

ABSTRACT OF THE DISCLOSURE

A process has steps of aerobic treatment to remove COD and nitrify a waste stream and anoxic treatment to denitrify a waste stream followed by anoxic treatment to remove selenium and anaerobic treatment to remove heavy metals and sulphur may be used to treat, for example, FGD blow down water. The process may further include one or more of (a) membrane separation of the waste stream upstream of the anoxic digestion to remove selenium, (b) dilution upstream of the biological treatment step, (c) physical/chemical pretreatment upstream of the biological processes or dilution step to remove TSS and soften the waste stream, or (d) ammonia stripping upstream of the biological treatment steps or dilutions step. These processes may be provided in a variety of suspended growth or fixed film reactors, for example a membrane bioreactor or a fixed film reactor having a GAC bed.

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CLAIMS:

We claim:

1. A process having steps of anoxic treatment to denitrify a waste stream
5 followed by anoxic treatment to remove selenium and anaerobic treatment to remove heavy metals, for example arsenic, mercury, or sulphur.
2. The process of claim 1 further comprising a step of aerobic treatment to remove COD from and nitrify the waste stream upstream of the steps of claim 1.
- 10 3. The process of claim 1 or 2 further comprising one or more steps of:
 - a) membrane separation of the waste stream upstream of the step of anoxic digestion to remove selenium;
 - b) dilution upstream of the digestion steps;
 - c) physical/chemical pretreatment upstream of the digestion
15 steps or the dilution step to remove TSS and soften the waste stream; or,
 - d) ammonia stripping upstream of the digestion steps or dilution step.
4. An apparatus having one or more reactors configured to provide aerobic treatment of COD, nitrification, denitrification, selenium removal and
20 heavy metal and sulphur removal by biological treatment.
5. The apparatus of claim 4 wherein one of the reactors is a membrane bioreactor.
6. The apparatus of claim 4 or 5 wherein one of the reactors is a fixed film reactor
- 25 7. The apparatus of any of claims 4 to 6 wherein the fixed film reactor has a granular activated carbon bed.

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8. The apparatus of any of claims 4 to 7 having one or more of an inlet for diluting the feed water to the reactors, a system for adding lime or sulfides to the wastewater upstream of the reactors, a precipitate remover, or an ammonia stripper.

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**TITLE: APPARATUS AND METHOD FOR TREATING FGD BLOWDOWN
OR SIMILAR LIQUIDS**

FIELD OF THE INVENTION

[0001] This invention relates to water treatment including biological water treatment and treatment of feeds having high concentrations of inorganic and organic contaminants, for example scrubber blow down water
5 from a flue gas desulfurization (FGD) operation in a coal fired power plant.

BACKGROUND OF THE INVENTION

[0002] The following background discussion does not imply or admit that any process or apparatus described below is citable as prior art or part of the knowledge of people skilled in the art in any country.

10 **[0003]** Scrubber blow-down water from a flue gas desulfurization operation in a coal-fired power plant contains a wide range of inorganic contaminants removed from the flue gas. The blow down water may also contain organic contaminants, such as di basic acid (DBA), and ammonia added as part of or to enhance the FGD process. The FGD scrubber blow-
15 down water may have very high total dissolved solids where the main anions are chlorides and the main cations are calcium, magnesium and sodium. The rate of blow-down may be controlled to maintain a desired chloride concentration causing the blow-down water to have a high, but generally stable chloride concentration. The concentration of other contaminants may
20 vary widely as influenced, for example, by burning coal from different sources even in a single power plant. However, the concentration of TDS, TSS, Ca and Mg hardness, nitrate, ammonia, and sulfur for example as sulphate are all likely to be high, and various heavy metals may be present, making the blow down water very difficult to treat, particularly to achieve very low levels of
25 contaminants.

[0004] Current methods of treating blow down water rely heavily on physical and chemical processes to remove inorganic contaminants. The physical and chemical processes also involve costly chemicals and produce

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large amounts of sludge. Arsenic, mercury and heavy metals may also be present in the blow down water at above regulated levels. Further, some jurisdictions have recently regulated selenium concentrations in effluents discharged to the environment. The permitted concentration of selenium may be 0.5 ppm or less or 200 ppb or less while the blow down water may contain 1-20 or 2-10 ppm of selenium which is not removed in conventional treatment plants.

[0005] In U.S. Patent No. 6,183,644, entitled Method of Selenium Removal and issued on February 6, 2001 to D. Jack Adams and Timothy M. Pickett, dissolved selenium is removed from contaminated water by treating the water in a reactor containing selected endemic and other selenium reducing organisms. Microbes may be isolated from the specific water or imported from other selenium contaminated water. The microbes are then screened for ability to reduce selenium under the site specific environmental conditions. The selected microbes are optimized for selenium reduction, then established in a high density biofilm within a reactor. The selenium contaminated water is passed through the reactor with optimized nutrient mix added as needed. The elemental selenium is precipitated and removed from the water. Products using this or a similar process have been sold as the ABMet™ process by Applied Biosciences Corp of Salt Lake City, Utah, U.S.A. The entirety of US Patent No. 6,183,644 is incorporated herein by this reference to it.

SUMMARY OF THE INVENTION

[0006] The following summary is intended to introduce the reader to the invention but not to define it. The invention may reside in any combination of one or more of the apparatus elements or process steps described anywhere in this document.

[0007] It is an object of this invention to improve on, or at least provide a useful alternative to, the prior art. It is another object of the invention to provide a wastewater treatment process or apparatus. Other objects of the invention are to provide an apparatus or process for treating FGD blow down

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water or other wastewaters having selenium or nitrate and selenium, or a process or apparatus for biologically removing inorganic contaminants, for example nitrogen, selenium, arsenic, mercury or sulphur, from waste water.

[0008] In one aspect, the invention provides a process having steps of
5 aerobic treatment to remove COD and nitrify a waste stream, anoxic treatment to denitrify a waste stream, anoxic treatment to remove selenium and anaerobic treatment to remove heavy metals or sulphur or both. Removal of heavy metals is possible because SO_4 is present and converted to sulphur by anaerobic SO_4 reducing bacteria. The process may further include one or
10 more of (a) membrane separation of the waste stream upstream of the anoxic digestion to remove selenium, (b) dilution upstream of the biological treatment step, (c) physical/chemical pretreatment upstream of the biological processes or dilution step to remove TSS and soften the waste stream, for example through the addition of lime or sulfides and the removal of precipitates or (d)
15 ammonia stripping upstream of the biological treatment steps or dilution step. Some of the biological treatment steps may be performed in a fixed film reactor, for example a granular activated carbon bed. One or more of the biological treatment steps may also be performed in a suspended growth reactor such as a membrane bioreactor. Each biological treatment step may
20 be performed in a distinct reactor optimized to perform a step or two or more of the biological treatment steps may be performed in a multiple purpose reactor.

[0009] In another aspect, the invention provides an apparatus having one or more reactors configured to provide aerobic treatment of COD,
25 nitrification, denitrification, selenium and heavy metals removal and sulphur removal by biological treatment. The reactors may include a membrane bioreactor or a fixed film reactor. The fixed film reactor may comprise a granular activated carbon bed. The apparatus may further have one or more of an inlet for diluting the feed water to the biological processes, a system for
30 adding lime or sulfides to the wastewater upstream of the biological reactors, a precipitate remover, or an ammonia stripper.

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[0010] The invention is particularly suited for treating FGD blow down water to produce an effluent with low concentrations of selenium, for example 1 ppm or less or 10 ppb or less, and low concentrations of total nitrogen, for example 1 mg/L or less or 10 ppm or less, in the effluent. However, the invention may also have applications in treating blow down water when selenium concentration in the effluent is not a concern. The invention may also be useful for treating other wastewaters having selenium, for example mining, contaminated ground or surface water streams, or petroleum refinery waste streams, particularly where the waste stream also has significant concentrations of one or more of COD, nitrate, ammonia, TDS, TSS, hardness, CaSO₄, or sulphate.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] Examples of embodiments of the invention will be described below with reference to the Figures described below.

[0012] Figure 1 is a schematic flow diagram of an apparatus and process for treating water.

[0013] Figure 2 is a more detailed process flow diagram of an exemplary system for treating FGD blow down water.

[0014] Figure 3 is a schematic diagram showing an alternate embodiment for part of the system and process of Figure 1 or 2.

DESCRIPTION OF EXEMPLARY EMBODIMENTS

[0015] Table 1 shows the contaminants, and their concentrations, assumed for FGD scrubber blow-down water in the design of the following exemplary embodiments. FGD blow-down water may exist with other contaminants or other concentrations of contaminants. The composition of FGD blow-down can also vary widely over time for a specified coal-fired power plant as influenced, for example, by changes in the source of coal. However, FGD blow-down water is generally characterized by very high total dissolved solids (TDS) where the main anion is chloride and the main cations are calcium, magnesium and sodium. The blow-down also contains significant

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concentrations of fine suspended solids, including CaSO_4 fines. The blow-down also contains a wide range of inorganic contaminants, including ammonia, which is added for selective catalytic reduction in the scrubbing process, as well as some organics, particularly DBA (dibasic acid) added to enhance scrubber efficiency. In the exemplary embodiments, the effluent is intended to have a total nitrogen (TN) content of 10 ppm or less and selenium concentrations of 0.4 ppm or less.

TABLE 1: Typical FGD Blowdown Water

Parameter	Typical Value	Min - Max
Chlorides	30,000 ppm	20-40,000 ppm
pH	>5.0<6.0	
TDS	75,000 mg/L	50,000 – 150,000 mg/L
TSS	2 % dry wt	1 – 5 % dry wt
Aluminum – Total	960 ppm	80-3700 ppm
Antimony	12 ppm	0.03-49.0 ppm
Ammonia – N	31 ppm	0.25-64 ppm
Nitrate – N	350 ppm	200-450 ppm
Total Nitrogen	200 ppm	50-400 ppm
Arsenic – Total	15 ppm	0.27-100 ppm
Barium – Total	100 ppm	2.0-770 ppm
Beryllium	2.1 ppm	0.06-6.9 ppm
Boron	----	20-40 ppm
Cadmium – Total	0.8 ppm	0.12-1.5 ppm
Calcium	18,000 ppm	10,000-30,000 ppm
Chromium – Total	23 ppm	0.5-210 ppm
Chromium VI	----	3-12 ppm
Cobalt	----	0.05-4 ppm
Copper – Total	1.7 ppm	0.3-6.6 ppm
CO_3/HCO_3	1500 ppm	1-3,000 ppm
Fluoride	360 ppm	61-1600 ppm
Iron – Total	1400 ppm	116-6400 ppm

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Lead – Total	19 ppm	0.2-140 ppm
Lithium	----	2-3 ppm
Magnesium	15,000 ppm	10,000-20,000 ppm
Manganese	10 ppm	3.6-200 ppm
Mercury – Total	0.38 ppm	0.5-1.4 ppm
Nickel – Total	10 ppm	0.5-74 ppm
Phosphate – Total	1.0 ppm	0-10 ppm
Potassium	6800 ppm	5000-10,000 ppm
Selenium – Total	17 ppm	1.5-100 ppm
Silver – Total	10.0 ppm	0.002-20 ppm
Sodium	15,000 ppm	10,000-20,000 ppm
Sulfate (SO ₄)	60,000 ppm	40,000-80,000 ppm
Thallium	0.76 ppm	0.02-2.2 ppm
Vanadium	----	1.0-11.0 ppm
Total Zinc	15.0 ppm	1.7-50.0 ppm
Temperature	130°F	125-130°F

[0016] In greater detail, treating the blow-down raises several challenges which the invention addresses in a variety of ways, as described generally below and then by describing examples of treatment systems and processes. In the following description, pre-treatment refers to treatment occurring upstream of biological process steps.

[0017] High TDS concentrations make it difficult to maintain activity for biological treatment. This issue is addressed by diluting the waste stream upstream of biological treatment. The high TDS also makes it difficult to flocculate and settle biomass in an activated sludge process. This issue is addressed by using fixed film bioreactors or membrane bioreactors.

[0018] High hardness causes scaling due to Ca or Mg oversaturation and any pH or temperature shifts, for example during denitrification, may cause precipitation of calcium or magnesium sulfates or carbonates. This issue is addressed by a softening pre-treatment, for example lime softening,

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and optionally by adding acid for pH adjustment upstream of the biological process.

[0019] The high TSS, particularly because it is essentially inorganic, causes problems with developing and controlling a suspended biomass and with bioreactor and membrane plugging. This issue is addressed by pre-
5 treating the waste stream to coagulate or flocculate and then physically remove (for example by settling or floating) suspended solids.

[0020] High nitrate concentrations are a concern because nitrate is a preferred electron acceptor for biological reduction over selenate. This issue
10 is addressed by decreasing the nitrate concentration upstream of a selenate reducing step. The nitrate reducing step may occur in an upstream part of a plug flow selenate reducing reactor, as part of a multi-step biological process or reactor upstream of a selenate reducing process, or part of a distinct process or reactor.

[0021] Ammonia in the blow down water is a concern because
15 concentration in the final effluent may be regulated and because oxidation of ammonia may increase nitrate concentration. This issue is addressed by removing the ammonia, for example, by stripping the ammonia as NH_3 in a pre-treatment process or removing ammonia biologically by a
20 nitrification/denitrification process either in a series process or with recirculating flows.

[0022] The presence of various heavy metals, for example Cu, As or Hg, or related oxidized contaminants are a concern because they may be regulated in the effluent but are difficult to remove in low concentrations. This
25 issue may be addressed in part by precipitating these elements out in a pre-treatment softening step. The issue may be further addressed by biologically reducing SO_4 and precipitating these contaminants as metal sulfides after removing nitrate and selenate and selenite.

[0023] The presence of selenium, as selenate or selenite, is a concern
30 because of recent regulation of selenium concentrations in effluent. The

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selenium is difficult to remove because of its low concentration and its tendency to form selenate or selenite and dissolve in water making physical or chemical removal difficult, costly or inefficient. Selenium is addressed in the invention by biologically reducing it to elemental selenium and then
5 precipitating it for removal.

[0024] Figure 1 shows a treatment system 10 having a pretreatment area 12 upstream of a biological treatment area 14 . Feed 16, which may be FGD blow-down water or another feed, flows into pretreatment area 12. In the pretreatment area 12, a large portion of the TSS in the feed is removed and
10 Ca and Mg are removed to soften the feed 16. The pretreatment area 12 uses physical/chemical methods to treat the feed 16. For example, lime or sulfides or both may be added to the feed 16 to precipitate calcium, magnesium and metals. The precipitates may be removed by clarifiers, for example single stage or double stage clarifiers. Settling can be enhanced by the addition of
15 coagulants or polymers. Alternately, the precipitates can be removed by dissolved air floatation (DAF) involving the addition of similar treatment chemicals. The DAF process also strips some ammonia particularly if feed 16 temperature is kept above 100 degrees F or above 130 degrees F and the DAF process maintained at a pH of 8.5 or more or 9.5 or more. This may
20 reduce or remove the need for ammonia removal, by nitrification, at the biological treatment area 14 described below in jurisdictions where emitting ammonia in a blow off gas is permitted. Optionally, the ammonia in the gas blow-off from a DAF reactor may be recycled to a selective catalytic reduction part of the FGD process. DAF reactors may be purchased from Infilco-
25 Degremont of Virginia, USA under the AquaDAF trade mark or from Clear Water Technology of California, USA under the GEM trade mark.

[0025] Pre-treatment effluent leaves the pretreatment area 12 through a pretreatment effluent line 20. Dilution water 18 is added to the pretreatment effluent. The dilution water 18 reduces the TDS of the pretreatment effluent to
30 make it acceptable for biological treatment downstream. Sufficient dilution water 18 may be added to make the TDS like that of seawater, for example

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with a TDS of 35 g/L or less. Any low TDS water can be used for dilution water 18, for example cooling circuit blow down water from a power plant. The dilution water 18 also cools the FGD blow-down water, for example from 50 °C or more to about 40 °C or less, to further facilitate biological treatment.

5 **[0026]** The diluted pretreatment effluent then flows to the biological treatment area 14. The biological treatment area 14 has four zones: an aerobic zone 22; a first anoxic zone 24; a second anoxic zone 26; and, an anaerobic zone 28. These zones 22, 24, 26, 28 are shown connected in series in Figure 1 although one or more of them may alternately be connected
10 with recirculation loops. Further alternately, some of the zones 22, 24, 26, 28 may not be required in some embodiments. The zones 22, 24, 26, 28 may also occur in separate reactors or one or more zones 22, 24, 26, 28 may be combined into a single reactor. One or more of nutrient streams 30, 32, 34 may be used to add nutrients to any zone 24, 26, 28 downstream of a nutrient
15 stream 30, 32, 34, either directly or through intervening zones 24, 26. For example, nutrients may be added in stream 30 or stream 32 to support the growth of bacteria in zones 26 or zone 28 or both.

[0027] The aerobic zone 22 is used to nitrify ammonia, to the extent that ammonia has not been stripped in the pretreatment area 12, and to
20 oxidize organic carbon. An optional supplemental aerobic zone may also be added downstream of the anaerobic zone 28 to remove residual nutrients added before or in zones 24, 26, 28 and to oxidize residual compounds from anaerobic zone 28. If there is no TN discharge limit for the effluent, or if ammonia is stripped in the pretreatment area 12 such that TN in the effluent
25 will be acceptable, the aerobic zone 22 may be omitted, or replaced by an aerobic zone downstream of the anaerobic zone 28.

[0028] In the first anoxic zone 24, nitrate acts as a preferred electron acceptor and is removed by denitrification. The nitrate may be removed to a concentration which facilitates the biological reduction of selenium in the
30 second anoxic zone 26, considering that nitrate in high concentration will be used as an electron acceptor over low concentrations of selenate or selenite.

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For example, NO_3 may be reduced to 10 mg/L as N or less or 1 mg/L as N or less or 10 ppm as N or less in the stream leaving the first anoxic zone 24.

[0029] In the second anoxic zone 26, selenium is removed by biological reduction and removal, for example by precipitation into flush flow water or waste sludge. These steps may occur, for example, according to the process described in US Patent No. 6,183,644 or in other fixed or suspended bed reactors. The reactors may be seeded with selenium reducing organisms.

[0030] In the anaerobic zone 28, sulfate-reducing bacteria reduce sulfates and produce sulfides in the form of H_2S or HS^- . Part of the HS^- may react with soluble metals to form insoluble metal sulfides which may precipitate out of solution. In this way the anaerobic zone removes heavy metals. The off gas from the anaerobic step 28 can be recycled to the aerobic step 22 or to a downstream aerobic step to reduce the production of odors associated with H_2S .

[0031] In general, the zones 22, 24, 26, 28 may be arranged into one or more reactors. Each zone 22, 24, 26, 28 may occupy its own reactor, for example a CSTR optimized to reduce the primary target contaminant of each zone 22, 24, 26, 28. Alternately, for example, zones 22 and 24 can be combined into a combined nitrification/denitrification reactor which may have 1, 2 or more tanks. Zones 24, 26 and 28 or 26 and 28 may be combined into a ABMet reactor having one or more tanks. Other reactors may also be used. For suspended growth reactors, the limited concentrations of the target contaminants may be low and the presence of other contaminants may make biomass separation difficult and so membrane bioreactors are preferred. Alternately, fixed film reactors may be used, for example Moving Bed Bioreactors, for example as produced by Anox Kaldnes of Norway, fluidized bed reactors, for example as produced by Shaw Envirogen of New Jersey, USA, biofilters as produced by Degremont of France under the trade mark BIOFOR, granular activated carbon reactors, for example as produced by the Applied Biosciences Corp. of Utah, USA under the ABMet trade mark, or in membrane supported biofilm reactors (MSBR) as described in PCT

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Publication Nos. WO 2004/071973 or WO 2005/016826. Depending on the zone, the MSBR may operate autotrophically or heterotrophically optionally using a process of heterotrophic denitrification as described in Canadian Patent Application No. CA 2,477,333. Membrane separation may optionally
5 be used with or after any fixed film reactor although there may also be no need for it. The entire disclosures of each of WO 2004/071973; WO 2005/016826 and CA 2,477,333 are incorporated herein by this reference to them.

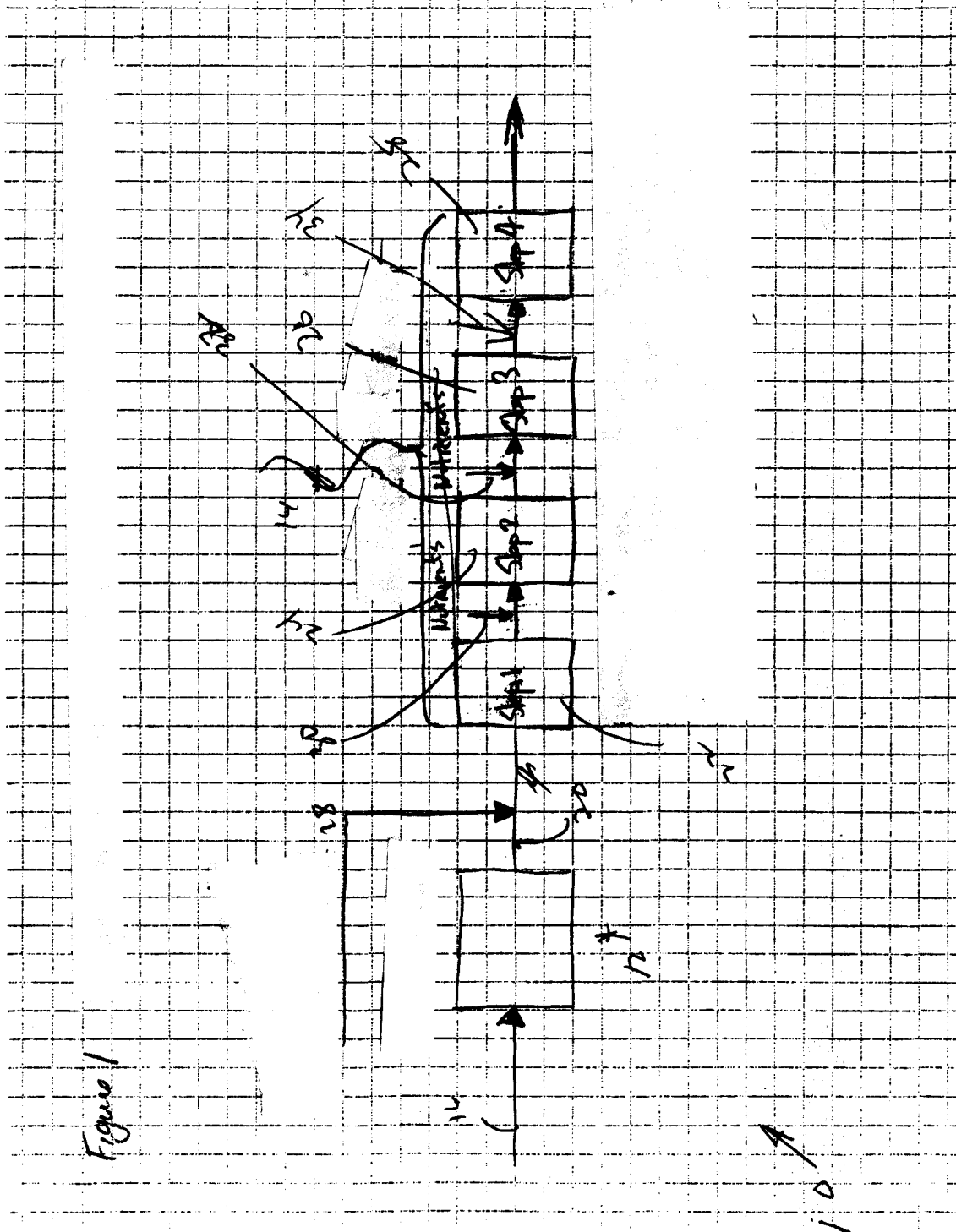
[0032] Figure 2 shows a process flow diagram of a treatment plant
10 for treating FGD blow-down as described in Table 1. In the pretreatment area 12, pretreatment is by lime softening, optionally with sulfide addition, and 1 or 2 stage settling in clarifiers. Such a process may be provided by WesTech of Utah, USA. PH is adjusted in the pretreatment effluent 20 when the dilution water 18 is added to a pH of less than 8.5, for example between 6 and 8 to
15 enhance biological treatment. In the aerobic zone 22, a membrane bioreactor having an aeration tank and a membrane tank containing ZeeWeed™ membranes from Zenon Environmental Inc. of Ontario, Canada, is used for nitrification. The first and second anoxic and anaerobic zones 24, 26, 28 are provided in an ABMet reactor system by Applied Bioscience Corp. of Utah,
20 USA, which may consist of a 2-stage reactor configuration. This reactor is an up-flow fixed film reactor using a GAC bed operated in plug flow so that 3 biological zones corresponding to the first anoxic, second anoxic and anaerobic zones 24, 26, 28 can be established in sequence. A single nutrient stream 30 is used upstream of the ABMet reactor. Precipitates are removed
25 from this reactor by periodically flushing the GAC bed to overflow troughs. Sludge from the pretreatment area 12 and biological treatment area 14 is fed to a sludge thickener and dewaterer. Thickened and dewatered sludge is sent to waste. Sludge thickening and dewatering effluent is returned to an equalization tank to be mixed with the FGD flow down feed water 16.

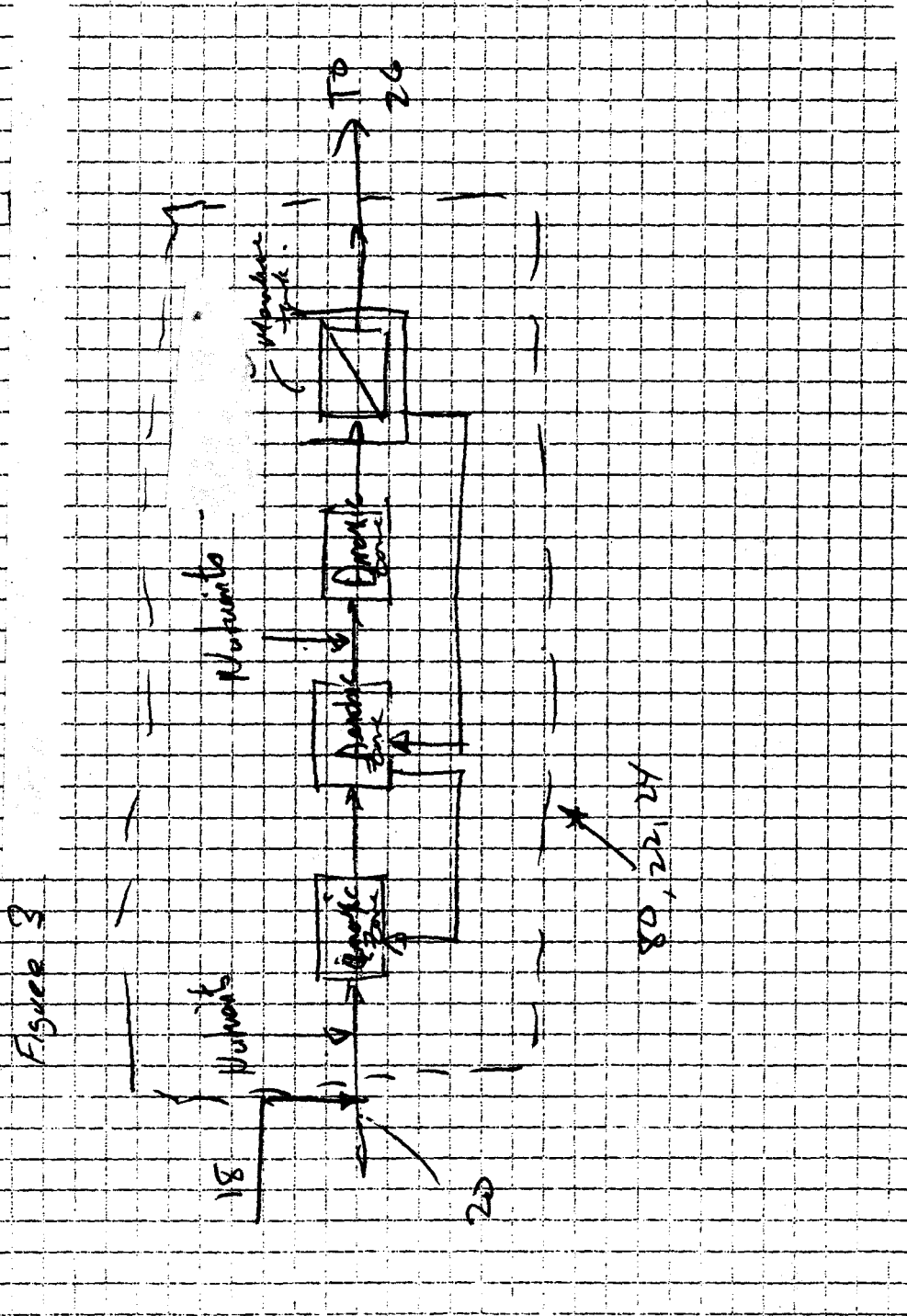
30 **[0033]** Figure 3 shows a nitrification/denitrification reactor 80 used to provide the aerobic and first anoxic zones 22, 24 of Figure 1. Nitrification/

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denitrification reactor 80 may also be used to replace the bioreactor tank and ZeeWeed tank of Figure 2 to provide the aerobic and first anoxic zones 22, 42 and allow the ABMet reactor to be operated with the second anoxic and anaerobic zones 26, 28 with a minimal or no first anoxic zone 24.

5





October 18, 2005

BERESKIN & PARR
P.O. Box 401
40 King Street West
TORONTO Ontario
M5H 3Y2

Application No. : 2,517,322
Owner : ZENON ENVIRONMENTAL, INC.
Title : APPARATUS AND METHOD FOR TREATING FGD
BLOWDOWN OR SIMILAR LIQUIDS
Your File No. : 4320-719

COURTESY LETTER

Your application for Patent has been allotted the above mentioned serial number and filing date of **August 26, 2005**.

To avoid a completion fee, the requirement(s) listed below must be submitted on or before the due date of **October 25, 2006**.

A new copy of the drawings, as the sheets do not permit direct reproduction in accordance with paragraph 68(1)(b) of the Patent Rules.

Also, the drawings contain interlineations, cancellations, corrections, which are not in accordance with paragraph 68(1)(c) of the Patent Rules.

Therefore, replacement sheets as well as a covering letter stating that these replacement sheets are as originally filed must be submitted.

Evidence Due Date: August 26, 2006

In addition, while not a completion requirement, under Section 37 of the Patent Rules the documentation showing the evidence that the applicant is the legal representative of the inventor must be registered in the Canadian Patent Office. The fee for recordal is \$100.00 per document. If the documents are not received in the Patent Office within 12 months of the Canadian filing date, a letter will be sent requisitioning the required documents within a 3 month time limit set under section 25 of the Patent Rules.

Patricia Lalonde
Patent Formalities Analyst
(819) 994-3208

Bereskin & Parr

INTELLECTUAL PROPERTY LAW



October 18, 2006

Scott R. Pundsack B.A.Sc. (Civil Eng.), LL.B.
416 957 1698 spundsack@bereskinparr.com

Our Reference: 4320-719

FORMAL DRAWINGSThe Canadian Intellectual Property Office
50 Victoria Street
Phase I, Place du Portage
Gatineau, Quebec K1A 0C9

Dear Sir:

Re: Canadian Patent Application No. 2,517,322
Filed: August 26, 2005
For: APPARATUS AND METHOD FOR TREATING FGD BLOWDOWN OR
SIMILAR LIQUIDS
Applicant: ZENON Environmental Inc.

This correspondence is responsive to the Courtesy Letter dated October 18, 2005, for the above-identified patent application.

As required, we enclose three sheets of formal drawings to replace the drawings filed on August 26, 2005. Applicant submits that the replacement sheets are formalized versions of those originally filed and that no new matter has been added.

Will the Office kindly acknowledge receipt of the enclosed drawings at its earliest convenience.

Respectfully submitted,

A handwritten signature in cursive script, appearing to read "Scott Pundsack".

Scott Pundsack
BERESKIN & PARR
/js

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TORONTO MISSISSAUGA WATERLOO MONTREAL

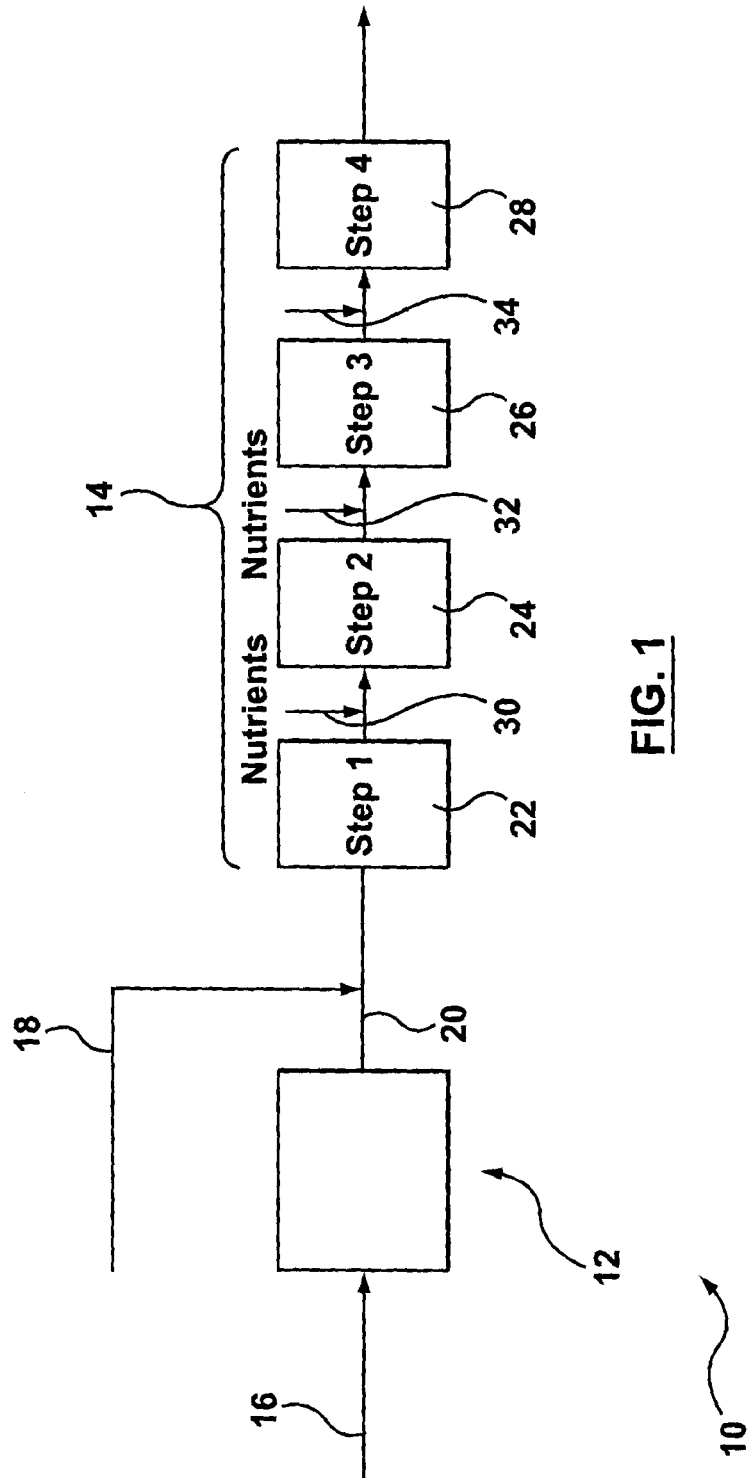
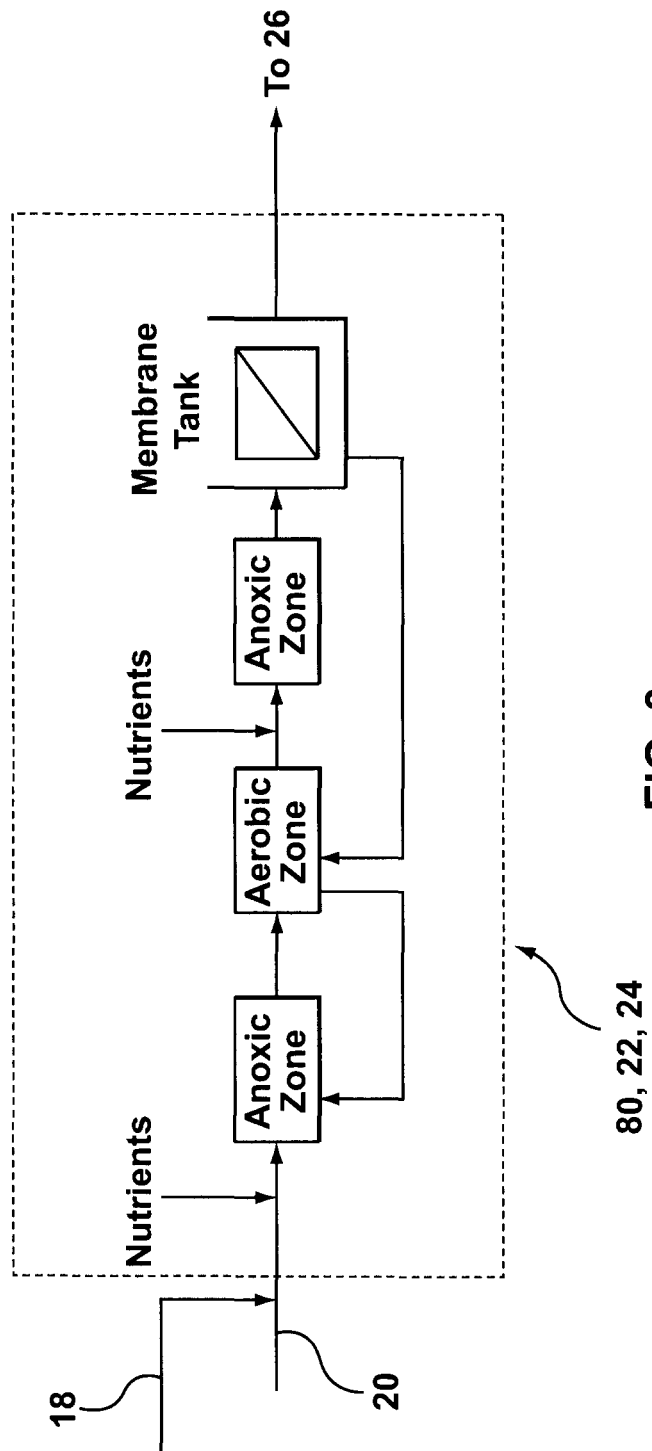


FIG. 1

**FIG. 3**

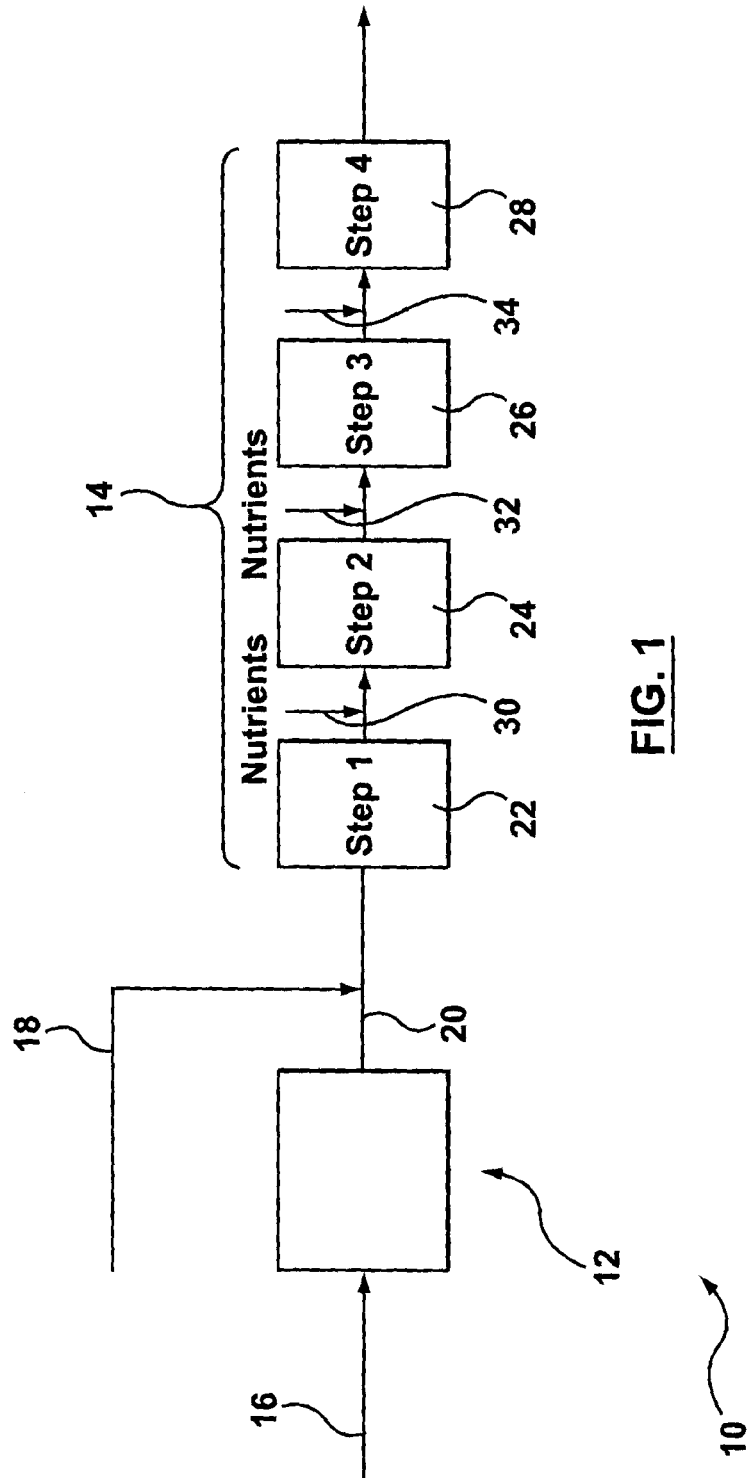


FIG. 1

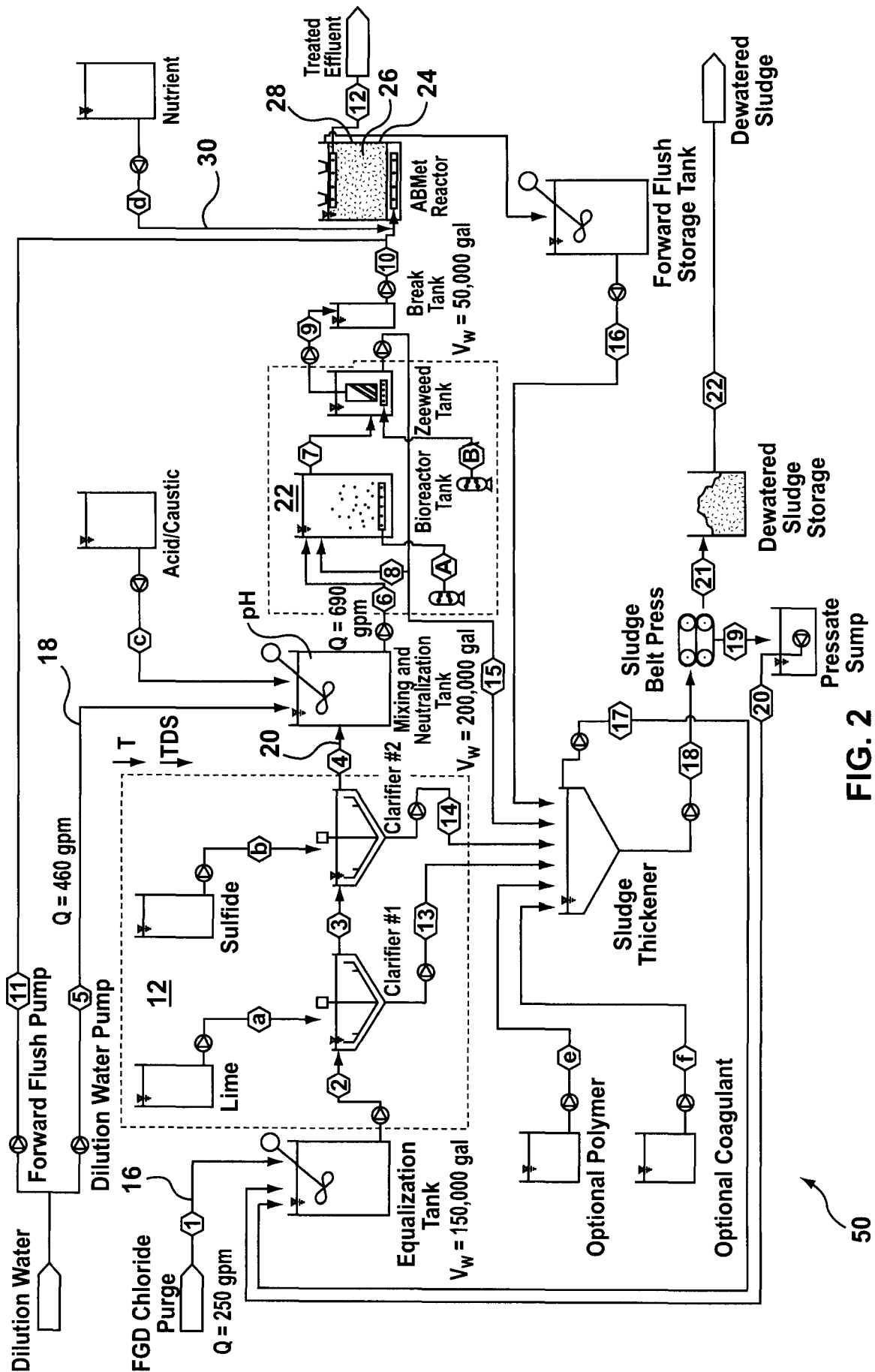
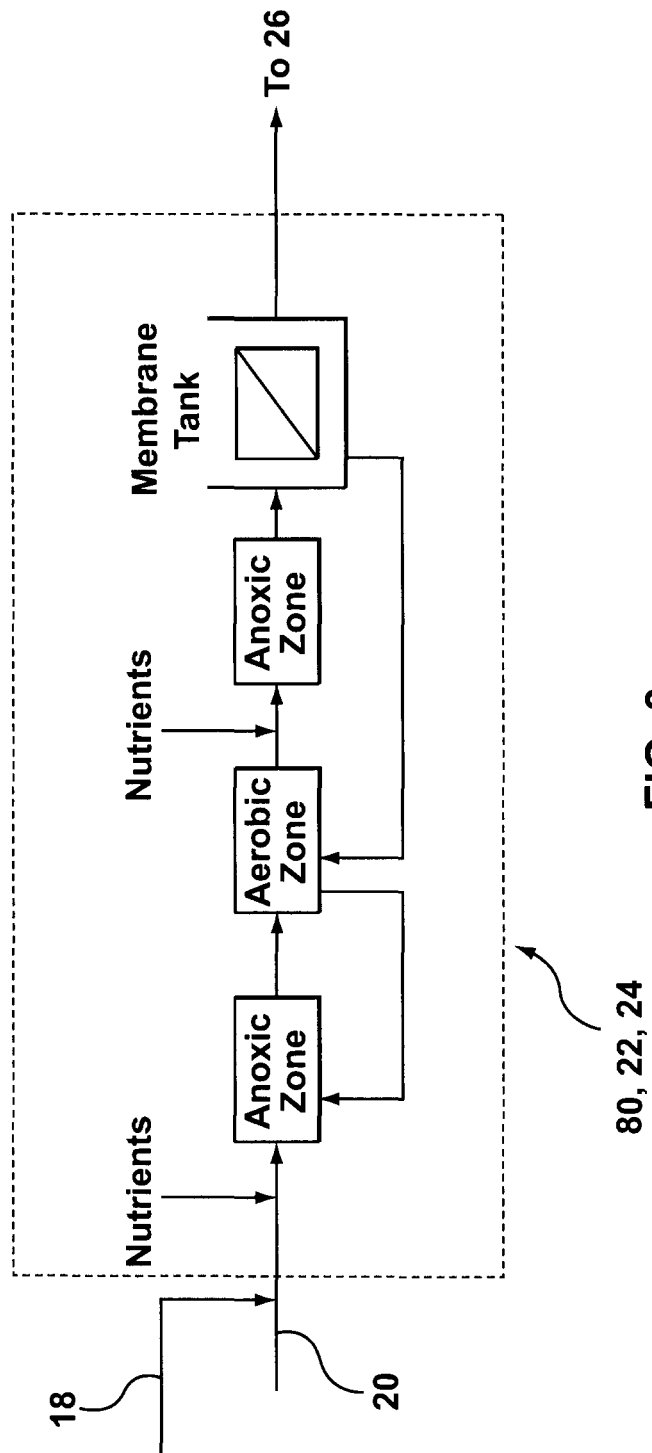


FIG. 2

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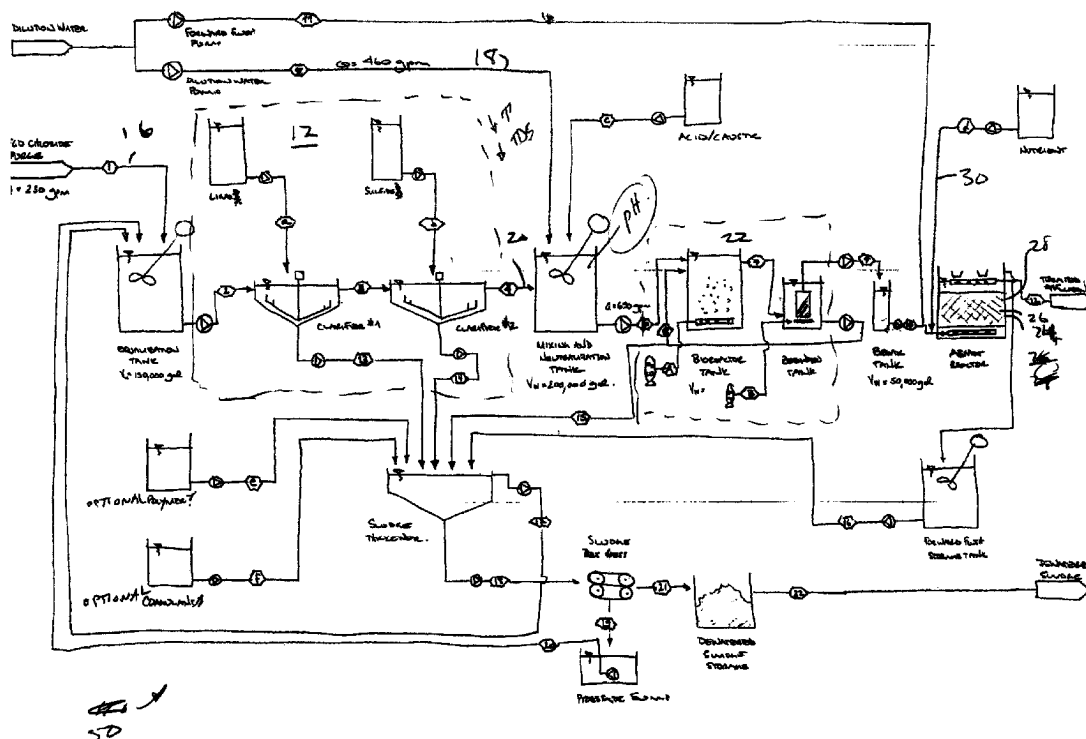
**FIG. 3**

80, 22, 24



(74) **Agent:** BERESKIN & PARR

(54) Title: APPARATUS AND METHOD FOR TREATING FGD BLOWDOWN OR SIMILAR LIQUIDS



A process has steps of aerobic treatment to remove COD and nitrify a waste stream and anoxic treatment to denitrify a waste stream followed by anoxic treatment to remove selenium and anaerobic treatment to remove heavy metals and sulphur may be used to treat, for example, FGD blow down water. The process may further include one or more of (a) membrane separation of the waste stream upstream of the anoxic digestion to remove selenium, (b) dilution upstream of the biological treatment step, (c) physical/chemical pretreatment upstream of the biological processes or dilution step to remove TSS and soften the waste stream, or (d) ammonia stripping upstream of the biological treatment steps or dilutions step. These processes may be provided in a variety of suspended growth or fixed film reactors, for example a membrane bioreactor or a fixed film reactor having a GAC bed.

Bereskin & Parr

INTELLECTUAL PROPERTY LAW

August 2, 2007

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DL



Your Reference: 2,517,322
Our Reference: 004320-719 (6853-006)

Maintenance Fee Payment

Canadian Intellectual Property Office
Place du Portage I, 3rd Floor
50 Victoria Street
Gatineau, Quebec
K1A 0C9

Dear Madam:


Re: FGD BLOWDOWN TREATMENT
Canadian Patent Application No. 2,517,322
Filing Date: August 26, 2005
Applicant: GE Water & Process Technologies

The maintenance fee for the above-identified application is due to be paid by **August 26, 2007**, the second anniversary. Please charge the maintenance fee of \$100.00 at the large entity rate to our firm's Visa account.

Should the fees submitted with this letter be insufficient to cover all fees for which payment is explicitly or implicitly requested by this letter, including the payment of any reinstatement and maintenance fees that may be required as of the date of this letter, the Commissioner is authorized to charge the amount of the insufficiency to our Visa account at the rate prescribed for a large entity.

Please amend the records of the Office to indicate the status of the applicant as a large entity.

Respectfully submitted,


BERESKIN & PARR
(Agents for the Applicant)

WM/kv

Scotia Plaza, 40 King Street West, 40th Floor, Toronto, Ontario, Canada M5H 3Y2
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TORONTO MISSISSAUGA WATERLOO MONTRÉAL

1621799
BT

August 12, 2008

Your Reference: 2,517,322
Our Reference: 20047-043 (6853-006)

Maintenance Fee Payment

Canadian Intellectual Property Office
Place du Portage I, 3rd Floor
50 Victoria Street
Gatineau, Quebec
K1A 0C9



Dear Madam:

Re: FGD BLOWDOWN TREATMENT
Canadian Patent Application No. 2,517,322
Filing Date: August 26, 2005
Applicant: GE Water & Process Technologies

The maintenance fee for the above-identified application is due to be paid by **August 26, 2008**, the third anniversary. Please charge the maintenance fee of \$100.00 at the large entity rate to our firm's Visa account. ✓

Should the fees submitted with this letter be insufficient to cover all fees for which payment is explicitly or implicitly requested by this letter, including the payment of any reinstatement and maintenance fees that may be required as of the date of this letter, the Commissioner is authorized to charge the amount of the insufficiency to our Visa account at the rate prescribed for a large entity.

Please amend the records of the Office to indicate the status of the applicant as a large entity.

Respectfully submitted,


BERESKIN & PARR
(Agents for the Applicant)

WM/kv



Place du Portage, Phase I
50, rue Victoria
Gatineau (Québec)
K1A 0C9

Place du Portage, Phase I
50 Victoria Street
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K1A 0C9

Reçu du paiement électronique / Electronic Payment Receipt

DATE: 2009-08-12
HEURE / TIME: 10:23:22

**NUMÉRO DE CONFIRMATION /
CONFIRMATION NUMBER**

2263846

Merci / Thank You

**NOM ET ADRESSE /
NAME AND ADDRESS:**

BERESKIN & PARR LLP/S.E.N.C.R.L.,S.R.L.
LANGTON, DAVID WILLIAM ROBERT
c/o Bereskin & Parr LLP
TORONTO, Ontario
M5H 3Y2
Canada

No de document Document No.	Description / Description	Taxes / Fees
2517322	APPARATUS AND METHOD FOR TREATING FGD Taxes de maintien - Demande / Maintenance Fee - Application année(s)/year(s): 4	\$ 100.00

Total des taxes payées / Total Fees Paid

\$ 100.00

INFORMATION SUR LE PAIEMENT / PAYMENT INFORMATION

(819) 994-2269

Page 1 de / of 1

Bereskin & Parr

INTELLECTUAL PROPERTY LAW

007 mb

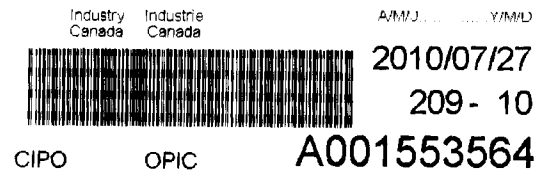
July 27, 2010

Scott R. Pundsack B.A.Sc. (Civil Eng.), J.D.
 416 957 1698 spundsack@bereskinparr.com

Your Reference: 2,517,322
 Our Reference: 20047-43

Examination Request

The Commissioner of Patents
 The Canadian Intellectual Property Office
 50 Victoria Street
 Phase I, Place du Portage
 Gatineau, Quebec
 K1A 0C9



Dear Commissioner:

2287854

Re: Canadian Patent Application No. 2,517,322
For: APPARATUS AND METHOD FOR TREATING FGD BLOWDOWN OR
SIMILAR LIQUIDS
Filed: August 26, 2005
Applicant: Zenon Technology Partnership

Pursuant to Section 35(1) of the Patent Act the applicant respectfully requests that the above-identified application be examined.

The government fee of \$800.00 is to be charge to our firm's Visa account. A completed Fee Payment Form is attached.

Should the fees submitted with this letter be insufficient to cover all the fees for which payment is explicitly or implicitly requested by this letter, including the payment of any maintenance and reinstatement fees that may be required, CIPO is authorized to charge the amount of the insufficiency using one of the payment methods specified on the accompanying Fee Payment Form at the rate prescribed for a large entity and, if required, reinstatement is requested.

Respectfully submitted,

BERESKIN & PARR LLP/S.E.N.C.R.L., s.r.l.
 Agent for the Applicant

Scott Pundsack
 /pd
 Encl.



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Reçu du paiement électronique / Electronic Payment Receipt

DATE: 2010-08-04
HEURE / TIME: 10:37:53

**NUMÉRO DE CONFIRMATION /
CONFIRMATION NUMBER**

2564122

Merci / Thank You

**NOM ET ADRESSE /
NAME AND ADDRESS:**

BERESKIN & PARR LLP/S.E.N.C.R.L.,S.R.L.
LANGTON, DAVID WILLIAM ROBERT
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TORONTO, Ontario
M5H 3Y2
Canada

No de document Document No.	Description / Description	Taxes / Fees
2517322	APPARATUS AND METHOD FOR TREATING FGD Taxes de maintien - Demande / Maintenance Fee - Application année(s)/year(s): 5	\$ 200.00

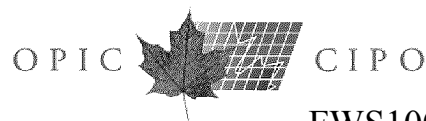
Total des taxes payées / Total Fees Paid	\$ 200.00
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INFORMATION SUR LE PAIEMENT / PAYMENT INFORMATION

(819) 994-2269

Canada

Page 1 de / of 1



IN THE CANADIAN PATENT OFFICE

To: The Commissioner of Patents

May 2, 2011

Application No.: **2,517,322**
 Title: **APPARATUS AND METHOD FOR TREATING FGD BLOWDOWN
 OR SIMILAR LIQUIDS**
 Applicant: **ZENON TECHNOLOGY PARTNERSHIP**
 Our File: **PAT 92005-1 and others, see schedule**

Attached for recording is a revocation of former agent and appointment of new agent in favour of Borden Ladner Gervais LLP for the above-noted patent application and others as listed in the schedule. The form is signed by Barbara Toop, patent counsel for Zenon Technology Partnership.

We look forward to receiving confirmation that our firm has now been recorded as agents and representatives for service for each matter.

Should any of these matters be abandoned for any reason, please regard this as the request(s) for reinstatement. Should the fees submitted with this letter be insufficient to cover all of the fees for which payment is explicitly or implicitly requested by this letter, or needed to reinstate the application, the Commissioner is authorized to charge the amount of the insufficiency to our deposit account number 600000247 or deposit account number 600001646.

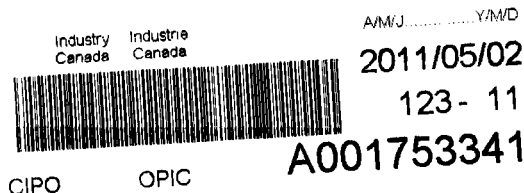
Yours very truly

Borden Ladner Gervais LLP/ s.r.l.

Agents

Borden Ladner Gervais LLP
 4100-40 King Street West
 Toronto ON M5H 3Y4

Scott Pundsack/mmm
 Tel: 416.367.6697
 Fax: 416.367.6749

1. Rev./Appoint. Of Agent

IN THE CANADIAN PATENT OFFICE

To: The Commissioner of Patents

Application No.: 2,517,322 (and others, see schedule)
 Title: APPARATUS AND METHOD FOR TREATING FGD
 BLOWDOWN OR SIMILAR LIQUIDS
 Applicant: ZENON TECHNOLOGY PARTNERSHIP
 Our File: PAT 92005-1 (and others, see schedule)

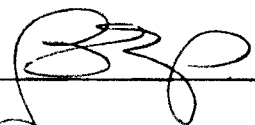
IN THE CANADIAN PATENT OFFICE
 REVOCATION OF APPOINTMENT OF AGENT
 AND NOMINATION OF REPRESENTATIVE, AND
 NOMINATION OF NEW AGENT AND REPRESENTATIVE

The undersigned hereby revokes all former Appointments of Agent and appoints Borden Ladner Gervais LLP, whose full post office address is Scotia Plaza, 40 King Street West, Toronto, Ontario, Canada M5H 3Y4, as their agent in respect of the Canadian patents and/or applications listed in the attached Schedule with full power to appoint an associate agent when required to do so by Rule 20 of the Patent Rules and to revoke such appointment, to sign the petition and drawings, to amend the specification and drawings, to prosecute the applications, and to receive the patent granted thereon; and ratifies any act done by the said last named appointee in respect of the said patents and/or applications.

The undersigned also hereby revokes all former Nominations of Representative and nominates said Borden Ladner Gervais LLP, to be their representative for the service of any proceedings taken under the Patent Act, in respect of the patents and/or applications identified in the attached Schedule.

SIGNED AT Trevose, PA this 13th day
 of April, 2011.

ZENON TECHNOLOGY PARTNERSHIP

By: 
 Title: Patent Counsel

PAT 92005-1

Page 2

SCHEDULE OF CANADIAN PATENTS AND PATENT APPLICATIONS

Serial No.	Title	Filing Date/ BLG Reference
2,615,945	APPARATUS AND METHOD FOR TREATING FGD BLOWDOWN OR SIMILAR LIQUIDS	July 24, 2006 PAT 92005W-1
2,512,759	SUPPORTED BIOFILM APPARATUS AND PROCESS	February 13, 2004 PAT 92063W-1
2,560,152	WATER FILTRATION USING IMMERSED MEMBRANES	February 25, 2005 PAT 92064W-1
2,686,056	MEMBRANE MODULE WITH MULTIPLE BOTTOM HEADERS AND FILTRATION PROCESS	May 8, 2008 PAT 92067W-1
2,614,676	PROCESS CONTROL FOR AN IMMERSED MEMBRANE SYSTEM	July 11, 2006 PAT 92069W-1

Patent No.	Title	Issue Date/ BLG Reference
2,345,682	CYCLIC AERATION SYSTEM FOR SUBMERGED MEMBRANE MODULES	January 13, 2009 PAT 92000W-1
2,227,692	VERTICAL SKEIN OF HOLLOW FIBER MEMBRANES AND METHOD OF MAINTAINING CLEAN FIBER SURFACES	April 17, 2001 PAT 92043W-1
2,290,053	IMMERSED MEMBRANE MODULE AND PROCESS	October 20, 2009 PAT 92051-1

May 12, 2011

BERESKIN & PARR LLP/S.E.N.C.R.L.,S.R.L.
40 King Street West
40th floor
TORONTO Ontario
M5H 3Y2

Application - Patent Nos. : 2,517,322 and 8 others

Owner : ZENON TECHNOLOGY PARTNERSHIP

This is to inform you that your appointment as representative and agent of record, has now been revoked for all the listed patent and application numbers (copy of the list enclosed).

Should you require any further information or assistance, please do not hesitate to contact the undersigned.

Yours truly,

Joanne Petrin
Maintenance Fees and Agent Renewal Registry Analyst
819-953-7837
Fax 819-953-2476
2517322A.WPD

May 12, 2011

BORDEN LADNER GERVAIS LLP

Scotia Plaza
40 King Street West
TORONTO Ontario
M5H 3Y4

Application - Patent Nos. : 2,517,322 and 8 others

Owner : ZENON TECHNOLOGY PARTNERSHIP

This acknowledges your letter dated May 2, 2011. Your request to revoke the former representative and agent, and record the newly submitted appointment of representative and agent in your favour, have both been made of record for all the listed application and patent numbers.

Our records indicate that there is an outstanding office action (copy enclosed).

Please note that the application **2,560,152** is abandoned since February 25, 2011 due to non-payment of the maintenance fees within the prescribed time pursuant to paragraph 73(1)(c) of the Patent Act.

Should you require any further information or assistance, please do not hesitate to contact the undersigned.

Yours truly,

Joanne Petrin
Maintenance Fees and Agent Renewal Registry Analyst
819-953-7837
Fax 819-953-2476
2517322B.WPD

PATENT OFFICE MAIL**Date: August 4, 2011**

Contact: Scott McDougall

Today's payment covers the following maintenance fees:

<u>Our File</u>	PCT No./ Serial No./ <u>Patent No.</u>
-----------------	--

Owner

PAT 92005-1

2,517,322

ZENON TECHNOLOGY PARTNERSHIP

Anniv.
Year

6th

Due Date

26/08/2011

Amount
Paid

200.00

SUB TOTAL:

200.00 ✓

GRAND TOTAL:

200.00

YOU ARE HEREBY AUTHORIZED TO CHARGE THESE FEES TO THE DEPOSIT ACCOUNT #600000247 OR TO THE DEPOSIT ACCOUNT #600001646 OF BORDEN LADNER GERVAIS LLP OTTAWA ON (AS PER THE ATTACHED CIPO FEE PAYMENT FORM).

Should any of the above noted applications/patents be abandoned for any reason, please regard this as the request(s) for reinstatement. Should the fees submitted with this letter be insufficient to cover all of the fees for which payment is explicitly or implicitly requested by this letter, or needed to reinstate the application, the Commissioner is authorized to charge the amount of the insufficiency to our deposit account number 600000247 or to our deposit account number 600001646 (as per the attached CIPO Fee Payment Form).

A/M/J Y/M/D

BORDEN LADNER GERVAIS LLP
4100-40 King Street West
Toronto ON M5H 3Y4
416.367.6000

Industrie
Canada

CIPO

OPIC

2011/08/04

217-11

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23

December 19, 2011

BORDEN LADNER GERVAIS LLP

Scotia Plaza
40 King Street West
TORONTO Ontario
M5H 3Y4

Application No. : **2,517,322**
Owner : ZENON TECHNOLOGY PARTNERSHIP
Title : **APPARATUS AND METHOD FOR TREATING FGD
BLOWDOWN OR SIMILAR LIQUIDS**
Classification : C02F 3/30 (2006.01)
Examiner : PHAM Thi Tham

YOU ARE HEREBY NOTIFIED OF A REQUISITION BY THE EXAMINER IN ACCORDANCE WITH SUBSECTION 30(2) OF THE *PATENT RULES*. IN ORDER TO AVOID ABANDONMENT UNDER PARAGRAPH 73(1)(a) OF THE *PATENT ACT*, A WRITTEN REPLY MUST BE RECEIVED WITHIN THE 6 MONTH PERIOD AFTER THE ABOVE DATE.

This application has been examined as originally filed.

The number of claims in this application is 8.

Documents Cited:

D1:	CA1274925	Downing et al.	2 October 1990 (02-10-1990)
D2:	CA2025433 A1	Maree et al.	3 April 1991 (03-04-1991)

D3: Droste (1997). Water treatment unit operations. In *Theory and Practice of Water and Wastewater Treatment* (pp. 227-234). New York: John Wiley & Sons.

The examiner has identified the following defects in the application:

Present claims 1-8 and claims 1-4 and 10-16 of co-pending application 2615945 are conterminous, and thus cannot be granted in separate patents.

Claim 1 encompasses subject-matter that was disclosed in D1 and does not comply with paragraph 28.2(1)(b) of the *Patent Act*.

D1 discloses a process for treatment of wastewater comprising anoxic denitrification, followed by anoxic selenium removal and anaerobic removal of sulfur and heavy metals (see pages 4-5, bridging paragraph; page 6; page 8, line 25 to page 9, line 18; pages 10-

11, bridging paragraph; Example 4). The process can be carried out in a single reactor with multiple reaction zones or in separate vessels defining two or more reaction stages (see page 13, lines 6-27). Therefore, claim 1 lacks novelty over D1.

Claims 1 and 3 (partly) encompasses subject-matter that was disclosed in D1 and does not comply with paragraph 28.2(1)(b) of the *Patent Act*.

D2 discloses a process for treatment of water containing dissolved sulphate, selenium, tellurate and/or nitrate ions, wherein the water is biologically treated in the absence of molecular oxygen, at a pH of 5.0 to 8.5 (see abstract; page 2, lines 24-25; pages 3-4, bridging paragraph; page 7, lines 24-26). Removal of heavy metals occur when the water to be treated contains sulphate ions (see 4, lines 5-10). Dilution of influent water upstream of the biological treatment stage is carried out when sulfate concentration is too high (see page 12, lines 1-3). The process is carried out in an apparatus comprising one or more reactors arranged in series (see page 10, lines 6-10) and is suitable for treating lime-neutralized mine water containing dissolved calcium ions (see page 6, lines 24-27). Therefore, claims 1 and 3 (partly) lack novelty over D2.

The claims on file do not comply with section 28.3 of the *Patent Act*. These claims are directed to subject-matter that would have been obvious at the claim date to a person skilled in the art or science to which they pertain having regard to D1 or D2, in view of general knowledge in the art.

Claim 1 is considered to lack novelty over D1; therefore, it follows that said claim also lack an inventive step.

Claims 1 and 3 are considered to lack novelty over D2; therefore, it follows that said claims also lack an inventive step.

D1 and D2 do not explicitly teach aerobic treatment of the influent wastewater upstream of the anoxic/anaerobic stages. Furthermore, D1 and D3 do not teach all of the steps recited in claim 3. Therefore, claims 2, 3 (partly), 4-8 are considered to be novel.

The problem to be solved is considered to be the provision of a process and apparatus for the treatment of flue gas desulfurization scrubber blow-down water. The solution is provided by integrating physical/chemical treatment (e.g., lime softening, flocculation, sedimentation, NH₃ stripping, etc.) with biological treatment (e.g., fixed film bioreactor, aerobic nitrification and COD removal, and anoxic/anaerobic removal or nitrates, selenium, sulfates and heavy metals) of the flue gas desulfurization scrubber blow-down water (see paragraphs [0017] to [0023]).

It is common general knowledge that wastewaters are normally treated by a combination of physical/chemical and biological operations (see D3, page 227, 3rd paragraph from bottom). It is, thus, expected of the skilled person to be able to choose appropriate operations from among known operation units and design a process that would meet the desired treatment requirement. That is, an inventive step cannot be acknowledged if the process or system

claimed is an integral of known features, each and in combination, providing known, expected outcomes. The features recited in claims 2-8 are all known (see D3, pages 227-231). Therefore, claims 2-8 lack an inventive step.

Claims 1, 3, 7 and 8 are indefinite and do not comply with subsection 27(4) of the *Patent Act*:

- In claim 1, inclusion of “for example” causes a lack of clarity.
- In claim 2, the expression “the digestion steps” has no antecedent.
- In claim 7, the expression “the fixed film reactor” has no antecedent when claim 7 is dependent on claim 4 or 5.
- In claim 8, the expressions “the feed water” and “the wastewater” have no antecedent.

The description does not comply with subsection 81(1) of the *Patent Rules*. Statements (at paragraphs [0005] and [0031]) that incorporate by reference other documents should be removed.

In view of the foregoing defects, the applicant is requisitioned, under subsection 30(2) of the *Patent Rules*, to amend the application in order to comply with the *Patent Act* and the *Patent Rules* or to provide arguments as to why the application does comply.

Under section 34 of the *Patent Rules*, any amendment made in response to this requisition must be accompanied by a statement explaining the nature thereof, and how it corrects each of the above identified defects.

PHAM Thi Tham
Patent Examiner
819-953-0771

2517322A.ptt

As per CIPO Client Service Standards, a response to a telephone enquiry or voice mail should be provided by the end of the next business day. In the event that attempts to reach the examiner are unsuccessful, the examiner's Section Head, André C. Martin, can be reached at 819-953-6441.

REPLACEMENT PAGE

CLAIMS:

We claim:

1. A process having steps of anoxic treatment to denitrify a waste stream followed by anoxic treatment to remove selenium, anaerobic treatment to remove heavy metals and a step of aerobic treatment to remove COD from and nitrify the waste stream upstream of the anoxic treatment.
2. The process of claim 1 further comprising one or more steps of:
 - a) membrane separation of the waste stream upstream of the step of anoxic digestion to remove selenium;
 - b) diluting the waste stream upstream of the digestion steps of claim 1;
 - c) physical/chemical pretreatment upstream of the steps of claim 1 to remove TSS and soften the waste stream; or,
 - d) ammonia stripping upstream of the steps of claim 1.
3. An apparatus having one or more reactors configured to provide aerobic treatment of COD, nitrification, denitrification, selenium removal and heavy metal and sulphur removal by biological treatment.
4. The apparatus of claim 3 wherein one of the reactors is a membrane bioreactor.
5. The apparatus of claim 3 or 4 wherein one of the reactors is a fixed film reactor
6. The apparatus of claim 5 wherein the fixed film reactor has a granular activated carbon bed.
7. The apparatus of any one of claims 3 to 6 having one or more of an inlet for adding diluting water to the reactors, a pretreatment area having a system for adding lime or sulfide to the pretreatment area upstream of the one or more reactors, a precipitate remover, or an ammonia stripper.

REPLACEMENT PAGE

8. A process for the treatment of a liquid comprising:
- a) physical and/or chemical pretreatment of the liquid to remove total suspended solids and to soften the liquid;
 - b) ammonia stripping of the liquid;
 - c) anoxic treatment to remove nitrate;
 - d) a second anoxic treatment after step (c) to remove selenium and anaerobic treatment to remove heavy metals; and,
 - e) membrane separation of the liquid upstream of step (d).
9. The process of claim 8 further comprising the step of: f) dilution upstream of the ammonia or anoxic steps.
10. The process of claim 8 or 9 wherein the process is carried out in a series of reactors and at least one of the reactors is a membrane bioreactor.
11. The process of claim 10 wherein one of the reactors is a fixed film reactor and is downstream of the membrane bioreactor.
12. The process of claim 11 wherein the fixed film reactor has a granular activated carbon bed.
13. The process of claim 12 wherein the operation of the activated carbon bed reactor comprises a step of considering the oxygen reduction potential of water in or exiting from a part of the reactor in determining a nutrient addition amount or rate.
14. The process of claim 10 having one or more inlets for diluting the liquid in the reactors, a system for adding lime or sulfides to the liquid upstream of the reactors, or a precipitate remover.
15. The process of any one of claims 8 to 14 wherein lime, sulfides or combinations thereof are added in the pretreatment step.

REPLACEMENT PAGE

16. The process of any one of claims 8 to 15 wherein the ammonia stripping takes place in a first aerobic zone.
17. A process for treating a waste stream comprising flue gas desulfurization blow down water having steps of physical and chemical pretreatment to remove suspended solids from the waste stream and soften the waste stream followed by treatment to denitrify the waste stream followed by treatment to remove selenium from the waste stream, wherein the steps of denitrifying the waste stream and removing selenium from the waste stream occur in one or more fixed film bioreactors.
18. The process of claim 17 further comprising a step of anaerobic treatment to remove arsenic, mercury, or sulphur.
19. The process of claim 17 or 18 further comprising a step of aerobic treatment to remove COD from or nitrify the waste stream upstream of the step of denitrifying the waste stream.
20. The process of any one of claims 17 to 19 further comprising a step of membrane separation of the waste stream upstream of the step of removing selenium.
21. An apparatus for treating a waste stream comprising flue gas desulfurization blow down water, the apparatus having a system for adding lime or sulfides to the waste stream and a precipitate remover upstream of one or more reactors configured to provide denitrification and selenium removal by biological treatment.
22. The apparatus of claim 21 wherein the one or more reactors further provide aerobic treatment of COD by biological treatment.
23. The apparatus of claim 21 or 22 wherein the one or more reactors further provide heavy metal or sulfur removal by biological treatment.
24. The apparatus of any one of claims 21 to 23 wherein one of the one or more reactors is a membrane bioreactor.

REPLACEMENT PAGE

25. The apparatus of any one of claims 21 to 24 wherein one of the one or more reactors is a fixed film reactor.

26. The apparatus of claim 25 wherein the fixed film reactor has an activated carbon bed used to support a population of microbes.

27. The apparatus of any one of claims 21 to 26 having an ammonia stripper.

- 1 -

TITLE: APPARATUS AND METHOD FOR TREATING FGD BLOWDOWN
OR SIMILAR LIQUIDS

FIELD OF THE INVENTION

[0001] This invention relates to water treatment including biological water treatment and treatment of feeds having high concentrations of inorganic and organic contaminants, for example scrubber blow down water
5 from a flue gas desulfurization (FGD) operation in a coal fired power plant.

BACKGROUND OF THE INVENTION

[0002] The following background discussion does not imply or admit that any process or apparatus described below is citable as prior art or part of the knowledge of people skilled in the art in any country.

10 **[0003]** Scrubber blow-down water from a flue gas desulfurization operation in a coal-fired power plant contains a wide range of inorganic contaminants removed from the flue gas. The blow down water may also contain organic contaminants, such as di basic acid (DBA), and ammonia added as part of or to enhance the FGD process. The FGD scrubber blow-
15 down water may have very high total dissolved solids where the main anions are chlorides and the main cations are calcium, magnesium and sodium. The rate of blow-down may be controlled to maintain a desired chloride concentration causing the blow-down water to have a high, but generally stable chloride concentration. The concentration of other contaminants may
20 vary widely as influenced, for example, by burning coal from different sources even in a single power plant. However, the concentration of TDS, TSS, Ca and Mg hardness, nitrate, ammonia, and sulfur for example as sulphate are all likely to be high, and various heavy metals may be present, making the blow down water very difficult to treat, particularly to achieve very low levels of
25 contaminants.

[0004] Current methods of treating blow down water rely heavily on physical and chemical processes to remove inorganic contaminants. The physical and chemical processes also involve costly chemicals and produce

REPLACEMENT PAGE

- 2 -

large amounts of sludge. Arsenic, mercury and heavy metals may also be present in the blow down water at above regulated levels. Further, some jurisdictions have recently regulated selenium concentrations in effluents discharged to the environment. The permitted concentration of selenium may be 0.5 ppm or less or 200 ppb or less while the blow down water may contain 1-20 or 2-10 ppm of selenium which is not removed in conventional treatment plants.

[0005] In U.S. Patent No. 6,183,644, entitled Method of Selenium Removal and issued on February 6, 2001 to D. Jack Adams and Timothy M. Pickett, dissolved selenium is removed from contaminated water by treating the water in a reactor containing selected endemic and other selenium reducing organisms. Microbes may be isolated from the specific water or imported from other selenium contaminated water. The microbes are then screened for ability to reduce selenium under the site specific environmental conditions. The selected microbes are optimized for selenium reduction, then established in a high density biofilm within a reactor. The selenium contaminated water is passed through the reactor with optimized nutrient mix added as needed. The elemental selenium is precipitated and removed from the water. Products using this or a similar process have been sold as the ABMet™ process by Applied Biosciences Corp of Salt Lake City, Utah, U.S.A.

SUMMARY OF THE INVENTION

[0006] The following summary is intended to introduce the reader to the invention but not to define it. The invention may reside in any combination of one or more of the apparatus elements or process steps described anywhere in this document.

[0007] It is an object of this invention to improve on, or at least provide a useful alternative to, the prior art. It is another object of the invention to provide a wastewater treatment process or apparatus. Other objects of the invention are to provide an apparatus or process for treating FGD blow down

- 3 -

water or other wastewaters having selenium or nitrate and selenium, or a process or apparatus for biologically removing inorganic contaminants, for example nitrogen, selenium, arsenic, mercury or sulphur, from waste water.

[0008] In one aspect, the invention provides a process having steps of

5 aerobic treatment to remove COD and nitrify a waste stream, anoxic treatment to denitrify a waste stream, anoxic treatment to remove selenium and anaerobic treatment to remove heavy metals or sulphur or both. Removal of heavy metals is possible because SO_4 is present and converted to sulphur by anaerobic SO_4 reducing bacteria. The process may further include one or

10 more of (a) membrane separation of the waste stream upstream of the anoxic digestion to remove selenium, (b) dilution upstream of the biological treatment step, (c) physical/chemical pretreatment upstream of the biological processes or dilution step to remove TSS and soften the waste stream, for example through the addition of lime or sulfides and the removal of precipitates or (d)

15 ammonia stripping upstream of the biological treatment steps or dilution step. Some of the biological treatment steps may be performed in a fixed film reactor, for example a granular activated carbon bed. One or more of the biological treatment steps may also be performed in a suspended growth reactor such as a membrane bioreactor. Each biological treatment step may

20 be performed in a distinct reactor optimized to perform a step or two or more of the biological treatment steps may be performed in a multiple purpose reactor.

[0009] In another aspect, the invention provides an apparatus having one or more reactors configured to provide aerobic treatment of COD,

25 nitrification, denitrification, selenium and heavy metals removal and sulphur removal by biological treatment. The reactors may include a membrane bioreactor or a fixed film reactor. The fixed film reactor may comprise a granular activated carbon bed. The apparatus may further have one or more of an inlet for diluting the feed water to the biological processes, a system for

30 adding lime or sulfides to the wastewater upstream of the biological reactors, a precipitate remover, or an ammonia stripper.

- 4 -

[0010] The invention is particularly suited for treating FGD blow down water to produce an effluent with low concentrations of selenium, for example 1 ppm or less or 10 ppb or less, and low concentrations of total nitrogen, for example 1 mg/L or less or 10 ppm or less, in the effluent. However, the invention may also have applications in treating blow down water when selenium concentration in the effluent is not a concern. The invention may also be useful for treating other wastewaters having selenium, for example mining, contaminated ground or surface water streams, or petroleum refinery waste streams, particularly where the waste stream also has significant concentrations of one or more of COD, nitrate, ammonia, TDS, TSS, hardness, CaSO₄, or sulphate.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] Examples of embodiments of the invention will be described below with reference to the Figures described below.

[0012] Figure 1 is a schematic flow diagram of an apparatus and process for treating water.

[0013] Figure 2 is a more detailed process flow diagram of an exemplary system for treating FGD blow down water.

[0014] Figure 3 is a schematic diagram showing an alternate embodiment for part of the system and process of Figure 1 or 2.

DESCRIPTION OF EXEMPLARY EMBODIMENTS

[0015] Table 1 shows the contaminants, and their concentrations, assumed for FGD scrubber blow-down water in the design of the following exemplary embodiments. FGD blow-down water may exist with other contaminants or other concentrations of contaminants. The composition of FGD blow-down can also vary widely over time for a specified coal-fired power plant as influenced, for example, by changes in the source of coal. However, FGD blow-down water is generally characterized by very high total dissolved solids (TDS) where the main anion is chloride and the main cations are calcium, magnesium and sodium. The blow-down also contains significant

- 5 -

concentrations of fine suspended solids, including CaSO_4 fines. The blow-down also contains a wide range of inorganic contaminants, including ammonia, which is added for selective catalytic reduction in the scrubbing process, as well as some organics, particularly DBA (dibasic acid) added to enhance scrubber efficiency. In the exemplary embodiments, the effluent is intended to have a total nitrogen (TN) content of 10 ppm or less and selenium concentrations of 0.4 ppm or less.

TABLE 1: Typical FGD Blowdown Water

Parameter	Typical Value	Min - Max
Chlorides	30,000 ppm	20-40,000 ppm
pH	>5.0<6.0	
TDS	75,000 mg/L	50,000 – 150,000 mg/L
TSS	2 % dry wt	1 – 5 % dry wt
Aluminum – Total	960 ppm	80-3700 ppm
Antimony	12 ppm	0.03-49.0 ppm
Ammonia – N	31 ppm	0.25-64 ppm
Nitrate – N	350 ppm	200-450 ppm
Total Nitrogen	200 ppm	50-400 ppm
Arsenic – Total	15 ppm	0.27-100 ppm
Barium – Total	100 ppm	2.0-770 ppm
Beryllium	2.1 ppm	0.06-6.9 ppm
Boron	----	20-40 ppm
Cadmium – Total	0.8 ppm	0.12-1.5 ppm
Calcium	18,000 ppm	10,000-30,000 ppm
Chromium – Total	23 ppm	0.5-210 ppm
Chromium VI	----	3-12 ppm
Cobalt	----	0.05-4 ppm
Copper – Total	1.7 ppm	0.3-6.6 ppm
CO_3/HCO_3	1500 ppm	1-3,000 ppm
Fluoride	360 ppm	61-1600 ppm
Iron – Total	1400 ppm	116-6400 ppm

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Lead – Total	19 ppm	0.2-140 ppm
Lithium	----	2-3 ppm
Magnesium	15,000 ppm	10,000-20,000 ppm
Manganese	10 ppm	3.6-200 ppm
Mercury – Total	0.38 ppm	0.5-1.4 ppm
Nickel – Total	10 ppm	0.5-74 ppm
Phosphate – Total	1.0 ppm	0-10 ppm
Potassium	6800 ppm	5000-10,000 ppm
Selenium – Total	17 ppm	1.5-100 ppm
Silver – Total	10.0 ppm	0.002-20 ppm
Sodium	15,000 ppm	10,000-20,000 ppm
Sulfate (SO ₄)	60,000 ppm	40,000-80,000 ppm
Thallium	0.76 ppm	0.02-2.2 ppm
Vanadium	----	1.0-11.0 ppm
Total Zinc	15.0 ppm	1.7-50.0 ppm
Temperature	130°F	125-130°F

[0016] In greater detail, treating the blow-down raises several challenges which the invention addresses in a variety of ways, as described generally below and then by describing examples of treatment systems and processes. In the following description, pre-treatment refers to treatment occurring upstream of biological process steps.

[0017] High TDS concentrations make it difficult to maintain activity for biological treatment. This issue is addressed by diluting the waste stream upstream of biological treatment. The high TDS also makes it difficult to flocculate and settle biomass in an activated sludge process. This issue is addressed by using fixed film bioreactors or membrane bioreactors.

[0018] High hardness causes scaling due to Ca or Mg oversaturation and any pH or temperature shifts, for example during denitrification, may cause precipitation of calcium or magnesium sulfates or carbonates. This issue is addressed by a softening pre-treatment, for example lime softening,

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and optionally by adding acid for pH adjustment upstream of the biological process.

[0019] The high TSS, particularly because it is essentially inorganic, causes problems with developing and controlling a suspended biomass and with bioreactor and membrane plugging. This issue is addressed by pre-treating the waste stream to coagulate or flocculate and then physically remove (for example by settling or floating) suspended solids.

[0020] High nitrate concentrations are a concern because nitrate is a preferred electron acceptor for biological reduction over selenate. This issue is addressed by decreasing the nitrate concentration upstream of a selenate reducing step. The nitrate reducing step may occur in an upstream part of a plug flow selenate reducing reactor, as part of a multi-step biological process or reactor upstream of a selenate reducing process, or part of a distinct process or reactor.

[0021] Ammonia in the blow down water is a concern because concentration in the final effluent may be regulated and because oxidation of ammonia may increase nitrate concentration. This issue is addressed by removing the ammonia, for example, by stripping the ammonia as NH_3 in a pre-treatment process or removing ammonia biologically by a nitrification/denitrification process either in a series process or with recirculating flows.

[0022] The presence of various heavy metals, for example Cu, As or Hg, or related oxidized contaminants are a concern because they may be regulated in the effluent but are difficult to remove in low concentrations. This issue may be addressed in part by precipitating these elements out in a pre-treatment softening step. The issue may be further addressed by biologically reducing SO_4 and precipitating these contaminants as metal sulfides after removing nitrate and selenate and selenite.

[0023] The presence of selenium, as selenate or selenite, is a concern because of recent regulation of selenium concentrations in effluent. The

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selenium is difficult to remove because of its low concentration and its tendency to form selenate or selenite and dissolve in water making physical or chemical removal difficult, costly or inefficient. Selenium is addressed in the invention by biologically reducing it to elemental selenium and then
5 precipitating it for removal.

[0024] Figure 1 shows a treatment system 10 having a pretreatment area 12 upstream of a biological treatment area 14 . Feed 16, which may be FGD blow-down water or another feed, flows into pretreatment area 12. In the pretreatment area 12, a large portion of the TSS in the feed is removed and
10 Ca and Mg are removed to soften the feed 16. The pretreatment area 12 uses physical/chemical methods to treat the feed 16. For example, lime or sulfides or both may be added to the feed 16 to precipitate calcium, magnesium and metals. The precipitates may be removed by clarifiers, for example single stage or double stage clarifiers. Settling can be enhanced by the addition of
15 coagulants or polymers. Alternately, the precipitates can be removed by dissolved air floatation (DAF) involving the addition of similar treatment chemicals. The DAF process also strips some ammonia particularly if feed 16 temperature is kept above 100 degrees F or above 130 degrees F and the DAF process maintained at a pH of 8.5 or more or 9.5 or more. This may
20 reduce or remove the need for ammonia removal, by nitrification, at the biological treatment area 14 described below in jurisdictions where emitting ammonia in a blow off gas is permitted. Optionally, the ammonia in the gas blow-off from a DAF reactor may be recycled to a selective catalytic reduction part of the FGD process. DAF reactors may be purchased from Infilco-
25 Degremont of Virginia, USA under the AquaDAF trade mark or from Clear Water Technology of California, USA under the GEM trade mark.

[0025] Pre-treatment effluent leaves the pretreatment area 12 through a pretreatment effluent line 20. Dilution water 18 is added to the pretreatment effluent. The dilution water 18 reduces the TDS of the pretreatment effluent to
30 make it acceptable for biological treatment downstream. Sufficient dilution water 18 may be added to make the TDS like that of seawater, for example

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with a TDS of 35 g/L or less. Any low TDS water can be used for dilution water 18, for example cooling circuit blow down water from a power plant. The dilution water 18 also cools the FGD blow-down water, for example from 50 °C or more to about 40 °C or less, to further facilitate biological treatment.

5 **[0026]** The diluted pretreatment effluent then flows to the biological treatment area 14. The biological treatment area 14 has four zones: an aerobic zone 22; a first anoxic zone 24; a second anoxic zone 26; and, an anaerobic zone 28. These zones 22, 24, 26, 28 are shown connected in series in Figure 1 although one or more of them may alternately be connected
10 with recirculation loops. Further alternately, some of the zones 22, 24, 26, 28 may not be required in some embodiments. The zones 22, 24, 26, 28 may also occur in separate reactors or one or more zones 22, 24, 26, 28 may be combined into a single reactor. One or more of nutrient streams 30, 32, 34 may be used to add nutrients to any zone 24, 26, 28 downstream of a nutrient
15 stream 30, 32, 34, either directly or through intervening zones 24, 26. For example, nutrients may be added in stream 30 or stream 32 to support the growth of bacteria in zones 26 or zone 28 or both.

[0027] The aerobic zone 22 is used to nitrify ammonia, to the extent that ammonia has not been stripped in the pretreatment area 12, and to
20 oxidize organic carbon. An optional supplemental aerobic zone may also be added downstream of the anaerobic zone 28 to remove residual nutrients added before or in zones 24, 26, 28 and to oxidize residual compounds from anaerobic zone 28. If there is no TN discharge limit for the effluent, or if ammonia is stripped in the pretreatment area 12 such that TN in the effluent
25 will be acceptable, the aerobic zone 22 may be omitted, or replaced by an aerobic zone downstream of the anaerobic zone 28.

[0028] In the first anoxic zone 24, nitrate acts as a preferred electron acceptor and is removed by denitrification. The nitrate may be removed to a concentration which facilitates the biological reduction of selenium in the
30 second anoxic zone 26, considering that nitrate in high concentration will be used as an electron acceptor over low concentrations of selenate or selenite.

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For example, NO_3 may be reduced to 10 mg/L as N or less or 1 mg/L as N or less or 10 ppm as N or less in the stream leaving the first anoxic zone 24.

[0029] In the second anoxic zone 26, selenium is removed by biological reduction and removal, for example by precipitation into flush flow water or waste sludge. These steps may occur, for example, according to the process described in US Patent No. 6,183,644 or in other fixed or suspended bed reactors. The reactors may be seeded with selenium reducing organisms.

[0030] In the anaerobic zone 28, sulfate-reducing bacteria reduce sulfates and produce sulfides in the form of H_2S or HS^- . Part of the HS^- may react with soluble metals to form insoluble metal sulfides which may precipitate out of solution. In this way the anaerobic zone removes heavy metals. The off gas from the anaerobic step 28 can be recycled to the aerobic step 22 or to a downstream aerobic step to reduce the production of odors associated with H_2S .

[0031] In general, the zones 22, 24, 26, 28 may be arranged into one or more reactors. Each zone 22, 24, 26, 28 may occupy its own reactor, for example a CSTR optimized to reduce the primary target contaminant of each zone 22, 24, 26, 28. Alternately, for example, zones 22 and 24 can be combined into a combined nitrification/denitrification reactor which may have 1, 2 or more tanks. Zones 24, 26 and 28 or 26 and 28 may be combined into a ABMet reactor having one or more tanks. Other reactors may also be used. For suspended growth reactors, the limited concentrations of the target contaminants may be low and the presence of other contaminants may make biomass separation difficult and so membrane bioreactors are preferred. Alternately, fixed film reactors may be used, for example Moving Bed Bioreactors, for example as produced by Anox Kaldnes of Norway, fluidized bed reactors, for example as produced by Shaw Envirogen of New Jersey, USA, biofilters as produced by Degremont of France under the trade mark BIOFOR, granular activated carbon reactors, for example as produced by the Applied Biosciences Corp. of Utah, USA under the ABMet trade mark, or in membrane supported biofilm reactors (MSBR) as described in PCT

REPLACEMENT PAGE

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Publication Nos. WO 2004/071973 or WO 2005/016826. Depending on the zone, the MSBR may operate autotrophically or heterotrophically optionally using a process of heterotrophic denitrification as described in Canadian Patent Application No. CA 2,477,333. Membrane separation may optionally
 5 be used with or after any fixed film reactor although there may also be no need for it.

[0032] Figure 2 shows a process flow diagram of a treatment plant 50
 10 for treating FGD blow-down as described in Table 1. In the pretreatment area 12, pretreatment is by lime softening, optionally with sulfide addition, and 1 or 2 stage settling in clarifiers. Such a process may be provided by WesTech of Utah, USA. PH is adjusted in the pretreatment effluent 20 when the dilution water 18 is added to a pH of less than 8.5, for example between 6 and 8 to
 15 enhance biological treatment. In the aerobic zone 22, a membrane bioreactor having an aeration tank and a membrane tank containing ZeeWeed™ membranes from Zenon Environmental Inc. of Ontario, Canada, is used for nitrification. The first and second anoxic and anaerobic zones 24, 26, 28 are provided in an ABMet reactor system by Applied Bioscience Corp. of Utah,
 20 USA, which may consist of a 2-stage reactor configuration. This reactor is an up-flow fixed film reactor using a GAC bed operated in plug flow so that 3 biological zones corresponding to the first anoxic, second anoxic and anaerobic zones 24, 26, 28 can be established in sequence. A single nutrient stream 30 is used upstream of the ABMet reactor. Precipitates are removed
 25 from this reactor by periodically flushing the GAC bed to overflow troughs. Sludge from the pretreatment area 12 and biological treatment area 14 is fed to a sludge thickener and dewaterer. Thickened and dewatered sludge is sent to waste. Sludge thickening and dewatering effluent is returned to an equalization tank to be mixed with the FGD flow down feed water 16.

30 **[0033]** Figure 3 shows a nitrification/denitrification reactor 80 used to provide the aerobic and first anoxic zones 22, 24 of Figure 1. Nitrification/

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denitrification reactor 80 may also be used to replace the bioreactor tank and ZeeWeed tank of Figure 2 to provide the aerobic and first anoxic zones 22, 42 and allow the ABMet reactor to be operated with the second anoxic and anaerobic zones 26, 28 with a minimal or no first anoxic zone 24.

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30**IN THE CANADIAN PATENT OFFICE**

To: The Commissioner of Patents

June 19, 2012

Application No.: **2,517,322**
 Title: **APPARATUS AND METHOD FOR TREATING FGD
 BLOWDOWN OR SIMILAR LIQUIDS**
 Applicant: **ZENON TECHNOLOGY PARTNERSHIP**
 Our File: **PAT 92005-1**

This is in response to the Examiner's requisition of December 19, 2010.

Please amend the application as follows:

In the Claims

Please replace pages 13 to 14 including claims 1-8 with new pages 13 to 16 attached hereto which contain claims 1-27. A marked up copy of the claims showing the changes to the claims is attached.

REMARKS**Claims**

Claim 1 has been amended to incorporate the matter of former claim 2, which has been cancelled. Claims 1, 2 and 7 (formerly claims 1, 3, 7 and 8) have been amended in response to indefiniteness rejections. Claims 8-16 are new and are similar to claims 1-9 of US Patent 7,550,087. Claims 17-27 are new and similar to claims 1-4 and 9-15 of US Patent 7,790,034.

Double Patenting

A voluntary amendment has been filed in application 2,615,945 to cancel claims 1-4 and 10-16 from it.

Novelty

Claims 1 and 3 were rejected for lack of novelty. Claim 1 has been amended to incorporate former claim 2. Claim 3 now depends on amended claim 1. Accordingly, the pending claims are novel.

Inventive Step

Claims 2-8 were rejected for lack of inventive step. The requisition alleges that some unit processes in the claims were known but the cited reference D3 does not describe these unit processes in the claimed combination. Almost all water treatment systems use combinations of known unit processes, but the order of the steps or selection of the unit process changes the operation and efficiency of the system as a whole. The water is changed from one process to another with the effluent from one unit process becoming the influent to the next unit process.

Merely asserting that some of the unit processes in the claims are known does not establish that each unit process is being used in a known way to provide a known outcome. Particularly in relation to the dependent claims, the requisition does not provide evidence that each element of the claims has been used in the prior art in the same way to achieve the same result. The Applicants submit that the requisition does not provide a report, pursuant to MOPOP 13.05, that is "as comprehensive as possible, to enable the Applicant to make informed decisions regarding the continued prosecution of their application and, if possible, to place the application in a condition for allowance". The Applicants further submit that: a) no obvious combination of the cited references provides a treatment process having aerobic treatment followed by two anoxic treatment steps and an anaerobic treatment step as further described in claim 1; b) that the cited references do not make obvious any combination of all of the steps in claim 2; and, c) that no combination of the cited references makes obvious an apparatus using biological treatment to remove all of the contaminants described in the claims. Accordingly, the claims are not obvious.

Indefiniteness

Claims 1, 3, 7 and 8 have been amended as shown in the marked up version of the claims. The Applicants submit that the amended claims are not indefinite.

Description

Paragraphs [0005] and [0031] have been amended to remove the statements incorporating other documents by reference.

Prior Art

Enclosed please find the front pages of U.S. Patent Nos. 7,550,087; 7,790,034 and 8,163,181 and the International Search Report from International Application No. PCT/CA2006/001220 which show the list of references that were cited or made of record during prosecution of those applications. Copies of the non-patent literature cited are also enclosed.

Favourable consideration of the application is respectfully requested.

Should this application be abandoned for any reason, please regard this as the request(s) for reinstatement. Should the fees submitted with this letter be insufficient to cover all of the fees for which payment is explicitly or implicitly requested by this letter, or needed to reinstate the application, the Commissioner is authorized to charge the amount of the insufficiency to our deposit account number 600000247 or deposit account number 600001646.

Yours very truly

Borden Ladner Gervais LLP / s.r.l.

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CLAIMS:

We claim:

1. A process having steps of anoxic treatment to denitrify a waste stream followed by anoxic treatment to remove selenium, ~~and anaerobic treatment to remove heavy metals, for example arsenic, mercury, or sulphur.~~ ~~2. The process of claim 1 further comprising and a~~ step of aerobic treatment to remove COD from and nitrify the waste stream upstream of the anoxic treatment ~~of the steps of claim 1.~~
32. The process of claim 1 ~~or 2~~ further comprising one or more steps of:
 - a) membrane separation of the waste stream upstream of the step of anoxic digestion to remove selenium;
 - b) ~~dilution~~ diluting the waste stream upstream of the digestion steps of claim 1;
 - c) physical/chemical pretreatment upstream of the ~~digestion steps of claim 1~~ or the ~~dilution step~~ to remove TSS and soften the waste stream; or,
 - d) ammonia stripping upstream of the ~~digestion steps of claim 1~~ or dilution step.
43. An apparatus having one or more reactors configured to provide aerobic treatment of COD, nitrification, denitrification, selenium removal and heavy metal and sulphur removal by biological treatment.
54. The apparatus of claim 43 wherein one of the reactors is a membrane bioreactor.
65. The apparatus of claim 43 ~~or 5-4~~ wherein one of the reactors is a fixed film reactor
76. The apparatus of claim 5 ~~any of claims 4 to 6~~ wherein the fixed film reactor has a granular activated carbon bed.
87. The apparatus of any one of claims 43 to 76 having one or more of an inlet for adding ~~diluting the feed-water to the reactors,~~ a pretreatment area having a system for adding lime or sulfides to the ~~wastewater~~ pretreatment area upstream of the one or more reactors, a precipitate remover, or an ammonia stripper.

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8. A process for the treatment of a liquid comprising:
 - a) physical and/or chemical pretreatment of the liquid to remove total suspended solids and to soften the liquid;
 - b) ammonia stripping of the liquid;
 - c) anoxic treatment to remove nitrate;
 - d) a second anoxic treatment after step (c) to remove selenium and anaerobic treatment to remove heavy metals; and,
 - e) membrane separation of the liquid upstream of step (d).
9. The process of claim 8 further comprising the step of: f) dilution upstream of the ammonia or anoxic steps.
10. The process of claim 8 or 9 wherein the process is carried out in a series of reactors and at least one of the reactors is a membrane bioreactor.
11. The process of claim 10 wherein one of the reactors is a fixed film reactor and is downstream of the membrane bioreactor.
12. The process of claim 11 wherein the fixed film reactor has a granular activated carbon bed.
13. The process of claim 12 wherein the operation of the activated carbon bed reactor comprises a step of considering the oxygen reduction potential of water in or exiting from a part of the reactor in determining a nutrient addition amount or rate.
14. The process of claim 10 having one or more inlets for diluting the liquid in the reactors, a system for adding lime or sulfides to the liquid upstream of the reactors, or a precipitate remover.
15. The process of any one of claims 8 to 14 wherein lime, sulfides or combinations thereof are added in the pretreatment step.

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16. The process of any one of claims 8 to 15 wherein the ammonia stripping takes place in a first aerobic zone.

17. A process for treating a waste stream comprising flue gas desulfurization blow down water having steps of physical and chemical pretreatment to remove suspended solids from the waste stream and soften the waste stream followed by treatment to denitrify the waste stream followed by treatment to remove selenium from the waste stream, wherein the steps of denitrifying the waste stream and removing selenium from the waste stream occur in one or more fixed film bioreactors.

18. The process of claim 17 further comprising a step of anaerobic treatment to remove arsenic, mercury, or sulphur.

19. The process of claim 17 or 18 further comprising a step of aerobic treatment to remove COD from or nitrify the waste stream upstream of the step of denitrifying the waste stream.

20. The process of any one of claims 17 to 19 further comprising a step of membrane separation of the waste stream upstream of the step of removing selenium.

21. An apparatus for treating a waste stream comprising flue gas desulfurization blow down water, the apparatus having a system for adding lime or sulfides to the waste stream and a precipitate remover upstream of one or more reactors configured to provide denitrification and selenium removal by biological treatment.

22. The apparatus of claim 21 wherein the one or more reactors further provide aerobic treatment of COD by biological treatment.

23. The apparatus of claim 21 or 22 wherein the one or more reactors further provide heavy metal or sulfur removal by biological treatment.

24. The apparatus of any one of claims 21 to 23 wherein one of the one or more reactors is a membrane bioreactor.

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25. The apparatus of any one of claims 21 to 24 wherein one of the one or more reactors is a fixed film reactor.

26. The apparatus of claim 25 wherein the fixed film reactor has an activated carbon bed used to support a population of microbes.

27. The apparatus of any one of claims 21 to 26 having an ammonia stripper.

REPLACEMENT PAGE

CLAIMS:

We claim:

1. A process having steps of anoxic treatment to denitrify a waste stream followed by anoxic treatment to remove selenium, anaerobic treatment to remove heavy metals and a step of aerobic treatment to remove COD from and nitrify the waste stream upstream of the anoxic treatment.
2. The process of claim 1 further comprising one or more steps of:
 - a) membrane separation of the waste stream upstream of the step of anoxic digestion to remove selenium;
 - b) diluting the waste stream upstream of the digestion steps of claim 1;
 - c) physical/chemical pretreatment upstream of the steps of claim 1 to remove TSS and soften the waste stream; or,
 - d) ammonia stripping upstream of the steps of claim 1.
3. An apparatus having one or more reactors configured to provide aerobic treatment of COD, nitrification, denitrification, selenium removal and heavy metal and sulphur removal by biological treatment.
4. The apparatus of claim 3 wherein one of the reactors is a membrane bioreactor.
5. The apparatus of claim 3 or 4 wherein one of the reactors is a fixed film reactor
6. The apparatus of claim 5 wherein the fixed film reactor has a granular activated carbon bed.
7. The apparatus of any one of claims 3 to 6 having one or more of an inlet for adding diluting water to the reactors, a pretreatment area having a system for adding lime or sulfide to the pretreatment area upstream of the one or more reactors, a precipitate remover, or an ammonia stripper.

REPLACEMENT PAGE

8. A process for the treatment of a liquid comprising:
 - a) physical and/or chemical pretreatment of the liquid to remove total suspended solids and to soften the liquid;
 - b) ammonia stripping of the liquid;
 - c) anoxic treatment to remove nitrate;
 - d) a second anoxic treatment after step (c) to remove selenium and anaerobic treatment to remove heavy metals; and,
 - e) membrane separation of the liquid upstream of step (d).
9. The process of claim 8 further comprising the step of: f) dilution upstream of the ammonia or anoxic steps.
10. The process of claim 8 or 9 wherein the process is carried out in a series of reactors and at least one of the reactors is a membrane bioreactor.
11. The process of claim 10 wherein one of the reactors is a fixed film reactor and is downstream of the membrane bioreactor.
12. The process of claim 11 wherein the fixed film reactor has a granular activated carbon bed.
13. The process of claim 12 wherein the operation of the activated carbon bed reactor comprises a step of considering the oxygen reduction potential of water in or exiting from a part of the reactor in determining a nutrient addition amount or rate.
14. The process of claim 10 having one or more inlets for diluting the liquid in the reactors, a system for adding lime or sulfides to the liquid upstream of the reactors, or a precipitate remover.
15. The process of any one of claims 8 to 14 wherein lime, sulfides or combinations thereof are added in the pretreatment step.

REPLACEMENT PAGE

16. The process of any one of claims 8 to 15 wherein the ammonia stripping takes place in a first aerobic zone.

17. A process for treating a waste stream comprising flue gas desulfurization blow down water having steps of physical and chemical pretreatment to remove suspended solids from the waste stream and soften the waste stream followed by treatment to denitrify the waste stream followed by treatment to remove selenium from the waste stream, wherein the steps of denitrifying the waste stream and removing selenium from the waste stream occur in one or more fixed film bioreactors.

18. The process of claim 17 further comprising a step of anaerobic treatment to remove arsenic, mercury, or sulphur.

19. The process of claim 17 or 18 further comprising a step of aerobic treatment to remove COD from or nitrify the waste stream upstream of the step of denitrifying the waste stream.

20. The process of any one of claims 17 to 19 further comprising a step of membrane separation of the waste stream upstream of the step of removing selenium.

21. An apparatus for treating a waste stream comprising flue gas desulfurization blow down water, the apparatus having a system for adding lime or sulfides to the waste stream and a precipitate remover upstream of one or more reactors configured to provide denitrification and selenium removal by biological treatment.

22. The apparatus of claim 21 wherein the one or more reactors further provide aerobic treatment of COD by biological treatment.

23. The apparatus of claim 21 or 22 wherein the one or more reactors further provide heavy metal or sulfur removal by biological treatment.

24. The apparatus of any one of claims 21 to 23 wherein one of the one or more reactors is a membrane bioreactor.

REPLACEMENT PAGE

25. The apparatus of any one of claims 21 to 24 wherein one of the one or more reactors is a fixed film reactor.

26. The apparatus of claim 25 wherein the fixed film reactor has an activated carbon bed used to support a population of microbes.

27. The apparatus of any one of claims 21 to 26 having an ammonia stripper.

REPLACEMENT PAGE

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large amounts of sludge. Arsenic, mercury and heavy metals may also be present in the blow down water at above regulated levels. Further, some jurisdictions have recently regulated selenium concentrations in effluents discharged to the environment. The permitted concentration of selenium may be 0.5 ppm or less or 200 ppb or less while the blow down water may contain 1-20 or 2-10 ppm of selenium which is not removed in conventional treatment plants.

[0005] In U.S. Patent No. 6,183,644, entitled Method of Selenium Removal and issued on February 6, 2001 to D. Jack Adams and Timothy M. Pickett, dissolved selenium is removed from contaminated water by treating the water in a reactor containing selected endemic and other selenium reducing organisms. Microbes may be isolated from the specific water or imported from other selenium contaminated water. The microbes are then screened for ability to reduce selenium under the site specific environmental conditions. The selected microbes are optimized for selenium reduction, then established in a high density biofilm within a reactor. The selenium contaminated water is passed through the reactor with optimized nutrient mix added as needed. The elemental selenium is precipitated and removed from the water. Products using this or a similar process have been sold as the ABMet™ process by Applied Biosciences Corp of Salt Lake City, Utah, U.S.A.

SUMMARY OF THE INVENTION

[0006] The following summary is intended to introduce the reader to the invention but not to define it. The invention may reside in any combination of one or more of the apparatus elements or process steps described anywhere in this document.

[0007] It is an object of this invention to improve on, or at least provide a useful alternative to, the prior art. It is another object of the invention to provide a wastewater treatment process or apparatus. Other objects of the invention are to provide an apparatus or process for treating FGD blow down

REPLACEMENT PAGE

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Publication Nos. WO 2004/071973 or WO 2005/016826. Depending on the zone, the MSBR may operate autotrophically or heterotrophically optionally using a process of heterotrophic denitrification as described in Canadian Patent Application No. CA 2,477,333. Membrane separation may optionally
 5 be used with or after any fixed film reactor although there may also be no need for it.

[0032] Figure 2 shows a process flow diagram of a treatment plant 50
 10 for treating FGD blow-down as described in Table 1. In the pretreatment area 12, pretreatment is by lime softening, optionally with sulfide addition, and 1 or 2 stage settling in clarifiers. Such a process may be provided by WesTech of Utah, USA. PH is adjusted in the pretreatment effluent 20 when the dilution water 18 is added to a pH of less than 8.5, for example between 6 and 8 to
 15 enhance biological treatment. In the aerobic zone 22, a membrane bioreactor having an aeration tank and a membrane tank containing ZeeWeed™ membranes from Zenon Environmental Inc. of Ontario, Canada, is used for nitrification. The first and second anoxic and anaerobic zones 24, 26, 28 are provided in an ABMet reactor system by Applied Bioscience Corp. of Utah,
 20 USA, which may consist of a 2-stage reactor configuration. This reactor is an up-flow fixed film reactor using a GAC bed operated in plug flow so that 3 biological zones corresponding to the first anoxic, second anoxic and anaerobic zones 24, 26, 28 can be established in sequence. A single nutrient stream 30 is used upstream of the ABMet reactor. Precipitates are removed
 25 from this reactor by periodically flushing the GAC bed to overflow troughs. Sludge from the pretreatment area 12 and biological treatment area 14 is fed to a sludge thickener and dewaterer. Thickened and dewatered sludge is sent to waste. Sludge thickening and dewatering effluent is returned to an equalization tank to be mixed with the FGD flow down feed water 16.

30 **[0033]** Figure 3 shows a nitrification/denitrification reactor 80 used to provide the aerobic and first anoxic zones 22, 24 of Figure 1. Nitrification/

PATENT OFFICE MAIL**Date: August 2, 2012**

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Dn



<u>Our File</u> PAT 92005-1	<u>PCT No./</u> Serial No./ <u>Patent No.</u> 2,517,322 ✓	<u>Owner</u> ZENON TECHNOLOGY PARTNERSHIP	<u>Anniv.</u> Year 7th	<u>Due Date</u> 26/08/2012	<u>Amount</u> <u>Paid</u> 200.00
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SUB TOTAL: 200.00

GRAND TOTAL: 200.00 ✓

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November 21, 2012

BORDEN LADNER GERVAIS LLP

Scotia Plaza
40 King Street West
TORONTO Ontario
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Application No. : **2,517,322**
Owner : ZENON TECHNOLOGY PARTNERSHIP
Title : **APPARATUS AND METHOD FOR TREATING FGD
BLOWDOWN OR SIMILAR LIQUIDS**
Classification : C02F 3/30 (2006.01)
Your File No. : **PAT 92005-1**
Examiner : PHAM Thi Tham -- G2

YOU ARE HEREBY NOTIFIED OF A REQUISITION BY THE EXAMINER IN ACCORDANCE WITH SUBSECTION 30(2) OF THE *PATENT RULES*. IN ORDER TO AVOID ABANDONMENT UNDER PARAGRAPH 73(1)(a) OF THE *PATENT ACT*, A WRITTEN REPLY MUST BE RECEIVED WITHIN THE 6 MONTH PERIOD AFTER THE ABOVE DATE.

This application has been examined taking into account the applicant's correspondence received in this office on 19 June 2012.

The number of claims in this application is 27.

As the application is apparently directed to a plurality of inventions, as detailed below, the examiner has proceeded on the presumption that the applicant will elect the claims of **Group A and B**. This presumption does not affect the applicant's right to elect, one time, a different invention for prosecution. The scope of the search and examination of the claims was therefore restricted to the subject-matter of the claims of **Group A and B (claims 1-7)**.

Documents Cited:

- D1: CA1274925 Downing et al. 2 October 1990 (02-10-1990)
- D2: CA2025433 A1 Maree et al. 3 April 1991 (03-04-1991)
- D3: Droste (1997). Water treatment unit operations. In *Theory and Practice of Water and Wastewater Treatment* (pp. 227-234). New York: John Wiley & Sons.
- D4: Carrera et al. (2003). Biological nitrogen removal of high-strength ammonium industrial wastewater with two-sludge system. *Water Research*, **37**:4211-4221.
- D5: USACE (30 April 1994). Treatment Technologies. In *Engineering and Design: Technical Guidelines for Hazardous and Toxic Waste Treatment and Cleanup Activities EM 1110-1-502* (chapter 4). Washington, DC: U.S. Army Corps of Engineers.

D6: JP1304100 A

Katagawa et al.

7 December 1989 (07-12-1989)

The examiner has identified the following defects in the application:

The subject matter of claims 13 and 16-27, as added by the applicant's correspondence received on June 19, 2012, does not comply with section 38.2 of the *Patent Act* because it is not reasonably to be inferred from the specification or drawings as originally filed:

- Per claim 13, the feature "considering the oxygen (*sic*) reduction potential of the water" is not disclosed in the application as originally filed.
- Per claim 16, the feature "wherein ammonia stripping takes place in a first aerobic zone" is not disclosed in the application as originally filed.
- Claim 17 is broader than the teaching of the description. The description teaches the sequential steps of "anoxic treatment to denitrify, anoxic treatment to remove selenium, and anaerobic treatment to removal heavy metals". Claim 17, as presently recited, does not define the treatment conditions for denitrification and selenium removal; therefore, claim 17 encompasses processes for denitrification and selenium removal, other than the disclosed sequence of anoxic treatment to denitrify, followed by anoxic treatment to remove selenium. As such, claim 17 goes beyond the description as originally filed.

The application does not comply with subsection 36(1) of the *Patent Act*. The claims (claims 13 and 16-27 excluded from examination due to new subject matter, as explained above) are directed to a plurality of alleged inventions as follows:

Group A - Claims 1-2 are directed to a process comprising the steps of anoxic, followed by anoxic, followed by anaerobic treatment, wherein an aerobic treatment step occurs upstream of the anoxic step;

Group B - Claims 3-7 are directed to an apparatus comprising reactors configured to provide aerobic treatment of COD, nitrification, denitrification, selenium removal and heavy metal and sulphur removal by biological treatment; and

Group C - Claims 8-12, 14, and 15 are directed to a process comprising physical and/or chemical pretreatment, ammonia stripping, anoxic treatment, a second anoxic treatment and anaerobic treatment, wherein membrane separation occurs upstream of the second anoxic treatment.

The common feature linking claims 1-12, 14, and 15 is identified as the treatment sequence: anoxic denitrification, followed by anoxic selenium removal, and anaerobic removal of sulfur and heavy metals. This treatment sequence is known (see D1; pages 4-5, bridging paragraph; page 6; page 8, line 25 to page 9, line 18; pages 10-11, bridging paragraph; Example 4). Therefore, the claims lack unity *a posteriori*.

It is noted that claim 3, as presently recited lacks essential features (see below) and it is further unclear whether the reactor for aerobic treatment of COD and nitrification of the waste stream is upstream of the denitrification reactor (as required by the method of claim 1). The subject matter of the claims of groups A and B would be acceptable in one

application if claim 3 clearly recites anoxic denitrification, anoxic selenium removal, and anaerobic removal of heavy metal and sulfur, wherein the reactor for aerobic treatment of COD and nitrification is upstream of the reactor for anoxic denitrification.

According to subsection 36(2) of the *Patent Act*, after limiting the claims of the present application to one invention only, the applicant may make any other invention disclosed the subject of a divisional application. The applicant is advised that once an election has been made, further prosecution of the present application will be limited to the invention so elected.

Claims 3-7 are not fully supported by the description, and do not comply with section 84 of the *Patent Rules*. The claimed subject matter is directed to the desired result rather than to the combination necessary to achieve that result as described in the description. As presently recited, the feature "reactors configured to provide ... nitrification, denitrification, selenium removal and heavy metal and sulphur removal by biological treatment", recited in main claim 3, is a desired result to be achieved, rather than a technical feature that would provide the desired result. It is noted that the present description only teaches biological treatment comprising: aerobic COD removal and nitrification, anoxic denitrification, anoxic selenium removal, and anaerobic removal of heavy metal and sulphur. Though biological nitrification is generally understood as an aerobic process, the biological denitrification process includes anoxic denitrification and aerobic denitrification. Process conditions and types of reactions occurring in the two denitrification processes are very different. The description only teaches anoxic denitrification. Furthermore, the description does not teach any other process for selenium removal and heavy metal and sulphur removal, other than biological anoxic treatment followed by anaerobic treatment. Therefore, claim 3 must specify the process conditions (i.e., anoxic, anaerobic, or aerobic) in the one or more reactors, with respect to the individual treatment process recited.

Claims 1-7 do not comply with section 28.3 of the *Patent Act*. These claims are directed to subject-matter that would have been obvious at the claim date to a person skilled in the art or science to which they pertain having regard to D1, in view of general knowledge in the art.

D1 discloses a process for treatment of wastewater comprising anoxic denitrification, followed by anoxic selenium removal and anaerobic removal of sulfur and heavy metals (see pages 4-5, bridging paragraph; page 6; page 8, line 25 to page 9, line 18; pages 10-11, bridging paragraph; Example 4). The process can be carried out in a single reactor with multiple reaction zones or in separate vessels defining two or more reaction stages (see page 13, lines 6-27).

Claim 1 differs from D1 in that claim 1 further recites an aerobic treatment step upstream of the anoxic treatment (it is assumed that this anoxic treatment refers to the first anoxic treatment for denitrification). It is well known that COD removal and nitrification of ammonia can be accomplished by aerobic treatment. It is within the purview of the skilled person to add an aerobic treatment step upstream of the process in D1, when seeking to treat wastewater containing high COD and/or ammonia. An inventive step can not be acknowledged in absence of data to show that such a modification provides an unexpected technical effect.

The applicant's arguments have been carefully considered, but are not convincing. The applicant is correct in asserting that wastewater treatment systems use combinations of known operation units. To be patentable the combination must be new and inventive. It is noted that the process of claim 1 meets the novelty requirement; however, it is maintained that the claim lacks an inventive step. The feature "aerobic treatment to remove COD and to nitrify the waste stream" is well-known (see, for example, D4, wherein it is known to provide an aerobic treatment step prior to the denitrification step, when dealing with wastewater containing high levels of ammonium). It is not clear what is the unexpected technical effect for having the step of "aerobic treatment to remove COD and to nitrify the waste stream upstream of the anoxic treatment", as presently recited in claim 1. Therefore, claim 1 lacks an inventive step.

Per claim 2, it is re-iterated that the process steps recited in claim 2 are known to the skilled person. For example, D6 (see abstract) teaches physical/chemical pretreatment of FGD wastewater (1) by adding fly ash (5) and solids removal (4), followed by COD treatment (9) and nitrogen removal (10). It is also common practice in biological treatment design to include suspended solids removal and wastewater dilution upstream of the biological process to minimize process upset (see, for example, page 4-16 of D5; page 12, lines 1-3, of D2). Ammonia stripping is a well-known option for treating industrial wastewater containing high levels of ammonium (see pages 4-1 to 4-6 of D5; page 4211, first line of right column, of D4). It is unclear what is the unexpected technical effects to be achieved by the features recited in claim 2. Therefore, claim 2 lacks an inventive step.

Apparatus claims 3-7 are considered to lack an inventive step as all of the features recited in claims 3-7 are known (see, for example, D3, pages 227-231). It is re-iterated that an inventive step cannot be acknowledged if the process or system claimed is an integral of known features, each and in combination, providing known, expected outcomes.

Claims 1 and 2 are indefinite and do not comply with subsection 27(4) of the *Patent Act*:

- In claim 1, it is unclear to what "the anoxic treatment" (end of claim) refers. It is noted that the process of claim 1 contains two anoxic treatments: anoxic treatment to denitrify and anoxic treatment to remove selenium.
- In claim 2, "the digestion" (in step (b)) has no proper antecedent.

In view of the foregoing defects, the applicant is requisitioned, under subsection 30(2) of the *Patent Rules*, to amend the application in order to comply with the *Patent Act* and the *Patent Rules* or to provide arguments as to why the application does comply.

Under section 34 of the *Patent Rules*, any amendment made in response to this requisition must be accompanied by a statement explaining the nature thereof, and how it corrects each of the above identified defects.

PHAM Thi Tham -- G2
Patent Examiner
819-953-0771

As per CIPO Client Service Standards, a response to a telephone enquiry or voice mail should be provided by the end of the next business day. In the event that attempts to reach the examiner are unsuccessful, the examiner's Section Head, André C. Martin, can be reached at 819-953-6441.

2517322B.ppt

REPLACEMENT PAGE

CLAIMS:

We claim:

1. A process for the treatment of a liquid comprising:
 - a) physical and/or chemical pretreatment of the liquid to remove total suspended solids and to soften the liquid;
 - b) removing ammonia from of the liquid;
 - c) anoxic treatment to remove nitrate;
 - d) a second anoxic treatment after step (c) to remove selenium and anaerobic treatment to remove heavy metals; and,
 - e) membrane separation of the liquid upstream of step (d).
2. The process of claim 1 further comprising the step of: f) dilution upstream of the ammonia or anoxic steps.
3. The process of claim 1 or 2 wherein the process is carried out in a series of reactors and at least one of the reactors is a membrane bioreactor.
4. The process of claim 3 wherein one of the reactors is a fixed film reactor and is downstream of the membrane bioreactor.
5. The process of claim 4 wherein the fixed film reactor has a granular activated carbon bed.
6. The process of claim 5 wherein the operation of the activated carbon bed reactor comprises a step of adding a nutrient to the activated carbon bed reactor.
7. The process of claim 3 having one or more inlets for diluting the liquid in the reactors, a system for adding lime or sulfides to the liquid upstream of the reactors, or a precipitate remover.

REPLACEMENT PAGE

8. The process of any one of claims 1 to 7 wherein lime, sulfides or combinations thereof are added in the pretreatment step.
9. The process of any one of claims 1 to 8 comprising nitrifying ammonia in a first aerobic zone.
10. A process for treating a waste stream comprising flue gas desulfurization blow down water having steps of physical and chemical pretreatment to remove suspended solids from the waste stream and soften the waste stream followed by anoxic treatment to denitrify the waste stream followed by anoxic treatment to remove selenium from the waste stream, wherein the steps of denitrifying the waste stream and removing selenium from the waste stream occur in one or more fixed film bioreactors.
11. The process of claim 10 further comprising a step of anaerobic treatment to remove arsenic, mercury, or sulphur.
12. The process of claim 10 or 11 further comprising a step of aerobic treatment to remove COD from or nitrify the waste stream upstream of the step of denitrifying the waste stream.
13. The process of any one of claims 10 to 12 further comprising a step of membrane separation of the waste stream upstream of the step of removing selenium.
14. An apparatus for treating a waste stream comprising flue gas desulfurization blow down water, the apparatus having a system for adding lime or sulfides to the waste stream and a precipitate remover upstream of one or more reactors configured to provide denitrification and selenium removal by biological treatment.
15. The apparatus of claim 14 wherein the one or more reactors further provide aerobic treatment of COD by biological treatment.
16. The apparatus of claim 21 or 22 wherein the one or more reactors further provide heavy metal or sulfur removal by biological treatment.

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REPLACEMENT PAGE

17. The apparatus of any one of claims 14 to 16 wherein one of the one or more reactors is a membrane bioreactor.

18. The apparatus of any one of claims 14 to 17 wherein one of the one or more reactors is a fixed film reactor.

19. The apparatus of claim 18 wherein the fixed film reactor has an activated carbon bed used to support a population of microbes.

20. The apparatus of any one of claims 21 to 26 having an ammonia stripper.

008

IN THE CANADIAN PATENT OFFICE

To: The Commissioner of Patents

May 17, 2012

Application No.: 2,517,322
Title: APPARATUS AND METHOD FOR TREATING FGD
BLOWDOWN OR SIMILAR LIQUIDS
Applicant: ZENON TECHNOLOGY PARTNERSHIP
Our File: PAT 92005-1

This is in response to the Examiner's requisition of November 21, 2012.

Please amend the application as follows:

In the Claims

Please replace pages 13 to 16 including claims 1-27 with new pages 13 to 15 attached hereto which contain claims 1-20. A marked up copy of the claims showing the changes to the claims is attached.

REMARKS

Claims 1 to 7 have been cancelled. The remaining claims are amended.

The Examiner rejected claims 13, 16 and 17 for added subject matter. The Applicants respectfully request that this rejection be reconsidered for the following reasons.

Claim 13, as amended, no longer recites the feature of "considering the oxygen reduction potential of the water". The remaining step of adding a nutrient to the reactor is supported by paragraph [0032], specifically page 11, lines 23-24, of the application.

Claim 16, as amended, replaces the reference to ammonia stripping in a first aerobic zone with a reference to nitrifying ammonia in an aerobic zone. This limitation is supported by paragraph [0027] of the application as filed.

Claim 17 has been amended to refer to anoxic treatment to denitrify followed by anoxic treatment to remove selenium.

The Applicants submit that all of the pending claims are supported by the application as filed.

Regarding subsection 36(1) of the *Patent Act*, the Applicants elect Group C and have cancelled claims 1 to 7. The Applicants submit that claims 17 to 27 are part of Group C since they share steps of removing suspended solids and softening with claims 8 to 16.

Given the cancellation of claims 1 to 7, the further rejections in the Requisition do not apply to this application.



Should this application be abandoned for any reason, please regard this as the request(s) for reinstatement. Should the fees submitted with this letter be insufficient to cover all of the fees for which payment is explicitly or implicitly requested by this letter, or needed to reinstate the application, the Commissioner is authorized to charge the amount of the insufficiency to our deposit account number 600000247 or deposit account number 600001646.

Yours very truly

Borden Ladner Gervais LLP / s.r.l. 

Agents

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CLAIMS:

We claim:

1. ~~A process having steps of anoxic treatment to denitrify a waste stream followed by anoxic treatment to remove selenium, anaerobic treatment to remove heavy metals and a step of aerobic treatment to remove COD from and nitrify the waste stream upstream of the anoxic treatment.~~
2. ~~The process of claim 1 further comprising one or more steps of:~~
 - ~~a) membrane separation of the waste stream upstream of the step of anoxic digestion to remove selenium;~~
 - ~~b) diluting the waste stream upstream of the digestion steps of claim 1;~~
 - ~~c) physical/chemical pretreatment upstream of the steps of claim 1 to remove TSS and soften the waste stream; or,~~
 - ~~d) ammonia stripping upstream of the steps of claim 1.~~
3. ~~An apparatus having one or more reactors configured to provide aerobic treatment of COD, nitrification, denitrification, selenium removal and heavy metal and sulphur removal by biological treatment.~~
4. ~~The apparatus of claim 3 wherein one of the reactors is a membrane bioreactor.~~
5. ~~The apparatus of claim 3 or 4 wherein one of the reactors is a fixed film reactor~~
6. ~~The apparatus of claim 5 wherein the fixed film reactor has a granular activated carbon bed.~~
7. ~~The apparatus of any one of claims 3 to 6 having one or more of an inlet for adding diluting water to the reactors, a pretreatment area having a system for adding lime or sulfide to the pretreatment area upstream of the one or more reactors, a precipitate remover, or an ammonia stripper.~~

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81. A process for the treatment of a liquid comprising:
- a) physical and/or chemical pretreatment of the liquid to remove total suspended solids and to soften the liquid;
 - b) ~~ammonia stripping~~removing ammonia from of the liquid;
 - c) anoxic treatment to remove nitrate;
 - d) a second anoxic treatment after step (c) to remove selenium and anaerobic treatment to remove heavy metals; and,
 - e) membrane separation of the liquid upstream of step (d).
92. The process of claim 8-1 further comprising the step of: f) dilution upstream of the ammonia or anoxic steps.
403. The process of claim 8-1 or 9-2 wherein the process is carried out in a series of reactors and at least one of the reactors is a membrane bioreactor.
414. The process of claim 40-3 wherein one of the reactors is a fixed film reactor and is downstream of the membrane bioreactor.
425. The process of claim 41-4 wherein the fixed film reactor has a granular activated carbon bed.
436. The process of claim 42-5 wherein the operation of the activated carbon bed reactor comprises a step of adding a nutrient to the activated carbon bed reactor~~considering the oxygen reduction potential of water in or exiting from a part of the reactor in determining a nutrient addition amount or rate.~~
447. The process of claim 40-3 having one or more inlets for diluting the liquid in the reactors, a system for adding lime or sulfides to the liquid upstream of the reactors, or a precipitate remover.
458. The process of any one of claims 8-1 to 44-7 wherein lime, sulfides or combinations thereof are added in the pretreatment step.

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~~469.~~ The process of any one of claims ~~8-1~~ to ~~15-8~~ wherein the ammonia stripping takes place comprising nitrifying ammonia in a first aerobic zone.

~~4710.~~ A process for treating a waste stream comprising flue gas desulfurization blow down water having steps of physical and chemical pretreatment to remove suspended solids from the waste stream and soften the waste stream followed by anoxic treatment to denitrify the waste stream followed by anoxic treatment to remove selenium from the waste stream, wherein the steps of denitrifying the waste stream and removing selenium from the waste stream occur in one or more fixed film bioreactors.

~~4811.~~ The process of claim ~~47-10~~ further comprising a step of anaerobic treatment to remove arsenic, mercury, or sulphur.

~~4912.~~ The process of claim ~~47-10~~ or ~~48-11~~ further comprising a step of aerobic treatment to remove COD from or nitrify the waste stream upstream of the step of denitrifying the waste stream.

~~2013.~~ The process of any one of claims ~~47-10~~ to ~~49-12~~ further comprising a step of membrane separation of the waste stream upstream of the step of removing selenium.

~~2414.~~ An apparatus for treating a waste stream comprising flue gas desulfurization blow down water, the apparatus having a system for adding lime or sulfides to the waste stream and a precipitate remover upstream of one or more reactors configured to provide denitrification and selenium removal by biological treatment.

~~2215.~~ The apparatus of claim ~~24-14~~ wherein the one or more reactors further provide aerobic treatment of COD by biological treatment.

~~2316.~~ The apparatus of claim 21 or 22 wherein the one or more reactors further provide heavy metal or sulfur removal by biological treatment.

~~2417.~~ The apparatus of any one of claims ~~24-14~~ to ~~23-16~~ wherein one of the one or more reactors is a membrane bioreactor.

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| 2518. The apparatus of any one of claims ~~24-14~~ to ~~24-17~~ wherein one of the one or more reactors is a fixed film reactor.

| 2619. The apparatus of claim ~~25-18~~ wherein the fixed film reactor has an activated carbon bed used to support a population of microbes.

| 2720. The apparatus of any one of claims 21 to 26 having an ammonia stripper.

REPLACEMENT PAGE

CLAIMS:

We claim:

1. A process for the treatment of a liquid comprising:
 - a) physical and/or chemical pretreatment of the liquid to remove total suspended solids and to soften the liquid;
 - b) removing ammonia from of the liquid;
 - c) anoxic treatment to remove nitrate;
 - d) a second anoxic treatment after step (c) to remove selenium and anaerobic treatment to remove heavy metals; and,
 - e) membrane separation of the liquid upstream of step (d).
2. The process of claim 1 further comprising the step of: f) dilution upstream of the ammonia or anoxic steps.
3. The process of claim 1 or 2 wherein the process is carried out in a series of reactors and at least one of the reactors is a membrane bioreactor.
4. The process of claim 3 wherein one of the reactors is a fixed film reactor and is downstream of the membrane bioreactor.
5. The process of claim 4 wherein the fixed film reactor has a granular activated carbon bed.
6. The process of claim 5 wherein the operation of the activated carbon bed reactor comprises a step of adding a nutrient to the activated carbon bed reactor.
7. The process of claim 3 having one or more inlets for diluting the liquid in the reactors, a system for adding lime or sulfides to the liquid upstream of the reactors, or a precipitate remover.

REPLACEMENT PAGE

8. The process of any one of claims 1 to 7 wherein lime, sulfides or combinations thereof are added in the pretreatment step.
9. The process of any one of claims 1 to 8 comprising nitrifying ammonia in a first aerobic zone.
10. A process for treating a waste stream comprising flue gas desulfurization blow down water having steps of physical and chemical pretreatment to remove suspended solids from the waste stream and soften the waste stream followed by anoxic treatment to denitrify the waste stream followed by anoxic treatment to remove selenium from the waste stream, wherein the steps of denitrifying the waste stream and removing selenium from the waste stream occur in one or more fixed film bioreactors.
11. The process of claim 10 further comprising a step of anaerobic treatment to remove arsenic, mercury, or sulphur.
12. The process of claim 10 or 11 further comprising a step of aerobic treatment to remove COD from or nitrify the waste stream upstream of the step of denitrifying the waste stream.
13. The process of any one of claims 10 to 12 further comprising a step of membrane separation of the waste stream upstream of the step of removing selenium.
14. An apparatus for treating a waste stream comprising flue gas desulfurization blow down water, the apparatus having a system for adding lime or sulfides to the waste stream and a precipitate remover upstream of one or more reactors configured to provide denitrification and selenium removal by biological treatment.
15. The apparatus of claim 14 wherein the one or more reactors further provide aerobic treatment of COD by biological treatment.
16. The apparatus of claim 21 or 22 wherein the one or more reactors further provide heavy metal or sulfur removal by biological treatment.

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REPLACEMENT PAGE

17. The apparatus of any one of claims 14 to 16 wherein one of the one or more reactors is a membrane bioreactor.

18. The apparatus of any one of claims 14 to 17 wherein one of the one or more reactors is a fixed film reactor.

19. The apparatus of claim 18 wherein the fixed film reactor has an activated carbon bed used to support a population of microbes.

20. The apparatus of any one of claims 21 to 26 having an ammonia stripper.



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Table composée de 2 rangée(s) et de 3 colonne(s). / Table with 2 row(s) and 3 column(s).

No de Document No.	Description / Description	Taxes / Fees
2517322	APPARATUS AND METHOD FOR TREATING FGD Taxes de maintien - Demande / Maintenance Fee - Application année(s)/year(s): 8 Numéro de référence / Reference Number: PAT 92005-1	\$ 200.00

Total des taxes payées / Total Fees Paid :

\$ 200.00

INFORMATION SUR LE PAIEMENT / PAYMENT INFORMATION

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Canada

November 5, 2013

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Application No. : **2,517,322**
Owner : ZENON TECHNOLOGY PARTNERSHIP
Title : **APPARATUS AND METHOD FOR TREATING FGD
BLOWDOWN OR SIMILAR LIQUIDS**
Classification : C02F 3/30 (2006.01)
Your File No. : **PAT 92005-1**
Examiner : PHAM Thi Tham -- G2

YOU ARE HEREBY NOTIFIED OF A REQUISITION BY THE EXAMINER IN ACCORDANCE WITH SUBSECTION 30(2) OF THE *PATENT RULES*. IN ORDER TO AVOID ABANDONMENT UNDER PARAGRAPH 73(1)(a) OF THE *PATENT ACT*, A WRITTEN REPLY MUST BE RECEIVED WITHIN THE 6 MONTH PERIOD AFTER THE ABOVE DATE.

This application has been examined taking into account the applicant's correspondence received in this office on May 17, 2013.

The number of claims in this application is 20.

Documents Cited:

D1: CA1274925 Downing et al. 2 October 1990 (02-10-1990)
D2: CA2025433 A1 Maree et al. 3 April 1991 (03-04-1991)
D3: Droste (1997). Water treatment unit operations. In *Theory and Practice of Water and Wastewater Treatment* (pp. 227-234). New York: John Wiley & Sons.
D4: Carrera et al. (2003). Biological nitrogen removal of high-strength ammonium industrial wastewater with two-sludge system. *Water Research*, **37**:4211-4221.
D5: USACE (30 April 1994). Treatment Technologies. In *Engineering and Design: Technical Guidelines for Hazardous and Toxic Waste Treatment and Cleanup Activities EM 1110-1-502* (chapter 4). Washington, DC: U.S. Army Corps of Engineers.
D6: JPH01304100 A Katagawa et al. 7 December 1989 (07-12-1989)

The examiner has identified the following defects in the application:

The subject matter of page of the claims 14-20 as amended by the applicant's correspondence received on May 17, 2013, does not comply with section 38.2 of the *Patent Act* because it is not reasonably to be inferred from the specification or drawings as originally filed. Independent claim 14 is broader than the teaching of the description. The description teaches a biological treatment process having the sequential steps of "anoxic treatment to denitrify, anoxic treatment to remove selenium, and anaerobic treatment to removal heavy metals". Claim 14, as presently recited, does not define the treatment conditions for denitrification and selenium removal; therefore, claim 14 encompasses processes for denitrification and selenium removal, other than the disclosed sequence of anoxic treatment to denitrify, followed by anoxic treatment to remove selenium. Per claim 16, the description only teaches biological anaerobic treatment for removal of heavy metal or sulfur, and not any biological treatment in general. Therefore, claims 14-20 go beyond the description as originally filed.

Claims 1-13 are not fully supported by the description, and do not comply with section 84 of the *Patent Rules*. It is noted that the description only teaches biological aerobic/anoxic/anaerobic treatment of wastewater. Therefore, the terms "anoxic treatment", "anaerobic treatment" and "aerobic treatment" should be further defined as biological treatment steps.

To expedite prosecution, the claims have been examined with the assumption that "anoxic treatment", "anaerobic treatment" and "aerobic treatment" in claims 1-13 refer to biological aerobic/anoxic/anaerobic treatment; the expression "biological treatment" is "biological anoxic treatment" in claim 14, and "biological anaerobic treatment" in claim 16.

Claims 1-13 do not comply with section 28.3 of the *Patent Act*. These claims are directed to subject-matter that would have been obvious at the claim date to a person skilled in the art or science to which they pertain having regard to D1, in view of common general knowledge in the art.

D1 discloses a process for biological treatment of wastewater comprising anoxic denitrification, followed by anoxic selenium removal and anaerobic removal of sulfur and heavy metals (see pages 4-5, bridging paragraph; page 6; page 8, line 25 to page 9, line 18; pages 10-11, bridging paragraph; Example 4). The process can be carried out in a single reactor with multiple reaction zones or in separate vessels defining two or more reaction stages (see page 13, lines 6-27).

Independent claims 1 and 10 share the following common features:

- a. physical and/or chemical pretreatment of the liquid to remove total suspended solids and to soften the liquid;
- b. anoxic treatment to remove nitrate; and
- c. second anoxic treatment to remove selenium

It is known from D1 to have first and second anoxic steps for biological removal of nitrates and selenium; therefore, claims 1 and 10 differ from D1 in that the method further comprises a physical and/or chemical pretreatment step. This difference is not considered to involve

an inventive step, as it is common practice to include a physical and/or chemical pretreatment step upstream of the biological treatment step(s). For example, D6 (see abstract) teaches physical/chemical pretreatment of FGD wastewater (1) by adding fly ash (5) and solids removal (4), followed by COD treatment (9) and nitrogen removal (10). It is noted that since the common features identified above are not considered to be inventive, compliance with subsection 36(1) of the *Patent Act* is also put into question.

Independent claim 1 is further defined by the features: removing ammonia from the liquid, anaerobic treatment to remove heavy metals, and membrane separation upstream of the second anoxic step. Anaerobic treatment to remove heavy metals is disclosed in D1 (see page 18, lines 7-10); ammonia removal by biological aerobic treatment (see D4) or by ammonia stripping (see pages 4-1 to 4-6 of D5; page 4211, first line of right column, of D4) is a well-known option for treating industrial wastewater containing high levels of ammonium; and membrane separation is a well-known liquid-solid separation process (see page 14, lines 16-17, of D1). It is not clear what is the unexpected technical effect to be achieved. Therefore, claim 1 lacks an inventive step.

Dependent claims 2-9 are directed to features known to the skilled person (see, for example, D3, pages 227-231, for various wastewater treatment unit operations available to the skilled person). Furthermore, it is also common practice in biological treatment design to include suspended solids removal and wastewater dilution upstream of the biological process to minimize process upset (see, for example, page 4-16 of D5; page 12, lines 1-3, of D2). An inventive step cannot be acknowledged if the process or system claimed is an integral of known features, each and in combination, providing known, expected outcomes. Therefore, claims 2-9 lack an inventive step.

Independent claim 10 is specifically directed to the treatment of FGD blowdown water and is further defined by the feature “wherein the steps of denitrifying the waste stream and removing selenium from the waste stream occur in one or more fixed film bioreactors”. The use of fixed film bioreactors is disclosed in D1 (see 17, lines 13-15); and application of an integrated process comprising chemical/physical treatment of the waste stream, followed by biological treatment, to treat FGD blowdown water is known (see D6 abstract). Therefore, it is within the purview of the skilled person to integrate the biological treatment sequence disclosed in D1 with a chemical/physical pretreatment step for the treatment of FGD blowdown water. Therefore, claim 10 lacks an inventive step.

The additional features recited in dependent claims 11-13 are known to the skilled person and do not appear to provide any unexpected technical effect. Therefore, claims 11-13 lack an inventive step.

Claims 14 and 15 encompass subject-matter that was disclosed in D6 before the claim date and do not comply with paragraph 28.2(1)(b) of the *Patent Act*.

D6 (see abstract) discloses an apparatus for treating FGD wastewater, the apparatus having a system (150) for adding lime or sulfides to the waste stream and a precipitate remover (4) upstream of aerobic treatment tank (9) and anoxic treatment tank (10). D6

teaches addition of fly ash (5) to eliminate or reduce the amount of caustic soda or slaked lime used in the chemical/physical treatment step. Therefore, the system (150) in D6 is suitable for adding lime or sulfides as recited in present claim 14. Anoxic tank (10) would be suitable for carrying out denitrification and selenium removal. Therefore, claims 14 and 15 lack novelty over D6.

Claims 14-20 do not comply with section 28.3 of the *Patent Act*. These claims are directed to subject-matter that would have been obvious at the claim date to a person skilled in the art or science to which they pertain having regard to D6, in view of common general knowledge in the art.

Claims 14 and 15 are considered to lack novelty over D6; therefore, it follows that said claims also lack an inventive step.

Dependent claims 16-20 are directed to features known to the skilled person and do not appear to provide any unexpected technical effect.

Claims 2 and 7 are indefinite and do not comply with subsection 27(4) of the *Patent Act*:

- In claim 2, the meaning of “the ammonia or anoxic steps” is not clear.
- In claim 7, the process is further defined by apparatus features.

Claims 16 and 20 do not comply with subsection 87(2) of the *Patent Rules*. A dependent claim must refer to a preceding claim or claims.

It is noted that in claims 10 and 14, the term “blow down” is used; whereas, in the title of the application, the term “blowdown” is used.

In view of the foregoing defects, the applicant is requisitioned, under subsection 30(2) of the *Patent Rules*, to amend the application in order to comply with the *Patent Act* and the *Patent Rules* or to provide arguments as to why the application does comply.

Under section 34 of the *Patent Rules*, any amendment made in response to this requisition must be accompanied by a statement explaining the nature thereof, and how it corrects each of the above identified defects.

PHAM Thi Tham -- G2
Patent Examiner
819-953-0771

As per CIPO Client Service Standards, a response to a telephone enquiry or voice mail should be provided by the end of the next business day. In the event that attempts to reach the examiner are unsuccessful, the examiner's Section Head, André C. Martin, can be reached at 819-953-6441.

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REPLACEMENT PAGE

CLAIMS:

We claim:

1. A process for the treatment of a liquid comprising:
 - a) physical and/or chemical pretreatment of the liquid to remove total suspended solids and to soften the liquid;
 - b) removing ammonia from the liquid;
 - c) biological treatment under anoxic conditions to remove nitrate;
 - d) a second biological treatment under anoxic conditions after step (c) to remove selenium and biological treatment under anaerobic conditions to remove heavy metals; and,
 - e) membrane separation of the liquid upstream of step (d).
2. The process of claim 1 further comprising the step of: f) dilution upstream of the step (b), step (c), or step (d).
3. The process of claim 1 or 2 wherein the process is carried out in a series of reactors and at least one of the reactors is a membrane bioreactor.
4. The process of claim 3 wherein one of the reactors is a fixed film reactor and is downstream of the membrane bioreactor.
5. The process of claim 4 wherein the fixed film reactor has a granular activated carbon bed.
6. The process of claim 5 wherein the operation of the activated carbon bed reactor comprises a step of adding a nutrient to the activated carbon bed reactor.
7. The process of claim 3 wherein: at least one of the reactors dilutes the liquid in the reactors using one or more inlets, lime or sulfides is added to the liquid upstream of the reactors, or a precipitate is removed.

REPLACEMENT PAGE

8. The process of any one of claims 1 to 7 wherein lime, sulfides or combinations thereof are added in the pretreatment step.
9. The process of any one of claims 1 to 8 comprising nitrifying ammonia in a first aerobic zone.
10. A process for treating a waste stream comprising flue gas desulfurization blowdown water having steps of physical and chemical pretreatment to remove suspended solids from the waste stream and soften the waste stream followed by biological treatment under anoxic conditions to denitrify the waste stream followed by biological treatment under anoxic conditions to remove selenium from the waste stream, wherein the steps of denitrifying the waste stream and removing selenium from the waste stream occur in one or more fixed film bioreactors.
11. The process of claim 10 further comprising a step of biological treatment under anaerobic conditions to remove arsenic, mercury, or sulphur.
12. The process of claim 10 or 11 further comprising a step of biological treatment under aerobic conditions to remove COD from or nitrify the waste stream upstream of the step of denitrifying the waste stream.
13. The process of any one of claims 10 to 12 further comprising a step of membrane separation of the waste stream upstream of the step of removing selenium.
14. An apparatus for treating a waste stream comprising flue gas desulfurization blowdown water, the apparatus having a system for adding lime or sulfides to the waste stream and a precipitate remover upstream of one or more reactors configured to provide denitrification and selenium removal by biological treatment.
15. The apparatus of claim 14 wherein the one or more reactors further provide aerobic treatment of COD by biological treatment.
16. The apparatus of claim 14 or 15 wherein the one or more reactors further provide

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REPLACEMENT PAGE

heavy metal or sulfur removal by biological treatment.

17. The apparatus of any one of claims 14 to 16 wherein one of the one or more reactors is a membrane bioreactor.

18. The apparatus of any one of claims 14 to 17 wherein one of the one or more reactors is a fixed film reactor.

19. The apparatus of claim 18 wherein the fixed film reactor has an activated carbon bed used to support a population of microbes.

20. The apparatus of any one of claims 14 to 19 having an ammonia stripper.

008
JTB**IN THE CANADIAN PATENT OFFICE**

To: The Commissioner of Patents

May 2, 2014

Application No.: **2,517,322**
 Title: **APPARATUS AND METHOD FOR TREATING FGD
 BLOWDOWN OR SIMILAR LIQUIDS**
 Applicant: **ZENON TECHNOLOGY PARTNERSHIP**
 Our File: **PAT 92005-1**

This is in response to the Examiner's requisition of November 5, 2013.

Please amend the application as follows:

In the Claims

Please replace pages 13-15 including claims 1-20 with new pages 13-15 attached hereto which contain claims 1-20.

REMARKS

A/M/J.....Y/M/D
 2014/05/02
 125- 14

Claims

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There remain 20 claims in the application. The former claims have been amended to more clearly define the claimed subject matter and to better conform to Canadian practice. A marked up copy of the former claims is enclosed for ease of reference. Applicant submits that the claims, as presently amended, are supported by the application as originally filed. Entry of the amendments is respectfully requested.

Added subject matter

The Examiner objected to claims 14-20 under Section 38.2 of the Patent Act, stating that the claimed subject matter is not reasonably inferred from the specification as originally filed. Applicant respectfully disagrees.

Applicant notes that paragraph [0009] of the description states that the apparatus can have "*one or more reactors* configured to provide aerobic treatment of COD, nitrification, denitrification, selenium and heavy metals removal and sulfur removal by biological treatment."

Applicant submits that this passage discloses that the apparatus can have one or more of the noted reactors, and that the reactors provide denitrification and selenium removal by biological treatment. Accordingly, it is reasonably inferred from the specification that the apparatus can have "a system for adding lime or sulfides to the waste stream and a precipitate remover upstream of one or more reactors configured to provide denitrification and selenium removal by biological treatment", as recited in claim 14. There is no requirement that there be a specific "sequence of anoxic treatment to denitrify, followed by anoxic treatment to remove selenium" — as characterized by the Examiner.

Applicant additionally submits that it is reasonably inferred from paragraph [0009] that the apparatus can provide "heavy metal or sulfur removal by biological treatment", as recited in claim 16. There is no requirement that the biological treatment to remove heavy metal or sulfur be "anaerobic" – as characterized by the Examiner.

Since the claims are reasonably inferable from the specification as originally filed, Applicant respectfully requests that the Examiner reconsider and withdraw the rejection raised under Section 38.2 of the Patent Act.

Scope

The Examiner rejected claims 1-13 under Section 84 of the Patent Act, stating that the claims are not fully supported by the description. The Examiner stated that the description only teaches biological aerobic/anoxic/anaerobic treatment of wastewater.

Solely in an effort to expedite prosecution, former claims 1, 10, 11 and 12 have been amended to recite "biological treatment under" the recited conditions.

Obviousness

The Examiner rejected former claims 1-13 under Section 28.3 of the Patent Act, stating that the claimed subject matter would have been obvious having regard to D1 in view of common general knowledge. However, Applicant understands that, in view of the additional comments in the Action, the Examiner rejected claims 1-9 as obvious having regard to D1 in view of D4, and rejected claims 10-13 as obvious having regard to D1 in view of D6.

Applicant respectfully disagrees with the Examiner's analysis and requests reconsideration and withdrawal of the rejection in view of the following comments.

Claims 1-9. The Examiner stated that D1 teaches all of the features of claim 1 except for removing ammonia from the liquid. The Examiner then argued that ammonia removal is taught in D4 and is a well-known option for treating industrial wastewater containing high levels of ammonium. The Examiner concluded that "it is not clear what is the *unexpected technical effect* to be achieved" [emphasis added], and that claim 1 lacks an inventive step. (See page 3 of the Action).

Firstly, Applicant notes that although an "unexpected" result or effect may help support a determination of inventiveness, there is no requirement for there to be such an unexpected result or feature in order for inventiveness to be acknowledged. For example, the solution to a previously unknown or unrealized problem can be an invention even if the technical solution is not surprising or unexpected.

For subject matter to be obvious, the courts have stated that a skilled person must be led "*directly and without difficulty*" from the prior art to the claimed subject matter. Therefore, if a skilled person is not led directly and without difficulty from the prior art to the claimed invention, then the claimed subject matter is inventive.

Applicant submits that the Examiner has not articulated why or how a skilled person would be led to combine the process of D1 with the ammonia removal of D4 and, accordingly, has not shown that the skilled person would be led directly and without difficulty from the combination of D1 and D4 to the claimed subject matter.

Secondly, Applicant notes that paragraphs [0020] and [0021] of the description clearly indicate the beneficial technical effect of removing ammonia from the blow down water. As noted, "oxidation of ammonia may increase nitrate concentration" and "high nitrate concentrations are a concern because nitrate is a preferred electron acceptor for biological reduction over selenate."

Applicant submits that merely because ammonia removal techniques were known in D4 does not mean that a skilled person would combine those ammonia removal techniques with the selenium removal process of D1, to arrive at the claimed subject matter. In fact, Applicant notes that D1 is directed to the treatment of drainage water containing selenium leached from soil. As noted in the chemical composition shown in Example 1, there is no ammonia present in such drainage water. Accordingly, a skilled person would not combine the ammonia removal methods of D4 with the process of D1 to arrive at the claimed invention.

For at least the reasons discussed above, Applicant submits that a skilled person would not have arrived directly and without difficulty from the teachings of D1 and D4 to the subject matter of claim 1. Claim 1 is, therefore, not obvious having regard to the combination of D1 and D4. Since dependent claims 2-9 include all the features of claim 1, they are also not obvious for at least the same reasons. Applicant requests that the Examiner reconsider and withdraw the rejection of claims 1-9 raised under Section 28.3 of the Patent Act.

Claims 10-13. The Examiner rejected the claimed subject matter as obvious in view of the combination of D1 and D6.

The Examiner stated that the use of fixed film bioreactors is disclosed in D1, and that a process to treat flue gas desulfurization (FGD) blowdown water is known in D6. The Examiner concluded that a skilled person would have integrated the biological treatment of D1 with the chemical/physical pretreatment of FGD blowdown water of D6.

Applicant respectfully submits that the Examiner is using hindsight analysis to arrive at the claimed subject matter.

D1 teaches a method of treating drainage water containing selenium leached from soil. In contrast, D6 teaches a method of treating FGD to remove heavy metals and fluorine by adding fly ash and coagulant to precipitate the hydroxide and fluorine compounds of the heavy metals. Applicant notes that the composition of the FGD disclosed by D6 includes heavy metals such as Al^{3+} and Fe^{2+} (see page 3 of D6), but does *not* include selenium. Accordingly, there is no teaching or motivation in D6 to combine the chemical/physical pretreatment of FGD blowdown water with the selenium treatment process of D1 – which is for treating drainage water.

In view of the above, Applicant submits that a skilled person, having no inventive ingenuity, would not combine the teachings of D1 (for treating drainage water having selenium dissolved therein) with the physical/chemical treatment steps of D6 (for treating FGD that does not have selenium dissolved therein) to arrive at the claimed invention. Applicant respectfully reiterates that the solution to a previously unknown or unrealized problem can be an invention even if the technical solution is not surprising or unexpected.

For at least the reasons discussed above, Applicant submits that a skilled person would not have arrived directly and without difficulty from the teachings of D1 and D6 to the subject matter of claim 10. Claim 10 is, therefore, not obvious having regard to the combination of D1 and D6. Since dependent claims 11-13 include all the features of claim 10, they are also not obvious for at least the same reasons. Applicant requests that the Examiner reconsider and withdraw the rejection of claims 10-13 raised under Section 28.3 of the Patent Act.

Anticipation and Obviousness

The Examiner rejected claims 14 and 15 under Section 28.2(1)(b) of the Patent Act, stating that the claimed subject matter is anticipated by D6. The Examiner stated that anoxic tank 10 would be suitable for carrying out denitrification and selenium removal.

Applicant respectfully disagrees with the Examiner's analysis and submits that there is no teaching in the abstract of D6 that "nitrogen compound treatment device 10": (i) is a biological treatment device, or (ii) that it would remove selenium. As noted above, the composition of the FGD disclosed by D6 includes heavy metals such as Al^{3+} and Fe^{2+} (see page 3 of D6), but does *not* include selenium. Accordingly, Applicant submits that the Examiner is reading features of the claimed subject matter into the teachings of D6.

Since D6 does not teach each and every feature of the claimed subject matter, Applicant submits that claim 14 is not anticipated by the cited reference. Dependent claim 15 is also not anticipated for at least the same reasons. Reconsideration and withdrawal of the rejection raised under Section 28.2(1)(b) of the Patent Act is respectfully requested.

The Examiner also rejected claims 14-20 under Section 28.3 of the Patent Act having regard to D6 in view of common general knowledge, stating that claims 14 and 15 obvious since they are anticipated, and that claims 16-20 are directed to features known in the art.

Applicant respectfully directs the Examiner to the comments presented above with respect to the novelty of claims 14 and 15. Reconsideration and withdrawal of the rejection raised to claims 14-20 under Section 28.3 of the Patent Act is respectfully requested since claims 14 and 15 define unanticipated subject matter, and since the Examiner has not provided any further comments with regard to the obviousness of the rejected claims.

Other

Former claim 2 has been amended to more specifically refer to the steps.

Former claim 7 has been amended to define the steps of the method.

Former claims 16 and 20 have been amended correctly refer to preceding claims.

Former claims 10 and 14 have been amended to correctly refer to "blowdown" water.

Withdrawal of the rejections raised under Section 27(4) of the Patent Act is respectfully requested.

Conclusion

Should this application be abandoned for any reason, please regard this as the request(s) for reinstatement. Should the fees submitted with this letter be insufficient to cover all of the fees for which payment is explicitly or implicitly requested by this letter, or needed to reinstate the application, the Commissioner is authorized to charge the amount of the insufficiency to our deposit account number 600000247 or deposit account number 600001646.

Yours very truly

Borden Ladner Gervais LLP / s.r.l.

Agents

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Fax: 416.361.2540

Encl.

1. Claim pages 13-15
2. Marked up copy of former claims

REPLACEMENT PAGE

CLAIMS:

We claim:

1. A process for the treatment of a liquid comprising:
 - a) physical and/or chemical pretreatment of the liquid to remove total suspended solids and to soften the liquid;
 - b) removing ammonia from the liquid;
 - c) biological treatment under anoxic conditions to remove nitrate;
 - d) a second biological treatment under anoxic conditions after step (c) to remove selenium and biological treatment under anaerobic conditions to remove heavy metals; and,
 - e) membrane separation of the liquid upstream of step (d).
2. The process of claim 1 further comprising the step of: f) dilution upstream of the step (b), step (c), or step (d).
3. The process of claim 1 or 2 wherein the process is carried out in a series of reactors and at least one of the reactors is a membrane bioreactor.
4. The process of claim 3 wherein one of the reactors is a fixed film reactor and is downstream of the membrane bioreactor.
5. The process of claim 4 wherein the fixed film reactor has a granular activated carbon bed.
6. The process of claim 5 wherein the operation of the activated carbon bed reactor comprises a step of adding a nutrient to the activated carbon bed reactor.
7. The process of claim 3 wherein: at least one of the reactors dilutes the liquid in the reactors using one or more inlets, lime or sulfides is added to the liquid upstream of the reactors, or a precipitate is removed.

REPLACEMENT PAGE

8. The process of any one of claims 1 to 7 wherein lime, sulfides or combinations thereof are added in the pretreatment step.
9. The process of any one of claims 1 to 8 comprising nitrifying ammonia in a first aerobic zone.
10. A process for treating a waste stream comprising flue gas desulfurization blowdown water having steps of physical and chemical pretreatment to remove suspended solids from the waste stream and soften the waste stream followed by biological treatment under anoxic conditions to denitrify the waste stream followed by biological treatment under anoxic conditions to remove selenium from the waste stream, wherein the steps of denitrifying the waste stream and removing selenium from the waste stream occur in one or more fixed film bioreactors.
11. The process of claim 10 further comprising a step of biological treatment under anaerobic conditions to remove arsenic, mercury, or sulphur.
12. The process of claim 10 or 11 further comprising a step of biological treatment under aerobic conditions to remove COD from or nitrify the waste stream upstream of the step of denitrifying the waste stream.
13. The process of any one of claims 10 to 12 further comprising a step of membrane separation of the waste stream upstream of the step of removing selenium.
14. An apparatus for treating a waste stream comprising flue gas desulfurization blowdown water, the apparatus having a system for adding lime or sulfides to the waste stream and a precipitate remover upstream of one or more reactors configured to provide denitrification and selenium removal by biological treatment.
15. The apparatus of claim 14 wherein the one or more reactors further provide aerobic treatment of COD by biological treatment.
16. The apparatus of claim 14 or 15 wherein the one or more reactors further provide

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REPLACEMENT PAGE

heavy metal or sulfur removal by biological treatment.

17. The apparatus of any one of claims 14 to 16 wherein one of the one or more reactors is a membrane bioreactor.

18. The apparatus of any one of claims 14 to 17 wherein one of the one or more reactors is a fixed film reactor.

19. The apparatus of claim 18 wherein the fixed film reactor has an activated carbon bed used to support a population of microbes.

20. The apparatus of any one of claims 14 to 19 having an ammonia stripper.

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CLAIMS:

We claim:

1. A process for the treatment of a liquid comprising:
 - a) physical and/or chemical pretreatment of the liquid to remove total suspended solids and to soften the liquid;
 - b) removing ammonia from of the liquid;
 - c) ~~anoxic~~ biological treatment under anoxic conditions to remove nitrate;
 - d) a second ~~anoxic~~ biological treatment under anoxic conditions after step (c) to remove selenium and ~~anaerobic~~ biological treatment under anaerobic conditions to remove heavy metals; and,
 - e) membrane separation of the liquid upstream of step (d).
2. The process of claim 1 further comprising the step of: f) dilution upstream of the ~~ammonia or anoxic step~~ step (b), step (c), or step (d).
3. The process of claim 1 or 2 wherein the process is carried out in a series of reactors and at least one of the reactors is a membrane bioreactor.
4. The process of claim 3 wherein one of the reactors is a fixed film reactor and is downstream of the membrane bioreactor.
5. The process of claim 4 wherein the fixed film reactor has a granular activated carbon bed.
6. The process of claim 5 wherein the operation of the activated carbon bed reactor comprises a step of adding a nutrient to the activated carbon bed reactor.
7. The process of claim 3 wherein: at least one of the reactors dilutes the liquid in the reactors using ~~having one or more inlets for diluting the liquid in the reactors, a system for~~

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adding lime or sulfides is added to the liquid upstream of the reactors, or a precipitate remover is removed.

8. The process of any one of claims 1 to 7 wherein lime, sulfides or combinations thereof are added in the pretreatment step.

9. The process of any one of claims 1 to 8 comprising nitrifying ammonia in a first aerobic zone.

10. A process for treating a waste stream comprising flue gas desulfurization blow-down water having steps of physical and chemical pretreatment to remove suspended solids from the waste stream and soften the waste stream followed by anaerobic biological treatment under anoxic conditions to denitrify the waste stream followed by anaerobic biological treatment under anoxic conditions to remove selenium from the waste stream, wherein the steps of denitrifying the waste stream and removing selenium from the waste stream occur in one or more fixed film bioreactors.

11. The process of claim 10 further comprising a step of anaerobic biological treatment under anaerobic conditions to remove arsenic, mercury, or sulphur.

12. The process of claim 10 or 11 further comprising a step of aerobic biological treatment under aerobic conditions to remove COD from or nitrify the waste stream upstream of the step of denitrifying the waste stream.

13. The process of any one of claims 10 to 12 further comprising a step of membrane separation of the waste stream upstream of the step of removing selenium.

14. An apparatus for treating a waste stream comprising flue gas desulfurization blow down water, the apparatus having a system for adding lime or sulfides to the waste stream and a precipitate remover upstream of one or more reactors configured to provide denitrification and selenium removal by biological treatment.

15. The apparatus of claim 14 wherein the one or more reactors further provide aerobic

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treatment of COD by biological treatment.

16. The apparatus of claim ~~21~~14 or ~~22~~15 wherein the one or more reactors further provide heavy metal or sulfur removal by biological treatment.

17. The apparatus of any one of claims 14 to 16 wherein one of the one or more reactors is a membrane bioreactor.

18. The apparatus of any one of claims 14 to 17 wherein one of the one or more reactors is a fixed film reactor.

19. The apparatus of claim 18 wherein the fixed film reactor has an activated carbon bed used to support a population of microbes.

20. The apparatus of any one of claims ~~21~~14 to ~~26~~19 having an ammonia stripper.

PATENT OFFICE MAIL

Date: August 1, 2014

Contact: Scott McDougall

Today's payment covers the following maintenance fees:

Our File	PCT No./
PAT 92005-1	Serial No./
	Patent No.
	2,517,322

Owner
ZENON TECHNOLOGY PARTNERSHIP

3666169

Borden Ladner Gervais LLP
4100-40 King Street West
Toronto ON M5H 3Y4
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A/M/J.....Y/M/D

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Anniv.	Due Date	Amount
Year	26/08/2014	Paid
9th		200.00

SUB TOTAL:	200.00
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GRAND TOTAL:	200.00
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YOU ARE HEREBY AUTHORIZED TO CHARGE THESE FEES TO THE DEPOSIT ACCOUNT 600000247 OR TO THE DEPOSIT ACCOUNT 600001646 OF BORDEN LADNER GERVAIS LLP OTTAWA ON (AS PER THE ATTACHED CIPO FEE PAYMENT FORM).

Should any of the above noted applications/patents be abandoned for any reason, please regard this as the request(s) for reinstatement. Should the fees submitted with this letter be insufficient to cover all of the fees for which payment is explicitly or implicitly requested by this letter, or needed to reinstate the application, the Commissioner is authorized to charge the amount of the insufficiency to our deposit account number 600000247 or to our deposit account number 600001646 (as per the attached CIPO Fee Payment Form).

29 October 2014 (29-10-2014)

BORDEN LADNER GERVAIS LLP

Scotia Plaza
40 King Street West
TORONTO Ontario
M5H 3Y4

Application No. : 2,517,322
Owner : ZENON TECHNOLOGY PARTNERSHIP
Title : APPARATUS AND METHOD FOR TREATING FGD BLOWDOWN
OR SIMILAR LIQUIDS
Classification : C02F 3/30 (2006.01)
Your File No. : PAT 92005-1
Examiner : PHAM, Thi Tham

YOU ARE HEREBY NOTIFIED OF A REQUISITION BY THE EXAMINER IN ACCORDANCE WITH SUBSECTION 30(2) OF THE *PATENT RULES*. IN ORDER TO AVOID ABANDONMENT UNDER PARAGRAPH 73(1)(a) OF THE *PATENT ACT*, A WRITTEN REPLY MUST BE RECEIVED WITHIN THE 6 MONTH PERIOD AFTER THE ABOVE DATE.

This application has been examined taking into account the applicant's correspondences received in this office on 17 May 2013 (17-05-2013) and 2 May 2014 (02-05-2014).

The number of claims in this application is 20.

As the application is apparently directed to a plurality of inventions, as detailed below, and the applicant has elected on 17 May 2013 (17-05-2013) to proceed with the claims of **Group A** (present claims 1-9). Further prosecution of the present application is therefore restricted to the subject-matter of the claims of **Group A** (present claims 1-9).

Documents Cited:

- D1: CA1274925 Downing et al. 2 October 1990 (02-10-1990)
- D2: CA2025433 A1 Maree et al. 3 April 1991 (03-04-1991)
- D3: Droste (1997). Water treatment unit operations. In *Theory and Practice of Water and Wastewater Treatment* (chapter 9). New York: John Wiley & Sons.
- D4: Carrera et al. (2003). Biological nitrogen removal of high-strength ammonium industrial wastewater with two-sludge system. *Water Research*, **37**:4211-4221.
- D5: USACE (30 April 1994). Treatment Technologies. In *Engineering and Design: Technical Guidelines for Hazardous and Toxic Waste Treatment and Cleanup Activities EM 1110-1-502* (chapter 4). Washington, DC: U.S. Army Corps of Engineers.

D6: JPH01304100 A Katagawa et al. 7 December 1989 (07-12-1989)

D7: Kaschka et al. (1999). *Phostrip Handbook*. 4th ed. Accessed online at http://www.pap.co.at/uploads/media/Phostrip_Handbook_1999.pdf

The examiner has identified the following defects in the application:

The application does not comply with subsection 36(1) of the *Patent Act*. The claims are directed to a plurality of alleged inventions as follows:

- Group A** - Claims 1-9 are directed to a process for the treatment of a liquid comprising:
a) physical and/or chemical pretreatment to remove total suspended solids and to soften the liquid; b) removing ammonia from the liquid; c) biological treatment under anoxic conditions to remove nitrate; d) a second biological treatment under anoxic conditions after step (c) to remove selenium and biological treatment under anaerobic conditions to remove heavy metals; and, e) membrane separation of the liquid upstream of step (d);
- Group B** - Claims 10-13 are directed to a process for treating a waste stream comprising flue gas desulfurization blowdown water having steps of physical and chemical pretreatment to remove suspended solids from the waste stream and soften the waste stream followed by biological treatment under anoxic conditions to denitrify the waste stream followed by biological treatment under anoxic conditions to remove selenium from the waste stream, wherein the steps of denitrifying the waste stream and removing selenium from the waste stream occur in one or more fixed film bioreactors; and
- Group C** - Claims 14-20 are directed to an apparatus for treating a waste stream comprising flue gas desulfurization blowdown water, the apparatus having a system for adding lime or sulfides to the waste stream and a precipitate remover upstream of one or more reactors configured to provide denitrification and selenium removal by biological treatment.

As acknowledged by the applicant in the correspondence dated 17 May 2013 (17-05-2013), the claims of Groups A to C are linked by the “steps of removing suspended solids and softening” of the waste stream upstream of anoxic biological treatment. It is, however, known (see D7: Figure 6; page 14) to add slaked lime (a precipitant) to a waste stream to soften the water, followed by solids separation to remove suspended solids, upstream of one or more biological reactors operating under anoxic conditions (i.e., configured to provide denitrification and selenium removal by biological treatment). Therefore, the present independent claims 1, 10, and 14 are considered to lack unity *a posteriori*.

Claims 1-9 do not comply with section 28.3 of the *Patent Act*. These claims are directed to subject-matter that would have been obvious at the claim date to a person skilled in the art or science to which they pertain having regard to D1, in view of common general knowledge in the art.

The problem to be solved is identified at paragraph [007] of the description as the provision of an “apparatus and process for treating FGD blowdown water or other wastewaters having

selenium or nitrate and selenium, or a process or apparatus for biologically removing inorganic contaminants, for example nitrogen, selenium, arsenic, mercury or sulphur, from wastewater". The proposed solution (see paragraph [008]) is to provide a biological treatment process having the sequential steps of anoxic treatment to denitrify, anoxic treatment to remove selenium, and anaerobic treatment to removal heavy metals.

D1 is considered to be the closest prior art as it pertains biological treatment of a wastewater for the removal of selenium, nitrates, sulfate, heavy metals, and boron. D1 teaches the same solution as presently claimed in claim 1, wherein the wastewater is subjected to anoxic conditions for biological removal of nitrates, followed by anoxic biological removal of selenium and anaerobic biological removal of sulfur and heavy metals (see pages 4-5, bridging paragraph; page 6; page 8, line 25 to page 9, line 18; pages 10-11, bridging paragraph; Example 4).

Present claim 1 differs from D1 in that the process of claim 1 further comprises:

- a) physical and/or chemical pretreatment of the liquid to remove total suspended solids and to soften the liquid;
- b) removing ammonia from the liquid; and
- e) membrane separation of the liquid upstream of step (d).

According to the description, steps (a), (b), and (e) are optional steps that can be carried out depending on the characteristics of the wastewater to be treated. That is, if the influent wastewater contains high suspended solids and/or hardness, lime addition followed by solids removal can be used to soften the wastewater and to reduce total suspended solids content. Similarly, if the influent wastewater contains high ammonia content, ammonia removal by air stripping and/or nitrification/denitrification processes can be used. In other words, these steps are not essential in solving the technical problem of providing a biological process for the removal of selenium, or nitrates and selenium, or inorganic contaminants such as nitrogen, selenium, arsenic, mercury or sulphur. Therefore, claim 1 is considered to lack an inventive step.

Furthermore, steps (a), (b), and (e) are generally known in the art. For example, D6 (see abstract) teaches physical/chemical pretreatment of FGD wastewater (1) by adding fly ash (5) and slaked lime (6) and solids removal (4), followed by COD treatment (9) and nitrogen removal (10). Ammonia removal by biological aerobic treatment (see D4) or by ammonia stripping (see pages 4-1 to 4-6 of D5; page 4211, first line of right column, of D4) is a well-known option for treating industrial wastewater containing high levels of ammonium; and membrane separation is a well-known liquid-solid separation process (see page 14, lines 16-17, of D1).

Dependent claims 2-9 are directed to features known to the skilled person (see, for example, D3, pages 227-231, for various wastewater treatment unit operations available to the skilled person). Furthermore, it is also common practice in biological treatment design to include suspended solids removal and wastewater dilution upstream of the biological process to minimize process upset (see, for example, page 4-16 of D5; page 12, lines 1-3, of D2). An inventive step cannot be acknowledged if the process claimed is an aggregation of known features, each and in combination, providing known, expected outcomes (see section 11.07.02 of MOPOP).

Therefore, it is maintained that claims 1-9 lack an inventive step.

The applicant's arguments have been carefully considered, but are not deemed persuasive. It is respectfully noted that it is general practice and well within the expected knowledge of the skilled person in the art to choose, from among known technologies, the appropriate water/wastewater treatment operations to be used in process and system design, based on influent water characteristics and the desired levels of treatment to be achieved (see, for example, page 219 of D3). As indicated above, the process as recited in claim 1 is an aggregation of known method steps; each method step producing a known outcome. A synergistic effect is not demonstrated for combining these steps. Therefore, it is maintained that the recited aggregation of steps lacks an inventive step.

Per the applicant's remark regarding the requirement that the skilled person must be led "*directly and without difficulty*" from the prior art to the claimed subject matter, it is respectfully submitted that the skilled person, wanting to treat a wastewater containing ammonia, nitrates, selenium, sulfur and heavy metals, would readily recognize that the process of D1 will only address the nitrates, selenium, sulfur and heavy metal components in the wastewater. This skilled person would also readily recognize that the ammonia component must be addressed and would look to known technologies for solving this problem. Consequently, this skilled person would be led *directly and without difficulty* to modify the process of D1, wherein a *known* step for ammonia removal (as taught, for example, in D4) is added, as presently claimed.

Per the applicant's remarks concerning the benefits of removing ammonia from FGD blowdown water, it is noted that claim is directed to a process for the treatment of a liquid in general, and is not directed to a process for the treatment of FGD blowdown water. Furthermore, the claimed process is defined by the term "comprising", which does not infer any sequential order of operation that may be required to provide this alleged benefit.

In view of the foregoing defects, the applicant is requisitioned, under subsection 30(2) of the *Patent Rules*, to amend the application in order to comply with the *Patent Act* and the *Patent Rules* or to provide arguments as to why the application does comply.

Under section 34 of the *Patent Rules*, any amendment made in response to this requisition must be accompanied by a statement explaining the nature thereof, and how it corrects each of the above identified defects.

PHAM, Thi Tham
Patent Examiner, Section G2
819-953-0771

As per CIPO Client Service Standards, a response to a telephone enquiry or voice mail should be provided by the end of the next business day. In the event that attempts to reach the examiner are unsuccessful, the examiner's Section Head, André C. Martin, can be reached at 819-953-6441.

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IN THE CANADIAN PATENT OFFICE*008*

To: The Commissioner of Patents

April 29, 2015

Application No.: **2,517,322**
 Title: **APPARATUS AND METHOD FOR TREATING FGD BLOWDOWN
 OR SIMILAR LIQUIDS**
 Applicant: **ZENON TECHNOLOGY PARTNERSHIP**
 Our File: **PAT 92005-1**

This is in response to the Examiner's requisition of October 29, 2014.

REMARKS

There remain 20 claims in the application. The Examiner has restricted any further prosecution of the present application to the subject matter of the present claims 1-9 "on the basis of the Applicant's election". On May 17, 2013 the Applicant wrote:

"Regarding subsection 36(1) of the Patent Act, the Applicants elect Group C and have cancelled claims 1 to 7. The Applicants submit that claims 17 to 27 [present claims 10-20] are part of Group C since they share steps of removing suspended solids and softening with claims 8 to 16 [present claims 1-9]."

In view of the foregoing, the Applicant respectfully requests examination of all present claims.

Lack of Unity

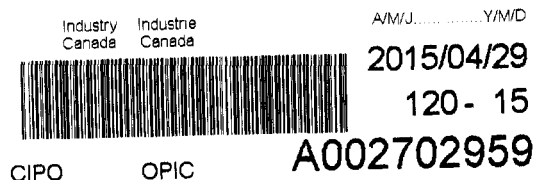
The Examiner has objected to the present independent claims 1, 10 and 14 on the basis of alleged lack of unity having regard to D7.

The Examiner stated that the independent claims 1, 10 and 14 are linked by the steps of removing suspended solids and softening of the waste stream upstream of anoxic biological treatment. In the Examiner's view D7 discloses adding a precipitant to a waste stream to soften the water, followed by solids separation to remove suspended solids, upstream of one or more biological reactors operating under anoxic conditions.

The Applicant respectfully disagrees and comments as follows.

Firstly, D7 relates to biological elimination of phosphorus from domestic sewage by applying the enhanced Phostrip ProcessTM.

Precipitation of phosphorus with slaked lime is described in page 14 of D7 as one of the suitable chemical methods to precipitate high concentrations of phosphorus known in the art. The disclosure goes on to state that the enhanced biological phosphorus elimination process offers distinct advantages in several aspects over the previously described chemical processes.



Secondly, D7 describes a "sidestream" process using activated sludge microorganisms (page 24-27 and Figure 6). In accordance with the teachings of D7, the influent flows into a primary clarifier where initial settling takes place. The primary clarifier effluent is then directed to an aeration tank where it is joined with the return activated sludge from the secondary clarifier. However, a portion of the return activated sludge is routed through a stripper tank where it undergoes anaerobic digestion. A denitrification reactor may be provided upstream of the stripper tank. To make the process more controllable and in order to guarantee that the discharge limits are met, the effluent from the stripper tank is subjected to a precipitation state.

As such, D7 discloses a method of biological elimination of phosphorus comprising of a precipitation stage downstream of the denitrification and anaerobic digestion stage.

This is in contrast with the claimed invention contained in independent claims 1, 10 and 14 whereby the entire influent undergoes suspended solids removal and softening of the waste stream upstream of anoxic biological treatment.

For at least the reasons discussed above, the Applicant submits that teachings of D7 do not render the independent claims 1, 10 and 14 non-compliant with the requirement for unity of invention *a posteriori*. The Application respectfully requests that the Examiner reconsider and withdraw the objection under subsection 36(1) of the *Patent Act*.

Obviousness

The Examiner rejected claims 1-9 under section 28.3 of the *Patent Act* having regard to D1, in view of common general knowledge in the art. The Examiner stated that the present claim 1 differed from D1 in that the process of claim 1 further comprises:

- (a) Physical and/or chemical pretreatment of the liquid to remove total suspended solids and to soften the liquid;
- (b) Removing ammonia from the liquid; and
- (e) Membrane separation of the liquid upstream of step (d).

In the Examiner's view, steps (a), (b) and (e) are optional steps that can be carried out depending on the characteristics of the wastewater to be treated.

Paragraph [0003] of the description states that "the concentration of TDS, TSS, Ca and Mg hardness, nitrate, ammonia, and sulfur for example as sulfate are all likely to be high, and various heavy metals may be present, making the blow down water very difficult to treat, particularly to achieve very low levels of contaminants". This is further expanded upon in paragraph [0015] of the description as well as Table 1, which shows the contaminants assumed in the design of the following exemplary embodiments. The benefits of reducing hardness as well as TDS, TSS, nitrate, ammonia and heavy metals concentrations upstream of the selenate reducing step is described in paragraphs [0017] through [0022] of the description.

The Examiner has made a unity objection in this application, which can only occur when an application describes multiple inventions. Steps (a), (b) and (e) are not required in all inventions

that are supported by the application, but they are part of the pending claims. In view of the likely characteristics of the feed water as well as the benefits of reducing the concentrations of various contaminants prior to the selenate reducing step, the Applicant submits that steps (a), (b) and (e) are part of a new and useful invention described in claims 1-9.

The Examiner also notes that steps (a), (b) and (e) are generally known in the art in view of D6 and D4.

D6 describes an apparatus for treating waste water adapted to permit the removal of metals and fluorine without adding caustic soda and slaked lime or by reducing the added amounts, by providing a heavy metal removal device for adding fly ash to desulfurized wastewater, a COD treatment device therefor and a device for removing nitrogen compounds therefrom.

D5 provides an overview of the design methodology known in the art for the treatment of industrial and hazardous waste, including air stripping to remove ammonia from wastewater.

D4 provides that the biological nitrogen removal process is the most common method for removing low quantities of ammonium from wastewater, but this is not the usual treatment for high-strength ammonium wastewater. D4 goes on to state that the main problem of the biological treatment of high-strength industrial wastewater is that high concentrations of ammonium or nitrite inhibit the nitrification, although it could be an interesting way of treating high-strength ammonium wastewater from an environmental and economical point of view.

There is no teaching or suggestion in the above-noted references to combine the described processes with the sequential steps of anoxic treatment to denitrify, anoxic treatment to remove selenium and anaerobic treatment to remove heavy metals. For at least the reasons discussed above, the Applicant respectfully submits that claim 1 is non-obvious having regard to the combination of D1, D4 and D6. Dependent claims 2-9 are non-obvious for the same reasons claim 1 is non-obvious.

Withdrawal of the rejections raised under section 28.3 of the *Patent Act* is respectfully requested.

Should this application be abandoned for any reason, please regard this as the request(s) for reinstatement. Should the fees submitted with this letter be insufficient to cover all of the fees for which payment is explicitly or implicitly requested by this letter, or needed to reinstate the application, the Commissioner is authorized to charge the amount of the insufficiency to our deposit account number 600000247 or deposit account number 600001646.

Yours very truly

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18 August 2015 (18-08-2015)

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Application No. : **2,517,322**
Owner : ZENON TECHNOLOGY PARTNERSHIP
Title : **APPARATUS AND METHOD FOR TREATING FGD BLOWDOWN
OR SIMILAR LIQUIDS**
Classification : C02F 3/30 (2006.01)
Your File No. : **PAT 92005-1**
Examiner : PHAM, Thi Tham

YOU ARE HEREBY NOTIFIED OF A REQUISITION BY THE EXAMINER IN ACCORDANCE WITH SUBSECTION 30(2) OF THE *PATENT RULES*. IN ORDER TO AVOID ABANDONMENT UNDER PARAGRAPH 73(1)(a) OF THE *PATENT ACT*, A WRITTEN REPLY MUST BE RECEIVED WITHIN THE **SIX (6)** MONTH PERIOD AFTER THE ABOVE DATE.

This application has been examined taking into account the applicant's correspondences received in this office on 17 May 2013 (17-05-2013); 2 May 2014 (02-05-2014); and 29 April 2015 (29-04-2015).

The number of claims in this application is 20.

As the application is apparently directed to a plurality of inventions, as detailed below, and the applicant has elected on 17 May 2013 (17-05-2013) to proceed with the claims of **Group A** (present claims 1-9). Further prosecution of the present application is therefore restricted to the subject-matter of the claims of **Group A** (present claims 1-9).

Documents Cited:

- D1: CA1274925 Downing et al. 2 October 1990 (02-10-1990)
D2: CA2025433 A1 Maree et al. 3 April 1991 (03-04-1991)
- D3: Droste (1997). Water treatment unit operations. In *Theory and Practice of Water and Wastewater Treatment* (chapter 9). New York: John Wiley & Sons.
- D4: Carrera et al. (2003). Biological nitrogen removal of high-strength ammonium industrial wastewater with two-sludge system. *Water Research*, **37**:4211-4221.
- D5: USACE (30 April 1994). Treatment Technologies. In *Engineering and Design: Technical Guidelines for Hazardous and Toxic Waste Treatment and Cleanup Activities EM 1110-1-502* (chapter 4). Washington, DC: U.S. Army Corps of Engineers.

D6: JPH01304100 A Katagawa et al. 7 December 1989 (07-12-1989)

D7: Kaschka et al. (1999). *Phostrip Handbook*. 4th ed. Accessed online at http://www.pap.co.at/uploads/media/Phostrip_Handbook_1999.pdf

The examiner has identified the following defects in the application:

The application does not comply with subsection 36(1) of the *Patent Act*. The claims are directed to a plurality of alleged inventions as follows:

- Group A** - Claims 1-9 are directed to a process for the treatment of a liquid comprising:
a) physical and/or chemical pretreatment to remove total suspended solids and to soften the liquid; b) removing ammonia from the liquid; c) biological treatment under anoxic conditions to remove nitrate; d) a second biological treatment under anoxic conditions after step (c) to remove selenium and biological treatment under anaerobic conditions to remove heavy metals; and, e) membrane separation of the liquid upstream of step (d);
- Group B** - Claims 10-13 are directed to a process for treating a waste stream comprising flue gas desulfurization blowdown water having steps of physical and chemical pretreatment to remove suspended solids from the waste stream and soften the waste stream followed by biological treatment under anoxic conditions to denitrify the waste stream followed by biological treatment under anoxic conditions to remove selenium from the waste stream, wherein the steps of denitrifying the waste stream and removing selenium from the waste stream occur in one or more fixed film bioreactors; and
- Group C** - Claims 14-20 are directed to an apparatus for treating a waste stream comprising flue gas desulfurization blowdown water, the apparatus having a system for adding lime or sulfides to the waste stream and a precipitate remover upstream of one or more reactors configured to provide denitrification and selenium removal by biological treatment.

As acknowledged by the applicant in the correspondence dated 17 May 2013 (17-05-2013), the claims of Groups A to C are linked by the steps of (1) removing suspended solids and softening of a liquid and (2) anoxic biological treatment of the liquid. It is, however, known (see D7: Figure 6; page 14) to add slaked lime (a precipitant) to a waste stream to soften the water, followed by solids separation to remove suspended solids, upstream of one or more biological reactors operating under anoxic conditions (i.e., configured to provide denitrification and selenium removal by biological treatment). Therefore, the present independent claims 1, 10, and 14 are considered to lack unity *a posteriori*.

The applicant's arguments are not deemed persuasive. It is noted that independent claims 1, 10, and 14 are defined using the open-ended term "comprising". The claims do not require the entire influent stream to undergo suspended solids removal and/or softening. It is further noted that in claim 1, only steps (c), (d), and (e) need to be carried out in sequential order; whereas, the order in which steps (a) and (b) are to be performed is not defined. Even if the order of operation in claim 1 is explicitly recited such that steps (a) and (b) occur before step (c), D7 also teaches solids removal and softening upstream of the anoxic treatment step.

The applicant is correct in that D7 is concerned with phosphorus removal in a sidestream; however, present claim 1 is directed to a process for the treatment of a liquid in general. The liquid stream leaving phosphorus product separator unit in D7 is directed to the primary clarifier to be mixed with raw influent, and the clarified mixture from primary clarifier is sent to the biological treatment tank having an anoxic zone. Therefore, D7 explicitly teaches solids removal and softening steps upstream of the anoxic treatment step.

Claims 1-9 do not comply with section 28.3 of the *Patent Act*. These claims are directed to subject-matter that would have been obvious at the claim date to a person skilled in the art or science to which they pertain having regard to D1, in view of common general knowledge in the art.

The problem to be solved is identified at paragraph [007] of the description as the provision of an “apparatus and process for treating FGD blowdown water or other wastewaters having selenium or nitrate and selenium, or a process or apparatus for biologically removing inorganic contaminants, for example nitrogen, selenium, arsenic, mercury or sulphur, from wastewater”. The proposed solution (see paragraph [008]) is to provide a biological treatment process having the sequential steps of anoxic treatment to denitrify, anoxic treatment to remove selenium, and anaerobic treatment to removal heavy metals.

D1 is considered to be the closest prior art as it pertains biological treatment of a wastewater for the removal of selenium, nitrates, sulfate, heavy metals, and boron. D1 teaches the same solution as presently claimed in claim 1, wherein the wastewater is subjected to anoxic conditions for biological removal of nitrates, followed by anoxic biological removal of selenium and anaerobic biological removal of sulfur and heavy metals (see pages 4-5, bridging paragraph; page 6; page 8, line 25 to page 9, line 18; pages 10-11, bridging paragraph; Example 4).

Present claim 1 differs from D1 in that the process of claim 1 further comprises:

- a) physical and/or chemical pretreatment of the liquid to remove total suspended solids and to soften the liquid;
- b) removing ammonia from the liquid; and
- e) membrane separation of the liquid upstream of step (d).

According to the description, steps (a), (b), and (e) are optional steps that can be carried out depending on the characteristics of the wastewater to be treated. That is, if the influent wastewater contains high suspended solids and/or hardness, lime addition followed by solids removal can be used to soften the wastewater and to reduce total suspended solids content. Similarly, if the influent wastewater contains high ammonia content, ammonia removal by air stripping and/or nitrification/denitrification processes can be used. In other words, these steps are not essential in solving the technical problem of providing a biological process for the removal of selenium, or nitrates and selenium, or inorganic contaminants such as nitrogen, selenium, arsenic, mercury or sulphur. Therefore, claim 1 is considered to lack an inventive step.

Furthermore, steps (a), (b), and (e) are generally known in the art. For example, D6 (see abstract) teaches physical/chemical pretreatment of FGD wastewater (1) by adding fly ash (5) and slaked lime (6) and solids removal (4), followed by COD treatment (9) and nitrogen

removal (10). Ammonia removal by biological aerobic treatment (see D4) or by ammonia stripping (see pages 4-1 to 4-6 of D5; page 4211, first line of right column, of D4) is a well-known option for treating industrial wastewater containing high levels of ammonium; and membrane separation is a well-known liquid-solid separation process (see page 14, lines 16-17, of D1).

Dependent claims 2-9 are directed to features known to the skilled person (see, for example, D3, pages 227-231, for various wastewater treatment unit operations available to the skilled person). Furthermore, it is also common practice in biological treatment design to include suspended solids removal and wastewater dilution upstream of the biological process to minimize process upset (see, for example, page 4-16 of D5; page 12, lines 1-3, of D2). An inventive step cannot be acknowledged if the process claimed is an aggregation of known features, each and in combination, providing known, expected outcomes (see section 11.07.02 of MOPOP).

Therefore, it is maintained that claims 1-9 lack an inventive step.

The applicant's arguments are not deemed persuasive. It is noted that paragraph [0003] of the description relates to the difficulties associated with treatment of FGD blowdown water. The benefits described in paragraphs [0017] through [0022] also relate to the treatment of FGD blowdown water. Present claim 1 is directed to a process for the treatment of a liquid in general, **not FGD blowdown water**.

If the defects referred to in the requisition are not overcome, the application may be rejected in a **FINAL ACTION**.

In view of the foregoing defects, the applicant is requisitioned, under subsection 30(2) of the *Patent Rules*, to amend the application in order to comply with the *Patent Act* and the *Patent Rules* or to provide arguments as to why the application does comply.

Under section 34 of the *Patent Rules*, any amendment made in response to this requisition must be accompanied by a statement explaining the nature thereof, and how it corrects each of the above identified defects.

PHAM, Thi Tham
Patent Examiner, Section G2
819-953-0771

As per CIPO Client Service Standards, a response to a telephone enquiry or voice mail should be provided by the end of the next business day. In the event that attempts to reach the examiner are unsuccessful, the examiner's Section Head, André C. Martin, can be reached at 819-953-6441.

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The Examination Search Report is provided for reference only and is not part of any requisition made by the examiner in accordance with the *Patent Act* or *Rules*. The applicant is not required to respond to the information contained in the Examination Search Report.

Examination Search Report

Box I: General Information			
Application No.	2,517,322	Search Report Date	10-09-2014
Title	APPARATUS AND METHOD FOR TREATING FGD BLOWDOWN OR SIMILAR LIQUIDS		
Examiner	PHAM, Thi Tham	Search Conducted?	No
No search was conducted for the following reasons :			
- Search deferred - see report for reasoning (lack of unity, excluded subject matter etc.)			N/A
- Relied on previous search results (CIPO and/or by Foreign Office)			Yes

Box II: Family Prosecution		
Family Member	File Wrapper Reviewed	Status of Prosecution
US7550087B2	10-09-2014	Completed
US7790034B2	10-09-2014	Completed
US8163181B2	10-09-2014	Completed
EP1910234B1	10-09-2014	Completed
WO2007012181A1	10-09-2014	Completed
CA2615945A1	08-07-2015	In Progress

Box III: Prior Art Submissions	
Type of submissions	Reviewed?

Box IV: Search History			
Claims Searched		Date of Search	
<u>Type of Search Conducted (select all that apply):</u>			
Canadian first to file search	<input type="checkbox"/>	Supplemental/top up search	<input type="checkbox"/>
Inventor/applicant search	<input type="checkbox"/>	Non laid open search	<input type="checkbox"/>
Comprehensive search	<input type="checkbox"/>	In-house searcher	<input type="checkbox"/>
<u>Search History from Databases Consulted:</u>			
No Search Conducted			

Version 8

REPLACEMENT PAGE

CLAIMS:

We claim:

1. A process for the treatment of a liquid comprising flue gas desulfurization blowdown water comprising:
 - a) physical and/or chemical pretreatment of the liquid to remove total suspended solids and to soften the liquid;
 - b) removing ammonia from the liquid;
 - c) biological treatment under anoxic conditions to remove nitrate;
 - d) a second biological treatment under anoxic conditions after step (c) to remove selenium and biological treatment under anaerobic conditions to remove heavy metals; and,
 - e) membrane separation of the liquid upstream of step (d).
2. The process of claim 1 further comprising the step of: f) dilution upstream of the step (b), step (c), or step (d).
3. The process of claim 1 or 2 wherein the process is carried out in a series of reactors and at least one of the reactors is a membrane bioreactor.
4. The process of claim 3 wherein one of the reactors is a fixed film reactor and is downstream of the membrane bioreactor.
5. The process of claim 4 wherein the fixed film reactor has a granular activated carbon bed.
6. The process of claim 5 wherein the operation of the activated carbon bed reactor comprises a step of adding a nutrient to the activated carbon bed reactor.
7. The process of claim 3 wherein: at least one of the reactors dilutes the liquid in the reactors using one or more inlets, lime or sulfides is added to the liquid upstream of the reactors, or a precipitate is removed.

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REPLACEMENT PAGE

8. The process of any one of claims 1 to 7 wherein lime, sulfides or combinations thereof are added in the pretreatment step.
9. The process of any one of claims 1 to 8 comprising nitrifying ammonia in a first aerobic zone.
10. A process for treating a waste stream comprising flue gas desulfurization blowdown water having steps of physical and chemical pretreatment to remove suspended solids from the waste stream and soften the waste stream followed by biological treatment under anoxic conditions to denitrify the waste stream followed by biological treatment under anoxic conditions to remove selenium from the waste stream, wherein the steps of denitrifying the waste stream and removing selenium from the waste stream occur in one or more fixed film bioreactors.
11. The process of claim 10 further comprising a step of biological treatment under anaerobic conditions to remove arsenic, mercury, or sulphur.
12. The process of claim 10 or 11 further comprising a step of biological treatment under aerobic conditions to remove COD from or nitrify the waste stream upstream of the step of denitrifying the waste stream.
13. The process of any one of claims 10 to 12 further comprising a step of membrane separation of the waste stream upstream of the step of removing selenium.
14. An apparatus for treating a waste stream comprising flue gas desulfurization blowdown water, the apparatus having a system for adding lime or sulfides to the waste stream and a precipitate remover upstream of one or more reactors configured to provide denitrification and selenium removal by biological treatment.
15. The apparatus of claim 14 wherein the one or more reactors further provide aerobic treatment of COD by biological treatment.

REPLACEMENT PAGE

16. The apparatus of claim 14 or 15 wherein the one or more reactors further provide heavy metal or sulfur removal by biological treatment.
17. The apparatus of any one of claims 14 to 16 wherein one of the one or more reactors is a membrane bioreactor.
18. The apparatus of any one of claims 14 to 17 wherein one of the one or more reactors is a fixed film reactor.
19. The apparatus of claim 18 wherein the fixed film reactor has an activated carbon bed used to support a population of microbes.
20. The apparatus of any one of claims 14 to 19 having an ammonia stripper.

IN THE CANADIAN PATENT OFFICE

To: The Commissioner of Patents

February 16, 2016

Application No.: **2,517,322**
 Title: **APPARATUS AND METHOD FOR TREATING FGD BLOWDOWN
 OR SIMILAR LIQUIDS**
 Applicant: **ZENON TECHNOLOGY PARTNERSHIP**
 Our File: **PAT 92005-1**

Attention: Thi Tham Pham, Patent Examiner

This is in response to the Examiner's Requisition dated August 18, 2015.

IN THE CLAIMS

Please replace claims pages 13-15, containing claims 1 to 15, with amended claims pages 13-15, containing claims 1 to 15, submitted herewith. A marked-up copy of the amended claims showing the changes is also enclosed herewith.

REMARKS**Amendments to the Claims**

Claim 1 is amended to recite "A process for the treatment of a liquid comprising flue gas desulfurization blow-down water". No new matter is added by way of this amendment.

Subsection 36(1) Objection – Lack of Unity

The Requisition rejects independent claims 1, 10 and 14 as lacking unity.

The Applicant respectfully submits that amended claims 1, 10 and 14 share common features that are not prior art.

Amended claim 1 is directed to a process for the treatment of a liquid comprising flue gas desulfurization blowdown water. It follows that Groups A, B and C identified in the Requisition are linked by a process for treating flue gas desulfurization (FGD) blowdown water, which comprises the steps of (1) removing suspended solids and softening of the blowdown water, and (2) anoxic biological treatment of the blowdown water to remove nitrate and selenium.

As opposed to the claimed invention, D7 discloses a process that is concerned with phosphorus removal in a sidestream and fails to teach any process for dealing with FGD blowdown water. In addition, D7 does not disclose a step of removing selenium from the treated water by means of anoxic biological treatment.

Therefore, claims 1, 10 and 14 share the common features that are not part of the prior art, thereby having unity in compliance with subsection 36(1) of the *Patent Act*.



Section 28.3 Objections – Obviousness

The Requisition objected to claims 1-9 as being obvious having regard to D1 in view of common general knowledge in the art. The Applicant respectfully submits that claims 1-20 are not obvious for the following reasons.

Amended claim 1 is directed to a process for the treatment of a liquid comprising FGD blowdown water. To solve the problems associated with the treatment of FGD blowdown water (see para. [0003]), the solution of claim 1 includes steps (a) to (e), wherein step (e) is performed before step (d).

Paragraph [0003] of the description states that “the concentration of TDS, TSS, Ca and Mg hardness, nitrate, ammonia, and sulfur for example as sulfate are all likely to be high, and various heavy metals may be present, making the blow down water very difficult to treat, particularly to achieve very low levels of contaminants”. This is further expanded upon in paragraph [0015] of the description as well as Table 1, which shows the contaminants assumed in the design of an exemplary embodiment. The benefits of reducing hardness as well as TDS, TSS, nitrate, ammonia and heavy metals concentrations upstream of the selenate reducing step is described in paragraphs [0017] through [0022] of the description.

In contrast, D1 only discloses a method of removing selenium from water and fails to teach or suggest a process for treating FGD blowdown water. D1 does not disclose steps (a), (b) and (e) of the claimed invention.

The last full paragraph on page 3 of the Requisition refers to Applicant's description. Applicant's description is not prior art. Teaching in Applicant's description cannot be combined with D1 to support an obviousness rejection.

The Requisition states that steps (a), (b) and (e) are generally known in the art as demonstrated by D4-D6. D4-D6 are scattered references published 14 years apart, one in Japanese, none with any evidence of widespread use in the field. D4-D6 are not evidence of general knowledge. Further, the cited references provide no teaching or suggestion to select steps (a), (b) or (e) and combine these steps with each other and with steps of anoxic treatment to denitrify, anoxic treatment to remove selenium and anaerobic treatment to remove heavy metals to treat FGD blowdown water.

For these reasons, Applicant submits that claims 1-9 depending from claim 1 are not obvious.

CONCLUSION

Applicant respectfully submits that the application is in condition for allowance in light of the remarks and amendments made above. Reconsideration is respectfully requested.

Should this application be abandoned for any reason, please regard this as the request(s) for reinstatement. Should the fees submitted with this letter be insufficient to cover all of the fees for which payment is explicitly or implicitly requested by this letter, or needed to reinstate the application, the Commissioner is authorized to charge the amount of the insufficiency to our deposit account number 600000247 or deposit account number 600001646.

Yours very truly

Scott Pundsack
Borden Ladner Gervais LLP/s.r.l.

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REPLACEMENT PAGE

CLAIMS:

We claim:

1. A process for the treatment of a liquid comprising flue gas desulfurization blowdown water comprising:
 - a) physical and/or chemical pretreatment of the liquid to remove total suspended solids and to soften the liquid;
 - b) removing ammonia from the liquid;
 - c) biological treatment under anoxic conditions to remove nitrate;
 - d) a second biological treatment under anoxic conditions after step (c) to remove selenium and biological treatment under anaerobic conditions to remove heavy metals; and,
 - e) membrane separation of the liquid upstream of step (d).
2. The process of claim 1 further comprising the step of: f) dilution upstream of the step (b), step (c), or step (d).
3. The process of claim 1 or 2 wherein the process is carried out in a series of reactors and at least one of the reactors is a membrane bioreactor.
4. The process of claim 3 wherein one of the reactors is a fixed film reactor and is downstream of the membrane bioreactor.
5. The process of claim 4 wherein the fixed film reactor has a granular activated carbon bed.
6. The process of claim 5 wherein the operation of the activated carbon bed reactor comprises a step of adding a nutrient to the activated carbon bed reactor.
7. The process of claim 3 wherein: at least one of the reactors dilutes the liquid in the reactors using one or more inlets, lime or sulfides is added to the liquid upstream of the reactors, or a precipitate is removed.

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REPLACEMENT PAGE

8. The process of any one of claims 1 to 7 wherein lime, sulfides or combinations thereof are added in the pretreatment step.
9. The process of any one of claims 1 to 8 comprising nitrifying ammonia in a first aerobic zone.
10. A process for treating a waste stream comprising flue gas desulfurization blowdown water having steps of physical and chemical pretreatment to remove suspended solids from the waste stream and soften the waste stream followed by biological treatment under anoxic conditions to denitrify the waste stream followed by biological treatment under anoxic conditions to remove selenium from the waste stream, wherein the steps of denitrifying the waste stream and removing selenium from the waste stream occur in one or more fixed film bioreactors.
11. The process of claim 10 further comprising a step of biological treatment under anaerobic conditions to remove arsenic, mercury, or sulphur.
12. The process of claim 10 or 11 further comprising a step of biological treatment under aerobic conditions to remove COD from or nitrify the waste stream upstream of the step of denitrifying the waste stream.
13. The process of any one of claims 10 to 12 further comprising a step of membrane separation of the waste stream upstream of the step of removing selenium.
14. An apparatus for treating a waste stream comprising flue gas desulfurization blowdown water, the apparatus having a system for adding lime or sulfides to the waste stream and a precipitate remover upstream of one or more reactors configured to provide denitrification and selenium removal by biological treatment.
15. The apparatus of claim 14 wherein the one or more reactors further provide aerobic treatment of COD by biological treatment.

REPLACEMENT PAGE

16. The apparatus of claim 14 or 15 wherein the one or more reactors further provide heavy metal or sulfur removal by biological treatment.
17. The apparatus of any one of claims 14 to 16 wherein one of the one or more reactors is a membrane bioreactor.
18. The apparatus of any one of claims 14 to 17 wherein one of the one or more reactors is a fixed film reactor.
19. The apparatus of claim 18 wherein the fixed film reactor has an activated carbon bed used to support a population of microbes.
20. The apparatus of any one of claims 14 to 19 having an ammonia stripper.

MARKED-UP COPY

CLAIMS:

We claim:

1. A process for the treatment of a liquid comprising flue gas desulfurization blowdown water comprising:
 - a) physical and/or chemical pretreatment of the liquid to remove total suspended solids and to soften the liquid;
 - b) removing ammonia from the liquid;
 - c) biological treatment under anoxic conditions to remove nitrate;
 - d) a second biological treatment under anoxic conditions after step (c) to remove selenium and biological treatment under anaerobic conditions to remove heavy metals; and,
 - e) membrane separation of the liquid upstream of step (d).
2. The process of claim 1 further comprising the step of: f) dilution upstream of the step (b), step (c), or step (d).
3. The process of claim 1 or 2 wherein the process is carried out in a series of reactors and at least one of the reactors is a membrane bioreactor.
4. The process of claim 3 wherein one of the reactors is a fixed film reactor and is downstream of the membrane bioreactor.
5. The process of claim 4 wherein the fixed film reactor has a granular activated carbon bed.
6. The process of claim 5 wherein the operation of the activated carbon bed reactor comprises a step of adding a nutrient to the activated carbon bed reactor.
7. The process of claim 3 wherein: at least one of the reactors dilutes the liquid in the reactors using one or more inlets, lime or sulfides is added to the liquid upstream of the reactors, or a precipitate is removed.

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MARKED-UP COPY

8. The process of any one of claims 1 to 7 wherein lime, sulfides or combinations thereof are added in the pretreatment step.
9. The process of any one of claims 1 to 8 comprising nitrifying ammonia in a first aerobic zone.
10. A process for treating a waste stream comprising flue gas desulfurization blowdown water having steps of physical and chemical pretreatment to remove suspended solids from the waste stream and soften the waste stream followed by biological treatment under anoxic conditions to denitrify the waste stream followed by biological treatment under anoxic conditions to remove selenium from the waste stream, wherein the steps of denitrifying the waste stream and removing selenium from the waste stream occur in one or more fixed film bioreactors.
11. The process of claim 10 further comprising a step of biological treatment under anaerobic conditions to remove arsenic, mercury, or sulphur.
12. The process of claim 10 or 11 further comprising a step of biological treatment under aerobic conditions to remove COD from or nitrify the waste stream upstream of the step of denitrifying the waste stream.
13. The process of any one of claims 10 to 12 further comprising a step of membrane separation of the waste stream upstream of the step of removing selenium.
14. An apparatus for treating a waste stream comprising flue gas desulfurization blowdown water, the apparatus having a system for adding lime or sulfides to the waste stream and a precipitate remover upstream of one or more reactors configured to provide denitrification and selenium removal by biological treatment.
15. The apparatus of claim 14 wherein the one or more reactors further provide aerobic treatment of COD by biological treatment.

MARKED-UP COPY

16. The apparatus of claim 14 or 15 wherein the one or more reactors further provide heavy metal or sulfur removal by biological treatment.
17. The apparatus of any one of claims 14 to 16 wherein one of the one or more reactors is a membrane bioreactor.
18. The apparatus of any one of claims 14 to 17 wherein one of the one or more reactors is a fixed film reactor.
19. The apparatus of claim 18 wherein the fixed film reactor has an activated carbon bed used to support a population of microbes.
20. The apparatus of any one of claims 14 to 19 having an ammonia stripper.

31 March 2016 (31-03-2016)

BORDEN LADNER GERVAIS LLP

Scotia Plaza
40 King Street West
TORONTO Ontario
M5H 3Y4

Application No. : **2,517,322**
Owner : ZENON TECHNOLOGY PARTNERSHIP
Title : **APPARATUS AND METHOD FOR TREATING FGD BLOWDOWN
OR SIMILAR LIQUIDS**
Classification : C02F 3/30 (2006.01)
Your File No. : **PAT 92005-1**
Examiner : Tham T. Pham, Ph.D.

YOU ARE HEREBY NOTIFIED OF A REQUISITION BY THE EXAMINER IN ACCORDANCE WITH SUBSECTION 30(2) OF THE *PATENT RULES*. IN ORDER TO AVOID ABANDONMENT UNDER PARAGRAPH 73(1)(a) OF THE *PATENT ACT*, A WRITTEN REPLY MUST BE RECEIVED WITHIN THE **SIX (6)** MONTH PERIOD AFTER THE ABOVE DATE.

This application has been examined taking into account the applicant's correspondence received in this office on 16 February 2016 (16-02-2016).

Documents Cited:

D1:	CA1274925	Downing et al.	2 October 1990 (02-10-1990)
D6:	JPH01304100 A	Katagawa et al.	7 December 1989 (07-12-1989)

The number of claims in this application is 20.

Claim 10 of this application and claims 12 and 13 of patent application 2615945 cannot be granted in separate patents.

The courts have affirmed the prohibition against double patenting and established that there are two branches to double patenting. The first branch, called "same invention" double patenting, occurs when the claims are "identical or conterminous". The second branch, called "obvious" double patenting, occurs when the claims are not patentably distinct from those of the earlier patent. Both branches prohibit the issuance of a second patent to the inventor with claims overlapping those of the earlier patent (see *GlaxoSmithKline Inc. V. Apotex Inc.* [2003] F.C.T. 687, and *Whirlpool Co. V. Camco On.* [2000] 2 S.C.R. 1067).

Claim 10 of the present application is considered to be conterminous with claims 12 and 13 of application 2615945. The ORP range recited in claims 12 and 13 of co-pending application 2615945 encompass the anoxic and anaerobic conditions occurring in the bioreactors during denitrification, selenium removal, and sulphur removal. Therefore, according to the first branch of double patenting, claim 10 of the present application cannot be granted in a separate patent and the overlapping subject-matter must be removed.

The examiner has identified the following defects in the application:

Claims 14-16 are not fully supported by the description and does not comply with section 84 of the *Patent Rules*:

- In claim 14, the feature “reactors configured to provide denitrification and selenium removal by biological treatment” is a desired result to be achieved. The description only teaches biological denitrification and selenium removal under anoxic conditions. Therefore, claim 14 must be limited to anoxic reactors.
- Per claims 15 and 16, the description does not teach aerobic treatment of COD, or removal of heavy metal or sulfur, in reactors configured to provide denitrification and selenium removal (as defined in claim 14). It is noted that denitrification and selenium removal occurs under anoxic conditions; therefore, aerobic COD removal would not occur in said anoxic reactors. Furthermore, sulfur/heavy metal removal under anaerobic conditions would also not occur in the anoxic reactors.

Claims 1, 10, and 14 are not clear and concise and do not comply with section 84 of the *Patent Rules*:

- The apparatus as claimed in independent claim 14 does not contain all apparatus elements required for carrying out the method of claim 1, or the method of claim 10.
- The process of independent claims 1 and 10 are characterized by different process steps: claim 1 requires the steps of removing ammonia from the FGD blowdown water and membrane separation of the water upstream of the anoxic treatment to remove selenium step (not recited in independent claim 10); whereas, claim 10 requires anoxic denitrification and selenium removal in one or more fixed film bioreactors (not recited in claim 1).

This causes a lack of clarity as to the nature of the inventive concept underlying the claims.

Claims 10-20 do not comply with section 28.3 of the *Patent Act*. These claims are directed to subject-matter that would have been obvious at the claim date to a person skilled in the art or science to which it pertains having regard to D6, in view of D1.

D6 (see abstract) discloses a method for treatment of FGD blowdown comprising physical/chemical pre-treatment of FGD wastewater (1) by adding fly ash (5) and slaked lime (6) and solids removal (4), followed by COD treatment (9) and nitrogen removal (10). D6 does not teach further biological treatment of the pre-treated FGD wastewater under anoxic conditions to remove selenium, as presently recited in claims 10 and 14.

It is, however, known from D1 to perform biological treatment of wastewater under anoxic conditions for removal of nitrates, followed by anoxic biological removal of selenium and anaerobic biological removal of sulfur and heavy metals (see pages 4-5, bridging paragraph; page 6; page 8, line 25 to page 9, line 18; pages 10-11, bridging paragraph; Example 4).

The skilled person in the art would readily recognize that the chemical/physical pre-treated FGD wastewater of D6 can be biologically treated under anoxic conditions as taught in D1, to achieve solids removal, as well as nitrates/selenium/heavy metals removal. In combining the teaching of D6 and D1, the skilled person would arrive directly at the process and apparatus as recited in claims 10 and 14. Therefore, claims 10 and 14 lack an inventive step.

Dependent claims 11-13 and 15-20 are directed to features known to the skilled person, and do not appear to provide any unexpected technical effect. Therefore, said claims lack an inventive step.

In view of the foregoing defects, the applicant is requisitioned, under subsection 30(2) of the *Patent Rules*, to amend the application in order to comply with the *Patent Act* and the *Patent Rules* or to provide arguments as to why the application does comply.

Under section 34 of the *Patent Rules*, any amendment made in response to this requisition must be accompanied by a statement explaining the nature thereof, and how it corrects each of the above identified defects.

Tham T. Pham, Ph.D.
Patent Examiner, Section G2
819-639-8529

As per CIPO Client Service Standards, a response to a telephone enquiry or voice mail should be provided by the end of the next business day. In the event that attempts to reach the examiner are unsuccessful, the examiner's Section Head, André C. Martin, can be reached at 819-639-8510.

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<http://ic.sondages-surveys.ca/s/SCB-OPS/langeng>.

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The Examination Search Report is provided for reference only and is not part of any requisition made by the examiner in accordance with the *Patent Act* or *Rules*. The applicant is not required to respond to the information contained in the Examination Search Report.

Examination Search Report

Box I: General Information			
Application No.	2,517,322	Search Report Date	2016-03-17
Title	APPARATUS AND METHOD FOR TREATING FGD BLOWDOWN OR SIMILAR LIQUIDS		
Examiner	Tham T. Pham	Search Conducted?	No
No search was conducted for the following reasons :			
- Search deferred - see report for reasoning (lack of unity, excluded subject matter etc.)			N/A
- Relied on previous search results (CIPO and/or by Foreign Office)			Yes

Box II: Family Prosecution		
Family Member	File Wrapper Reviewed	Status of Prosecution
US7550087B2	10-09-2014	Completed
US7790034B2	10-09-2014	Completed
US8163181B2	10-09-2014	Completed
EP1910234B1	10-09-2014	Completed
WO2007012181A1	10-09-2014	Completed
CA2615945A1	17-03-2016	In Progress

Box III: Prior Art Submissions	
Type of submissions	Reviewed?

Box IV: Search History			
Claims Searched		Date of Search	
<u>Type of Search Conducted (select all that apply):</u>			
Canadian first to file search	<input type="checkbox"/>	Supplemental/top up search	<input type="checkbox"/>
Inventor/applicant search	<input type="checkbox"/>	Non laid open search	<input type="checkbox"/>
Comprehensive search	<input type="checkbox"/>	In-house searcher	<input type="checkbox"/>
<u>Search History from Databases Consulted:</u>			
No Search Conducted			

Version 8

IN THE CANADIAN PATENT OFFICE

To: The Commissioner of Patents

September 22, 2016

Application No.: **2,517,322**
 Title: **APPARATUS AND METHOD FOR TREATING FGD BLOWDOWN
 OR SIMILAR LIQUIDS**
 Applicant: **ZENON TECHNOLOGY PARTNERSHIP**
 Our File: **PAT 92005-1**

Attention: Thi Tham Pham, Patent Examiner

This is in response to the Examiner's Requisition dated March 31, 2016.

REMARKS

The Examiner rejected claim 10 for double patenting in view of claims 12 and 13 of patent application 2615945. Claims 12 and 13 have been cancelled from application 2615945.

The Examiner objected to claims 14-16 for not being supported by the description or complying with section 84 of the Patent Rules. Claim 14 refers to one or more reactors configured to provide denitrification and selenium removal. Claim 14 does not require that the one or more reactors only provide denitrification and selenium removal, and does not exclude the possibility that the one or more reactors also provide other treatments. For example, paragraph [0009] of the specification describes one or more reactors configured to provide aerobic treatment of COD, nitrification, denitrification, selenium removal and sulphur removal. The Applicant submits that the specification does not require that the one or more reactors in claim 14 be limited to anoxic reactors to be supported by the specification. The Applicant submits further that claims 15 and 16 properly depend from claim 14.

The Examiner rejected claims 1, 10 and 14 for lack of clarity and compliance with section 84 of the Patent Rules. Claims 1, 10 and 14 are independent claims each having different scope. Each claim is clear and complies with section 84. While a lack of clarity can sometimes be created by a discrepancy in scope between an independent claim and is dependent claims, independent claims are expected to have different from each other. The Applicants submit that each of claims 1, 10 and 14 are clear and concise and that they comply with Rule 84.

Claims 10-20 were rejected for obviousness having regard to D6 in view of D1. The Applicant respectfully requests that this rejection be reconsidered for the following reasons.

D1 provides merely one method of removing selenium. D1 is not the only known method of removing selenium. There is no indication given in D6 that any further removal of selenium is required. There is also no suggestion in D6, if further selenium removal were required, to select a biological method of removing selenium over any other method. The Applicant submits that the combination of D1 and D6 proposed in the Requisition has no indicators of obviousness.

The Applicant submits further that D6 teaches against a combination with D1. The stated purpose of D6 is to reduce the amount of lime used in treating FGD blowdown water. Figure 2 shows an expanded treatment train that requires less lime. Figure 2 includes the addition of caustic 105 and flocculant 106 to a flocculation pan 104. This causes precipitation of heavy

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metals in settling tank 107. Selenium is a heavy metal. Accordingly, D6 already includes a method of removing selenium by chemical precipitation upstream of nitrogen removal. There is therefore no need for further biological treatment. A combination with D1 would go against the teachings in D6 to remove selenium by chemical precipitation upstream of nitrogen removal.

Claims 1, 10 and 14 also each require biological denitrification. D6 refers to a nitrogen compound processing unit 10. However, there is no evidence in D6 that unit 10 is a biological reactor. Accordingly, even if the references were combined as proposed in the Requisition, the combination still would not provide all of the elements of any claim pending in this application.

Should this application be abandoned for any reason, please regard this as the request(s) for reinstatement. Should the fees submitted with this letter be insufficient to cover all of the fees for which payment is explicitly or implicitly requested by this letter, or needed to reinstate the application, the Commissioner is authorized to charge the amount of the insufficiency to our deposit account number 600000247 or deposit account number 600001646.

Yours very truly

Borden Ladner Gervais LLP/s.r.l.

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18 November 2016 (18-11-2016)

BORDEN LADNER GERVAIS LLP

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TORONTO Ontario
M5H 4E3

Application No. : 2,517,322
Owner : ZENON TECHNOLOGY PARTNERSHIP
Title : APPARATUS AND METHOD FOR TREATING FGD BLOWDOWN
OR SIMILAR LIQUIDS
Classification : C02F 3/30 (2006.01)
Your File No. : PAT 92005-1
Examiner : Tham T. Pham, Ph.D.

YOU ARE HEREBY NOTIFIED OF A REQUISITION BY THE EXAMINER IN ACCORDANCE WITH SUBSECTION 30(2) OF THE *PATENT RULES*. IN ORDER TO AVOID ABANDONMENT UNDER PARAGRAPH 73(1)(a) OF THE *PATENT ACT*, A WRITTEN REPLY MUST BE RECEIVED WITHIN THE **SIX (6)** MONTH PERIOD AFTER THE ABOVE DATE.

This application has been examined taking into account the applicant's correspondence received in this office on 22 September 2016 (22-09-2016).

The number of claims in this application is 20.

Documents Cited:

D1: CA1274925 (A)	Downing et al.	2 October 1990 (02-10-1990)
D8: JPH0938694 (A)	Fukase, T.	10 February 1997 (10-02-1997)

The examiner has identified the following defects in the application:

Claims 14 and 15 are not fully supported by the description and does not comply with section 84 of the *Patent Rules*:

- In claim 14, the feature “reactors configured to provide denitrification and selenium removal by biological treatment” is a desired result to be achieved. Biological denitrification is generally understood as occurring under anoxic conditions. Per biological selenium removal, the description only teaches biological selenium removal under anoxic conditions. Therefore, it is maintained that claim 14 must be limited to anoxic reactors.
- Per claim 15, the description does not teach aerobic treatment of COD in reactors configured to provide denitrification and selenium removal (as defined in claim 14). As detailed above, the specification teaches denitrification and selenium removal under anoxic conditions; therefore, aerobic COD removal would not occur in anoxic reactors. The applicant admits that paragraph [0009] of the specification “describes one or more

reactors configured to provide aerobic treatment of COD” (emphasis added). The specification does not teach one reactor configured for biological denitrification, selenium removal, AND aerobic COD removal as recited in claim 15.

Claims 1, 10, and 14 are not clear and concise and do not comply with section 84 of the *Patent Rules*:

- The apparatus as claimed in independent claim 14 does not contain all apparatus elements required for carrying out the method of claim 1, or the method of claim 10.
- The process of independent claims 1 and 10 are characterized by different process steps: claim 1 requires the steps of removing ammonia from the FGD blowdown water and membrane separation of the water upstream of the anoxic treatment to remove selenium step (not recited in independent claim 10); whereas, claim 10 requires anoxic denitrification and selenium removal in one or more fixed film bioreactors (not recited in claim 1).

This causes a lack of clarity as to the nature of the inventive concept underlying the claims. Furthermore, the differences identified above bring into question as to whether or not the independent claims are unified by a single inventive concept as required by subsection 36(1) of the *Patent Act*.

Claims 10, 12, 14, 15, 18, and 19 encompass subject-matter that was disclosed in D8 before the claim date and do not comply with paragraph 28.2(1)(b) of the *Patent Act*.

D8 (see Figures; paragraphs 27-31 of machine translated text) teaches an apparatus and process for treating a waste stream comprising FGD blowdown water, the apparatus having pre-treatment system (1) for adding lime or sulfides to the wastewater and a precipitate remover, to remove suspended solids from the waste stream and to soften the waste stream, upstream of one or more reactors (4) configured to provide denitrification and selenium removal by biological treatment. The apparatus comprises aerobic reactor (3) for nitrification and post-treatment reactor (6) for aerobic COD removal (see paragraph 24). Anoxic reactor (4) can be a fixed-bed type (see paragraph 21), with activated carbon as biofilm carriers (see paragraph 17). Therefore, claims 10, 12, 14, 15, 18 and 19 lack novelty over D8.

Claims 1-20 do not comply with section 28.3 of the *Patent Act*. These claims are directed to subject-matter that would have been obvious at the claim date to a person skilled in the art or science to which it pertains having regard to D8, in view of D1.

Claims 10-20:

Claims 10, 12, 14, 15, 18, and 19 are considered to lack novelty over D8; therefore, they also lack an inventive step.

Dependent claims 11, 13, 16, 17, and 20 are directed to features known to the skilled person in the art. For example, it is known that removal of heavy metals and sulfur also occurs during non-aerated biological treatment of wastewater (see examples in D1). Membrane bioreactors and ammonia stripping are known options for the skilled person in the art. The present application does not contain any working examples; therefore, it is not clear what the unexpected technical effects to be achieved are. Therefore, said claims lack an inventive step.

Claims 1-9:

D8 (see Figures and related text; working example) discloses a process for the treatment of a liquid comprising FGD blowdown water comprising physical and/or chemical pretreatment of the liquid to remove suspended solids and to soften the liquid (1); removing ammonia from the liquid (3); anoxic/anaerobic treatment to remove nitrate and selenium (4).

It is common general knowledge that biological selenium reduction occurs after reduction of nitrates. The process in D8 is considered to implicitly teach nitrate removal followed by selenium removal under anoxic conditions.

Claim 1 is considered to differ from D8 in that:

1. D8 does not explicitly teach removal of heavy metals (other than selenium) under anaerobic conditions; and
2. D8 does not teach membrane separation of the liquid upstream of the selenium/heavy metal removal step.

Per item (1) above, the FGD blowdown water in D8 (see working example) contains sulfates. It is known from D1 (see examples; page 8, lines 3-5; page 18, line 7-10) that biological reduction of sulfates occurs after nitrate and selenium reduction, and heavy metals are converted to insoluble metal sulfides. Therefore, removal of heavy metals (other than selenium) would also occur in D8. Regardless, it would be obvious to the skilled person to modify the process of D8, by adding an anaerobic treatment step as taught in D1, for removal of heavy metals.

Per item (2), D8 teaches solids separation, but does not explicitly teach membrane separation upstream of the selenium removal step. Membrane separation is a well-known solids/liquid separation option available to the skilled person. The present application does not contain any working examples. It is not clear what the unexpected technical effect to be achieved is.

Therefore, claim 1 lacks an inventive step over D8, in view of D1.

Per claims 2 and 7, dilution of waste streams is generally performed in wastewater treatment processes. Therefore, said claims lack an inventive step.

Per claim 3, membrane bioreactors are commonly known in the art. Therefore, said claim lacks an inventive step.

Per claims 4-6, D8 teaches fixed-bed reactors, with activated carbon as suitable biofilm carrier, and nutrient addition to one or more reactors (see paragraphs 17, 19, and 21). Therefore, said claims lack an inventive step.

Per claim 8, D8 teaches softening of the FGD blowdown water using sodium carbonate. Lime softening is a well-known option available to the skilled person. Therefore, said claim lacks an inventive step.

Per claim 9, D8 teaches nitrifying ammonia in aerobic zone (3). Therefore, said claim lacks an inventive step.

In view of the foregoing defects, the applicant is requisitioned, under subsection 30(2) of the *Patent Rules*, to amend the application in order to comply with the *Patent Act* and the *Patent Rules* or to provide arguments as to why the application does comply.

Under section 34 of the *Patent Rules*, any amendment made in response to this requisition must be accompanied by a statement explaining the nature thereof, and how it corrects each of the above identified defects.

Tham T. Pham, Ph.D.
Patent Examiner, Section G2
819-639-8529

As per CIPO Client Service Standards, a response to a telephone enquiry or voice mail should be provided by the end of the next business day. In the event that attempts to reach the examiner are unsuccessful, the examiner's Section Head, André C. Martin, can be reached at 819-639-8510.

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<http://ic.sondages-surveys.ca/s/SCB-OPS/langeng>.

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The Examination Search Report is provided for reference only and is not part of any requisition made by the examiner in accordance with the *Patent Act* or *Rules*. The applicant is not required to respond to the information contained in the Examination Search Report.

Examination Search Report

Box I: General Information			
Application No.	2,517,322	Search Report Date	2016-11-17
Title	APPARATUS AND METHOD FOR TREATING FGD BLOWDOWN OR SIMILAR LIQUIDS		
Examiner	Tham T. Pham	Search Conducted?	Yes

Box II: Family Prosecution		
Family Member	File Wrapper Reviewed	Status of Prosecution
US7550087B2	2014-09-10	Completed
US7790034B2	2014-09-10	Completed
US8163181B2	2014-09-10	Completed
EP1910234B1	2014-09-10	Completed
WO2007012181A1	2014-09-10	Completed
CA2615945A1	2016-11-16	In Progress

Box III: Search History			
Claims Searched	1-20	Date of Search	2016-11-16
<u>Type of Search Conducted (select all that apply):</u>			
Canadian first to file search	<input type="checkbox"/>	Supplemental/top up search	<input checked="" type="checkbox"/>
Inventor/applicant search	<input type="checkbox"/>	Non laid open search	<input type="checkbox"/>
Comprehensive search	<input type="checkbox"/>	In-house searcher	<input type="checkbox"/>
<u>Search History from Databases Consulted:</u>			
<p>##### STN #####</p> <p>User Settings: Abbreviations=on; Plurals=on; Spelling=on; Apostrophe=on; Chemical Names=on; Diacritics=on; Hyphen=on; Cross File=on</p> <p>L1: (FGD or flue gas desulfurization) and selenium CPlus: 332 DWPI: 38 L2: L1 and PD<=20050826 CPlus: 129 DWPI: 5 L3: L2 and biological* CPlus: 7 DWPI: 0</p>			

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