordance with the present embodiments are advantageously used to achieve automated responsive wastewater treatment by an electrocoagulation treatment process.

[0027] By considering a base condition of pH and current density 206 to train the responsive treatment model 208, a base COD removal rate (using a first order decay model) can be obtained for each specific source. Hence, keeping the pH constant and variating the current density can evaluate the effect of current density on removal rate as shown in the graph of FIG. 3B. Similarly, keeping the current density constant and changing the pH values can describe the effects of pH on removal rate as shown in the graph of FIG. 3A.

[0028] Based on the information obtained 206, two separated models 216 were generated to correlate COD removal rates with pH and current density, respectively. And based on the real pH values obtained from a sensor installed at the influent of the EC reactor 130, the base COD removal rate was predicted using the model generated. By having the initial COD values 212 and specifying the target value for COD after the treatment process 216, the required COD removal rate can be obtained using a first order decay model equation. The required COD decay rate can advantageously and responsively be achieved by either changing the current density or retention time and the COD decay rate can be decided based on less energy consumption or feasibility of implementing such changes in the system 100, thereby providing an electrocoagulation-based wastewater treatment system which automatedly and responsively optimizes its operation.

[0029] Accordingly, the pH and current data in addition to COD time-series obtained from forty-minute experiments were read (an exemplary set is presented in Table 2 presented hereinafter), plotted (as seen in the graphs of FIGs. 3A and 3B wherein FIG. 3A depicts a graph of COD versus time for various pH levels when current density is 7 ma/cm^2 and FIG. 3B depicts a graph of COD versus time for various current density levels when pH is 9), stored in arrays to determine the rate, and then fitted to an exponential equation to train the models necessary to perform the COD prediction in accordance with the present embodiments.

[0030] The graphs of FIGs. 4A to 4E, depict graphs of the correlation between pH and COD removal rate using a linear equation for different sources in accordance with the present embodiments where the pH rate was fitted to the linear equation. FIG. 4A depicts a graph of the pH and COD correlation rate for commercial laundry wastewater which is also summarized in Table 2 below. FIG. 4B depicts a graph of the pH and COD correlation rate for high strength rust cleaning wastewater also summarized in Table 2 below. FIG. 4C depicts a graph of the pH and COD correlation rate for low strength rust cleaning wastewater which is also summarized in Table 2 below. FIG. 4D depicts a graph of the pH and COD correlation rate for a food and beverage outlet wastewater, the datapoints summarized in Table 2 below. And FIG. 4E depicts a graph of the pH and COD correlation rate for cooling tower reused water which is addressed in Table 2 below.

[0031] The current rate was then fitted to a linear equation. The graphs of FIGs. 5A to 5E depict graphs of the correlation between current density and COD removal rate using a linear equation for different sources in accordance with the present embodiments where the current rate was fitted to the linear equation. FIG. 5A depicts a graph of the current density and COD correlation rate for the commercial laundry

wastewater, FIG. 5B depicts a graph of the current density and COD correlation rate for the high strength rust cleaning wastewater, FIG. 5C depicts a graph of the current density and COD correlation rate for the low strength rust cleaning wastewater, FIG. 5D depicts a graph of the current density and COD correlation rate for the food and beverage outlet wastewater, and FIG. 5E depicts a graph of the current density and COD correlation rate for cooling tower reused water.

[0032] The variables were then inputted (e.g., at step 212 of the flowchart 200): initial COD, pH, Target COD, Retention Time, and bias to obtain predicted COD values. The predicted COD values often differ from the actual COD values. By analyzing the values predicted by the model in accordance with the present embodiments and the actual values specifically for each source, a bias can be defined individually for different sources. The bias essentially allows the model to take the predicted-actual discrepancy into account.

[0033] As seen in the bar graphs of FIGs. 6A to 6E, the current that was required to meet the target COD was determined with the use of the first-order kinetic model and predicted COD values and measured final COD after treatment processes for different sources were plotted for different current density values and different pH values in accordance with the present embodiments. FIG. 6A depicts a bar graph of the predicted versus the measured final COD values for bioenergy wastewater, such as commercial laundry wastewater. FIG. 6B depicts a bar graph of the predicted versus the measured final COD values for cooling tower reused water. FIG. 6C depicts a bar graph of the predicted versus the measured final COD values for food and beverage outlet wastewater. FIG. 6D depicts a bar graph of the predicted versus the measured final COD values for the high strength rust cleaning wastewater. And FIG. 6E depicts a bar graph of the predicted versus the measured final COD values for low range rust cleaning

wastewater. Table 2 summarizes example data from the various wastewater sources for the effects of pH and current density on COD removal rate.

No.	Source	pH	Current Density (mA/cm2)	COD Removal Rate (1/min)
1	Laundry wastewater	5	5	0.4111
2	Laundry wastewater	7	5	0.4206
3	Laundry wastewater	9	5	0.4418
4	Laundry wastewater	9	3	0.4103
5	Laundry wastewater	9	5	0.4263
6	Laundry wastewater	9	7	0.4343
7	Laundry wastewater	9	10	0.4458
8	High strength rust cleaning wastewater	3	7	0.0124
9	High strength rust cleaning wastewater	5	7	0.0255
10	High strength rust cleaning wastewater	7	7	0.0435
11	High strength rust cleaning wastewater	9	7	0.0573
12	High strength rust cleaning wastewater	9	3	0.0322
13	High strength rust cleaning wastewater	9	5	0.0383
14	High strength rust cleaning wastewater	9	7	0.0579
15	High strength rust cleaning wastewater	9	10	0.0607
16	Low strength rust cleaning wastewater	3	7	0.0120
17	Low strength rust cleaning wastewater	5	7	0.0255
18	Low strength rust cleaning wastewater	7	7	0.0435
19	Low strength rust cleaning acid wastewater	9	7	0.0573
20	Low strength rust cleaning wastewater	9	3	0.0322
21	Low strength rust cleaning wastewater	9	5	0.0383

22	Low strength rust cleaning wastewater	9	7	0.0579
23	Low strength rust cleaning wastewater	9	10	0.0607
24	Food and beverage wastewater	3	7	0.0120
25	Food and beverage wastewater	5	7	0.0255
26	Food and beverage wastewater	7	7	0.0435
27	Food and beverage wastewater	9	7	0.0573
28	Food and beverage wastewater	9	3	0.0322
29	Food and beverage wastewater	9	5	0.0383
30	Food and beverage wastewater	9	7	0.0579
31	Food and beverage wastewater	9	10	0.0607
32	Cooling tower reuse wastewater	3	5	0.0124
33	Cooling tower reuse wastewater	5	5	0.0265
34	Cooling tower reuse wastewater	7	5	0.0425
35	Cooling tower reuse wastewater	9	5	0.0576
36	Cooling tower reuse wastewater	7	3	0.0320
37	Cooling tower reuse wastewater	7	5	0.0392
38	Cooling tower reuse wastewater	7	7	0.0590
39	Cooling tower reuse wastewater	7	10	0.0603

TABLE 2

[0034] The Pearson's correlation coefficient (R) values in the graphs of FIGs. 6A to 6E are all above 0.95 which indicates that the predicted values are close to the measured COD values. In addition, the mean absolute error (MAE) values for each waste water source in the graphs of FIGs. 6A to 6E is not more than 10% of the initial COD values

which further reinforces the minimal difference between the predicted and measured COD values. Across each waste water source, it is evident that the measured COD values were close to the predicted COD values.

[0035] Thus, it can be seen that the present embodiments provide systems and methods for automated responsive electrocoagulation-based waste water treatment that readily adjusts operating parameters such as current density, retention time with respect to the influent wastewater characteristics or parameters. In accordance with the present embodiments, a system and a method is provided which provides improved waste water treatment using automated real-time adjustment of the parameters of electrocoagulation based on continuous monitoring and prediction of chemical oxygen demand (COD). The prediction of COD is based on monitoring of water quality parameters of the influent waste water and a difference between the predicted COD calculated after the electrocoagulation process and the target predicted COD values calculated before the electrocoagulation process is used to adjust/vary the operational parameters of the electrocoagulation process, such as current density of the electrocoagulation reactor and retention time of the waste water in the electrocoagulation reactor. In accordance with the present embodiments, the electrocoagulation reactor can advantageously provide a COD efficiency removal rate of greater than 70%.

[0036] While exemplary embodiments have been presented in the foregoing detailed description of the present embodiments, it should be appreciated that a vast number of variations exist. It should further be appreciated that the exemplary embodiments are only examples, and are not intended to limit the scope, applicability, operation, or configuration of the invention in any way. Rather, the foregoing detailed description will provide those skilled in the art with a convenient road map for implementing exemplary embodiments of the invention, it being understood that various changes may

be made in the function and arrangement of steps and method of operation described in the exemplary embodiments without departing from the scope of the invention as set forth in the appended claims.

CLAIMS

What is claimed is:

1. A system for waste water treatment comprising:

an electrocoagulation (EC) reactor for processing influent waste water;

one or more sensors for monitoring water quality parameters of the influent waste water; and

processing means coupled to the one or more sensors for determining a predicted chemical oxygen demand (COD) in response to the monitored parameters of the influent wastewater, and wherein the processing means is coupled to the electrocoagulation reactor for controlling operation thereof in response to the predicted COD.

2. The system in accordance with Claim 1 wherein the processing means controls operation of the EC reactor by altering a current density of the EC reactor in response to the predicted COD.

3. The system in accordance with either Claim 1 and Claim 2 wherein the processing means controls operation of the EC reactor by varying a wastewater retention time in the EC reactor in response to the predicted COD.

4. The system in accordance with any of Claims 1 to 3 wherein the one or more sensors comprise a total suspended solids (TSS) sensor, and wherein the processing means further determines the predicted COD in response to a total suspended solids parameter of the influent wastewater monitored by the TSS sensor.

5. The system in accordance with any of Claims 1 to 4 wherein the one or more sensors further comprise a potential of hydrogen (pH) sensor and/or a total dissolved solids (TDS) sensor, and wherein the processing means further determines the predicted COD in response to either or both of a pH parameter of the influent wastewater monitored by the pH sensor, or a total dissolved solids parameter monitored by the TDS sensor.

6. The system in accordance with any of Claims 1 to 5 further comprising a power supply coupled to the EC reactor, wherein the processing means is coupled to the power supply for controlling a current and a voltage supplied to the EC reactor for operation thereof in response to the predicted COD.

7. The system in accordance with any of Claims 1 to 6 wherein the processing means controls operation of the EC reactor by comparing the predicted COD determined from the monitored water quality parameters of the influent wastewater and a calculated COD of the effluent water.

8. The system in accordance with Claim 7 wherein the processing means adjusts a current density of the EC reactor when the predicted COD determined from the monitored water quality parameters of the influent wastewater is less than the calculated COD of the effluent water.

9. The system in accordance with either Claim 7 or Claim 8 wherein the processing means adjusts a wastewater retention time in the EC reactor when the

predicted COD determined from the monitored water quality parameters of the influent wastewater is less than the calculated COD of the effluent water.

10. The system in accordance with any of Claims 7 to 9 wherein the processing means determines the predicted COD based on influent water quality parameters using a COD prediction model generated and trained in response to initial parameter values, wherein the initial parameter values include an initial COD level.

11. The system in accordance with Claim 10 wherein the initial parameter values further include one or more of a pH value of a water source, a target COD value, a EC reactor retention time, a total suspended solids (TSS) value, and a calculated bias value, wherein the calculated bias value is calculated on the difference between predicted and actual COD values in the water source.

12. A method for wastewater treatment comprising:

monitoring water quality parameters of influent wastewater;

determining a predicted chemical oxygen demand (COD) in response to the monitored parameters of the influent wastewater; and

controlling operation of an electrocoagulation reactor for processing the influent wastewater in response to the predicted COD.

13. The method in accordance with Claim 12 wherein controlling operation of the electrocoagulation (EC) reactor comprises controlling operation of the EC reactor by altering a current density of the EC reactor in response to the predicted COD.

14. The method in accordance with either Claim 12 and/or Claim 13 wherein controlling operation of the EC reactor comprises controlling operation of the EC reactor by varying a wastewater retention time in the EC reactor in response to the predicted COD.

15. The method in accordance with any of Claims 12 to 14 wherein monitoring water quality parameters of the influent wastewater comprises monitoring a total suspended solids (TSS) parameter of the influent wastewater, and wherein determining the predicted COD comprises determining the predicted COD further in response to the TSS parameter of the influent wastewater.

16. The method in accordance with any of Claims 12 to 15 wherein monitoring water quality parameters of the influent wastewater further comprises monitoring a potential of hydrogen (pH) parameter of the influent wastewater of the influent wastewater, and wherein determining the predicted COD comprises determining the predicted COD further in response to the pH parameter of the influent wastewater.

17. The method in accordance with any of Claims 12 to 16 wherein monitoring water quality parameters of the influent wastewater further comprises monitoring a total dissolved solids (TDS) parameter of the influent wastewater, and wherein determining the predicted COD comprises determining the predicted COD further in response to the TDS parameter of the influent wastewater.

18. The method in accordance with any of Claims 12 to 17 wherein controlling operation of the EC reactor comprises controlling operation of the EC reactor by

comparing the predicted COD determined from monitoring the water quality parameters of the influent wastewater and a calculated COD of the effluent water.

19. The method in accordance with Claim 18 wherein controlling operation of the EC reactor comprises adjusting a current density of the EC reactor when the predicted COD determined from the monitored water quality parameters of the influent wastewater is less than the calculated COD of the effluent water.

20. The method in accordance with Claim 18 or Claim 19 wherein controlling operation of the EC reactor comprises adjusting a wastewater retention time in the EC reactor when the predicted COD determined from the monitored water quality parameters of the influent wastewater is less than the calculated COD of the effluent water.

21. The method in accordance with any of Claims 18 to 20 wherein determining the predicted COD comprises determining the predicted COD based on the monitored parameters of the influent wastewater using a COD prediction model generated and trained in response to initial parameter values, wherein the initial parameter values include an initial COD level.

22. The method in accordance with Claim 21 wherein the initial parameter values further include one or more of a pH value of a water source, a target COD value, a EC reactor retention time, a total suspended solids (TSS) value, and a calculated bias value, wherein the calculated bias value is calculated on the difference between predicted and actual COD values in the water source.