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PATENT SPECIFICATION

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(54) PROCESS FOR THE ANAEROBIC DIGESTION OF AQUEOUS EFFLUENT

(71) We, WESTERN PACIFIC WATER TREATMENT CORPORATION LIMITED, a company incorporated in the State of New South Wales, of 159 Kent Street, Sydney, New South Wales 2000, Australia, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to the treatment of aqueous factory waste and will be described with particular reference to the treatment of effluent from a palm oil mill although it will be understood that the invention is not limited to that particular application.

Pollution of waterways by factory by-products is a problem of immense proportion in modern day societies. In the palm oil industry in particular, waste from factory processes are currently washed into local rivers causing immense pollution therein. Further, the soil of conventional palm oil plantations is very loose and is very easily washed into rivers since palm oil plantations are traditionally located in areas of frequent heavy rain fall. Fertilising of such plantations is an expensive operation.

It is an object of this invention to ameliorate the disadvantages associated with disposal of conventional factory waste products.

In one broad form this invention provides a method of treatment of aqueous effluent comprising the steps of:—

- (a) conducting said effluent through a screen to remove therefrom solids of size greater than that of the screen mesh;
(b) thence conducting the effluent with remaining fine solids through a sand trap for removal from the effluent of fine particulate solid material;
(c) thence conducting said effluent to a retaining basin;
(d) adding appropriate quantities of chemicals to said effluent in said retaining

basin to bring the pH of the effluent to approximately 7;

(e) thence conducting the substantially neutralised effluent to an anaerobic digester and retaining and treating said effluent in said digester for a sufficient time period to allow substantial break-down of the pollutant materials remaining in said effluent;

(f) thence conducting said treated effluent from said digester to a sedimentation tank wherein the remaining particles in said effluent are precipitated and may be removed as sludge and wherefrom the water may be removed by further treatment if desired.

Various preferred embodiments of the method of this invention will now be indicated with particular reference to application of the invention to the palm oil industry.

Separated from the factory effluent at the screen referred to above are quantities of material including palm oil nut particles, skin particles and also some flesh. These screen separated particles may be burned and the ash of these burnt particles is known to be high in potash content and is therefore useful as a component of fertilisers.

It is preferred that, at both the retaining basin and sand trap stages, of the processes defined above any remaining palm oil in the effluent undergoing treatment is skimmed-off so that the only product which is treated in the retaining basin by chemicals adapted to neutralise the remaining effluent is oil free. Thus, oil arrestors are provided in both sand trap and retaining basin.

Further, in the retaining basin the effluent is agitated further by a propeller mechanism or by introduction thereto of compressed air so that sufficient oxygen is introduced to the effluent to sustain the life of bacteria therein, which bacteria act on the pollutant particles remaining in the effluent so that at the end of the defined process, relatively pure water may be drawn off. The oxygen

supplied is sufficient to meet the biochemical oxygen demand, B.O.D. of the effluent.

5 Effluent of the palm oil industry introduced to the retaining basin referred to above is acidic in nature and neutralisation, or substantial neutralisation, is effected in the retaining basin by the addition of
10 quantities of lime sufficient to bring the pH of the remaining effluent to approximately 7. In practice a pH of from 6.8 to 8 is considered acceptable.

15 After neutralisation of the effluent in the retaining basin the effluent is then pumped to one or more anaerobic digester(s) where the effluent is retained for a minimum period of ten (10) days.

20 At any period of the process defined above prior to the entry of the effluent into the anaerobic digester(s) it is preferred that the effluent *be further polluted* by the addition thereto of quantities of nitrates and phosphates. Considerable advantage flows from such a preferred embodiment of this
25 invention in that the ultimate sludge withdrawn from the system contains nitrate and phosphate and may be used as a fertiliser in the local palm oil plantation at less expense than is involved in purchasing
30 outside fertiliser for that purpose. Where greater quantities of fertiliser are produced in the preferred process than are necessary for use in the local plantation, the fertiliser sludge remaining may be stored and sold
35 elsewhere.

40 It is further preferred that the digester(s) be closed and the gases produced by agitation of the effluent in the digester(s), which gases are high in methane and carbon-dioxide content, be conducted from the digester(s) and used to provide heat energy to the digester(s). It is further
45 preferred that the operation temperature of the digester(s) be maintained at or near 50°C which is considered to be the optimum breakdown temperature of the pollutant materials in the palm oil effluent. The effluent in the digester(s) is agitated therein by a propeller or other suitable mechanism.
50 It is possible that greater quantities of gas may be generated from the digester(s) than are necessary for maintaining the temperature of the digester(s) at the required level. These further quantities of gas may be conducted away for heating
55 purposes elsewhere in the plant or may be burnt-off as desired. From the digester(s) water and suspended sludge is conducted to a sludge sedimentation tank where the sludge is allowed to precipitate from the combination and may be conducted from the first to a second sludge tank wherein the
60 sludge is further dried before collection upon removal from said second tank. Sludge may be run-off into containers and the ash
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of the remainder of the harvest previously removed at and before the screen stage of the process defined added to this sludge, which sludge is then effective as a quality fertiliser. This fertiliser may be returned to the local plantation for fertilising and soil rejuvenation in the area or may be stored, pressed and sold elsewhere as a dry fertiliser. Water from the first sedimentation tank is considered to be of approximately
70 90% purity, i.e. considerably more pure than untreated effluent. However, this water is considered not of sufficient purity to be released with safety and it is preferred that water drawn from the sedimentation tank is conducted to a trickling filter wherein the water is caused to circulate as sufficient as is
75 necessary to remove further fine contaminants therefrom. Water treated in this trickling filter may then be conducted to an aeration basin as disclosed in United Kingdom Patent No. 1,358,356. Further, an activated sludge tank and a sludge stabilisation tank may be inserted in this system between the aeration basin and the second sludge sedimentation tank. The activated sludge tank accords with the disclosure of West German Patent Application No. 26 35 670.7.

80 A preferred embodiment of the system of this invention is now described with reference to the accompanying drawings wherein:—

85 Fig. 1 is a schematic plan view of an effluent treatment plant according to this invention.

90 Fig. 2 is a flow diagram illustrating the process.

95 In the drawings, effluent is conducted to screen 1 where solids of greater size than that of the screen mesh are removed therefrom. The effluent is then conducted to and through sand trap 2 where further particulate matter is removed. The effluent is thence conducted to a retaining basin 3 adjacent which is disposed a neutralising tank 3A. Effluent is retained in retaining basin 3 for a sufficient time period to allow quantities of chemicals from neutralising tank 3A to be added to the effluent in
100 retaining basin 3 to bring the pH of the retained effluent to approximately 7. Effluent which has been substantially neutralised is then conducted to a pair of anaerobic digesters 4. The number of such anaerobic digesters used in a particular application is a matter of choice and depends on the size of the plant into which a system as described herein is placed. A single digester may be suitable for some plants whereas larger plants may require eight (8) or more such digesters.

105 Effluent is retained in the digesters for a sufficient period of time to allow a substantial breakdown of detritus in the
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effluent. In a typical palm oil effluent treatment operation the effluent will be retained in the digester for a minimum period of ten (10) days.

Digesters 4 are closed to atmosphere and gases produced by agitation of effluent in the digesters are led away by conduit 4A for burning to maintain or assist in maintaining the digester temperature at or near 50°C and for recycling via conduit 4D to agitate the effluent in the digesters. Excess gas from the digesters may be conducted as by conduit 4B for use in heating elsewhere in the plant. Alternatively, such excess gas may be burnt off as at 4C.

When the effluent has been treated in the anaerobic digester(s) it is conducted to sedimentation tank 5 where sludge is precipitated and this sludge, in turn, conducted to second sludge tank 6. Before the effluent enters digesters 4 it is further polluted by the addition thereto of nitrates and phosphates so that the sludge which is eventually removed from tank 6 via conduit 7 is useful as a fertiliser.

After sludge has precipitated from the effluent in tank 5 the remaining fluid contents of tank 5, of approximately 90% purity, is conducted to trickling filter 8 and thence to aeration basin 9 as disclosed and described in U.K. patent No. 1,358,356. After treatment in filter 8 and basin 9 the water which results is considered to be of such purity as to be able to be released into local rivers or to be used as boiler water.

Activated sludge tank 10 and sludge stabilisation tank 11 are also provided in this embodiment of the system of this invention. Sludge, albeit in small quantities, may be led from basin 9 to activated sludge tank 10. Liquid from tank 10 may be conducted back to trickling filter 8 or to basin 9 as desired. Fluid and sludge from tank 10 may also be fed to stabilisation tank 11 and thence to second sedimentation tank 6. Fluid from tank 6 may, as illustrated, be conducted back to anaerobic digesters 4 for retreatment.

Further, fluid run off from basin 9 may, if desired, be conducted back into the system for full retreatment through screen 1 and the remainder of the system.

WHAT WE CLAIM IS:—

1. This invention provides a method of treatment of aqueous effluent comprising the steps of:—

(a) conducting said effluent through a screen to remove therefrom solids of size greater than that of the screen mesh;

(b) thence conducting the effluent with remaining fine solids through a sand trap for removal from the effluent of fine particulate solid material;

(c) thence conducting said effluent to a retaining basin;

(d) adding appropriate quantities of chemicals to said effluent in said retaining basin to bring the pH of the effluent to approximately 7;

(e) thence conducting the substantially neutralised effluent to an anaerobic digester and retaining and treating said effluent in said digester for a sufficient time period to allow substantial break-down of the pollutant materials remaining in said effluent; and

(f) thence conducting said treated effluent from said digester to a sedimentation tank wherein the remaining particles in said effluent are precipitated and may be removed as sludge and wherein the water may be removed by further treatment if desired.

2. A method as defined in claim 1 applied to palm oil factory effluent comprising the further steps of skimming remaining palm oil from the effluent at both sand trap and retaining basin stages.

3. A method as defined in claim 1 or claim 2 wherein the effluent in the retaining basin is agitated by a propeller mechanism or by introduction to said effluent in said retaining basin of compressed air.

4. A method as defined in any preceding claim wherein the effluent is further polluted prior to its entry to the anaerobic digester by the addition thereto of nitrates and phosphates.

5. A method as defined in any preceding claim wherein the anaerobic digester is closed to atmosphere and gases given off by the effluent in the digester are conducted therefrom for use in heating processes including heating of the anaerobic digester.

6. A method as defined in any preceding claim wherein the temperature of the effluent in the digester is maintained at approximately 50°C.

7. A method as defined in any preceding claim wherein the effluent from the digester is conducted to a first sedimentation tank.

8. A method as defined in claim 7 wherein sludge is allowed to precipitate in said first sedimentation tank and is thereafter conducted to a second sedimentation tank for drying and wherein the water remaining in the first sedimentation tank after sludge precipitation is conducted from said first sedimentation tank for further treatment.

9. A method as defined in claim 8 wherein the sludge from said second sedimentation tank is conducted to containers and is mixed with the ash of the burnt refuse collected at said screen so as to be thereafter useful as fertiliser.

10. A method as defined in claim 8 or claim 9 wherein the water conducted from said first sedimentation tank is conducted

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effluent. In a typical palm oil effluent treatment operation the effluent will be retained in the digester for a minimum period of ten (10) days.

Digesters 4 are closed to atmosphere and gases produced by agitation of effluent in the digesters are led away by conduit 4A for burning to maintain or assist in maintaining the digester temperature at or near 50°C and for recycling via conduit 4D to agitate the effluent in the digesters. Excess gas from the digesters may be conducted as by conduit 4B for use in heating elsewhere in the plant. Alternatively, such excess gas may be burnt off as at 4C.

When the effluent has been treated in the anaerobic digester(s) it is conducted to sedimentation tank 5 where sludge is precipitated and this sludge, in turn, conducted to second sludge tank 6. Before the effluent enters digesters 4 it is further polluted by the addition thereto of nitrates and phosphates so that the sludge which is eventually removed from tank 6 via conduit 7 is useful as a fertiliser.

After sludge has precipitated from the effluent in tank 5 the remaining fluid contents of tank 5, of approximately 90% purity, is conducted to trickling filter 8 and thence to aeration basin 9 as disclosed and described in U.K. patent No. 1,358,356. After treatment in filter 8 and basin 9 the water which results is considered to be of such purity as to be able to be released into local rivers or to be used as boiler water.

Activated sludge tank 10 and sludge stabilisation tank 11 are also provided in this embodiment of the system of this invention. Sludge, albeit in small quantities, may be led from basin 9 to activated sludge tank 10. Liquid from tank 10 may be conducted back to trickling filter 8 or to basin 9 as desired. Fluid and sludge from tank 10 may also be fed to stabilisation tank 11 and thence to second sedimentation tank 6. Fluid from tank 6 may, as illustrated, be conducted back to anaerobic digesters 4 for retreatment.

Further, fluid run off from basin 9 may, if desired, be conducted back into the system for full retreatment through screen 1 and the remainder of the system.

WHAT WE CLAIM IS:—

1. This invention provides a method of treatment of aqueous effluent comprising the steps of:—

(a) conducting said effluent through a screen to remove therefrom solids of size greater than that of the screen mesh;

(b) thence conducting the effluent with remaining fine solids through a sand trap for removal from the effluent of fine particulate solid material;

(c) thence conducting said effluent to a retaining basin;

(d) adding appropriate quantities of chemicals to said effluent in said retaining basin to bring the pH of the effluent to approximately 7;

(e) thence conducting the substantially neutralised effluent to an anaerobic digester and retaining and treating said effluent in said digester for a sufficient time period to allow substantial break-down of the pollutant materials remaining in said effluent; and

(f) thence conducting said treated effluent from said digester to a sedimentation tank wherein the remaining particles in said effluent are precipitated and may be removed as sludge and wherein the water may be removed by further treatment if desired.

2. A method as defined in claim 1 applied to palm oil factory effluent comprising the further steps of skimming remaining palm oil from the effluent at both sand trap and retaining basin stages.

3. A method as defined in claim 1 or claim 2 wherein the effluent in the retaining basin is agitated by a propeller mechanism or by introduction to said effluent in said retaining basin of compressed air.

4. A method as defined in any preceding claim wherein the effluent is further polluted prior to its entry to the anaerobic digester by the addition thereto of nitrates and phosphates.

5. A method as defined in any preceding claim wherein the anaerobic digester is closed to atmosphere and gases given off by the effluent in the digester are conducted therefrom for use in heating processes including heating of the anaerobic digester.

6. A method as defined in any preceding claim wherein the temperature of the effluent in the digester is maintained at approximately 50°C.

7. A method as defined in any preceding claim wherein the effluent from the digester is conducted to a first sedimentation tank.

8. A method as defined in claim 7 wherein sludge is allowed to precipitate in said first sedimentation tank and is thereafter conducted to a second sedimentation tank for drying and wherein the water remaining in the first sedimentation tank after sludge precipitation is conducted from said first sedimentation tank for further treatment.

9. A method as defined in claim 8 wherein the sludge from said second sedimentation tank is conducted to containers and is mixed with the ash of the burnt refuse collected at said screen so as to be thereafter useful as fertiliser.

10. A method as defined in claim 8 or claim 9 wherein the water conducted from said first sedimentation tank is conducted

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for further treatment in a trickling filter.

Application No. 26 35 670.7.

5 11. A method as defined in claim 10 wherein water conducted from said trickling filter is further treated in accordance with apparatus and methods disclosed in either or both of United Kingdom Patent No. 1,358,356 and West German Patent

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