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(71) Applicants *(for all designated States except US)*: **MORGAN AUTOMATION LIMITED** [GB/GB]; Rake Health House, London Road, Hill Brow, Liss GU33 7NT (GB). **ENVIKRAFT A-S** [DK/DK]; Topstykket 18, DK-3460 Birkerod (DK).

(72) Inventors; and
(75) Inventors/Applicants *(for US only)*: **CLARKE, Howard, Morgan** [GB/GB]; Morgan Automation Limited, Rake Heath House, London Road, Hill Brow, Liss GU33 7NT (GB). **BJORKVIK, Kurt** [DK/DK]; Envikraft A-S, Topstykket 18, DK-3460 Birkerod (DK).

(74) Agent: **SCHLICH, George, William**; HLBBshaw, Shaw House, Pegler Way, Crawley, West Sussex RH11 7AF (GB).

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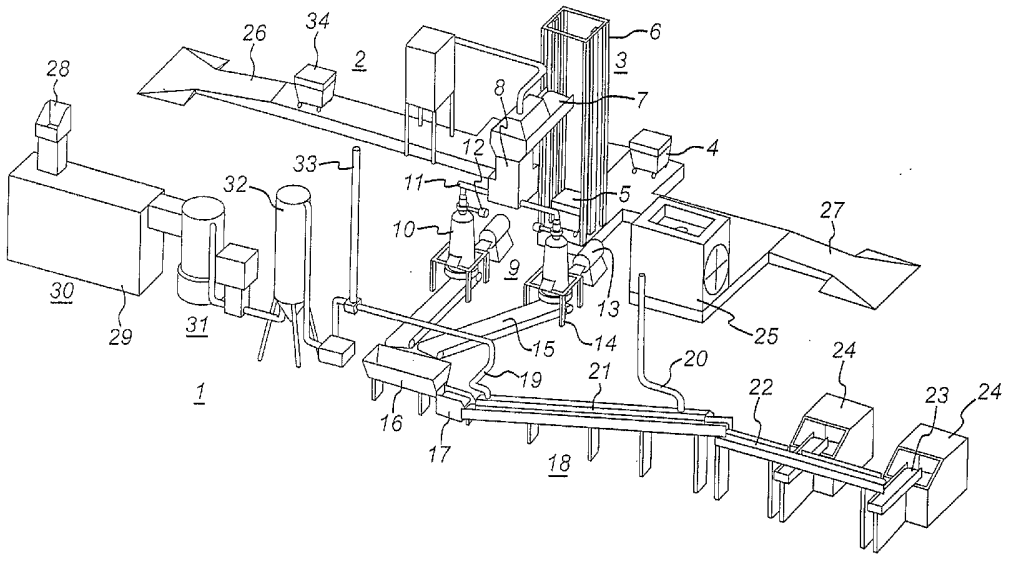
(54) **Title:** WASTE TREATMENT METHOD AND APPARATUS



(57) **Abstract:** A waste treatment plant (1) comprises an incinerator unit (30) and an autoclave unit (9) and operates such that steam for the autoclave is generated from heat in the incinerator and contaminated water from the autoclave is used to control the temperature in the incinerator, the contamination being destroyed in the process. Exhaust gas from the incinerator is used to reduce the water content of waste treated in the autoclave. Steam generated by the incinerator is available for plant washing operations, to wash bins that supplied waste to the plant before the bins are returned.

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WASTE TREATMENT METHOD AND APPARATUS

The present invention relates to a waste treatment method and apparatus and, in particular, to a plant for disposal of various types of waste, especially clinical waste.

Treatment and disposal of waste, especially hazardous waste such as waste from hospitals, is a continuing and ever-growing concern for modern society. In the UK alone, it is calculated that the National Health Service (NHS) generates approximately 350,000 tonnes of waste per year, divided into categories according to the hazard represented by the various different types.

It is known to incinerate waste, generating ash which represents a significantly reduced volume compared to the starting material. Incineration or gasification is, however, not a particularly environmentally friendly process generating gases which either have to be further treated or are released into the atmosphere potentially as pollutants. As a result, gasification plants must meet stringent standards. Waste must often be transported large distances to such sites whilst there is a growing move towards destroying waste near the point of generation. However, the high capital cost of building incinerator units means it is not practical to build small units in greater numbers.

Clinical waste can be divided into at least two categories, a first category which must be incinerated and a second category, less hazardous, which can be treated for example by steam sterilisation in an autoclave. Treating waste in this way is a more environmentally friendly approach. The cost per tonne is reduced compared to incineration, but a larger volume of residual material is generated which must then be disposed of for example as landfill.

A number of incineration plants are known, and described for example in DE-3400189, FR-2817151 and DE-3413743. Both DE-3400189 and FR-2817151 describe plant in which waste is first sterilized and then the sterilized waste is incinerated. Hence, a costly dual treatment is carried out. DE-3413743 describes an

incinerator used for decontamination of clothing. In all of these, hot gas from the incinerator is used to generate steam.

EP-0908190 describes a waste sterilization system using high pressure steam in an autoclave. This method of sterilization is well known, operating on the principal that steam temperatures in excess of 132°C have been demonstrated to destroy not only bacteria and viruses but also spores. The resulting waste from this process has a high calorific value, though also a high weight due to the water content.

It is an object of the present invention to provide an alternative waste treatment method and apparatus, enabling treatment of different waste streams by incineration or water/steam based sterilization. An object of preferred embodiments of the invention is to provide a plant comprising waste treatment method and apparatus for efficient processing of waste both by incineration and sterilization. A further object of a preferred embodiment of the invention is to so combine respective incineration and sterilization units in a single plant as to achieve operational efficiencies rendering practical the construction of such units on a smaller scale than is currently possible.

Accordingly, the present invention provides waste disposal and/or treatment apparatus, comprising an incinerator for incineration of waste, and an autoclave for steam treatment of waste, wherein the incinerator comprises a steam generator and the apparatus comprises a conduit to supply steam from the steam generator in the incinerator to the autoclave.

Also provided by the present invention is a method of waste treatment, comprising simultaneously incinerating a first waste stream in an incinerator, using heat from the incinerator to generate steam, passing the steam to an autoclave and steam-treating a second waste stream in the autoclave.

Hence, two parallel waste streams can be processed, once by incineration, for example in a gasification-type incinerator unit, and the other via steam-treatment, for example in a sterilization unit such as an autoclave.

The waste disposal treatment apparatus may additionally comprise, with the incinerator, autoclave and steam generator, a conduit for transfer of water from the autoclave to a combustion chamber in the incinerator. Steam used in the autoclave condenses as water and is then regarded as contaminated. Water used at other times to clean the inside of the autoclave is similarly regarded as contaminated. This contamination is conveniently destroyed in the incinerator whilst at the same time being used to control incinerator temperature. Generally, water in the plant is collected in a storage unit, either a single unit or several, preferably linked. A conduit then enables transfer of water from the autoclave to the storage unit and another conduit allows for transfer of water from the storage unit to the combustion chamber.

Incinerator heat can also advantageously be used to reduce the water content of damp material from the autoclave. A preferred apparatus includes a drier, for drying of steam-treated waste which exits the autoclave, and a conduit to supply hot air or exhaust from the incinerator to the drier. The drier can also be operated using heat, e.g. supplied in the form of steam from the steam generator, via a conduit, e.g. to supply steam from the steam generator, to the drier.

On an autoclave side of a plant containing the apparatus, it is preferred that waste is gravity fed into a pressure vessel of the autoclave. The apparatus suitably comprises a feeder for feeding waste to an entry port located on an upper portion of the autoclave, preferably at the top of the autoclave. The autoclave may then comprise an exit port located on a lower portion of the autoclave chamber. When the exit port is open waste can then exit through the exit port via gravity. This arrangement enables gravity feeding into and out of the autoclave and in an embodiment of the invention an initial processing step is to lift the waste above the autoclave for feeding via a valve, which can be closed and opened, into the top. There are advantages to this: no special equipment is needed to extract steam-treated waste, as this just falls out of the pressure vessel; filling of the vessel is easier and hence a higher proportion of its capacity is utilized.

Preferred valves for the entry port and exit port are slide valves. In the example below slide valves from the oil industry are used with associated seals, capable of withstanding the operating pressure in the autoclave, thus typically 4 bar or greater. Slide valves have the advantage they can be operated automatically, e.g. by control equipment monitoring when the autoclave is full using a signal from a level detector.

In a specific embodiment of the invention described in more detail below, the autoclave comprises a feed chute located at or near the top of the pressure vessel and an exit chute located at or near its bottom. There is also a feeder to feed waste to the feed chute, the feed chute being located higher than the autoclave, whereby waste is fed from the feed chute to the autoclave by gravity, the exit chute is located below the autoclave and waste exiting the autoclave is fed to the exit chute by gravity.

A shredder is preferably incorporated into the apparatus, very suitably upstream of the autoclave. Hence, finely divided material rather than e.g. intact bags is steam treated. This increases the steam contact area during processing and increases the fill efficiency of the vessel. It is again preferred that the shredder and autoclave are so arranged that shredded waste exiting the shredder is gravity-fed to the autoclave. A further shredder may be provided, as back-up for the first.

A further optional and valuable feature of an apparatus of the invention is a level detector, to detect the level of waste in the autoclave. This can operate with an optional vibrator to vibrate waste inside the autoclave chamber so as to redistribute waste within the chamber. In use, as the waste accumulates in the chamber some of it may sit on top of other waste and pile up in the central area, leaving empty spaces at the sides. It would be difficult for an operator to judge the extent of this as the vessel walls are opaque. In the apparatus the detector triggers the vibrator to vibrate the vessel and redistribute the waste more evenly. Typically, control equipment associated with the level detector operates to activate the vibrator when waste within the chamber is above a predetermined level. After a point the vessel is nearly full and vibrating does less and less to change the level. Hence it is preferred that the control equipment also operates to deactivate the vibrator, when after activation for a

predetermined period of time, the level of waste within the chamber has not dropped below the predetermined level. It is optional for there to be manual override to this, to enable an operator to ensure efficient filling is achieved.

Waste is typically fed into the autoclave side from bins, generally standard wheelie bins, received in batches from e.g. a local hospital or waste collector. In use, these are loaded onto a ramp for delivery to a bin lift. The apparatus can comprise a weighing station and control equipment in association with a bin lift, which operates so as to weigh a bin containing waste both before and after the bin is emptied and to identify a bin which, after having been emptied, weighs more than a predetermined amount. Bins which do not empty can thus be identified and separated from an automatic line for manual processing – e.g. if waste will not fall out of the bin upon tipping but needs to be dislodged for some reason.

The apparatus may also comprise a metal detector, to detect metal in the waste before the waste is fed into the autoclave. Preferably, the detector is upstream of the shredder, and more preferably upstream of the bin-lift. Associated control equipment can be set to divert waste which triggers the detector to the incinerator.

In apparatus described below in more detail, a weighing station is incorporated into a feeder, so that a bin can be weighed whilst it is being lifted into position for feeding of its contents to the autoclave.

A plant embodying apparatus of the invention can operate to process waste in separate streams, one for incineration and one by steam treatment. It is preferred that the incinerator operates continuously, as once it has been lit or otherwise started it is inefficient to stop and restart it. For processing waste from different sources, and with differing levels of contamination, it has been found that efficient operation of the combined plant can be achieved when the ratio of waste treatment capacity per unit time of the incinerator to the waste treatment capacity per unit time of the autoclave is from 1:7 to 5:7, preferably from 2:7 to 4:7. In a particular embodiment a ratio of about 3:7 has been found to demonstrate good results.

Heat from the incinerator can as described be used to produce steam. An additional option is for there to be a second steam generator, not powered by the incinerator, and a conduit for transfer of steam from the second steam generator to the autoclave. This second generator can be a back-up in the event of failure of the first. It can be used when the incinerator is not operating for another reason. It thus enables the two sides of the plant to operate independently if necessary – though advantages of the two are principally seen whilst both sides are running. Control equipment can be employed to turn on the second steam generator, which is optionally oil-, gas- or electrically-powered, in the event of failure or inadequate operation of the steam generator in the incinerator.

Steam from the steam generator or boiler is used for the autoclave. The steam can also be used elsewhere. Apparatus of the invention can also have one or more steam lines from the steam generator to supply steam for cleaning of equipment that is part of or associated with the autoclave or another part of the apparatus or its operation, for example, bins used to deliver waste to the autoclave, surfaces of apparatus, vehicles that deliver unprocessed waste. Thus incinerator heat is used for another purpose, increasing energy efficiency in the apparatus.

Bins can be washed in a bin washer, supplied with steam from the boiler. Water collected from the washer would normally be regarded as contaminated. In the apparatus of the invention, this water can be transferred to the water storage unit; it can then be either recycled into steam or injected into the incinerator to control temperature whilst any contamination is destroyed.

A method of the invention, followed in the specific embodiment below, comprises simultaneously:-

(i) incinerating a first waste stream in an incinerator;

(ii) using heat from the incinerator to generate steam;

(iii) passing the steam of (ii) to an autoclave; and

(iv) steam-treating a second waste stream in the autoclave.

During operation, water is preferably transferred from the autoclave into a combustion chamber of the incinerator. Generally a gasifier type of incinerator will have several combustion chambers, one primary chamber for initial combustion and one or more secondary chambers for subsequent processing of the resultant combustion gases. Water is typically injected into the primary chamber using a valve under control of equipment that senses the internal temperature and monitors when it exceeds an acceptable running temperature. In a typical plant having an apparatus of this type, transferring water to the incinerator comprises transferring water from the autoclave to a store and transferring water, when required, from the store to the combustion chamber. The store can also receive water from other parts of the plant, e.g. a bin washer, header tanks for the steam generators, a bubbler above the autoclave through which steam passes during steam-treatment of waste.

A method of the invention may comprise using heat from the incinerator to reduce the water content of waste which has been steam-treated in the autoclave. For example, waste steam-treated in the autoclave can be transferred to an air drier, wherein the air drier is supplied with hot exhaust from the incinerator or with steam from the steam generator.

Whilst filling the pressure vessel of the autoclave, incomplete filling can occur. It is preferred whilst doing so to feed the second waste stream into the top of a chamber or pressure vessel in the autoclave, accumulating waste in the chamber and vibrate the chamber so as to redistribute the accumulated waste within the chamber.

The method may further comprise opening an exit port at the bottom of the autoclave chamber and feeding the steam-treated sterilised waste out of the chamber by gravity. Apparatus suitable for this has been described elsewhere herein, and enables convenient gravity-feeding of raw material into the autoclave and treated material out. Raw material is preferably subjected to shredding before it is steam-treated.

For efficient operation it is preferred that the ratio of the waste treated per unit time in the incinerator to the waste treated per unit time of the autoclave is from 1:7 to 5:7, preferably from 2:7 to 4:7.

Other optional features of the apparatus and method are apparent from the specific description of a plant incorporating apparatus of and for carrying out the method of the invention. These features may each individually or in combination be used in further embodiments of the invention.

Also provided by the invention are a waste treatment plant, comprising apparatus according to any embodiment of the invention and a waste treatment plant, comprising apparatus for carrying out the method of any embodiment of the invention.

The plant of a specific embodiment of the invention thus is able to treat all forms of clinical waste in a single unit. The energy consumption of the combined unit can be significantly less than the total energy consumption of individual units. When the plant is run using both the gasification and the autoclave sides, the costs per tonne for processing waste via autoclaving is reduced, as is the cost per tonne for treating waste via gasification. The capital cost of the combined unit is significantly less than the combined cost of two separate units of comparable size and makes having one unit per small city or population area more commercially viable. By destruction of contaminated water from the autoclave the combined emissions of the plant are significantly reduced. The combined plant is also flexible in that, for example, if there is a lack of waste to fuel the incinerator, it can be fuelled by other special waste such as pornography, bank notes, confidential data or normal untreated yellow bag waste or even the treated waste exiting the autoclave process at no extra cost.

There now follows detailed description of a specific embodiment of the invention with reference to the accompanying drawings in which:-

Fig. 1 shows a schematic diagram of a plant comprising apparatus according to the invention,

Fig. 2 shows a schematic diagram of water flow within the plant, and

Fig. 3 shows a schematic diagram of interconnections between the sides of the plant.

Referring to the diagram of the plant, the labels indicate the following:-

1. plant comprising waste treatment apparatus
2. bin loading area
3. bin lift
4. reject bin
5. bin about to be lifted
6. bin lift structure
7. conveyor
8. shredder
9. autoclave unit
10. pressure vessel
11. feed from shredder
12. slide valve
13. bottom slide valve plus mounting
14. pressure vessel support
15. conveyor
16. hopper
17. conveyor
18. dryer
19. pipe from incinerator
20. exhaust
21. drying tunnel
22. conveyor
23. conveyor
24. collecting bins
25. bin wash unit

26. ramp (in)
27. ramp (out)
28. incinerator door
29. combustion chambers
30. incinerator
31 steam boiler
32. reactor
33. flue
34. bin

Example

Referring to all figures, a waste disposal treatment plant of the invention is shown generally as 1, comprising an autoclave unit 9 and an incineration unit 30.

The autoclave unit is designed to take waste designated in the UK as yellow bag waste, reduce it by shredding and then steam-sterilize it. A bin 34 containing such waste is delivered via an input conveyor up the in-ramp 26 in the bin loading area 2 to the bin lift 3. The input conveyor includes a metal detector to detect metal in the bags of waste, its sensitivity set so that metal in an amount or of a size that would risk damaging a shredder or any other part of the autoclave unit triggers diversion of that bin away from the in-ramp. The detector and apparatus is set to divert that bin so that its contents are passed to the incinerator. Apparatus (not shown) which can reject a bin for example if it is damaged or if attempts to empty it are unsuccessful forms part of the bin lift. A reject bin is shown in position 4. A conveyor (not shown) on the ramp has capacity for ten bins, enabling a operator to load ten bins in a single operation.

A bin about to be lifted is shown as 5 in bin lift 3, comprising support and associated structure 6. The bin 5 is lifted to a height of 7 metres. During lifting it is weighed and is again weighed after having been emptied. Control equipment records the

empty weight of each bin and if this generates an error, for example indicating that the bin has not been emptied, it is transferred to reject bin position 4.

At the top of the bin lift 3, the contents of the bin are delivered to conveyor 7, a short, approximately 3 metre long conveyor to hopper-fed shredder 8. "Height" fingers on the conveyor are located so as to urge the bags on the conveyor to lie at a single height and spread them evenly on the conveyor. The conveyor speed relative to the bin lift speed is set so that the content of one bin is cleared before a further one is delivered. Shredder 8 uses a low speed, high torque rotor to cut open waste bags and shred their contents, reducing their size. Bags are fed into the hopper of the shredder by gravity and are pushed against the cutting edge of the rotor by a hydraulic ram. Whilst a number of shredders of different type can be used, in this apparatus the rotor has a series of V blades which cut through a comb-like arrangement of counter knives and the resulting material is then pushed through a 25mm screen. Shredded material falls into an auger screw located in feed pipe 11 between the shredder and the pressure vessel 10 of the autoclave unit 9. It is optional for the plant to have an additional shredder, as back-up in the event of the first being out of service for any reason. This ensures the plant can run continuously during e.g. repair or maintenance of one shredder.

In this apparatus there are two pressure vessels, and hence the auger operates in clockwise or anticlockwise direction according to which vessel is being fed. Sterilization in these respective pressure vessels occurs alternately, enabling a continuous flow and processing of waste material such that one batch of waste is being sterilized whilst another batch is being fed into the other pressure vessel. By control of the filling rates, the process is hence continuous.

The area containing the shredder, its hopper and its conveyor are enclosed to prevent contamination of the rest of the plant. A HEPA filter system prevents air-bourne contamination. The area is in addition operated under a slight negative pressure so that air does not flow out of the area but only flows in and is subsequently filtered

before being released. Used filters are recycled either into the shredder or the incinerator.

The pressure vessels 10 of the autoclave unit are approximately 2.3 metres high, sealed by slide valves at the top and bottom. The top valve is approximately 250mm diameter and the bottom approximately 1 metre diameter. The pressure vessels thus have approximately frusto-conical dimensions, being notably broader at the bottom than at the top.

Shredded waste enters the pressure vessel via the top, slide valve 12, delivered by the auger in the feed pipe 11. A level detector (not shown) determines when the level of waste has reached a certain height. This typically occurs when the vessel is approximately half full, at which point an agitator is used to agitate the vessel to spread the contents and prevent coning. Thus, the waste is distributed evenly throughout the vessel. Eventually, use of the agitator no longer results in any reduction in the level, indicating the pressure vessel is full. During this process steam can be injected into the vessel to dampen the load and assist filling.

When the vessel is full the feed from the shredder is stopped and a jet of steam is introduced to clear the passage of slide valve 12 and assist closing. The valve is automatically closed by control equipment linked to the valve and the level detector and the sterilization process begins.

High pressure, high temperature, dry steam is introduced via conduits (not shown) from a steam generator 31 in the incinerator unit 30. Steam is delivered to the bottom and part-way up the vessel and drives trapped air out of the vessel through a bleed valve in the upper part. This exhausted air passes through a water trap or bubbler (not shown) and then through a HEPA filter system before being vented. The temperature and flow of air through the water trap is monitored and the bleed valve is closed once most air has been removed from the pressure vessel and steam is detected. In practice, there is a clearly audible change in the sound emitted from the bubbler,

indicating that the flow from the pressure vessel is now solely steam, at which point the bleed valve can be closed.

Steam is continued to be fed into the vessel, raising the pressure and temperature, until the pressure reaches approximately 4 bar (400 KPa) (150°C). At this point the steam input is reduced and the pressure maintained for a treatment cycle of 10 minutes. After this period, steam is turned off and water in the vessel is withdrawn via a valve at the bottom of the pressure vessel which passes water to a central water storage unit (not shown).

Pressure in the vessel is now relieved through the bubbler, exiting steam thus condensing as water and as the amount of steam exiting reduces the bottom slide valve 13 is opened. The pressure vessel is mounted on support structure 14 over a conveyor 15. When the bottom slide valve 13 is opened, treated waste falls onto the conveyor 15 and is conveyed to the hopper 16 which combines the outputs of both pressure vessels. The treated material is at high temperature, approximately 100°C at this point, and initial drying occurs as the hot material gives off steam.

From hopper 16 via conveyor 17 the material is transferred to air dryer 18, fed with hot air or steam from the incinerator via pipe 19, the hot air then exiting via exhaust flue 20. Waste material proceeds along the drying tunnel 21 and then exits to conveyor 22 and subsequent conveyors 23 for delivery to collecting bins 24.

As soon as the treated material is clear of the bottom valve 13 this is closed so that reloading of that vessel can start.

The dried waste delivered to collecting bins 24 can be taken for landfill or given to third party users as a fuel source.

The bottom floor of each pressure vessel is set at an angle of approximately 2° to enable water condensing in the vessel to gather at one side so that it can be removed

via bottom valve connected to the water storage unit. Steam jets in the vessel are provided for cleaning of the slide valves.

In operation, the pressure vessel weighs many times the waste being processed, so after treating the first waste load the temperature of the vessel surface will rise typically to around 150°C and be in excess of 100°C at the start of the next cycle. This elevated temperature reduces the cycle time and heats untreated waste whilst it is being loaded. Dampening the load to assist filling hence either only slightly increases the cycle time or does not increase it at all.

Emptied bins proceed via the ramp to bin washing unit 25, fed with steam from the steam boiler 31 of the incinerator 30. Water collected at this wash unit is recycled to the water storage unit, for use either to generate further steam or for injection into the incinerator, as described in more detail below.

Water supplied to the plant passes through a water softener and into a header tank which supplies water to the bubbler and the water storage unit. Steam exiting the pressure vessel is passed through the bubbler, with exhaust air then filtered. Water drained from the pressure vessel and recovered from the bin washing unit or elsewhere around the plant is collected in the water storage unit. From here it is passed to a header tank in the steam boiler 31 and a header tank in an optional back-up steam generator. A separate line enables water from the storage unit to be delivered into a combustion chamber of the incinerator 30. Steam from the steam boiler 31 is used for steam cleaning around the plant, including the bin washer and for supply of steam into the pressure vessels 9.

The gasification unit of the incinerator 30 is designed to take waste which, in the UK, is classified as red bag waste and reduce it to gas and ash. Energy generated by gasification is used to drive the autoclave system and provides steam for other uses around the plant.

A bin containing red bag waste (not shown) is lifted and delivered to the hopper/incinerator door 28 leading to a combustion chamber 29 in the incinerator. The hopper/incinerator door unit includes flapper doors which ensure the waste is first fed to an outer feed chamber (not shown) which is then sealed to the outer atmosphere before a separate door is opened transferring the waste into the combustion chamber. An evacuation fan operates to remove gas and smoke before a further bin of waste is delivered. The unit operates automatically, in that control equipment calls for more waste from the hopper/incinerator door as and when required.

The incinerator comprises a primary combustion chamber, into which combustion air is added via several different input ports. Waste is burnt in this chamber at between 800 and 1000°C. When the temperature exceeds 1000°C control equipment reduces input of combustion air or activates injection of water into the chamber so as to reduce the temperature to below 1000°C. Contaminated water from the water storage unit of the plant is used for cooling and is thus conveniently destroyed whilst at the same time controlling the temperature of the incinerator.

The apparatus and method described herein can thus treat two waste streams, and can do so simultaneously, in parallel.

Ash accumulating in the chamber is removed via an auger system, which also assists mixing of the waste to ensure a complete burn. Ash is transferred to a container with sufficient capacity for one week's continuous operation. Highly combustible gases are released in the primary combustion chamber and enter a combustion chamber typically held at a minimum of 850°C with a retention time of at least 2 seconds. Gases from this chamber then pass to steam boiler 31 through a lined flue gas duct.

The steam boiler 31 cools down the flue gases to a temperature low enough for them to be treated by a gas cleaner tower, whilst generating steam for use in other parts of the plant as described. The steam boiler is fed with water from the water storage unit. Water is passed through the boiler and a heat exchanger generating steam at 160-170°C.

Cooled gases exit the steam boiler system and are filtered and treated. Lime and activated carbon are added to react with and be absorbed by gas components such as acids, heavy metals and dioxins. Flue gas containing the lime and carbon is then passed to a gas cleaning tower 32, part of the reactor. Filters in the tower collect dust from the flue gas, building up a layer of lime and carbon. When the pressure drop across the filters reaches a pre-set level these are cleaned by subjecting them to an air stream. Used chemicals fall to the bottom and are drawn by a continuously working airtight rotating valve into an ash container for disposal.

Cleaned flue gas leaves the filter system and passes to a flue gas induced draught fan and then out to the atmosphere via a short stack or flue 33.

The apparatus can thus conveniently treat substantially all healthcare waste on a single site, avoiding separate collections from hospitals to different delivery locations. The combination of the respective sides of the plant, the gasification side and the autoclave side, results in a highly efficient plant. As described, contaminated water from the autoclave is fed to a combustion chamber in the incinerator. Heat from the incinerator is used to generate steam for the autoclave and for bin washing and other plant washing. Flue gas from the incinerator is used to reduce the water content of steam-treated material exiting the autoclave. Water storage units around the plant collect water from various different locations, including the bin washing unit, the bottom of pressure vessels and elsewhere, filtering the water as necessary to recycle it for use either for steam generation or to dampen the temperature of the incinerator.

The heat energy from a prior art incinerator is normally wasted and cannot be used for any practical purpose, but in the present combination plant is efficiently used. A small incinerator would not, otherwise, be able usefully to use the heat for generating electrical energy or for other purposes. An autoclave system usually generates significant quantities of contaminated water which have to be treated. In the present, combined plant this contaminated water is either destroyed in the incinerator or in generation of steam. Using heat from the incinerator to reduce the water content of

steam-treated waste reduces its weight and hence reduces its subsequent transport costs and landfill costs (if applicable) and increases its calorific value.

It is in addition possible for both of the units to operate on their own if need be. A separately powered, for example oil-powered, steam generator is provided as a back-up for the autoclave system so this can continue to operate if the incinerator has to be shut down for repair or maintenance or any other reason.

Once an incinerator has been started it is desirable to operate it continuously, and the combined plant enables the incinerator to be run continuously, processing approximately three units of waste for seven units of waste treated in the autoclave.

Hence, a waste treatment apparatus and method is provided.

CLAIMS

1. Waste disposal treatment apparatus, comprising:-
an incinerator, for incineration of waste,
an autoclave, for steam treatment of waste,
wherein the incinerator comprises a steam generator and the apparatus comprises a conduit to supply steam from the steam generator in the incinerator to the autoclave.

2. Apparatus according to claim 1, further comprising a conduit for transfer of water from the autoclave to a combustion chamber in the incinerator.

3. Apparatus according to claim 2, comprising a water storage unit, a conduit for transfer of water from the autoclave to the storage unit and a conduit for transfer of water from the storage unit to the combustion chamber.

4. Apparatus according to any of claims 1 to 3, comprising a drier, for drying of steam-treated waste which exits the autoclave and a conduit to supply heat from the incinerator to the drier.

5. Apparatus according to any of claims 1 to 4, comprising a drier, for drying of steam-treated waste which exits the autoclave and a conduit to supply exhaust from the incinerator or steam from the steam generator to the drier.

6. According to any of claims 1 to 5, comprising a feeder for feeding waste to an entry port located on an upper portion of the autoclave.

7. Apparatus according to claim 6, wherein the entry port is at the top of the autoclave.

8. Apparatus according any of claims 1 to 7, wherein the autoclave comprises an exit port located on a lower portion of the autoclave chamber.

9. Apparatus according claim 8, wherein when the exit port is open waste in the autoclave exits through the exit port via gravity.

10. Apparatus according to any of claims 1 to 9, wherein the ratio of waste treatment capacity per unit time of the incinerator to the waste treatment capacity per unit time of the autoclave is from 1:7 to 5:7.

11. Apparatus according to claim 10, wherein the ratio is from 2:7 to 4:7.

12. Apparatus according to any of claims 1 to 11, further comprising a second steam generator, not powered by the incinerator, and a conduit for transfer of steam from the second steam generator to the autoclave.

13. Apparatus according to claim 12, further comprising control equipment to turn on the second steam generator, which is optionally oil-, gas- or electrically-powered, in the event of failure or inadequate operation of the steam generator in the incinerator.

14. Apparatus according to any previous claim, comprising a steam line from the steam generator to supply steam for cleaning of equipment that is part of or associated with the autoclave, for example, bins used to deliver waste to the autoclave.

15. Apparatus according to any previous claim wherein the autoclave comprises a feed chute and an exit chute and wherein the apparatus comprises a feeder to feed waste to the feed chute, the feed chute being located higher than the autoclave, whereby waste is fed from the feed chute to the autoclave by gravity, the exit chute is located below the autoclave and waste exiting the autoclave is fed to the exit chute by gravity.

16. Apparatus according to any previous claim, comprising a shredder upstream of the autoclave.

17. Apparatus according to claim 16 wherein shredded waste exiting the shredder is gravity-fed to the autoclave.

18. Apparatus according to any previous claim wherein the autoclave comprises a level detector, to detect the level of waste in the autoclave and a vibrator to vibrate waste inside the autoclave chamber so as to redistribute waste within the chamber.

19. Apparatus according to claim 18, comprising control equipment associated with the level detector which operates to activate the vibrator when waste within the chamber is above a predetermined level.

20. Apparatus according to claim 19, wherein the control equipment also operates to deactivate the vibrator, when after activation for a predetermined period of time, the level of waste within the chamber has not dropped below the predetermined level.

21. Apparatus according to any previous claim, comprising a metal detector to detect metal in waste upstream of the autoclave.

22. Apparatus according to claim 21, wherein the metal detector is upstream of the shredder.

23. Apparatus according to claim 21 or 22, comprising control equipment adapted to divert waste which contains metal to the incinerator.

24. Apparatus according to any previous claim, comprising a weighing station and control equipment which operates so as to weigh a bin containing waste both before and after the bin is emptied and to identify a bin which, after having been emptied, weighs more than a predetermined amount.

25. Apparatus according to claim 24, wherein the weighing station is incorporated into a feeder, so that a bin can be weighed whilst it is being lifted into position for feeding of its contents to the autoclave.

26. Apparatus according to any previous claim, comprising the incinerator in a first waste processing stream and the autoclave in a second, parallel stream.

27. Apparatus according to any previous claim, comprising a bin washing unit and a conduit for transfer of water used for washing to the water storage unit.

28. Apparatus according to any previous claim wherein the autoclave comprises slide valves, which open to allow waste into the autoclave and to allow treated waste to exit and which close to seal the autoclave.

29. Apparatus according to any previous claim, comprising control equipment associated with a slide valve at an entry port of the autoclave and adapted to close the slide valve when the autoclave is full of waste.

30. A method of waste treatment, comprising simultaneously:-

(v) incinerating a first waste stream in an incinerator;
(vi) using heat from the incinerator to generate steam;
(vii) passing the steam of (ii) to an autoclave; and
(viii) steam-treating a second waste stream in the autoclave.

31. A method according to claim 30, further comprising transferring water from the autoclave into a combustion chamber of the incinerator.

32. A method according to claim 31, comprising transferring water from the autoclave to a store and transferring water, when required, from the store to the combustion chamber.

33. A method according to any of claims 30 to 32 comprising using heat from the incinerator to reduce the water content of waste which has been steam-treated in the autoclave.

34. A method according to claim 33, wherein waste steam-treated in the autoclave is transferred to an air drier, wherein the air drier is supplied with hot exhaust from the incinerator.

35. A method according to any of claims 30 to 34, comprising feeding the second waste stream into the top of a chamber in the autoclave, accumulating waste in the chamber and vibrating the chamber so as to redistribute the accumulated waste within the chamber.

36. A method according to any of claims 30 to 35, comprising opening an exit port at the bottom of the autoclave chamber and feeding the steam-treated waste out of the chamber by gravity.

37. A method according to any of claims 30 to 36, comprising shredding the waste stream before it is steam-treated.

38. A method according to any of claims 30 to 37, wherein the ratio of the waste treatment per unit time of the incinerator to the waste treatment per unit time of the autoclave is from 1:7 to 5:7.

39. A method according to claim 38 wherein the ratio is from 2:7 to 4:7.

40. A waste treatment plant, comprising apparatus according to any of claims 1 to 29.

41. A waste treatment plant, comprising apparatus for carrying out the method of any of claims 30 to 39.

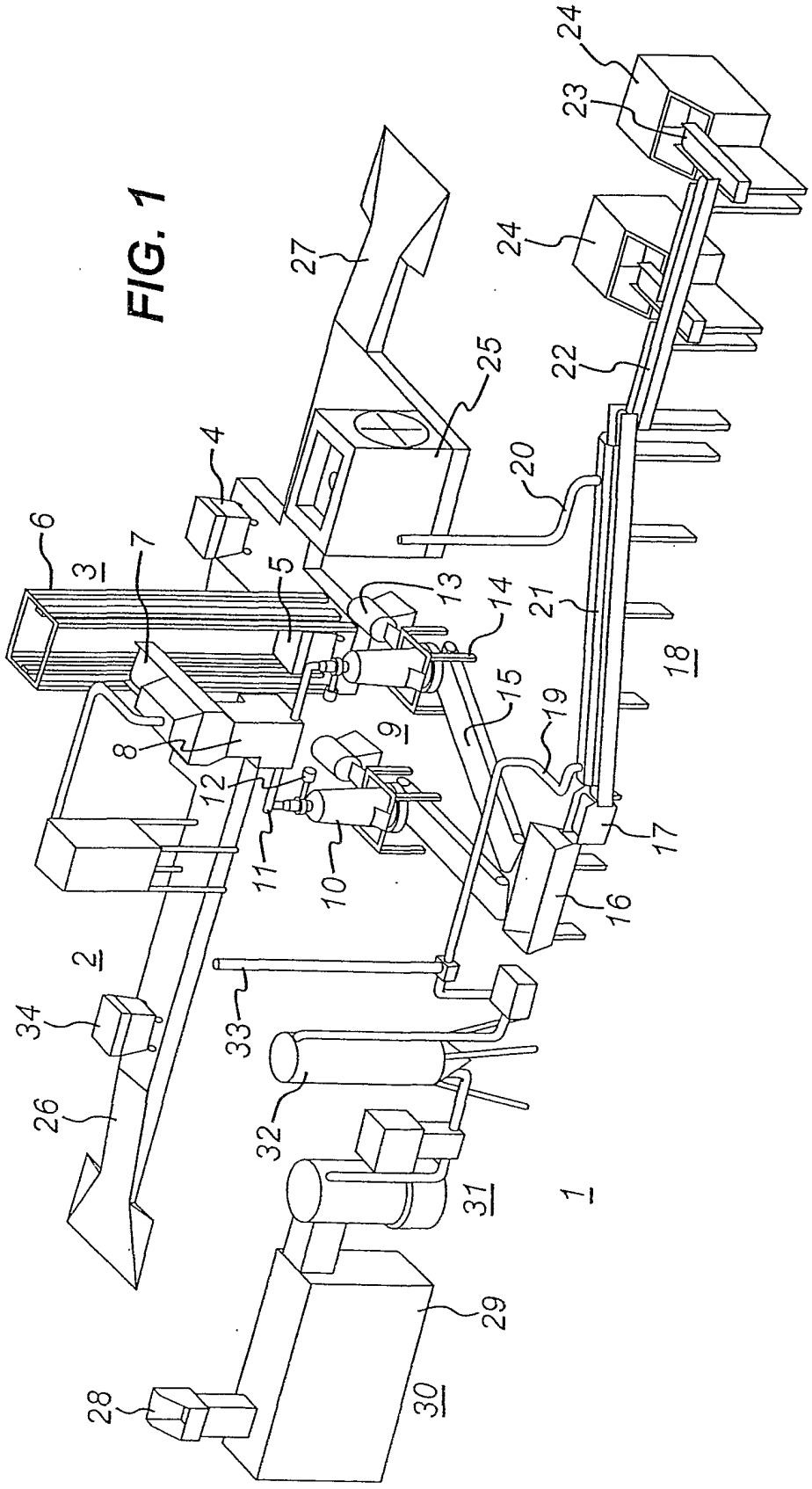
42. Waste treatment apparatus substantially as hereinbefore described and claimed.

43. A method of waste treatment, substantially as hereinbefore described and claimed.

44. Waste treatment apparatus substantially as hereinbefore described with reference to the accompanying drawings.

45. A method of waste treatment substantially as hereinbefore described with reference to the accompanying drawings.

FIG. 1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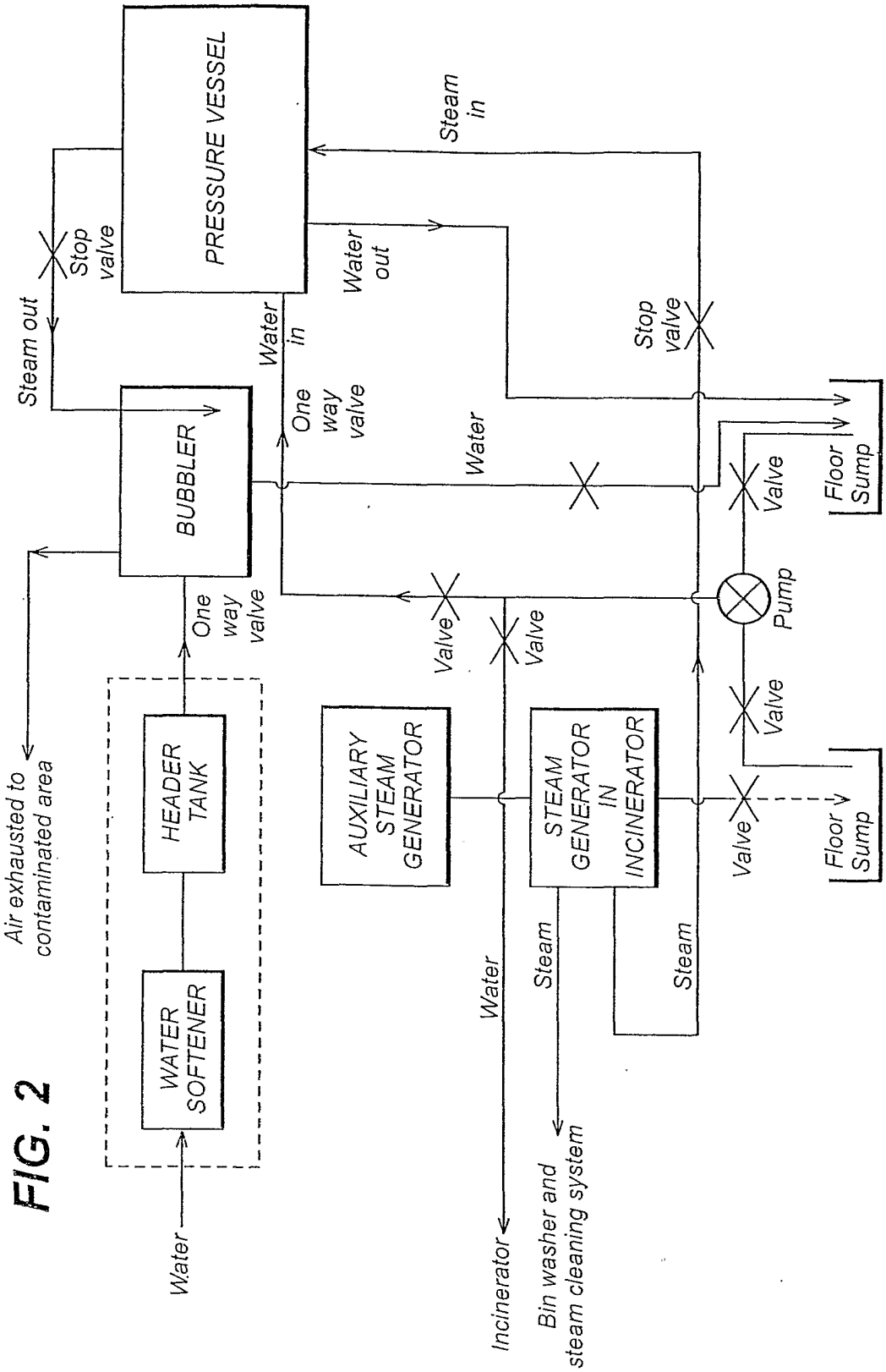
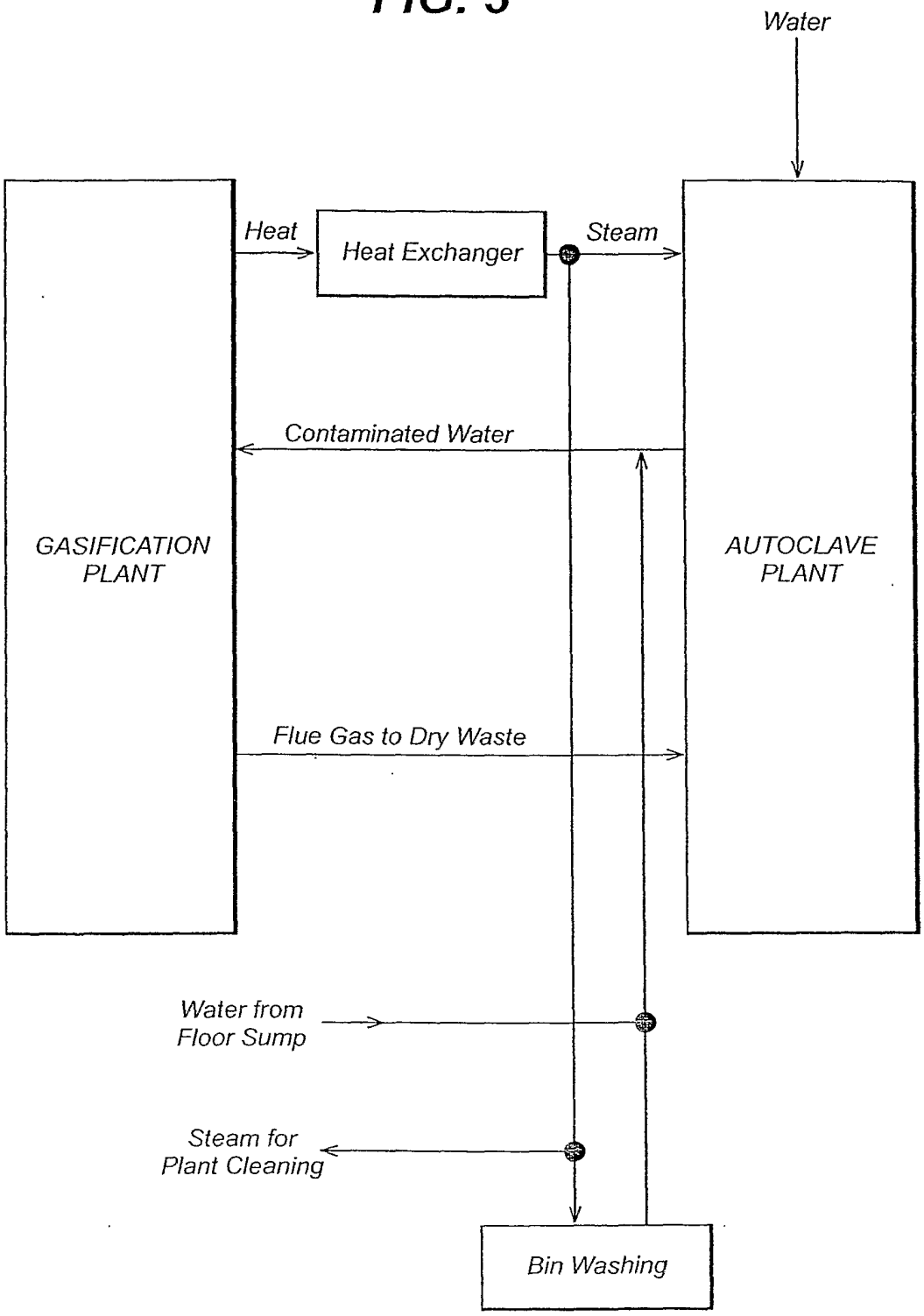

PRESSURE VESSEL
Steam in
Stop valve
Steam out
Water out
Water in
Stop valve
BUBBLER
One way valve
Water
Valve
Floor Sump
Pump
Valve
Valve
Valve
One way valve
Air exhausted to contaminated area
HEADER TANK
AUXILIARY STEAM GENERATOR
STEAM GENERATOR IN INCINERATOR
Valve
Floor Sump
WATER SOFTENER
Water
Water
Steam
Steam
Incinerator
Bin washer and steam cleaning system

FIG. 2

FIG. 3


Water
Heat
Heat Exchanger
Steam
Contaminated Water
GASIFICATION PLANT
AUTOCLAVE PLANT
Flue Gas to Dry Waste
Water from Floor Sump
Steam for Plant Cleaning
Bin Washing

INTERNATIONAL SEARCH REPORT

International application No
PCT/GB2006/002032

A. CLASSIFICATION OF SUBJECT MATTER
INV. F23G5/46 F23G5/033 F23G5/04

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)
F23G

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 practical, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y A	DE 197 08 459 A1 (KIM, HONG-GI, 17159 DARGUN, DE) 20 August 1998 (1998-08-20) column 2, line 42 - column 3, line 25 figure 1	1,16,30, 37,40-45 6-9,15, 17,36,37 4,5,33, 34
Y	EP 0 649 661 A (ECONOS S.R.L) 26 April 1995 (1995-04-26) column 2, line 38 - column 5, line 36 claims 1,2,10,14,15; figures 1,2	6-9,15, 17,36,37

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[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 document 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

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

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

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
7 August 2006	16/08/2006

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31–70) 340–2040, Tx. 31 651 epo nl, Fax: (+31–70) 340–3016	Gavriliu, C

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INTERNATIONAL SEARCH REPORT

International application No
PCT/GB2006/002032

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2004/221778 A1 (PALLETT RICHARD B ET AL) 11 November 2004 (2004-11-11) page 2, paragraph 22 - paragraph 24 page 2, paragraph 27 - page 3, paragraph 44; figures 1,4	1,16,30, 37,40-45
X	FR 2 817 151 A (PB CONSULTING) 31 May 2002 (2002-05-31) cited in the application page 2, line 12 - line 31 claims 1,3; figure 1	1,30, 40-45
A	EP 0 908 190 A (GENERAL WASTE REDUCTION LIMITED) 14 April 1999 (1999-04-14) cited in the application column 1, line 3 - line 6 column 4, line 40 - line 53 column 5, line 39 - column 6, line 9; figure 2	1,30, 40-45

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Information on patent family members

International application No
PCT/GB2006/002032

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