(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
16 December 2004 (16.12.2004)

PCT

(10) International Publication Number
WO 2004/108608 A1

(51) International Patent Classification[7]: C02F 1/52

(21) International Application Number: PCT/KR2004/000955

(22) International Filing Date: 22 April 2004 (22.04.2004)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
10-2003-0038583 11 June 2003 (11.06.2003) KR
10-2003-0091090 15 December 2003 (15.12.2003) KR

(71) Applicant and
(72) Inventor: **HONG, Seong Soo** [KR/KR]; Hyundai I Park 103-1903, 99-10, Yongdang-dong, Nam-gu, Pusan 608-793 (KR).

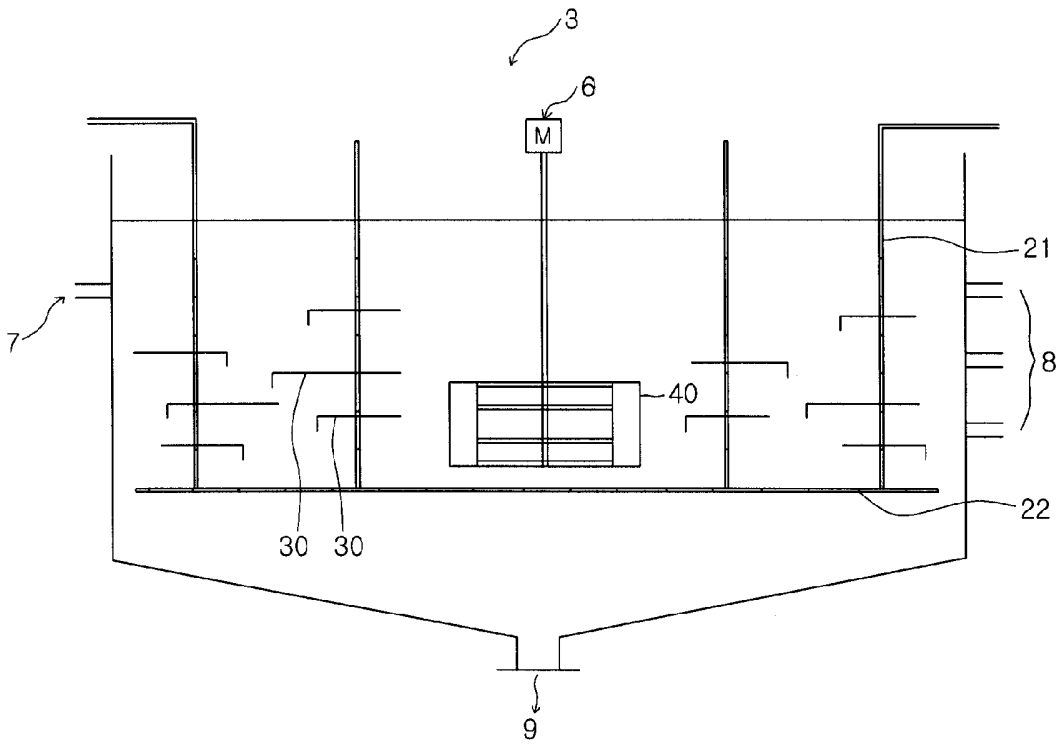
(74) Agent: **BAEG, Seung Jun**; Chungjo Building 301, 33-1 2-ka, Daechang-dong, Jung-gu, Pusan 600-102 (KR).

(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NA, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

[Continued on next page]

(54) Title: METHOD AND APPARATUS FOR TREATING WASTEWATER CONTAINING ORGANIC COMPOUND OF HIGH CONCENTRATION



(57) Abstract: The present invention discloses a method and apparatus for treating high concentration organic wastewater such as dyeing wastewater, leather wastewater, food wastewater and plating wastewater only by physical and chemical treatment, without secondary biochemical treatment.

WO 2004/108608 A1

Published:
— *with international search report*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

Description

METHOD AND APPARATUS FOR TREATING WASTEWATER CONTAINING ORGANIC COMPOUND OF HIGH CONCENTRATION

Technical Field

[1] The present invention relates to a method and apparatus for treating high concentration organic wastewater, and more particularly, to a method and apparatus for treating high concentration organic wastewater such as dyeing wastewater, leather wastewater, food wastewater and plating wastewater containing high-concentration organic compounds only by chemical treatment, without biochemical treatment and advanced treatment, to thereby simplify a wastewater treatment system and shorten wastewater treatment time.

[2] Particularly, the present invention relates to a treatment of high concentration organic wastewater in a single reaction tank, characterized in that wastewater is treated with chemicals in the order of acid treatment, neutralization and alkali treatment to remove high concentration organic compounds contained in the wastewater, whereby it is possible to shorten the treatment time of wastewater as compared to general chemical treatments, and reduce the scale of a wastewater treatment system to treat wastewater in the same quantity.

Background Art

[3] Generally, according to a conventional wastewater treatment, high-concentration organic wastewater is subjected to a primary neutralization treatment with an acid and a base and then, essentially to a secondary biological treatment of an activated sludge process, in which organic compounds are degraded and removed by microorganisms, to reduce chemical oxygen demand (COD), biological oxygen demand (BOD), total phosphorus (T-P) and total nitrogen (T-N). However, the method has problems in that: the microorganisms are apt to die when professional management of nutrient supply, pH, temperature and the like is not achieved; a primary treatment system needs various treatment tanks including mixing tank, neutralization tank, oxidation tank, reduction tank, reaction tank, coagulation tank, sediment tank, thickener and the like; at least 4 to 10 secondary aerators are required in proportion to a quantity to be treated; and it takes a long period of time of at least 15 to 40 hours for the entire treatment, causing enormous expense.

Disclosure of Invention

Technical Problem

[4] Therefore, in order to solve the foregoing problems, there have been filed numerous patents directed to methods for treating wastewater generated in livestock raising farms and industrial spots. As a representative example among them, Korean Patent Laid-Open publication No. 10-2003-40910, published on May 23, 2003 discloses a method for treating wastewater comprising neutralizing wastewater by adding a ferric sulfate and introducing sodium hydroxide, followed by stirring. This method has a problem in that a treatment system has to have a scale greater than a certain level to treat a large quantity of wastewater in a treatment tank of a limited scale, since the stirring process takes about 12 hours at the maximum.

Technical Solution

[5] Thus, the present invention has been made in order to solve the above-described problems, and it is an object to provide a method for treating wastewater containing high concentration organic compounds, characterized by treating wastewater containing organic compounds only by a primary physical and chemical treatment to reduce the enormous investment cost of equipment, high management expense and long treatment time for a secondary activated sludge treatment.

[6] It is another object of the present invention to provide a method for treating wastewater containing high concentration organic compounds in a single reaction tank, characterized by treating wastewater chemicals in an order of acid treatment, neutralization, alkali treatment to remove high concentration organic compounds in the wastewater, whereby it is possible toshorten the treatment time, as compared to general chemical treatments, and hence, reducethe scale of a wastewater treatment system.

[7] It is a yet another object of the present invention to provide an apparatus for treating wastewater containing high concentration organic compounds, characterized by comprising vertical diffusers installed at regular intervals in every direction in a single reaction tank, in which the diffusers are formed integrally with diaphragms which can control an ascending current of bubbles generated in the diffuser so that air diffused by a base diffuser rises to the water surface while being interfered with the ascending of bubbles by the diaphragms, whereby oxygen can be dissolved at the maximum in wastewater.

[8] It is a further object of the present invention to provide an apparatus for treating wastewater containing high-concentration organic compounds, characterized in that holes on a vertical diffuser are uniformly arranged in the clockwise or counter-

clockwise direction so that wastewater in a reaction tank flows in the clockwise or counterclockwise direction by air bubbles generated through the holes during aeration, whereby the stirring of wastewater is effected by aeration.

Advantageous Effects

[9] As described above, according to the present invention, by treating wastewater containing high-concentration organic compounds only by a primary physical and chemical treatment, it is possible to reduce enormous investment cost of equipment and high management expense for a secondary activated sludge treatment. Also, by omitting a biological treatment for a long period of time, it is possible to reduce the treatment time of wastewater.

[10] Particularly, according to method for chemically treating wastewater in a single reaction tank, since the high-concentration organic compounds contained in wastewater are treated in an order of acid treatment, neutralization and alkali treatment, it is possible to perform the treatment of wastewater in a shorter period of time than a general chemical treatment of wastewater and to reduce the treatment time of wastewater in the same volume as compared to a general chemical treatment of wastewater and the scale of a treatment system.

[11] Also, since the apparatus for treating wastewater according to the present invention comprises vertical diffusers installed at regular intervals in every direction in a single reaction tank which are formed integrally with diaphragms capable of controlling a rising current of air bubbles generated in a base diffuser at the lower part of the reaction tank, the air bubbles diffused from the base diffuser rise to the surface while being hindered by the diaphragms, whereby oxygen can be dissolved at the maximum in wastewater. Also, since the holes formed on the vertical diffuser are arranged in one direction, the wastewater in the reaction tank flows in whirls, thereby increasing treatment efficiency of wastewater by stirring effect.

Description of Drawings

[12] Further objects and advantages of the invention can be more fully understood from the following detailed description taken in conjunction with the accompanying drawings in which:

[13] Fig. 1 is a view showing the whole construction of the apparatus for treating wastewater according to the present invention;

[14] Fig. 2 is a cross-sectional view of a reaction tank according to the present invention;

[15] Fig. 3 is a perspective view of an agitator equipped with a plurality of impellers

installed in the reaction tank according to the present invention;

[16] Fig. 4 is a perspective view of a vertical diffuser integrally formed with a plurality of diaphragms installed in the reaction tank according to the present invention;

[17] Fig. 5 is a plane view of a vertical diffuser integrally formed with a plurality of diaphragms installed in the reaction tank according to the present invention; and

[18] Fig. 6 is a perspective view of one side plate forming the diaphragm according to the present invention.

Best Mode

[19] According to the present invention, the above objects are achieved as follows.

[20] The present invention is directed to a method and apparatus for treating wastewater containing high-concentration organic compounds in a single reaction tank in a shortened period of treatment time comprising: an acid digestion treatment of high-concentration organic compounds contained in wastewater by introducing sulfuric acid or hydrochloric acid to wastewater to adjust pH of wastewater to 2 to 3; a neutralization of wastewater by introducing $CaSO_4$ salt in a paste state; an alkali digestion treatment of high-concentration organic compounds contained in wastewater by introducing calcium hydroxide or sodium hydroxide to wastewater to adjust pH of wastewater to 10 to 11.

[21] Firstly, the method for treating wastewater containing high-concentration organic compounds according to the present invention is described in detail.

[22] The method for treating wastewater containing high-concentration organic compounds according to the present invention includes the steps of:

[23] i) passing wastewater containing high-concentration organic compounds through a screen to remove floating matters and foreign materials from the wastewater, collecting the wastewater in a storage tank and transporting the wastewater to a batch type reaction tank;

[24] ii) introducing sulfuric acid or hydrochloric acid to the wastewater transported to the reaction tank in the step i), while aerating, to adjust pH of the wastewater to 2 to 3 for an acid digestion of high-concentration organic compounds contained in wastewater;

[25] iii) adsorbing contaminants with an adsorbent of activated charcoal by introducing activated charcoal in an amount of 0.3 to 1.5 g/ℓ to the wastewater acid-digested in the step ii) in accordance with a concentration of the wastewater, while aerating;

[26] iv) preparing $CaSO_4$ salt in the paste state by introducing 93% $Ca(OH)_2$ to 10% H_2SO_4 in a rate of 5 : 1 so that $Ca(OH)_2$ is supersaturated;

[27] v) neutralizing the wastewater treated in the step iii) by introducing $CaSO_4$ salt in the paste sate prepared in the step iv) in an amount of 0.4 to 2.4 ml /ℓ;

[28] vi) introducing calcium hydroxide or sodium hydroxide to the wastewater neutralized in the step v), while aerating, to adjust pH of the wastewater to 10 to 11 for an alkali treatment of the high-concentration organic compounds contained in wastewater;

[29] vii) introducing a coagulant of aluminum sulfate ($Al_2(SO_4)_3.18H_2O$) in an amount of 0.3 to 3.5g/ℓ to the wastewater alkalized in the step vi), followed by aerating for 10 to 30 minutes;

[30] viii) neutralizing the wastewater treated in the step vii) by adding sulfuric acid while aerating, introducing a polymer coagulant in an amount of 5.0 to 30.0 g/ m^3 and stirring at a high speed of 150 to 300rpm for 2 minutes to 10 minutes and then at a low speed of 40 to 80 rpm for 0.5 minutes to 2 minutes to coagulate the high-concentration organic compounds and grow flocs; and

[31] ix) sedimenting the flocs contained in the wastewater treated in the step viii), discharging the treated supernatant, transporting the sedimented flocs to a sludge thickener, followed by solid-liquid separation with a dehydrator.

[32] The adsorbent used in the step iii) is to remove heavy metal ions, colorants and organic compounds and may be one or more selected from diatomite, zeolite, bentonite and the like in accordance with properties of wastewater to be treated, with activated carbon being preferred.

[33] The amount of the activated carbon varies according to components and concentrations of contaminants contained in wastewater to be treated and is preferably 0.3 to 1.5 g/ℓ. When it is less than 0.3 g/ℓ, the adsorption of contaminants contained in the wastewater becomes poor, while when it exceeds 1.5 g/ℓ, the economical efficiency is deteriorated due to excessive addition of activated carbon.

[34] Also, the amount of $CaSO_4$ salt added in the step v) is preferably 0.4 to 2.4 ml /ℓ. When it is out of the foregoing range, the coagulation effect of the high-concentration organic compounds contained in wastewater becomes deteriorated.

[35] The coagulant used in the step vii) is aluminum sulfate ($Al_2(SO_4)_3.18H_2O$) and is preferably added in an amount of 0.3 to 3.5g/ℓ. When its added amount is less than the foregoing range, the coagulation effect becomes deteriorated, while when it exceeds the foregoing range, the coagulation effect is not proportionate to the increase of the added amount of aluminum sulfate.

[36] The coagulant used in the present invention is most preferably aluminum sulfate

but may be ferrous sulfate, ferric sulfate, ferric chloride and the like. Particularly, aluminum sulfate is known to be suitable for purification by coagulation and sediment of suspended matters in muddy water generated during collection of raw water for municipal water supply and may be used in dyeing wastewater to remove COD from dyes. The ferric sulfate ($FeCl_3.6H_2O$) is cheap and works similarly to aluminum sulfate, but has a problem in that it is seldom dehydrated.

[37] The polymer coagulant used in the step viii) has the effect of growing flocs and may be added to form large-sized flocs when flocs are not sufficiently formed or sedimented after a coagulant is used. Polyacrylamide may be used. Such polymer coagulant is effective in wastewater which cannot be treated only by aluminum sulfate. The added coagulant is not crystallized but aluminum may form precipitation. Also, polymer coagulant has advantages of no pH change, improvement of dehydration and no ion increase. Further, it is hardly affected by co-existing salts and temperature.

[38] The polymer coagulant which can be used in the present invention may be one or more selected from cationic polymer coagulants and nonionic polymer coagulants such as polyacrylamide and polyethyleneoxide, and anionic polymer coagulants such as a copolymer of acrylamide and sodium acrylate and a mannich modified product of polyacrylamide.

[39] The added amount of the polymer coagulant according to the present invention is preferably 5.0 to 30.0 g/ m^3 . When the amount is less than the foregoing range, the co-agulation is deteriorated, while when it exceeds the foregoing range, the coagulation efficiency is not proportionate to the increase of polymer coagulant.

[40] In the step viii), the stirring is performed firstly at a high speed so that the polymer coagulant introduced to wastewater can be sufficiently mixed with the high-concentration organic compounds contained in wastewater at the maximum and then at a low speed so that the formed flocs can grow without break.

[41] Now, the apparatus for treating wastewater according to the present invention will be explained in further detail with reference to the drawings.

[42] Fig. 1 shows the whole construction of the apparatus for treating wastewater according to the present invention, which comprises a screen 1 for filtering floating matters contained in wastewater, a wastewater storage tank 2 for collecting wastewater, reaction tanks 3, 3', 3' for reacting high-concentration organic compounds contained in wastewater with an acid or base, a sludge thickener 4 for thickening sludge produced in the reaction tanks and a dehydrator 5 for dehydrating the thickened sludge, like a general apparatus for the treatment of wastewater.

[43] The reaction tanks 3, 3', 3' are each a single reaction tank of a batch type. Meanwhile, the reaction tanks are not limitedly installed as the three reaction tanks 3, 3', 3', as shown in the drawing, but also can be installed in the proper number of less than 3 or more than 3 in accordance with capacity of wastewater to be treated.

[44] Fig. 2 is a cross-sectional view of a reaction tank according to the present invention. The reaction tanks 3, 3', 3' are each a single reaction tank having an agitator 6 installed at the center. Also, the single reaction tank is provided with diffusers for supplying air to wastewater introduced to the reaction tank. Concretely, the single reaction tank has a vertical diffuser 21 installed at regular intervals in every direction, which is integrally formed with a plurality of diaphragms 30 capable of controlling rising flow of bubbles diffused by a base diffuser 22.

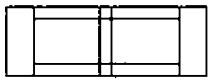
[45] The bottoms of the reaction tanks 3, 3', 3' are formed in an inclined direction to a sludge discharge port 9 for facilitating the discharge of the coagulated and sedimented sludge.

[46] One of the features of the present invention is that the air bubbles diffused by the base diffuser 22 collide with diaphragms 30 while rising up and are broken into numerous fine bubbles. Consequently, the contact area between the bubbles and wastewater is increased and a maximized amount of oxygen can be dissolved in wastewater due to delay of rising time of bubbles.

[47] As shown in Fig. 2, the diffuser is divided into the base diffuser 22 for diffusing air bubbles at the base part of the reaction tank and the vertical diffuser 21 formed integrally with a plurality of diaphragms 30. Both the base diffuser 22 and the vertical diffuser 21 have holes formed at regular intervals for diffusing air bubbles. The number of the vertical diffusers 21 installed in the reaction tank is determined in accordance with the capacity of the reaction tank and properly installed at regular intervals in every direction in the reaction tank.

[48] The holes formed on the vertical diffuser 21 uniformly arranged in the clockwise or counterclockwise direction so that wastewater in the reaction tank 3 flows in the clockwise or counterclockwise direction by air bubbles generated through the holes during aeration, whereby the stirring of wastewater is effected by aeration.

[49] Fig. 3 is a perspective view of an agitator equipped with a plurality of impellers installed in the reaction tank according to the present invention. The agitator 6 can perform a high speed stirring and a low speed stirring and each impeller 40 attached to the agitator 6 is formed in the shape of '



' to maximize the stirring effect of wastewater upon rotation of the impeller and the number and length of the impellers 40 attached to the agitator 6 is properly adjusted as required.

[50] Fig. 4 is a perspective view of a vertical diffuser integrally formed with a plurality of diaphragms installed in the reaction tank according to the present invention and Fig. 5 is a plane view of a vertical diffuser integrally formed with a plurality ofdiaphragms installed in the reaction tank according to the present invention, in which the diffuser is magnified for easiness of explanation. The vertical diffuser 21 according to the present invention is formed integrally with diaphragms 30, each being a one-sided plate spreading in 6 directions and crossly arranged at regular intervals on the vertical diffuser 21. The diaphragm 30 of a one-sided plate spreading in 6 directions has short arms and long arms alternately arranged. The length of the one side plate is properly adjusted in accordance with the capacity of the reaction tank.

[51] Fig. 6 is a perspective view of a one-sided plate forming the diaphragm according to the present invention. The diaphragm 30 has one end of the one side plate formed in the shape of '

[52] ㄱ

[53] ' to inhibit the rising of air bubbles at the maximum.

Mode for Invention

[54] Now, the method for treating dyeing wastewater, leather wastewater and food wastewater containing high-concentration organic compounds according to the present invention will be explained in detail by the following examples.

[55] [Example 1 to 3]

[56] The dyeing wastewater and leather wastewater were taken from wastewater of a representative factory and the food wastewater was taken from wastewater of a fish cake factory and each wastewater was directly used in the experiment on the spot. The wastewater subjected to an acid digestion treatment of high-concentration organic compounds contained in wastewater in a reaction tank by introducing sulfuric acid or hydrochloric acid to adjust pH of wastewater to 2 to 3 while aeration. Activated carbon as an adsorbent was added in an amount of 0.3 to 1.5 g/ℓ to remove contaminants. While aeration, a $CaSO_4$ salt in the paste state was added in an amount of 0.4 to 2.4 mℓ /ℓ, calcium hydroxide or sodium hydroxide was added to adjust pH of wastewater to 10 to 11 and aluminum sulfate was added in an amount of 0.3 to 3.5 g/ℓ. Then, the

wastewater was neutralized by adding sulfuric acid for 10 minutes to 30 minutes while aeration. Polymer A-floc A-101 (SEIN Co.) as an anionic polymer coagulant was added in an amount of about 5.0 to 30.0 g/ m^3 and stirred under an optimal condition for coagulation including a high speed stirring of 150 to 300 rpm for 2 minutes to 10 minutes and then a low speed stirring of 40 to 80 rpm for 0.5 minutes to 2 minutes to remove contaminants of the wastewater.

[57] Thus, the wastewaters of Example 1, 2 and 3 were treated according to the present invention and the results of the dyeing wastewater are shown in Table 1, the results of the leather wastewater are shown in Table 2 and the results of the food wastewater are shown in Table 3.

[58] In the tables, COD, BOD and SS among the emission standards are based on a company having a wastewater discharge per day of 2,000 m^3 or more in a GA region under Permissible Discharge Standards of the Enforcement Regulations [5] of the Korean Environment Protection Law and total phosphorus and total nitrogen are also based on the standards in a GA region under Permissible Discharge Standards of the Enforcement Regulations [5] of the Korean Environment Protection Law. The test method of each category was performed according to the provisions of the Standard Methods for the Examination of Water and Wastewater.

[59] [Table 1]

[60]

(unit; mg/ℓ)

Categories		COD	BOD	SS	Total nitrogen	Total phosphorus
Permissible discharge standard		70	60	60	60	8
Dyeing wastewater	Raw water	854	1,232	1,320	12	5
	Treated water	13	18	26	7.5	0.5

[61] [Table 2] .

[62]

(unit; mg/ℓ)

Categories		COD	BOD	SS	Total nitrogen	Total phosphorus
Permissible discharge standard		70	60	60	60	8
Leather wastewater	Raw water	1,196	1,493	1,826	295	11
	Treated water	51	46	31	18	2.4

[63] [Table 3]

[64]

(unit; mg/ℓ)

Categories		COD	BOD	SS	Total nitrogen	Total phosphorus
Permissible discharge standard		70	60	60	60	8
Food wastewater	Raw water	912	1,658	1,136	320	14
	Treated water	48	49	28	12	4.5

[65] As can be seen from the results, the dyeing wastewater, leather wastewater and food wastewater were treated within the Permissible Discharge Standards of COD, BOD and SS for a company having a wastewater discharge per day of 2,000 m^3 or more in a GA region under Permissible Discharge Standards of the Enforcement Regulations [5] of the Korean Environment Protection Law and total nitrogen and total phosphorus were also treated within the Permissible Discharge standards.

[66] Also, the treatment time of wastewater according to tent invention was within 2 hours and thus, the method for treating wastewater according to the present invention takes a shorter time than a general chemical treatment method of wastewater.

Industrial Applicability

[67] As described above, according to the present invention, by treating wastewater containing high-concentration organic compounds only by a primary physical and chemical treatment, it is possible to reduce enormous investment cost of equipment and high management expense for a secondary activated sludge treatment. Also, by omitting a biological treatment for a long period of time, it is possible to reduce the treatment time of wastewater.

[68] Particularly, according to method for chemically treating wastewater in a single reaction tank, since the high-concentration organic compounds contained in wastewater are treated in an order of acid treatment, neutralization and alkali

treatment, it is possible to perform the treatment of wastewater in a shorter period of time than a general chemical treatment of wastewater and to reduce the treatment time of wastewater in the same volume as compared to a general chemical treatment of wastewater and the scale of a treatment system.

[69] Also, since the apparatus for treating wastewater according to the present invention comprises vertical diffusers installed at regular intervals in every direction in a single reaction tank which are formed integrally with diaphragms capable of controlling a rising current of air bubbles generated in a base diffuser at the lower part of the reaction tank, the air bubbles diffused from the base diffuser rise to the surface while being hindered by the diaphragms, whereby oxygen can be dissolved at the maximum in wastewater. Also, since the holes formed on the vertical diffuser are arranged in one direction, the wastewater in the reaction tank flows in whirls, thereby increasing treatment efficiency of wastewater by stirring effect.

Claims

[1] A method for treating wastewater containing high-concentration organic compounds, comprises the steps of:

i) passing wastewater containing high-concentration organic compounds through a screen to remove floating matters and foreign materials from the wastewater, collecting the wastewater in a storage tank and transporting the wastewater to a batch type reaction tank;

ii) introducing sulfuric acid or hydrochloric acid to the wastewater transported to the reaction tank in the step i), while aerating, to adjust pH of the wastewater to 2 to 3 for an acid digestion of high-concentration organic compounds contained in wastewater;

iii) adsorbing contaminants with an adsorbent of activated charcoal by introducing activated charcoal in an amount of 0.3 to 1.5 g/ℓ to the wastewater acid-digested in the step ii) in accordance with a concentration of the wastewater, while aerating;

iv) preparing $CaSO_4$ salt in the paste state by introducing 93% $Ca(OH)_2$ to 10% H_2SO_4 in a rate of 5 : 1 so that $Ca(OH)_2$ is supersaturated;

v) neutralizing the wastewater treated in the step iii) by introducing $CaSO_4$ salt in the paste sate prepared in the step iv) in an amount of 0.4 to 2.4 mℓ /ℓ;

vi) introducing calcium hydroxide or sodium hydroxide to the wastewater neutralized in the step v), while aerating, to adjust pH of the wastewater to 10 to 11 for an alkali treatment of the high-concentration organic compounds contained in wastewater;

vii) introducing a coagulant of aluminum sulfate ($Al_2(SO_4)_3.18H_2O$) in an amount of 0.3 to 3.5g/ℓ to the wastewater alkalized in the step vi), followed by aerating for 10 to 30 minutes;

viii) neutralizing the wastewater treated in the step vii) by adding sulfuric acid while aerating, introducing a polymer coagulant in an amount of 5.0 to 30.0 g/ m^3 and stirring at a high speed of 150 to 300rpm for 2 minutes to 10 minutes and then at a low speed of 40 to 80 rpm for 0.5 minutes to 2 minutes to coagulate the high-concentration organic compounds and grow flocs; and

ix) sedimenting the flocs contained in the wastewater treated in the step viii), discharging the treated supernatant, transporting the sedimented flocs to a sludge thickener, followed by solid-liquid separation with a dehydrator.

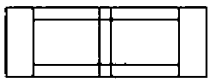
[2] The method according to claim 1, wherein the adsorbent used in the step iii) is one or more selected from diatomite, zeolite and bentonite.

[3] The method according to claim 1, wherein the coagulant used in the step vii) is one selected from ferrous sulfate, ferric sulfate and ferric chloride.

[4] The method according to claim 1, wherein the polymer coagulant used in the step viii) is one or more selected from a cationic polymer coagulant and nonionic polymer coagulant of polyacrylamide and polyethyleneoxide and an anionic polymer coagulant of a copolymer of acrylamide and sodium acrylate and a mannich modified product of polyacrylamide.

[5] An apparatus for treating wastewater containing high-concentration organic compounds, which comprises a screen 1 for filtering floating matters contained in wastewater, a wastewater storage tank 2 for collecting wastewater, reaction tanks 3, 3', 3' for coagulating and sedimenting high-concentration organic compounds contained in wastewater by addition of an acid or base, a sludge thickener 4 for thickening sludge produced in the reaction tanks and a dehydrator 5 for dehydrating the thickened sludge,
wherein the reaction tanks 3, 3', 3' are each a single reaction tank of a batch type which has an agitator 6 installed at the center thereof and is provided with diffusers for supplying air to wastewater introduced to the reaction tank, wherein the diffusers include a vertical diffuser 21 which is installed at regular intervals in every direction and integrally formed with a plurality of diaphragms 30 capable of controlling rising flow of bubbles diffused by a base diffuser 22, and the bottoms of the reaction tanks 3, 3', 3' are formed in an inclined direction to a sludge discharge port 9 for facilitating the discharge of the coagulated and sedimented sludge.

[6] The apparatus according to claim 5, wherein the agitator 6 performs both a high speed stirring and a low speed stirring and each impeller 40 attached to the agitator 6 is formed in the shape of '



' to maximize the resistance against wastewater upon rotation of the impeller.

[7] The apparatus according to claim 5, wherein the vertical diffuser 21 integrally formed with the diaphragms 30 comprises one side plates spreading in 6 directions which are crossly arranged at regular intervals on

the vertical diffuser 21 and each diaphragm 30 of the one side plate spreading in 6 directions has short arms and long arms alternately arranged.

[8] The apparatus according to claim 5, wherein the reaction tanks 3, 3', 3' are not limitedly installed in the number of 3 but also can be installed in the proper number of less than 3 or more than 3 in accordance with capacity of wastewater to be treated.

[9] The apparatus according to claim 5, wherein the vertical diffusers 21 integrally formed with the diaphragms 30 are installed in great numbers at regular intervals in every direction in the reaction tank 3.

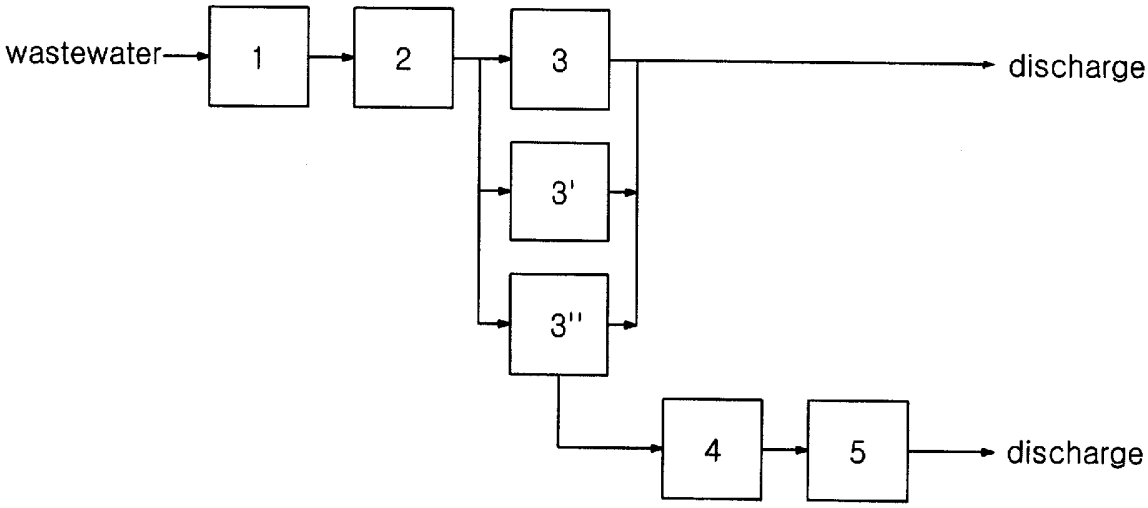
[10] The apparatus according to claim 5, wherein the vertical diffuser 21 has holes uniformly arranged in the clockwise direction or counterclockwise direction.

[11] The apparatus according to claim 5, wherein the diaphragm 30 has one end of the one side plate formed in the shape of '

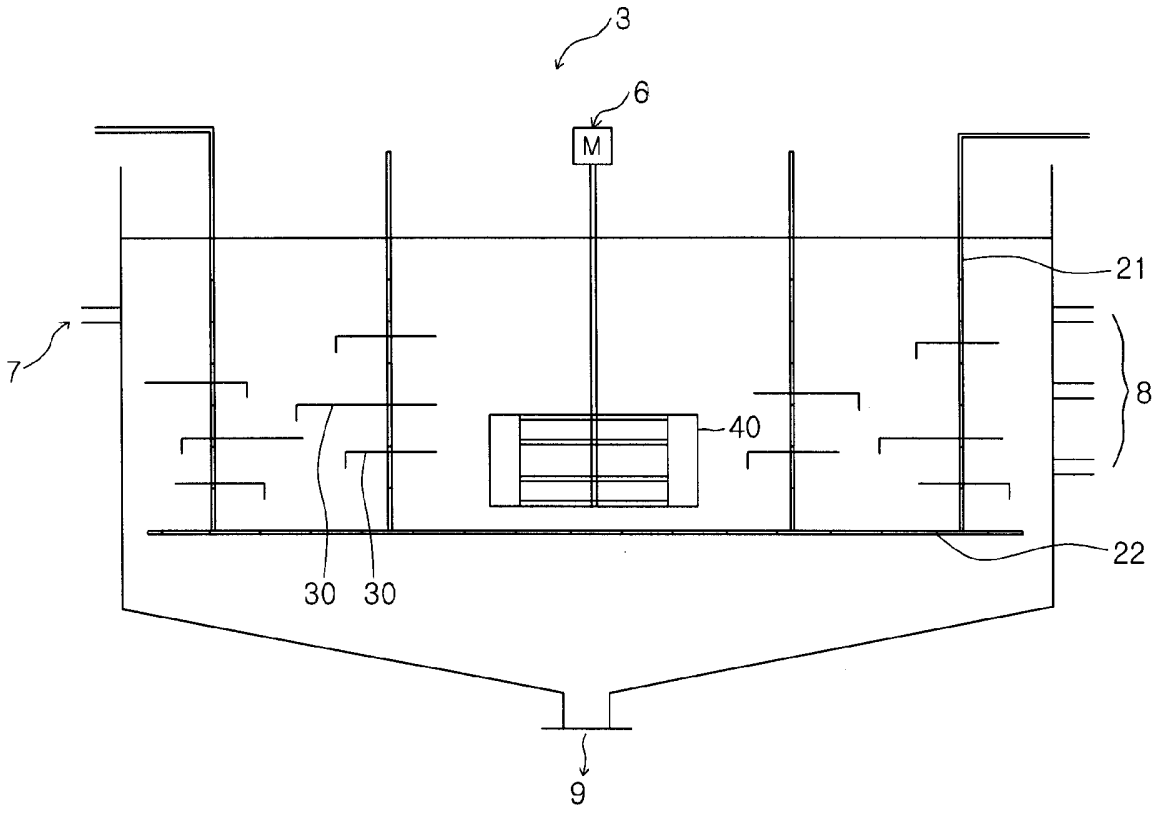
¬

' to inhibit the rising of air bubbles at the maximum.

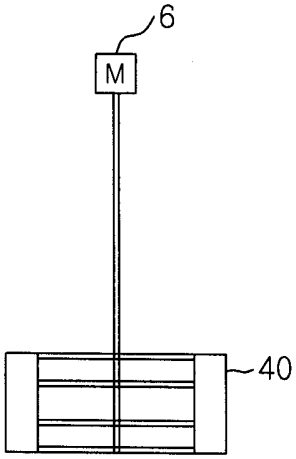
[Fig. 1]


wastewater
1
2
3
discharge
3'
3''
4
5
discharge

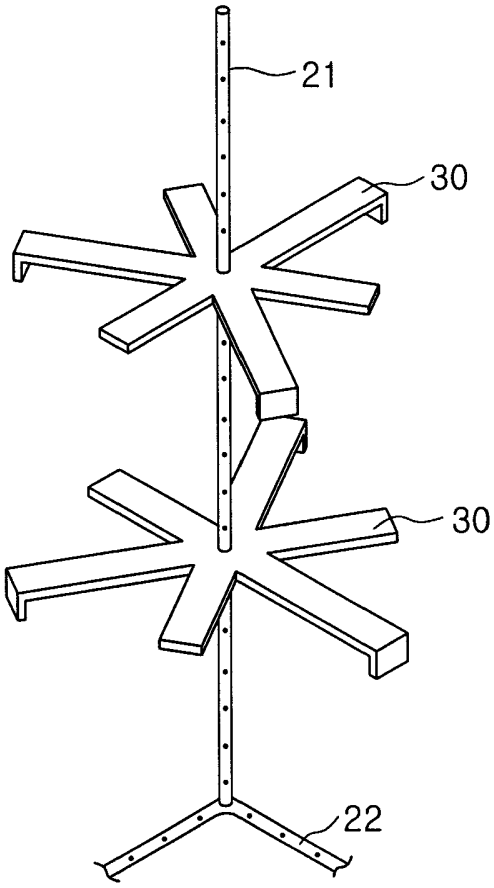
[Fig. 2]


3
6
M
21
7
8
40
22
30
30
9

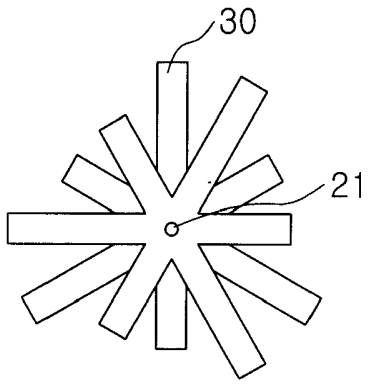
[Fig. 3]



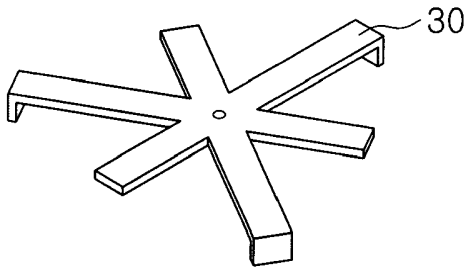
[Fig. 4]



[Fig. 5]



[Fig. 6]



INTERNATIONAL SEARCH REPORT

[illegible]national application No.
PCT/KR2004/000955

A. CLASSIFICATION OF SUBJECT MATTER

IPC7 C02F 1/52

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC7 B01D, C02F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Korean Patents and applications for inventions since 1975
Korean Utility models and applications for Utility models since 1975

Electronic data base consulted during the intertnational search (name of data base and, where practicable, search terms used)
eKIPASS, Delphion, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5354458 A (International Environmental Systems, Inc.) 11 October 1994 See the whole document	1-6
A	US 5069783 (International Environmental Systems, Inc., Environmental Protection, Inc.) 3 December 1991 See the whole document	1-6
A	US 6126837A (Calgon Corporation) 3 October 2000 See the whole document	4
A	KR 10-2000-63312 A (Kim Hyo Keun, ENVIRO Co., Ltd.) 6 November 2000 See the whole document	1-6
A	JP 8-47686 A (Murakami Osamu) 20 February 1996 See the whole document	1-6
A	JP 6-226265 A (Toppan Printing Co., Ltd.) 16 August 1994 See the whole document	1-6

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents,such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
18 AUGUST 2004 (18.08.2004)	23 AUGUST 2004 (23.08.2004)

Name and mailing address of the ISA/KR	Authorized officer
Korean Intellectual Property Office 920 Dunsan-dong, Seo-gu, Daejeon 302-701, Republic of Korea Facsimile No. 82-42-472-7140	LEE, Jin Yong Telephone No. 82-42-481-8116

Form PCT/ISA/210 (second sheet) (January 2004)

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.
PCT/KR2004/000955

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 5354458 A	11-10-1994	US 5552051	03-09-1996
		US 5451320	19-09-1995
		US 5399267	21-03-1995
		US 5275732	04-01-1994
		US 5240600	31-08-1993
		US 5232584	03-08-1993
		US 5167806	01-12-1992
		US 5049320	17-09-1991
		CN 1067227 A	23-12-1992
		CN 1040070 B	07-10-1998
US 5069783	03-12-1991	NONE	
US 6126837 A	03-10-2000	WO 0047523 A1	17-08-2000
		AU 0035883 A5	29-08-2000
KR 10-2000-63312 A	06-11-2000	NONE	
JP 8-47686 A	20-02-1996	NONE	
JP 6-226265 A	16-08-1994	NONE	