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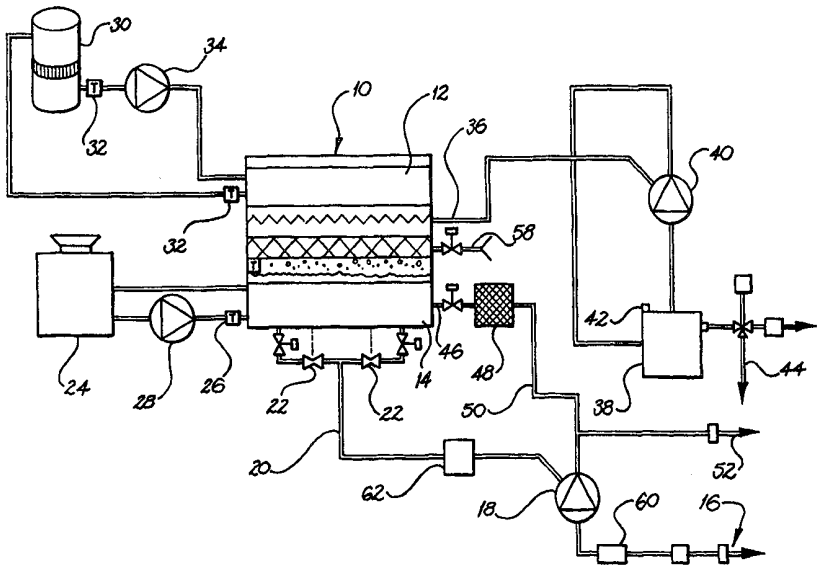

(57) Abstract

The present invention relates to a method and apparatus for treating liquid waste materials which method includes steps of feeding the waste materials into a heating chamber to receive waste materials, said heating chamber being adapted to operate in conditions of low pressure and having communicable passage with a cooling chamber in which distillate is generated; heating the materials to a temperature above the temperature at which the waste material will boil in the low pressure environment of the chamber and allowing the vapourised liquid to pass into the cooling chamber; condensing the vaporised liquid in the cooling chamber, thereby forming a distillate; and drawing off concentrated waste from the heating chamber and distillate from the cooling chamber. The method also includes an air pressure reduction means to reduce pressure in heating chamber. There is provided an inventive apparatus which functions with the inventive method.

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Treatment of aqueous wastes

Field of the invention

This invention relates to apparatus for and a method of treating waste liquids, particularly aqueous wastes.

Background of the invention

Many industrial, farming, manufacturing and other operations will produce significant quantities of waste liquids which need to be disposed of or otherwise treated in a manner which is not unduly environmentally damaging. Traditionally, wastes have been simply pumped into drains or rivers, but in recent years the appreciation of the environment damage inherent in such waste disposal arrangements has led to authorities being far stricter in determining which waste materials are appropriate to be disposed of in this way.

The disposal of toxic wastes or waste materials which are unsuitable for pumping down drains or into waterways is costly. Such materials are generally transported to an appropriate authorised waste disposal site at which the materials are treated. The treatment procedures generally are costly as are the costs of transportation. It is accordingly desirable to provide an arrangement whereby waste materials can be treated at the location where they are created and, preferably, the treatment will produce by-products which in themself have value.

Summary of the invention

According to a first aspect of the invention that is provided a method of treating liquid waste materials which includes steps of:

feeding the waste materials into a low pressure distillation chamber, said chamber having a lower region in which waste materials are received, and an upper region in which distillate is generated;

heating the materials to a temperature above the temperature at which the waste material will boil in the low pressure environment of the chamber and allowing the vapourised liquid to pass into the upper region;

condensing the vaporised liquid in the upper region, thereby forming a distillate; and

drawing off concentrated waste from the lower region and distillate from the upper region.

According to another aspect of the invention that is provided a method of treating liquid waste materials which includes steps of:

feeding the waste materials into a heating chamber to receive waste materials, said heating chamber being adapted to operate in conditions of low pressure and having communicable passage with a cooling chamber in which distillate is generated;

heating the materials to at least a temperature at which the water in the waste material will boil in the low pressure environment of the chamber and allowing the vapourised liquid to pass into the cooling chamber;

condensing the vaporised liquid in the cooling chamber, thereby forming a distillate; and

drawing off concentrated waste from the heating chamber and distillate from the cooling chamber.

Preferably the liquid waste material is pumped into the chamber through a venturi, the venturi being configured to generate a negative pressure in the throat thereof, said throat being pneumatically connected to the interior of the chamber to thereby provide an arrangement for reducing the pressure within the chamber. Alternatively, said venturi may be associated with some other flow line feeding into or from said distillation chamber, for example, a flow line taking distillate from said distillation chamber.

Alternatively a vacuum pump means can be provided and is preferably connected to the cooling chamber which reduces the pressure in both the heating and cooling chambers.

According to another aspect of the invention there is provided apparatus for treating aqueous waste, said apparatus including:

a low pressure chamber, said distillation chamber being divided internally into a lower region and an upper region;

an inlet into said lower region of the distillation chamber for introducing aqueous waste into said lower region;

an outlet from said upper region for extracting distillate from said upper region;

means for maintaining the pressure within the chamber at a pressure below that of atmospheric pressure;

means for heating said aqueous waste to a temperature above the boiling point of the aqueous waste in the below atmospheric pressure environment of the distillation chamber; an

means in said upper region for condensing steam generated by said heating means to form distillate.

According to another aspect of the invention there is provided apparatus for treating aqueous waste, said apparatus including:

a low pressure heating chamber and a cooling chamber, said heating chamber having communicable passage with said cooling chamber to allow vapour generated in said heating chamber to pass into said cooling chamber for the forming of a distillate;

an inlet into said heating chamber for introducing aqueous waste into said heating chamber;

an outlet from said cooling chamber for extracting distillate from said cooling chamber;

means for maintaining the pressure within at least the heating chamber at a pressure below that of atmospheric pressure;

means for heating said aqueous waste to a temperature above the boiling point of the aqueous waste in the below atmospheric pressure environment of the heating chamber; and

means in said cooling chamber for condensing vapour generated by said heating means to form distillate.

The means for maintaining the pressure within the distillation chamber at below atmospheric pressure preferably comprises a venturi associated with a fluid flow line into or from the distillation chamber. In the preferred form of the invention waste material is pumped through venturi which is located in a feed line which feeds the waste material into the distillation chamber. The configuration of the venturi, the pressure at which the waste material is supplied, and hence the pressure maintained within the distillation chamber may be selected or controlled so as to maintain the said pressure at a level which optimises the treatment of the waste material within the distillation chamber.

Alternatively the means for maintaining the pressure within the heating chamber is a vacuum pump means. Preferably if a vacuum pump is utilised the vacuum pump extracts air from said

cooling chamber and thus said heating chamber, thereby rendering both chambers at an air pressure lower than atmospheric

The means for heating the aqueous waste may comprise an external boiler, optionally gas powered, which circulates heated fluid through heating coils located in said lower region. The means for condensing steam may comprise heat exchange coils located in said upper region, cooled liquid being circulated through a cooling circuit which incorporates said heat exchange coils, and further includes a cooling tower which is external of said distillation chamber.

Alternatively the heating and cooling means provided in the apparatus is a heat pump system having evaporator and an condenser elements with refrigerant compressed by mean of a compressor to provide the sources of heating in the heating chamber and cooling in the cooling chamber.

The apparatus preferably includes an automated dosing system for automatically dosing treatment chemicals into said distillation chamber.

Further there is provided means for the waste materials to be monitored by one or more probes to control the condition of the waste material being introduced into the distillation chamber.

The apparatus preferably includes a series of probes and/or sensors for monitoring critical parameters of the process being carried out in the distillation chamber, the apparatus further including a control device for controlling the flow rate, temperature, pressure, additives and/or condition of the fluids so as to optimise the quality of the distillate and/or waste material being extracted from the distillation chamber.

These and further features of the invention will be made apparent from the description of an embodiment thereof given below by way of example. In the description references are made to the accompanying drawing but the specific features shown in the drawings should not be construed as limiting on the invention.

Brief description of the drawings

Figure 1 shows a flow schematic of the apparatus embodying the invention; and

Figure 2 shows a flow schematic of an another apparatus embodying the invention.

Detailed description

Referring to figure 1, apparatus for treating aqueous waste includes a low pressure distillation chamber or vessel 10 having a cooling or condensing upper chamber 12 and a heating or

evaporating lower chamber 14. The low pressure distillation chamber 10 is a sealed chamber and the interior of the chamber is adapted to be maintained at a pressure below atmospheric pressure as described in more detail below.

The distillation chamber or vessel may be similar to that described in PCT patent application no. PCT/AU83/00048, the specification of which is incorporated herein by way of reference. That specification discloses a condensation chamber or vessel which might suitably be used with the method of this invention, although the chamber or vessel will be modified in accordance with the details contained herein.

The distillation chamber or vessel 10 is adapted to receive waste material from a source of aqueous waste indicated at numeral 16. The incoming aqueous waste is pumped at pressure by means of pump 18 along flow line 20 into the heating chamber 14 of the vessel 10. The incoming water passes through a pair of venturis 22, the venturis 22 being described in more detail below.

The lower or heating chamber 14 is heated by means of an external heat source 24 which conveniently comprises a gas powered water boiler which pumps hot water through heating coils located in the heating chamber 14. The temperature of the heated water is monitored by an appropriate thermal sensor 26 and the heated water is circulated by means of a pump 28.

Likewise, the cooling or condensing chamber 12 incorporates a coil-type heat exchanger which is supplied with cooled water which is cooled in a cooling tower 30. The operation of the cooling tower and the circulation of water in the cooling coils is monitored by thermal sensors 32 and water is circulated through the cooling system by means of a pump 34. The distillate from the condensing chamber 12 is extracted through an outlet 36, the clean water being supplied to a fresh water tank 38, circulation of clean water from the condensing chamber being controlled by a pump 40. The fresh water tank 38 includes a contamination probe 42 which will monitor the quality of the water being extracted from the condensing chamber and, should this water be contaminated, the contaminated water will be dumped via flow line 34 back into the waste tank.

Concentrated waste is extracted from the heating chamber through an outlet 46 from the heating chamber. The outlet 46 leads via a carbon filter 48 and waste line 50 to a waste storage location 52. The waste storage location can either be the original waste holding tank or it may be a concentrated waste holding tank. Waste which passes from the heating chamber 14 may

have commercial value in its concentrated form and in this case the waste will be collected and either treated further in an additional waste treatment facility, or otherwise utilised.

Distilled water from the condensing chamber 12 can either be used in the process which generated the waste in the first place, may be discharged into a drain or waterway, or otherwise utilised. It is envisaged that this distilled water will be sufficiently pure to be used or disposed of without further treatment.

Additional chemicals may be dosed into the heating chamber 14 (and/or the cooling chamber 12 if desired) through an automatic dosing system 58 which is adapted to dose chemicals directly into the chambers 14 or 12. If the chemicals are added to the heating chamber 14 the chemicals can be some form of surfactant such as an anti-foaming agent or it may be of a type which is adapted to prevent precipitation of waste material in the heating chamber. The type of chemical that is added into the chamber 14 or 12 will depend on the waste material which is being treated.

In most situations it will be important that the waste materials supplied into the heating chamber are not too highly concentrated and for this reason a conductivity probe 60 is provided in the waste feed line to monitor the condition of the waste material being supplied to the chamber 10. A water flow meter 62 monitors the flow of waste water into the chamber 10.

It will be appreciated that all of the different control, monitoring and pumping facilities may be automatically controlled by means of an appropriate microprocessor or other automatic control device. A shut down facility can be provided for situations where the monitored parameters fall outside of predetermined limits. It is envisaged that the control of the entire apparatus may be conducted from a remote location using an appropriate modem and other telecommunication equipment. Provided the quality of the waste material being supplied to the chamber is reasonably constant it should be possible to ensure that the treatment of the material within the chamber is carried out in such a manner that a relatively pure water distillate is extracted from the condensing chamber and a high concentration of waste material is extracted through the outlet 46. Typically 90 to 95% of water would be extracted from aqueous waste.

Various different waste materials can be separated out from aqueous waste using the apparatus described. For example, heavy metals, minerals, salts in solution, acids, alkalies, detergents, factory floor washings, and various types of bacteria and viruses may be treated using the process. Most bacteria and viruses would not survive a distillation process. The technology is known to remove microcystin, radioactive isotopes, and micro-organisms such as *e-coli*,

coliforms, polio virus, legionella, and other bacteria to levels better than those set by the World Health Organisation for potable water.

In addition, the process may be used to treat material such as whey and also for de-watering milk and the like. Since the process is conducted at relatively low temperature (approximately 38°C) the process causes minimal protein damage.

For each material being treated by the process, the chemical additives may differ. For example, certain waste materials may require a relatively high temperature for effective treatment in which case the pressure within the vessel need not be significantly less than atmospheric pressure. For other materials being treated it might be necessary for the waste to boil at a far lower temperature, such as between say 30 and 40°C, in which case the pressure within the vessel will be maintained at a far lower level. One advantage of treating waste materials in the manner described is that, since the process takes place at a relatively low temperature, the waste materials do not decompose during the distillation process. Particularly, the organic components of the waste material do not decompose during treatment.

A typical process using the invention is as follows:

A major Australian electroplating company uses dichromate in chrome plating. The waste stream contains chrome (6), an extremely toxic and corrosive material. The treatment process consists of a reduction of chromium (6) to chromium (3) using sodium metabisulphite followed by a precipitation of $Ca(OH)_3$ using lime.

$$2\ Cr0_3 + 6\ Na\ H\ SO_3 + 6Ca\ (OH)_2 \rightarrow 2\ Cr(OH) + 3\ Ca\ SO_3 + Ca\ SO_4 + 6\ Na\ OH + 3\ H_2O$$

Co-precipitated is calcium sulphite and calcium sulphate.

The colour changes from orange to green. The sludge in the settling tank is allowed to settle and the supernatant liquid is fed into the precipitation chamber for concentration. This solution is saturated with calcium sulphate (solubility 2.1 g/l) but precipitation during dewatering can be prevented by using a complexing agent (like DEQUEST) which is automatically added through the dosing mechanism.

Pure water is recovered in the distillate for further use in the plating shop. The dissolved chrome and calcium salts are further concentrated and deposited as sludge in the holding tank.

Illustrated in Figure 2 is a schematic of an apparatus 200 similar to that of figure 1, but with improvements thereto. Like parts have been like numbered.

The apparatus 200 of figure 2 includes a refrigerant compressor 120 which compresses the refrigerant (preferably R22 but other appropriate refrigerants, preferably of an environmentally friendly nature, can be utilised) and this compressed refrigerant has the heat taken out of it in a heating chamber 14 where aqueous waste has entered via control valve 144. The compressor 120 is preferably a variable capacity compressor, so that at start up a lower capacity operation is possible, by comparison to normal production operation. For example if a multi-cylinder compressor is utilised some cylinders are able to be taken off line and brought back into operation as required. As another example a screw compressor which provides a variable capacity could be used.

A difference between the embodiment of figure 1 and that of figure 2 is that the heating and cooling chambers 14 and 12 of figure 1 are contained within a single vessel, whereas in figure 2 separate vessels are provided.

The aqueous waste absorbs heat from the refrigerant by mean of heating coils located in the heating chamber 14. The heating coils which transfer heat from the refrigerant to the liquid surrounding the coils are used to boil the water in the aqueous waste. The heating chamber 14 is kept below atmospheric pressure by means of a vacuum pump 104 which draws air out of both the cooling chamber 12 and the heating chamber 14. A conduit 13 links the top of the heating chamber 14 with the cooling chamber 12 to firstly allow water vapour which results from the heating of the aqueous waste to enter the cooling chamber 12 from the heating chamber 14 and secondly allows air contained in the heating chamber 14 to be withdrawn by means of the vacuum pump 104.

In apparatus 200 the ball valves 142, 118 110, 106 128 and 130 serve the purpose of isolating the elements of the apparatus for servicing , repair or removal purposes. Once all elements of the apparatus are properly functioning all the ball valves will be in the open condition. For the rest of the description of the apparatus of fig 2, no further mention will be made of these ball valves.

The refrigerant having cooled in the heating chamber 12 is cooled further as it passes through an auxiliary air cooled refrigerant condenser 140, which takes out more heat in the refrigerant.

If apparatus 200 were located at a site which also included a boiler for the generation of heat or electricity etc, the auxiliary air cooled refrigerant condenser 140 could be replaced by a heat

exchange unit to remove the heat from the refrigerant and transfer it to the water, to thereby preheat the water, for use in the boiler system at the site. In a typical system an estimated 45 kW of heat could be available from a substitute heat exchanger to preheat water for a boiler or for any other desirable purpose.

The refrigerant passes from the condenser 140 (or a substitute heat exchanger if present) to a liquid refrigerant recovery unit 138. The liquid refrigerant is then drawn via conduit 137 through a sight glass 136 for the purpose of ensuring that no vapour is entrapped in the liquid refrigerant.

After the sight glass 136 the liquid refrigerant passes through a drier 134 and when in normal running condition of apparatus 200 (that is not in start up mode) the refrigerant travels through conduit 139 where in normal operation solenoid valve 132 would be in the open condition while solenoid 126 would be in the closed condition. This ensures that the cooled refrigerant now in the liquid phase passes through the expansion/temperature valve 100 where the refrigerant is cooled even further. The cooled refrigerant then passes into the cooling chamber 12 where water vapour which entered the cooling chamber 12 from the heating chamber 14 has heat taken out of it by condensing or cooling coils in the cooling chamber which carry the cooled refrigerant. The condensing coils in the cooling chamber 12 absorb the heat from the water vapour changing the water vapour into liquid or distillate which precipitates to the bottom of the cooling tank 12. The accumulated distillate is then withdrawn at desired times from the cooling tank 12 by means of the control valve 103 being opened and the distillate being drawn out by the pump 102.

The refrigerant which has absorbed heat from the water vapour in the cooling chamber 12, passes out of the cooling chamber 12 and through a crankcase pressure regulator 108, which ensures that a preset suction pressure is available.

In non start up mode the solenoid valve 116 is closed, and when apparatus 200 is running normally the solenoid valve 126 is also in the closed condition. This ensures that heated refrigerant exiting the cooling chamber 12 and regulator 108 will travel along conduit 141 into the suction accumulator 122. In the suction accumulator 122 any liquid which may be present in the refrigerant will accumulate and the refrigerant in vapour phase will be drawn off to be compressed by the refrigerant compressor 120 thereby starting the cycle again.

The vacuum pump 104 reduces the pressure in both chamber 12 and 14. The resulting effect in chamber 14 is that the solubility of the waste in the waste water is increased, and this results in a reduction of scaling in the heating chamber 14. Another consequence of the reduced pressure is the ability to boil off the water in the aqueous waste mixture at a lower temperature. In the condensing/cooling chamber 12 the reduced pressure will provide no noticeable advantage. In the apparatus 200, the vacuum pump 104 can help to reduce the energy consumption of the apparatus 200.

The above described features of the apparatus 200 are thought to be capable of reducing running costs relative to the running costs of the apparatus of figure 1.

The apparatus 2 does have some operational requirements which differ from that of figure 1. A main one being that in start up mode the circuit of refrigerant needs to vary from normal operating mode to ensure that the refrigerant and the components of the refrigerant circuit function correctly. Thus in start up mode, the compressor 120 is controlled so as to operate with a minimum capacity. Whereas the solenoid valve 116 is controlled to be in an open condition and solenoid valves 128 and 132 are in a closed condition. This ensures that the refrigerant leaving the refrigerant drier 134 does not travel through conduit 139, but rather the refrigerant will pass through an expansion/temperature valve 114 thereby controlling the heat in the refrigerant. From the valve 114 the refrigerant will pass through an auxiliary air cooled refrigeration evaporator 112 which heats the refrigerant in a heat exchange unit by means of the outside air transferring its heat to the refrigerant. The refrigerant then passes through conduit 143, and in view of solenoid valve 132 being closed it passes into conduit 145 and down to the suction accumulator 122 where the refrigerant vapour is drawn off to be compressed by the refrigerant compressor 120. Once there is sufficient vapour phase present in the refrigerant which enters and is compressed by the compressor 120, solenoid valve 116 closes and solenoid valve 132 opens causing the refrigerant to take the path through the cooling coils in the cooling chamber 12 as described above. At this point the maximum capacity of the compressor can be brought on line to compress the refrigerant, or if desired, additional capacity can be brought into operation sequentially.

If the refrigerant is in a condition where there is too much vapour phase or the temperature of that vapour phase is too high, the solenoid valve 132 can be closed and the solenoid valve 126 can be opened ensuring that no further heat will be added to the refrigerant by preventing the

refrigerant from passing through the cooling coil in the cooling chamber 12. Once the heat has been sufficiently taken out of the refrigerant by the heating coils on the heating chamber 14 the solenoid valve 126 can be closed and solenoid valve 132 opened returning the apparatus of figure 2 to normal running conditions.

The variable capacity compressor 120 and the solenoid valves 116, 126 and 132 are preferably controlled by a central control and processing unit which monitors the apparatus 200 and automatically controls same. Preferably the control valves 103 and 144 and pumps 102 and vacuum pump 104 are also controlled by the same or another pre-programmed central control an processing unit.

Additional chemicals can be dosed into the heating chamber 14 of figure 2 in much the same manner as figure 1, by an automatic dosing system 58 which is adapted to dose chemicals directly into the heating chamber 14 or if desired into the cooling chamber 12 .

It should be noted that in both the embodiments described above that the heating of the waste so as to boil off the water contained therein, and the temperature at which that boiling occurs is dependent on what contaminants are present in the waste, what the use of the output water is and the required quality of that output water. Some contaminants can vaporise with the water and thus be distilled in the distilled water. Thus varying the boiling temperature may be required to ensure that only desirable vapours and thus distillates are produced, or produced to with predetermined ranges

It will be understood that the invention disclosed and defined herein extends to all alternative combinations of two or more of the individual features mentioned or evident from the text or drawings. All of these different combinations constitute various alternative aspects of the invention.

The foregoing describes embodiments of the present invention and modifications, obvious to those skilled in the art can be made thereto, without departing from the scope of the present invention.

Claims

1. A method of treating liquid waste materials which includes steps of:

feeding the waste materials into a heating chamber to receive waste materials, said heating chamber being adapted to operate in conditions of low pressure and having communicable passage with a cooling chamber in which distillate is generated;

heating the materials to at least a temperature at which the water in the waste material will boil in the low pressure environment of the chamber and allowing the vapourised liquid to pass into the cooling chamber;

condensing the vaporised liquid in the cooling chamber, thereby forming a distillate; and

drawing off concentrated waste from the heating chamber and distillate from the cooling chamber.

2. A method as claimed in claim 1 wherein said heating chamber and said cooling chamber are contained in a single vessel, with the heating chamber being provided in a lower region of said vessel and the cooling chamber is provided in an upper region of said chamber, said heating an cooling chambers having communicable passage therebetween.

3. A method as claimed in claim 1 or 2, wherein an air pressure reduction means reduces pressure in said heating chamber.

4. A method as claimed in claim 3 wherein said air pressure reduction means is provided by said liquid waste material being pumped into the heating chamber through a venturi which is configured to generate a negative pressure in the throat thereof, said throat being pneumatically connected to the interior of the heating chamber to thereby provide an arrangement for reducing the pressure within the heating chamber.

5. A method as claimed in claim 3 wherein said air pressure reduction means is a venturi which is configured to generate a negative pressure in the throat thereof being connected to or associated with a flow line feeding into or from said cooling chamber.

6. A method as claimed in claim 3 wherein said air pressure reduction means is connected to said cooling chamber to draw air directly from said cooling chamber and thus said heating chamber thereby reducing the pressure in both said heating chamber and said cooling chamber.

7. A method as claimed in claim 3 or claim 6, wherein said air pressure reduction means is a vacuum pump.

8. An apparatus for treating aqueous waste, said apparatus including:

a low pressure heating chamber to receive an aqueous waste and to heat said aqueous waste

a cooling chamber having communicable passage with said heating chamber to allow vapour generated in said heating chamber to pass into said cooling chamber for the forming of a distillate;

an inlet into said heating chamber for introducing aqueous waste into said heating chamber;

an outlet from said cooling chamber for extracting distillate from said cooling chamber;

means for maintaining the pressure within at least the heating chamber at a pressure below that of atmospheric pressure;

means for heating said aqueous waste to a temperature above the boiling point of the aqueous waste in the below atmospheric pressure environment of the heating chamber; and

means in said cooling chamber for condensing vapour generated by said heating means to form distillate.

9. A method as claimed in claim 8 wherein said heating chamber and said cooling chamber are contained in a single vessel, with the heating chamber being provided in a lower region of said vessel and the cooling chamber is provided in an upper region of said chamber, said heating an cooling chambers having communicable passage therebetween.

10. An apparatus as claimed in claim 8 or 9, wherein an air pressure reduction means reduces pressure in said heating chamber.

11. An apparatus as claimed in claim 10 wherein said air pressure reduction means is provided by said liquid waste material being pumped into the heating chamber through a venturi which is configured to generate a negative pressure in the throat thereof, said throat being pneumatically connected to the interior of the heating chamber to thereby provide an arrangement for reducing the pressure within the heating chamber.

12. An apparatus as claimed in claim 10 wherein said air pressure reduction means is a venturi which is configured to generate a negative pressure in the throat thereof being connected to or associated with a flow line feeding into or from said cooling chamber.

13. An apparatus as claimed in claim 10 wherein said air pressure reduction means is connected to said cooling chamber to draw air directly from said cooling chamber and thus said heating chamber thereby reducing the pressure in both said heating chamber and said cooling chamber.

14. An apparatus as claimed in claim 10 or claim 13, wherein said air pressure reduction means is a vacuum pump.

15. An apparatus as claimed in any one of claims 9 to 14 wherein the pressure maintained within the heating chamber is selected or controlled so as to maintain said pressure at a level which optimises the treatment of the waste material within the distillation chamber.

16. An apparatus as claimed in any one of claims 9 to 15 wherein the means for heating the aqueous waste are heating coils located in said heating chamber, and through said heating coils circulates a heated fluid.

17. An apparatus as claimed in claim 16, wherein said heating coils are connected to a boiler located externally of said heating chamber.

18. An apparatus as claimed in any one of claims 9 to 17, wherein the means for condensing or cooling the vapour are heat exchange coils located in said cooling chamber, with cooled liquid being circulated through a cooling circuit which incorporates said heat exchange coils.

19. An apparatus as claimed in claim 18 wherein said heat exchange coils are connected to a cooling tower which is external of said cooling chamber.

20. An apparatus as claimed in any one of claim 9 to 16 or 18, wherein the heating and cooling means is a heat pump system having evaporator and condenser elements with refrigerant compressed by mean of a compressor to provide the source of heating in the heating chamber and the source of cooling in the cooling chamber.

21. An apparatus as claimed in any one of claims 9 to 20, wherein there is also provided an automated dosing system for automatically dosing treatment chemicals into said distillation chamber.

22. An apparatus as claimed in any one of claims 9 to 21 wherein there is provided means for the waste materials to be monitored by one or more probes to control the condition of the waste material being introduced into the distillation chamber.

23. An apparatus as claimed in any one of claims 9 to 22, wherein there is included a series of probes and/or sensors for monitoring critical parameters of the process being carried out in the heating and cooling chambers.

24. An apparatus as claimed in any one of claims 9 to 23 wherein there is further included a control device for controlling the flow rate, temperature, pressure, additives and/or condition of the fluids so as to optimise the quality of the distillate and/or waste material being extracted from the heating chamber and/or the cooling chamber.

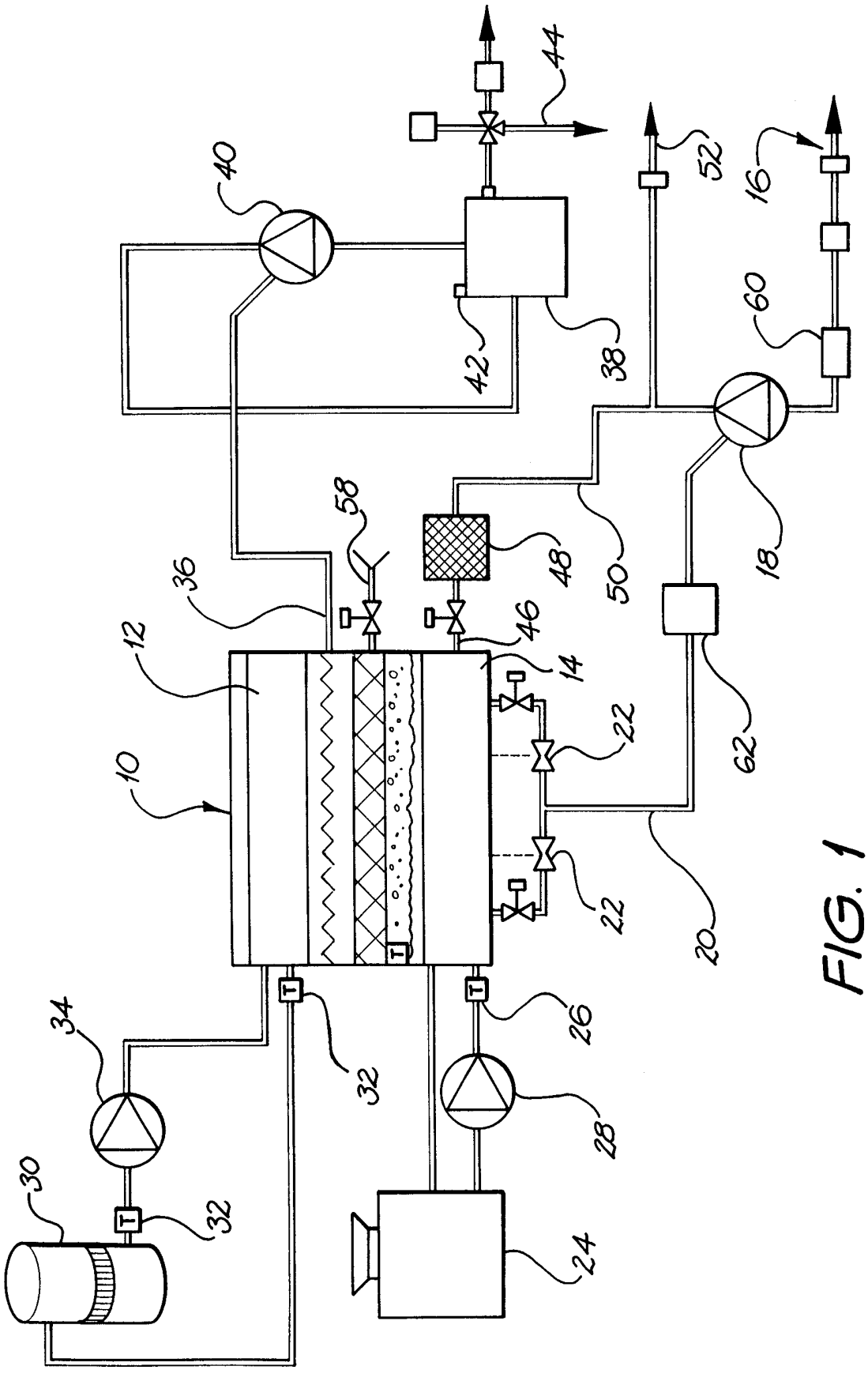
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FIG. 1

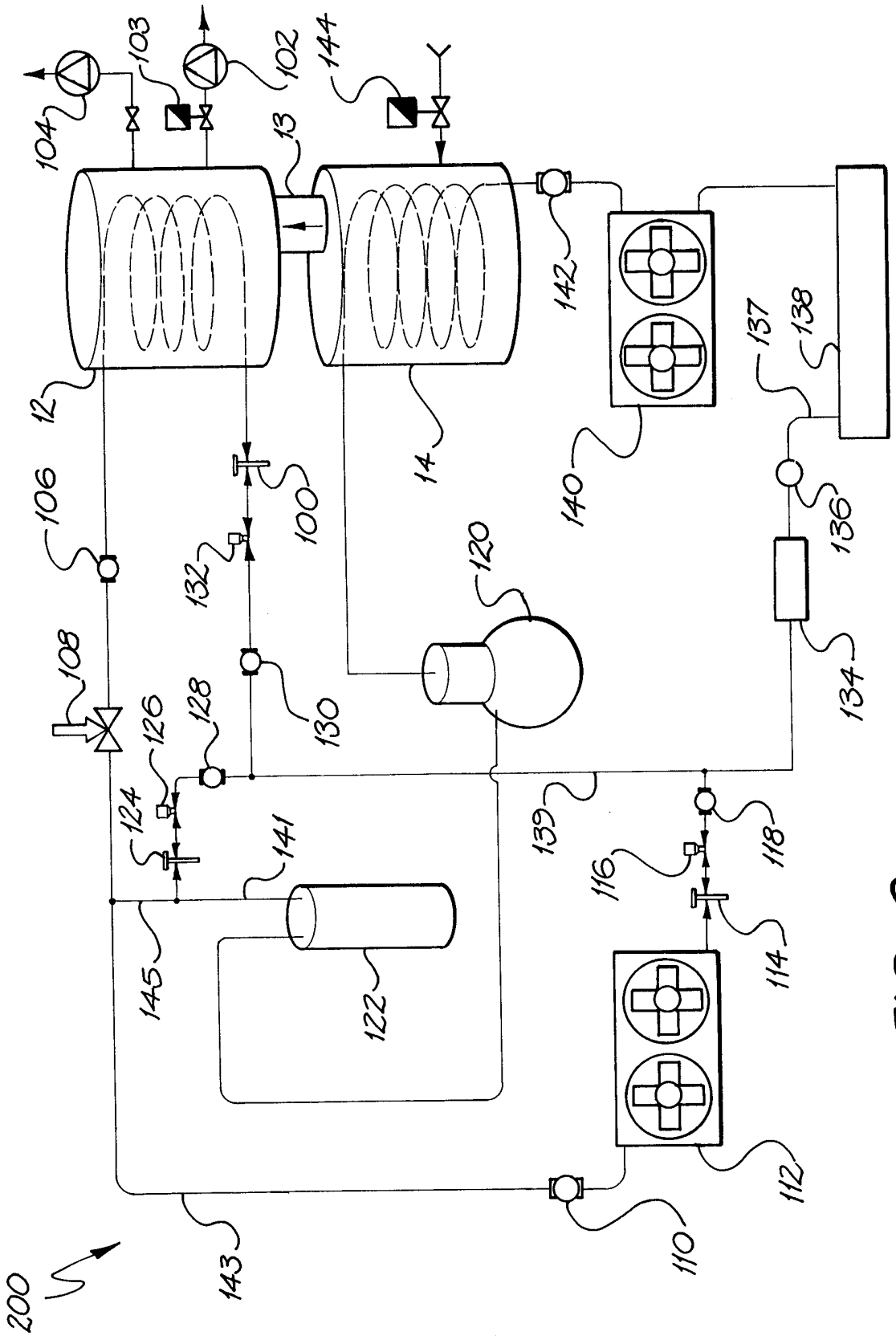
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FIG. 2

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU 99/00685

A. CLASSIFICATION OF SUBJECT MATTER

Int Cl[6]: C02F 1/04, B01D 3/10, F25B 43/00

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC(6): C02F, B01D, F25B, IPC(2): C02B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
WPAT

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DE 3413892 (MULTIMATIC MASCH GM), 5 September 1985 Abstract, figure 1	1-24
X	DE 19646459 (GEYER), 14 May 1998 Abstract, figure 1	1-24
X	US 5466344 (HOUSTON FEARLESS 76 INC.), 14 November 1995 Whole document	1-3, 6-10, 13-24

[X] Further documents are listed in the continuation of Box C

[X] See patent family annex

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search
2 November 1999

Date of mailing of the international search report
-9 NOV 1999

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU 99/00685

C (Continuation). **DOCUMENTS CONSIDERED TO BE RELEVANT**

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	FR 2696735 (BEHNAM), 15 April 1994 Abstract	1-3, 6-10, 13-24

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/AU 99/00685

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report		Patent Family Member			
DE	3413892	EP	154868	JP	60-209202

END OF ANNEX