639642

AUSTRALIA

Patents Act 1990

PATENT REQUEST: STANDARD PATENT

I/We, being the person(s) identified below as the Applicant, request the grant of a patent to the person identified below as the Nominated Person, for an invention described in the accompanying standard complete specification

Full application details follow.

[71] Applicant:

LOUIS ADOLF DANAU, of 3 Mulberry Close, Dawesville, Western Australia, Australia; and

MICHAEL EDWARD GEORGE WRAY, of 20 Hancock Street, Mandurah, Western Australia, Australia.

[70] Nominated Persons: LOUIS ADOLF DANAU and MICHAEL EDWARD GEORGE WRAY

Address: As above

[54] Invention Title: "DOMESTIC WASTE WATER TREATMENT & APPARATUS THEREFOR"

[72] Name of actual inventors: LOUIS ADOLF DANAU and MICHAEL EDWARD GEORGE WRAY

[74] Address for service in Australia: WRAY & ASSOCIATES, Primary Industry House, 239 Adelaide Terrace, Perth, Western Australia, 6000.

Attorney code: WR

ASSOCIATED PROVISIONAL APPLICATION(S) DETAILS

[60] Application Number and Date: PK7796 (16/8/91)

Drawing number recommended to accompany the abstract: 1

LOUIS ADOLF DANAU and MICHAEL EDWARD GEORGE WRAY
By their Patent Attorney,

P 008788 040892

4 August 1992

P/00/008
Section 29(1)
Regulation 3.1(2)

AUSTRALIA

Patents Act 1990

NOTICE OF ENTITLEMENT

(To be filed before acceptance)

We, LOUIS ADOLF DANAU, of 3 Mulberry Close, Dawesville, Western Australia, Australia, and MICHAEL EDWARD GEORGE WRAY, of ~~46~~ 20 HANCOCK ~~Leighton Road~~, Mandurah, Western Australia, Australia, being the applicant in respect of Application No. , state the following:-

1. The person(s) nominated for the grant of the patent have entitlement from the actual inventor by agreement. LOUIS ADOLF DANAU is the actual inventor and MICHAEL EDWARD GEORGE WRAY is entitled to be joint applicant with LOUIS ADOLF DANAU by virtue of the agreement.

2. The person(s) nominated for the grant of the patent are the applicant(s) of the provisional application listed on the patent request form.

LOUIS ADOLF DANAU
Date: 1/8/92.

MICHAEL EDWARD GEORGE WRAY
Date: 1-8-92

AU9220823

(12) PATENT ABRIDGMENT (11) Document No. AU-B-20823/92
(19) AUSTRALIAN PATENT OFFICE (10) Acceptance No. 639642

(54) Title
WASTE WATER TREATMENT & APPARATUS THEREFOR

International Patent Classification(s)
(51)[5] **C02F 003/30** **C02F 009/00**

(21) Application No. : **20823/92** (22) Application Date : **04.08.92**

(30) Priority Data

(31) Number	(32) Date	(33) Country
PK7796	**16.08.91**	**AU AUSTRALIA**

(43) Publication Date : **22.04.93**

(44) Publication Date of Accepted Application : **29.07.93**

(71) Applicant(s)
LOUIS ADOLF DANAU; MICHAEL EDWARD GEORGE WRAY

(72) Inventor(s)
LOUIS ADOLF DANAU; MICHAEL EDWARD GEORGE WRAY

(74) Attorney or Agent
WRAY & ASSOCIATES , PO Box 6292, Hay Street, EAST PERTH WA 6004

(57) Claim

1. A waste water treatment apparatus which is capable of receiving waste water from a waste water supply, treating that waste water, and discharging treated waste water, said apparatus comprising:

a pretreatment unit having an anaerobic zone and an anoxic zone;

an aerobic unit having a first filter and a second filter, said first filter having an aerobic portion and an anoxic portion,

a clarification and chlorination unit having a clarification zone and a chlorination zone; and

a first recycle stream capable of recycling a part of the stream exiting the first filter, such that at least a portion of the first recycle stream is capable of passing into the second filter while the remainder of the first recycle stream passes into the anoxic zone of the pretreatment unit.

.../2

17. A method of treating waste water, said method comprising subjecting waste water to:

- anaerobic fermentation in an anaerobic zone of a pretreatment unit to remove a significant amount of organic matter, to achieve partial denitrification and to promote at least partial phosphate release;
- anoxic reduction in an anoxic zone of the pretreatment unit to further reduce the organic matter, to achieve further denitrification and to substantially complete the phosphate removal;
- nitrification and soluble organic matter removal under aerobic conditions in an upper section of a first filter of an aerobic unit, and denitrification under anoxic conditions in a lower section thereof;
- nitrification and soluble organic matter removal under aerobic conditions in a second filter of the aerobic unit;
- clarification in a clarification zone in a clarification and chlorination unit; and
- chlorination in a chlorination zone in the clarification and chlorination unit to allow destruction of harmful organisms, and to produce a final dischargeable treated waste water product,

wherein a part of the stream exiting the first filter is recycled via a first recycle stream such that at least a portion of the first recycle stream passes into the second filter while the remainder of the first recycle stream passes into the anoxic zone of the pretreatment unit.

639642

AUSTRALIA

Patents Act 1990

COMPLETE SPECIFICATION

For a Standard Patent

ORIGINAL

Name of Applicants: LOUIS ADOLF DANAU and MICHAEL EDWARD GEORGE WRAY

Actual Inventor(s): LOUIS ADOLF DANAU

Address for Service:

WRAY & ASSOCIATES, Primary Industry House, 239 Adelaide Terrace, Perth, Western Australia, 6000.

Attorney code: WR

Invention Title: "WASTE WATER TREATMENT & APPARATUS THEREFOR"

Details of Associated Provisional Application: No: PK7796

The following statement is a full description of this invention, including the best method of performing it known to us:-

The present invention relates to an apparatus and method for the treatment of waste water. In particular, the present invention relates to both biological and chemical treatment of domestic waste water together with the removal of various nutrients therefrom.

The discharge from septic tanks together with the treatment and processing of the waste water and sludges and slimes removed therewithin pose serious environmental threats to our existing ground waters, rivers and estuarine systems. The present septic tank process for treating domestic waste water discharges has a capacity to reduce the organic matter contained therein to about 40% of the incoming organic load (BOD). The treated waste water is thus unsuitable for reuse for surface irrigation, or for direct discharge to ground water, storm water drains or river systems.

In particular, the septic tank process has no ability to achieve notable reductions of the total nitrogen (organic nitrogen, ammoniacal nitrogen, nitrites and nitrates) present in domestic waste waters, and further has no ability to achieve notable reductions of the total phosphorous present in those domestic waste waters.

Alternatively, there are presently available small aerobic treatment plants which have replaced the septic tank treatment process. However, the processes used in these small aerobic treatment plants are designed to aerobically treat the waste water to reduce only the incoming organic load (BOD) and to achieve an acceptable suspended solids reduction in the final discharge. The processes used do not have a capacity to achieve notable reduction of the pollutant nutrient load (organic nitrogen, ammoniacal nitrogen, nitrites, nitrates and total phosphorous).

An aim of the present invention is to provide a method and apparatus for the treatment of waste water which will overcome, or will at least partly alleviate, the above mentioned problems. In this respect, while the present invention is particularly useful for the treatment of domestic waste waters, and certainly the following description will primarily describe that, it will be understood that the present invention is also useful for the treatment of commercial waste waters as will be described later.

The present invention provides a waste water treatment apparatus which is capable of receiving waste water from a waste water supply, treating that waste water, and discharging treated waste water, said apparatus comprising:

a pretreatment unit having an anaerobic zone and an anoxic zone;

an aerobic unit having a first filter and a second filter, said first filter having an aerobic portion and an anoxic portion,

a clarification and chlorination unit having a clarification zone and a chlorination zone; and

a first recycle stream capable of recycling a part of the stream exiting the first filter, such that at least a portion of the first recycle stream is capable of passing into the second filter while the remainder of the first recycle stream passes into the anoxic zone of the pretreatment unit.

The apparatus preferably also includes a second recycle stream which recycles a portion of the discharged treated waste water to the anoxic zone of the pretreatment unit.

The present invention also provides a method of treating waste water, said method comprising subjecting waste water to:

- anaerobic fermentation in an anaerobic zone of a

pretreatment unit to remove a significant amount of organic matter, to achieve partial organic nitrogen removal and to promote at least partial phosphate release;

- anoxic reduction in an anoxic zone of the pretreatment unit to further reduce the organic matter, to achieve partial denitrification and to substantially complete the phosphate removal;
- nitrification and soluble organic matter removal under aerobic conditions in an upper section of a first filter of an aerobic unit, and denitrification under anoxic conditions in a lower section thereof;
- nitrification and soluble organic matter removal under aerobic conditions in a second filter of the aerobic unit;
- clarification in a clarification zone in a clarification and chlorination unit,
- chlorination in a chlorination zone in the clarification and chlorination unit to allow destruction of harmful organisms, and to produce a final dischargeable treated waste water product,

wherein a part of the stream exiting the first filter is recycled via a first recycle stream such that at least a portion of the first recycle stream passes into the second filter while the remainder of the first recycle stream passes into the anoxic zone of the pretreatment unit.

As indicated above, preferably a portion of the discharged treated waste water is recycled via a second recycle stream to the anoxic zone of the pretreatment unit.

The waste water to be treated preferably passes from the domestic supply to an inlet of the apparatus of the invention in the anaerobic zone. The waste water thereafter may be subjected to the anaerobic fermentation to remove a significant amount of the organic matter, to achieve some organic nitrogen removal, and to promote a

degree of phosphate release. The partially treated waste water may then pass to the anoxic zone of the pretreatment unit where it undergoes further reductions in organic matter, achieves further denitrification, and substantially completes the phosphate removal. The material exiting from the pretreatment unit (the anaerobic zone and the anoxic zone) contains mainly dissolved organic matter, and ammoniacal and organic nitrogen.

As the biological phosphate removal in the anaerobic zone may be incomplete, due mainly to the lack of a high amount of biodegradable raw material in that anaerobic zone, a supplementary chemical phosphate removal process and apparatus using mineral salts may be utilised in the anoxic zone. Preferably, the recycle water of the second recycle stream passes through the mineral salts, leaching metal ions into the recycle water such that the metal ions in solution produce insoluble precipitates and complexes to chemically complete the removal of phosphates.

A pH correction process and apparatus may also be installed to treat the second recycle stream prior to entering the anoxic zone. As the metal salts of the supplementary chemical phosphate removal apparatus are acidic in nature, and as the mains water supplying some homes and the like may already be slightly acidic, the low pH factor (often less than pH 6) after the addition of the salts could interfere with the system nitrification cycle. Thus, a pH correction facility may be provided which uses an alkaline medium, either in rock or slurry form, over which the recycled water may be passed.

Furthermore, because the partially treated waste waters exiting the anaerobic zone and entering the anoxic zone are still heavily anaerobic, and because the discharge water that is recycled to pass through the mineral salts is also not heavily saturated with oxygen, further oxygen may be

required within the anoxic zone to convert the anaerobic waste waters to anoxic conditions. Such saturated oxygen material is provided by the portion of the first recycle stream which is not passed into the second filter.

The partially treated waste water may then pass from the anoxic zone to above the first filter, where it combines with the exit stream of the second filter. The exit stream of the second filter is highly oxygen saturated due to the provision of an aeration means associated with the first recycle stream which is the input to the second filter.

The first filter preferably achieves some nitrification and soluble organic matter removal under aerobic conditions in the upper section thereof, and achieves denitrification under anoxic conditions in the lower section thereof. The aerobic conditions in the upper section are maintained by the oxygen supplied in the oxygen saturated stream from the second filter. As the stream passes through the first filter the amount of dissolved oxygen decreases towards the lower anoxic zone to provide the anoxic conditions and allow for denitrification.

The denitrification that subsequently takes place within the anoxic zone of the first filter is dictated by the facultative organisms in the anoxic zone using the oxygen from the nitrates produced in the second filter, reducing them in turn to nitrites then to nitric oxide gas in the form of nitrous oxide and nitrogen.

The second aerobic filter, which as indicated above is fed by the first recycled stream taking material exiting from the first filter, achieves nitrification and removal of soluble organic matter (BOD) under aerobic conditions. The second filter may be aerated by a forced draft ventilation fan providing an air flow through the filter to provide the aerobic conditions. The amount of oxygen required to

maintain the aerobic conditions and to promote nitrification and removal of the organic matter (BOD) is preferably controlled by the volume of water recycled through the second filter.

The treatment of the domestic waste water by the apparatus of the present invention is thus achieved in the anaerobic and anoxic zones of the pretreatment unit and in the first and second filters of the aerobic unit. The degree of removal of organic matter, together with the amount of denitrification, nitrification, and phosphate removal which are required to produce a final discharge water suitable for reuse as surface irrigation or for inclusion in an open water course, is thus preferably controlled by the relative volume of the first recycle system which in turn is dependent upon the volume of the supply of the raw waste water to the system and the amount of biodegradable material within that raw waste water.

The treated waste waters may then flow through a clarification zone and enter a chlorination chamber where they will be retained for a sufficient period to allow the destruction of the harmful organisms. Following this chlorination treatment the treated waste water may be discharged as appropriate.

In a preferred form of the invention the pretreatment unit and the aerobic unit are located adjacent each other and the clarification and chlorination unit is in turn located adjacent to the aerobic unit. Further, the second filter within the aerobic unit is preferably located immediately above the first filter so that each of the filters may be operated under the effect of gravity allowing the material exiting from the second filter to pass directly into the top of the first filter together with the waste water previously treated within the anoxic zone of the pretreatment unit.

In order to assist in arriving at an understanding of the present invention, a preferred embodiment will now be described in relation to the accompanying drawing. The accompanying drawing is a schematic illustration of an apparatus for the treatment of domestic waste water in accordance with the present invention.

Illustrated in the drawing is an apparatus for the treatment of domestic waste water having a pretreatment unit 10, an aerobic unit 12 and a clarification and chlorination unit 14. The pretreatment unit 10 includes an anaerobic zone 16 and an anoxic zone 18, while the aerobic unit includes a first filter 20 having an upper aerobic portion and a lower anoxic portion and a second filter 22 which is an aerobic filter. The clarification and chlorination unit 14 includes a clarification zone 24, a chlorination zone 26 and a discharge pump 28 which discharges the treated waste water to the outlet 30.

The respective water levels during operation of the apparatus are illustrated in each section by the letters WL and these water levels are determined by the height of the respective discharge weirs between sections. Discharge weir 32 controls the transfer of waste water from the anaerobic zone 16 to the anoxic zone 18 of the pretreatment unit 10; discharge weir 34 controls the transfer of waste water from the anoxic zone 18 of the pretreatment unit 10 to the top of the first filter 20; discharge weir 36 controls the transfer of waste water from the clarification zone 24 to the chlorination zone 26; and discharge weir 38, which is the final controlling factor in the flow of waste water through the apparatus, controls the transfer of the treated waste water from the chlorination zone 26 to the discharge pump 28.

Raw waste water is provided to the inlet 40 of the apparatus via normal sewerage and waste plumbing. The raw waste water contains significant quantities of biodegradable organic matter which promotes high rates of anaerobic fermentation. This stimulates the growth of acinetobacter which in turn accumulates an excess quantity of phosphate. A fatty acid substrate is produced which releases acetate and the acetate in turn promotes phosphate release so that the phosphate may accumulate on the acinetobacter. The degree of phosphate release in this manner is dependent upon the raw domestic waste water being virtually devoid of all oxygen and nitrates. Therefore, the higher the amount of anaerobic fermentation products present in the raw waste water the greater the % of phosphate which can be released and eventually removed.

The anaerobic zone 16 of the pretreatment unit 10 will generally remove about 40% of the organic matter from the raw waste water, will achieve a degree of organic nitrogen removal, and provides conditions to promote a degree of phosphate release.

The partially treated waste waters enter the anoxic zone 18 under gravitational flow over discharge weir 32. A small portion of oxygen that is provided in the anoxic zone to make that zone anoxic comes from the second recycle stream 42. The recycle stream 42 returns a small portion of the treated discharge waste water from the outlet 30 through valve 44 and into the anoxic zone 18.

As the biological phosphate removal in the anaerobic zone is often incomplete, due mainly to the lack of a high amount of biodegradable raw material in that anaerobic zone, a supplementary chemical phosphate removal process using mineral salts is utilised in the anoxic zone 18. Such mineral salts are provided in rock form and are stored in a mineral salts bed 46 so that the recycle water 42

passes therethrough prior to entering the anoxic zone 18. As the recycle water passes through the mineral salts, metal ions are leached into the recycle water such that the metal ions in solution produce insoluble precipitates and complexes to chemically complete the removal of phosphates.

The mineral salts may alternatively be provided in a bucket such that the recycle stream flows into the bucket and then overflows to exit into the anoxic zone.

Furthermore, a pH correction apparatus 47 and a further flow control valve 49 are also installed to treat the second recycle stream prior to entering the anoxic zone. As the metal salts of the supplementary chemical phosphate removal apparatus are acidic in nature, and as the mains water supplying some homes and the like are sometimes slightly acidic, the low pH factor (often less than pH 6) after the addition of the salts could interfere with the system nitrification cycle. Thus, a pH correction facility may be provided which uses an alkaline medium, either in rock or slurry form, over which the recycled water may be passed. Again, this may be provided in the form of a trickle bed or the like, or a bucket for overflow therefrom.

Because the partially treated waste waters exiting the anaerobic zone and entering the anoxic zone are still heavily anaerobic, and because the discharge water that is recycled to pass through the mineral salts bed 46 is small in volume and is also not heavily saturated with oxygen, further oxygen is required within the anoxic zone 18 to convert the anaerobic waste waters to anoxic conditions. Such saturated oxygen material is provided by the first recycle stream 48 which is pumped from below the first filter 20 via pump 50.

About 25% of recycle stream 48 is passed through water spray discharge bars 52 above the second filter 22 to pass through that filter. About 75% of the stream 48 continues via valve 54 to be recycled back to the anoxic zone 18 via stream 49. The recycled waste water in this first recycle stream is aerated and saturated with oxygen by a forced draft ventilation fan 56 which provides a downward air flow through filter 22 and is adapted to aerate the discharge from the water spray bars 52 and the further recycle stream 49. It should be noted that any excess air is exhausted from the aerobic unit 12 (which is sealed by a lid 58) via a ventilation shaft 60 which contains activated carbon media to suppress any odours which may otherwise be developed within the system.

The waste waters within the anoxic zone 18 undergo further organic matter reductions, further denitrification, and substantially complete phosphate removal. In this respect, the use of a metal salt to chemically assist the phosphate removal also assists in the precipitation of organic colloidal suspended matter.

The partially treated waste waters containing mainly dissolved organic matter and ammoniacal and organic nitrogen matter then enter the aerobic unit 12 which contains the two filters 20 and 22. This entry is via discharge weir 34 and results in the partially treated waste waters being fed to the first filter 20.

The first filter 20 preferably consists of random packing material with a minimum void area of about 40 to 50%. However, it will be appreciated that any suitable type of filter material may be utilised. The partially treated waste waters entering the first filter 20 are aerobic, due preferably to the saturation (by the forced draft ventilation fan) of the material passing through filter 22. This oxygen saturated material joins the partially treated

waste water from the anoxic zone 18 which passes over discharge weir 34 to enter the first filter 20. Thus, in the upper portion of the first filter 20 the removal of organic material (BOD) occurs.

The dissolved organic matter (BOD) is consumed by hetrotrophic bacteria which are a part of the micro-organisms biological film growth.

The amount of oxygen required to maintain the aerobic conditions to promote organic matter (BOD) removal is controlled by the volume of water recycled through the distribution sprays over the second filter. As the majority of this oxygen is utilised during the passage of the waste waters through the second filter 22, the amount of oxygen remaining is only sufficient to allow the upper zone of the first filter 20 to be aerobic. Thus, as the waste waters pass down through the packing of the first filter 20 the dissolved oxygen concentration gradually decreases to a point where the lower portion of the first filter 20 becomes anoxic.

In the lower anoxic portion of the first filter 20 denitrification takes place. The facultative organisms in this anoxic portion further uses the small amount of oxygen from the nitrates produced in the second filter 22 as their source of oxygen, reducing them in turn to nitrites then the nitric oxide gas, nitrous oxide and nitrogen.

The second filter 22 preferably consists of random packing material with a minimum void area of about 90%.

Thus, the second filter 22 achieves removal of soluble organic matter (BOD) and nitrification under aerobic conditions. Nitrification is a bacterial process in which the dissolved organic and ammoniacal nitrogen is oxidised into nitrites by the Nitrosomonas bacteria and then into

nitrates by the Nitrobactor bacteria which form part of the biological microorganisms growing on the packing surface area. Nitrification does not normally occur until nearly all the BOD organic matter is removed. Therefore, nitrification occurs only in the mid to lower parts of the second filter 22. The first filter 20 achieves denitrification under anoxic conditions in the lower portion thereof and removal of soluble organic matter (BOD) under aerobic conditions in the upper portion thereof.

The degree of organic matter removal, denitrification and nitrification, and phosphate removal, which are required to produce a final discharge water suitable for reuse as surface irrigation or for discharge to an open water course, is controlled by selecting the required operating hours of the recycle pump 50 and controlling the recycle volumes. The recycle pump may be controlled by a timing device having various automatic functions. For example, an apparatus according to the invention which is about 7 metres long in total and has a diameter in the pretreatment unit and the clarification and chlorination unit of about 1.5 metres with the aerobic unit having a height of about three metres, provides an operating volume in the order of 3600 litres. Such an apparatus would be capable of servicing the domestic waste produced by up to ten people, but would most likely require the recycle pump 50 to be operating 24 hours a day. Alternatively, if a smaller number of people are serviced by the apparatus it may only be necessary to have the recycle pump 50 working during the night and perhaps for only two hours in every three hours. Of course, the forced draft fan preferably works continuously to provide continuous airflow.

It will also be appreciated that an apparatus may be provided that is capable of servicing a large number of domestic occupancies or commercial occupancies. Indeed, with scale-up of the relevant components of the apparatus,

it is envisaged that the waste water generated by up to 30 or 40 people in a domestic situation will be catered for, or up to as many as 1000 to 1200 people may be possible. Of course, the apparatus itself will need to be larger (in volume), and it is envisaged that, for example, a unit having a total length of 15 metres would adequately service about 160 people. Furthermore, it will be apparent that units this size may be manufactured in parts for assembly on-site.

The excess activated sludges and filter slimes biologically produced in the aerobic unit 12 will settle in the cone shaped bottom 61 of the aerobic unit 12. However, these sludges and slimes are proportionally transferred by the recycle pump 50 to the anoxic zone 18 of the pretreatment unit via recycle stream 48 for periodical removal with the phosphate precipitates and other settle sludges which accumulate in the anoxic zone 18. There is thus only a small amount of solids accumulating in the aerobic unit 12.

Access covers 62 may be provided where necessary in order to allow the removal of accumulated sludges and slimes in the normal way that septic tanks and the like are desludged. In this respect, it will be noted that the apparatus of the present invention is not cleaned when it is desludged, as there must remain some bacteria within the system in order to create the fermentation processes required.

The fully treated waste waters flow upwards from the cone shaped portion 61 below the aerobic unit 12 through the clarification zone 24 and into the chlorination chamber under gravity over discharge weir 36. A normal chlorination process is adopted to eliminate the harmful organisms present and to provide final disinfection of the treated waste water. The chlorination is provided by the recycle of a small proportion of the discharge water

through recycle stream 64 via valve 66 and through a chlorination tablet container 68. In this form, the desired residual concentration of the final discharge water may be controlled by the volume of water passing through the valve 66 over the chlorine tablets contained in container 68 and into the chlorination chamber 26. A retention time within the chlorination chamber of about 1 hour has proved satisfactory.

An example of the type of pollutant removal obtainable by the apparatus of the invention is given in Table 1 below. From this it can be seen that the final discharge water is of a quality which is readily suitable for reuse on gardens or for direct discharge to river systems or storm water drains.

POLLUTANT REMOVAL

RAW WASTE WATER COMPOSITION		DISCHARGE WASTE WATER COMPOSITION	% REMOVAL
BOD_5	330 mg/l	less than 20 mg/l	94%
SS	330 mg/l	less than 30 mg/l	91%
TKN	83 mg/l	less than 3 mg/l	96%
As ammonia	60 mg/l	less than 2 mg/l	97%
Phosphorous	17 mg/l	less than 1 mg/l	94%

Bacteria count - less than 10 organisms/100 ml

It will be appreciated that various modifications and alterations may be made to the above apparatus without departing from the ambit of the present invention.

The claims defining the invention are as follows:

1. A waste water treatment apparatus which is capable of receiving waste water from a waste water supply, treating that waste water, and discharging treated waste water, said apparatus comprising:

a pretreatment unit having an anaerobic zone and an anoxic zone;

an aerobic unit having a first filter and a second filter, said first filter having an aerobic portion and an anoxic portion,

a clarification and chlorination unit having a clarification zone and a chlorination zone; and

a first recycle stream capable of recycling a part of the stream exiting the first filter, such that at least a portion of the first recycle stream is capable of passing into the second filter while the remainder of the first recycle stream passes into the anoxic zone of the pretreatment unit.

2. An apparatus according to claim 1 further including a second recycle stream, said second recycle stream recycling a portion of the discharged treated waste water to the anoxic zone of the pretreatment unit.

3. An apparatus according to claim 1 or claim 2 further including supplementary chemical phosphate removal apparatus in the anoxic zone of the pretreatment unit.

4. An apparatus according to claim 3 when appended directly or indirectly through claim 2, wherein the phosphate removal apparatus comprises a source of mineral salts located such that the second recycle stream passes therethrough prior to entering the anoxic zone of the pretreatment unit.

5. An apparatus according to any one of claims 1 to 4 further including a pH correction apparatus in the pretreatment unit.

6. An apparatus according to claim 5 when appended directly or indirectly through claim 2 wherein the pH correction apparatus comprises a source of an alkaline medium located such that the second recycle stream passes therethrough prior to entering the pretreatment unit.

7. An apparatus according to any one of claims 1 to 6 wherein the second filter is located above the first filter, there being provided an inlet above the first filter but below the second filter for the entry of partially treated waste water from the anoxic zone of the pretreatment unit to the first filter, said partially treated waste water combining with the exit stream of the second filter prior to entry to the first filter.

8. An apparatus according to claim 7 wherein the inlet stream of the second filter is the portion of the first recycle stream, said portion of the first recycle stream being aerated by aeration means prior to entry to the second filter.

9. An apparatus according to claim 8 wherein the aeration means is a forced draft ventilation fan.

10. An apparatus according to any one of claims 1 to 9 wherein a discharge pump is located within the chlorination zone for selective discharge of the treated waste water from the waste water treatment apparatus.

11. An apparatus according to any one of claims 1 to 9 wherein a chlorination apparatus is provided in fluid communication with the chlorination zone.

12. An apparatus according to claim 11 when appended through claim 10, wherein a portion of the treated waste water discharged from the discharge pump is recycled to pass through the chlorination apparatus prior to reentering the chlorination zone to chlorinate the treated waste water.

13. An apparatus according to any one of claims 1 to 12 wherein the pretreatment unit is located adjacent the aerobic unit which is in turn located adjacent the clarification and chlorination unit.

14. An apparatus according to any one of claims 1 to 13 wherein a discharge weir separates the anaerobic zone and the anoxic zone of the pretreatment unit, another discharge weir separates the clarification zone from the chlorination zone and a third discharge weir separates the pretreatment unit from the aerobic unit.

15. An apparatus according to any one of claims 1 to 14, said apparatus being an integral one-piece apparatus.

16. An apparatus according to claim 1 substantially as herein described in relation to the accompanying drawing.

17. A method of treating waste water, said method comprising subjecting waste water to:

- anaerobic fermentation in an anaerobic zone of a pretreatment unit to remove a significant amount of organic matter, to achieve partial denitrification and to promote at least partial phosphate release;
- anoxic reduction in an anoxic zone of the pretreatment unit to further reduce the organic matter, to achieve further denitrification and to substantially complete the phosphate removal;
- nitrification and soluble organic matter removal under aerobic conditions in an upper section of a

first filter of an aerobic unit, and denitrification under anoxic conditions in a lower section thereof;

- nitrification and soluble organic matter removal under aerobic conditions in a second filter of the aerobic unit;
- clarification in a clarification zone in a clarification and chlorination unit; and
- chlorination in a chlorination zone in the clarification and chlorination unit to allow destruction of harmful organisms, and to produce a final dischargeable treated waste water product,

wherein a part of the stream exiting the first filter is recycled via a first recycle stream such that at least a portion of the first recycle stream passes into the second filter while the remainder of the first recycle stream passes into the anoxic zone of the pretreatment unit.

18. A method according to claim 17 wherein a portion of the discharged treated waste water is recycled via a second recycle stream to the anoxic zone of the pretreatment unit.

19. A method according to claim 18 wherein the second recycle stream is subjected to a supplementary chemical phosphate removal process prior to entering the anoxic zone of the pretreatment unit.

20. A method according to claim 18 or claim 19 wherein the second recycle stream is subjected to a pH correction process prior to entering the anoxic zone of the pretreatment unit.

21. A method according to claim 18 wherein the partially treated waste water exiting the anoxic zone of the pretreatment unit enters the first filter with the exit stream of the second filter.

22. A method according to claim 21 wherein the portion of the first recycle stream passing into the second filter is aerated by aeration means prior to entry to the second filter.

23. A method according to any one of claims 17 to 22 wherein treated waste water is discharged from the chlorination zone by a discharge pump.

24. A method according to claim 23 wherein a portion of the treated waste water exiting the discharge pump is recycled to pass through chlorination apparatus prior to reentering the chlorination zone to chlorinate the treated waste water.

25. A method according to claim 17 substantially as herein described in relation to the accompanying drawing.

DATED this TWENTIETH day of MAY 1993

LOUIS ADOLF DANAU and MICHAEL EDWARD GEORGE WRAY
Applicants.

WRAY & ASSOCIATES,
Perth, Western Australia,
Patent Attorneys for the Applicants.

ABSTRACT

A waste water treatment apparatus which is capable of receiving waste water from a waste water supply, treating that waste water, and discharging treated waste water. The apparatus comprises a pretreatment unit 10 having an anaerobic zone 16 and an anoxic zone 18, an aerobic unit 12 having a first filter 20 and a second filter 22, said first filter 20 having an aerobic portion and an anoxic portion, and a clarification and chlorination unit 14 having a clarification zone 24 and a chlorination zone 26.