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(54) **DOWNSTREAM MODIFIED WASTE DISPOSAL APPARATUS**

(57) Waste treatment apparatus comprises:

- (i) a chamber to receive a waste;
- (ii) a heater to heat the waste in the chamber;
- (iii) an inlet for air;
- (iv) an outlet for exit of treated waste from the chamber, connected via a conduit to a valve distal from the chamber, the valve controlling exit of treated waste from the outlet; and

(v) an insulating unit capable of (a) locating insulation between the outlet and the valve so that the valve is protected from chamber heat and (b) removing the insulation so that treated waste can exit the chamber via the distal valve.

Instead of or in addition to the insulating unit a sump is provided in which liquids in the chamber collect and are prevented from flowing via the outlet to the valve.

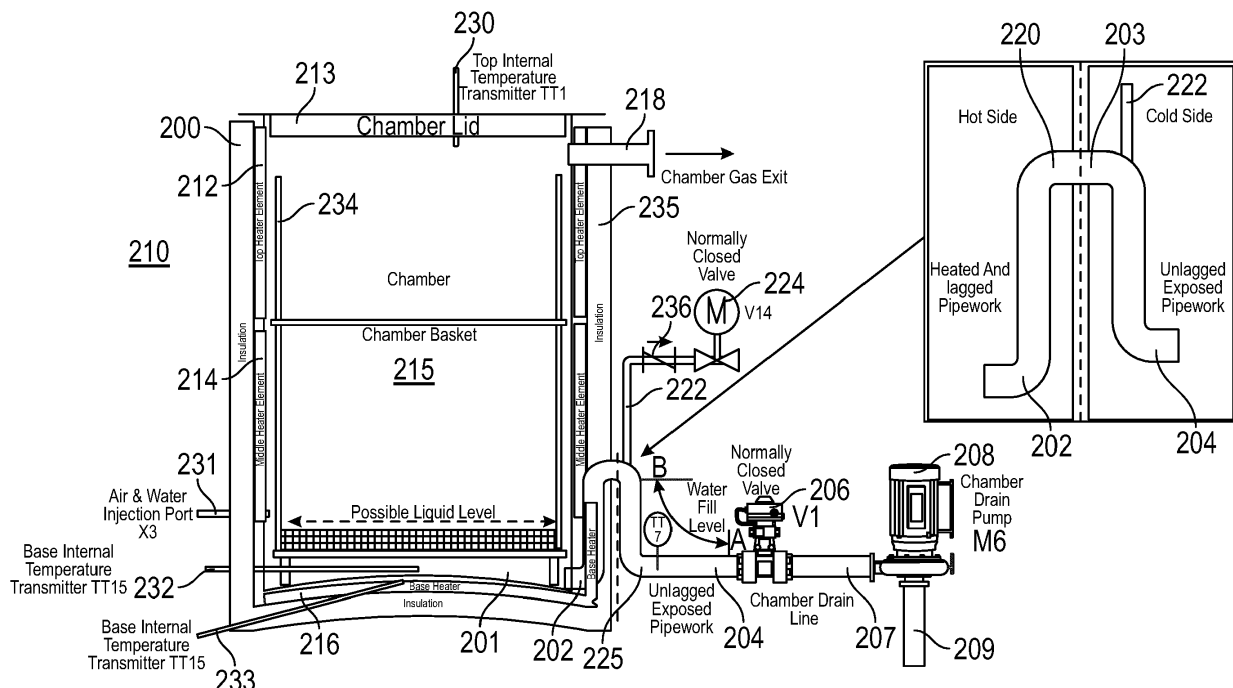


FIG. 2

Description

Introduction

[0001] The present invention relates to waste disposal apparatus, especially for carrying out a process with both pyrolysis and gasification steps.

Background to the Invention

[0002] Waste disposal apparatus is known that treats waste by a sequence of pyrolysis and gasification steps. Specific apparatus is described in WO 2011/033113, WO 2010/073008 and WO 2007/104954.

[0003] Using such apparatus, both pyrolysis and gasification are carried out in a chamber at elevated temperatures, generally in the region of 400 - 700 degrees C for pyrolysis and 400 degrees C upwards for gasification. Off gas exits the chamber, processed to remove certain noxious gases so it can be vented to the atmosphere. After waste treatment, residue especially ash remains and is flushed from the chamber using gas or more often water and via an outlet that includes an exit port and can be connected to the sewage system. The outlet is located at the base of the chamber and also includes one or more valves so that it is sealed during waste treatment and open during flushing.

[0004] While the elevated temperature waste treatment is continuing, the chamber and components attached to or integral to the chamber are heated by conduction and/or convection. It has been found by the present applicants, who manufacture and operate apparatus described in the art referenced above, that certain components associated with the exit port, valves and/or pumps are liable to damage by this heating, leading to malfunction and/or failure.

[0005] It has also been found that plastic-rich wastes when treated using the known apparatus yield gaseous and liquid plastic that migrate down the exit port (drain) and damage the drain pump and/or solidify in the pipe-work, blocking the drain.

[0006] There therefore exist problems with known apparatus, particularly and uniquely known to the applicants who are believed to be the only ones operating such equipment and hence the only ones in a position to identify these issues.

[0007] An aim of the present invention is to provide apparatus that is an alternative to known apparatus, preferably apparatus that represent an improvement thereto and preferably ameliorates one or more problems identified therein. An aim of specific embodiments is to provide apparatus that provides for reduced component malfunction and/or failure as a result of use with plastics and/or reduced damage due to exposure to heat.

Summary of the Invention

[0008] Accordingly, a waste treatment apparatus of the

invention comprises:

- (i) a chamber to receive a waste;
- (ii) a heater to heat the waste in the chamber;
- (iii) an inlet for air;
- (iv) an outlet for exit of treated waste from the chamber, connected via a conduit to a valve distal from the chamber, the valve controlling exit of treated waste via the outlet; and
- (v) an insulating unit capable of (a) locating insulation between the outlet and the valve so that the valve is protected from heat from the chamber and (b) removing the insulation so that treated waste can exit the chamber.

[0009] A related process for waste treatment comprises:-

- (i) introducing waste into a chamber, wherein the chamber has an outlet for exit of treated waste connected via a conduit to a valve distal from the chamber, the valve controlling exit of waste via the outlet;
- (ii) locating insulation between the outlet and the valve;
- (iii) treating the waste, e.g. by heating the waste to an elevated temperature to effect pyrolysis of the waste and/or introducing oxygen into the chamber to effect gasification of the waste; and
- (iv) removing the insulation and flushing the treated waste through the outlet and valve.

[0010] Hence, provision of the insulation protects valve and other components used during the flushing of the chamber after waste treatment.

[0011] A further waste treatment apparatus of the invention comprises:

- (i) a chamber to receive a waste;
- (ii) a heater to heat the waste in the chamber;
- (iii) an inlet for air;
- (iv) an outlet for exit of the treated waste from the chamber, connected via a conduit to a valve distal from the chamber, the valve controlling exit of waste from the outlet; and
- (v) a sump in which liquids collect and are prevented from flowing into the outlet.

[0012] A related process of the invention comprises

- (i) introducing plastic-containing waste into a chamber, wherein the chamber has an outlet for exit of treated waste connected via a conduit to a valve distal from the chamber, the valve controlling exit of waste from the outlet;
- (ii) treating the waste, e.g. by heating the waste to an elevated temperature to effect pyrolysis of the waste and/or introducing oxygen into the chamber to effect gasification of the waste; and

(iv) flushing the treated waste through the outlet and valve,

wherein the process is carried out using above apparatus such that liquid plastic collects in the sump.

[0013] Hence, liquid plastic can collect in the sump rather than be allowed to pass through the outlet; pipe-work blockage and damage to valve and other components due to contamination by plastics is reduced or prevented.

Detailed Description of the Invention

[0014] The invention thus provides a waste treatment apparatus, comprising:

- (i) a chamber to receive a waste;
- (ii) a heater to heat the waste in the chamber;
- (iii) an inlet for air;
- (iv) an outlet for exit of treated waste from the chamber, connected via a conduit to a valve distal from the chamber, the valve controlling exit of treated waste from the outlet; and
- (v) an insulating unit capable of (a) locating insulation between the outlet and the valve so that the valve is protected from heat from the chamber and (b) removing the insulation so that treated waste can exit the chamber via the valve.

[0015] The insulation typically comprises an aqueous solution, conveniently water. To provide the insulating effect, the unit may be connected to a supply of an aqueous solution and be arranged to fill part of the conduit with the aqueous solution, suitably prior to operation of the apparatus, and also suitably between uses of the apparatus for successive batches of waste. The insulating unit can also close the distal valve so that during treatment the insulation is present and the distal valve is closed, thus the outlet is sealed, and then for removal of treated waste via the outlet the insulation is removed and the distal valve is opened.

[0016] Preferably, a supply of aqueous solution, e.g. water, is connected to the chamber and operated by a control system so that treated waste is flushed from the chamber using the solution, e.g. water. A pump is preferably downstream of the distal valve to pump flushing water from the chamber; note that the distal valve may be part of or separate from the pump.

[0017] Further preferably, the apparatus has a supply of aqueous solution, again e.g. water, optionally separate from the supply mentioned immediately above, capable of filling the conduit between the outlet and the valve. In use, once the chamber is to be emptied the chamber is typically flushed with the solution, as described above. Using this supply, the whole of the conduit, from the valve to the outlet can be filled with the solution, priming the conduit and removing any air bubbles prior to draining of the chamber and/or pumping away the flushing solution.

[0018] The apparatus may also comprise a second valve, proximal to the outlet. In use, insulation is located the other side of this proximal valve, and the insulating unit is capable of locating the insulation between the proximal and distal valves. Waste to be treated can include various contaminants, and it is an option to close the proximal valve during initial heating stages, e.g. until temperature increase and high temperature duration has adequately reduced the microbial load of the waste; this reduces or prevents the risk that such contamination reach the water of the insulation and be shielded from the sterilizing effect of chamber heat.

[0019] In addition, the above apparatus may in effect incorporate or be provided with a sump in which liquids collect, suitably with a capacity of 5 litres or more, 10 litres or more, or 30 litres or more.

[0020] In general, the positioning of the outlet and/or associated pipework may mean that a portion of the base forms the sump, rather than there being a separate sump compartment.

[0021] The sump may be located with respect to the outlet so that the liquids are prevented from flowing into the outlet. The sump is typically located at a base of the chamber and may be associated with an outlet suitably raised so that liquids, such as plastic generated e.g. by treatment of plastic-containing material, collect in the sump rather than flow through the outlet and towards the valve.

[0022] The sump may alternatively be arranged with respect to the outlet and connecting pipework so that liquids may enter the outlet but are prevented from flowing to and reaching the valve. In an embodiment described below in more detail, the outlet is at the base of the chamber and the conduit comprises an inverted U bend raised above the base of the chamber. Hence, in use liquids accumulate in the sump and enter the outlet and an initial portion of the conduit; the liquid level can rise within acceptable limits but without reaching the U bend. Hence, flow into downstream portions of the pipework and all the way to the valve is prevented. The sump provides liquid accommodating capacity before the level in the sump reaches the raised U bend. The capacity of the sump is preferably such that it more than accommodates the anticipated liquid levels during use without those levels reaching the U bend. An advantage of having the outlet at the base is that during chamber flushing (described elsewhere) the base of the chamber can be drained completely between cycles.

[0023] Preferably, as illustrated in an example below, the conduit (also referred to as the flushing conduit) comprises, in order, an ascending portion, the inverted U bend and a descending portion. During waste processing the ascending portion can then be heated when the chamber is heated. This means that liquid plastic rising up the ascending portion remains liquid and can flow back when liquid levels drop during later stages of operation.

[0024] Preferably, at least the descending portion and all pipework downstream therefrom are outside the

chamber. More preferably, at least a portion of the U bend, optionally most of it or substantially all of it, is outside chamber - this reduces heating thereof by the chamber.

[0025] The apparatus suitably comprises a further conduit, a water injection line, connected to the descending portion of the flushing conduit having a one way valve and a water supply, capable of filling the descending portion and the flushing conduit all the way to the valve, and when the filling is continued capable of filling the remainder of the flushing conduit all the way to the outlet to remove air and prime the conduit ready for chamber flushing (as also described above).

[0026] The invention also provides a further waste treatment apparatus, comprising:

- (i) a chamber to receive a waste;
- (ii) a heater to heat the waste in the chamber;
- (iii) an inlet for air;
- (iv) an outlet for exit of the treated waste from the chamber, connected via a conduit to a valve distal from the chamber, the valve controlling exit of waste from the outlet; and
- (v) a sump in which liquids collect and are prevented from flowing into the outlet.

[0027] This apparatus omits the insulation; the sump of this apparatus is suitably as described elsewhere in relation to other apparatus of the invention.

[0028] Further provided by the invention is a process for waste treatment comprising:-

- (i) introducing waste into a chamber, wherein the chamber has an outlet for exit of treated waste connected via a conduit to a valve distal from the chamber, the valve controlling exit of waste from the outlet;
- (ii) locating insulation between the outlet and the valve;
- (iii) treating the waste, e.g. by heating the waste to an elevated temperature to effect pyrolysis of the waste and/or introducing oxygen into the chamber to effect gasification of the waste; and
- (iv) removing the insulation and flushing the treated waste through the outlet and valve.

[0029] Separately, the invention provides a process for waste treatment comprising:-

- (i) introducing plastic-containing waste into a chamber, wherein the chamber has an outlet for exit of treated waste connected via a conduit to a valve distal from the chamber, the valve controlling exit of waste from the outlet;
- (ii) treating the waste, e.g. by heating the waste to an elevated temperature to effect pyrolysis of the waste and/or introducing oxygen into the chamber to effect gasification of the waste; and
- (iv) flushing the treated waste through the outlet and

valve,

wherein the process is carried out using sump-containing apparatus of the invention such that liquid plastic collects in the sump.

[0030] The processes suitably comprise treating waste by pyrolysis at 400-700°C. They may comprise treating waste by gasification at a temperature of at least 400°C. A preferred process comprises both pyrolysis and gasification steps, in sequence and in the same chamber. More preferably, the process is carried out using apparatus as described elsewhere herein.

[0031] In a preferred embodiment of the invention, described below in an example, the apparatus uses water to flush treated waste, usually mainly ash, from the chamber via the outlet, through the distal valve and via associated pipework and into, say, the sewer. High pressure air is also an option. The distal valve is open for discharge of chamber contents. It is usual for the valve to be closed while waste is being treated. This helps seal the chamber if and when pyrolysis is carried out and more generally to ensure that off gases exit the chamber via a designated exhaust outlet and are processed appropriately e.g. to remove noxious components.

[0032] When the chamber of the prior art is processing waste e.g. during pyrolysis or gasification steps, extreme chamber heat is conducted through structure of the apparatus or convected by hot gases in the chamber to the valve etc. Also during use of the prior art chamber, liquid plastic migrates out of the chamber and through outlet pipework, causing blockage and damage e.g. to valves. These problems alone and in combination are believed hitherto unknown. The invention provides solutions to these.

[0033] The invention provides for operating such processes while insulating the valve from the heat and provides for reducing such plastic migration. Further the invention provides one or more advantages, including one or more or all of reducing migration of plastic, both liquid and gaseous, to valve and pump components, hence reducing blockage and damage, allowing use of lower cost components. The invention can keep valve and pump parts relatively cool in use despite high temperatures in the chamber, preventing damage and again allowing use of lower cost components. For example, it is now an option to choose a valve and pump in which the drain pump impeller does not need to form part of the valve.

[0034] As a result of the invention lifetime of valve and related components, pump etc can be significantly increased, with reduced damage and malfunction and reduced need for repair.

[0035] Using a water column additionally can provide a highly effective gas seal of the outlet, it being intended that off gases exit only via a designated exhaust port.

[0036] A further advantage of the invention is that one possible approach to dealing with chamber heat reaching the valve is to use high temperature valves, but these would be expensive and need regular servicing, and the

invention avoids that.

[0037] Embodiments of the invention are also provided as follows:

1. A waste treatment apparatus, comprising: 5
 - (i) a chamber to receive a waste;
 - (ii) a heater to heat the waste in the chamber;
 - (iii) an inlet for air;
 - (iv) an outlet for exit of treated waste from the chamber, connected via a conduit to a valve distal from the chamber, the valve controlling exit of treated waste from the outlet; and 10
 - (v) an insulating unit capable of (a) locating insulation between the outlet and the valve so that the valve is protected from chamber heat and 15
 - (b) removing the insulation so that treated waste can exit the chamber.
2. Apparatus according to embodiment 1, wherein the insulation comprises an aqueous solution. 20
3. Apparatus according to embodiment 2, wherein the insulating unit is connected to a supply of an aqueous solution and can fill part of the conduit with the aqueous solution. 25
4. Apparatus according to any preceding embodiment, wherein the insulating unit can close the distal valve.
5. Apparatus according to any preceding embodiment, comprising a water supply connected to the chamber and a control system so that treated waste can be flushed from the chamber using water. 30
6. Apparatus according to any preceding embodiment, comprising a water supply, optionally separate from the water supply of embodiment 5, capable of filling the conduit between the outlet and the valve. 35
7. Apparatus according to any preceding embodiment, comprising a pump downstream of the distal valve to pump water from the chamber.
8. Apparatus according to any preceding embodiment, comprising a second valve, proximal to the outlet and wherein the insulating unit is capable of locating the insulation between the proximal and distal valves. 40
9. Apparatus according to any preceding embodiment, comprising a sump in which liquids in the chamber collect and are prevented from flowing via the outlet to the valve. 45
10. Apparatus according to embodiment 9, wherein the sump is located at a base of the chamber and associated with the outlet so that liquid plastic collects in the sump rather than flow through the outlet and towards the proximal and/or distal valves. 50
11. Apparatus according to embodiment 9 or 10, wherein the outlet is located at the base of the chamber and the conduit comprises an inverted U bend raised above the base of the chamber. 55
12. Apparatus according to embodiment 11, wherein

the conduit comprises, in order, an ascending portion, the inverted U bend and a descending portion, and wherein the ascending portion is heated when the chamber is heated.

13. A waste treatment apparatus, comprising:
 - (i) a chamber to receive a waste;
 - (ii) a heater to heat the waste in the chamber;
 - (iii) an inlet for air;
 - (iv) an outlet for exit of treated waste from the chamber, connected via a conduit to a valve distal from the chamber, the valve controlling exit of waste from the outlet; and
 - (v) a sump in which liquids collect and are prevented from flowing via the outlet to the valve.
14. Apparatus according to embodiment 13, wherein the sump is located at a base of the chamber and associated with the outlet so that liquid plastic collects in the sump rather than flow through the outlet and towards the valve.
15. Apparatus according to embodiment 13 or 14, wherein the outlet is located at the base of the chamber and the conduit comprises an inverted U bend raised above the base of the chamber.
16. Apparatus according to embodiment 15, wherein the sump has a capacity of 10 litres or more before the level of liquid in the sump reaches the inverted U bend.
17. Apparatus according to embodiment 15 or 16, wherein the conduit comprises, in order, an ascending portion, the inverted U bend and a descending portion, and wherein the ascending portion is heated when the chamber is heated.
18. A process for waste treatment comprising:-
 - (i) introducing waste into a chamber, wherein the chamber has an outlet for exit of treated waste connected via a conduit to a valve distal from the chamber, the valve controlling exit of waste from the outlet;
 - (ii) locating insulation between the outlet and the valve;
 - (iii) treating the waste, e.g. by heating the waste to an elevated temperature to effect pyrolysis of the waste and/or introducing oxygen into the chamber to effect gasification of the waste; and
 - (iv) removing the insulation and flushing the treated waste through the outlet and valve.
19. A process according to embodiment 18, comprising treating waste by pyrolysis at 400-700°C.
20. A process according to embodiment 18 or 19, comprising treating waste by gasification at a temperature of at least 400°C.
21. A process according to any of embodiments 18 to 20, wherein the insulation comprises an aqueous solution.

22. A process according to embodiment 21, comprising filling a part of the conduit with the aqueous solution.

23. A process according to any of embodiments 18 to 22, wherein (ii) comprises closing the distal valve.

24. A process according to any of embodiments 18 to 23, wherein (iv) comprises flushing treated waste from the chamber using water.

25. A process according to embodiment 24, wherein (iv) comprises backfilling the conduit with water to prime the conduit for flushing treated waste from the chamber using water.

26. A process according to any of embodiments 18 to 25, wherein the chamber comprises a second valve, proximal to the outlet and wherein the process comprises closing the valve at least until after an initial period of heat treatment of the waste.

27. A process according to any of embodiments 18 to 26, carried out using apparatus according to any of embodiments 1 to 12.

27. A process for waste treatment comprising:-

(i) introducing plastic-containing waste into a chamber, wherein the chamber has an outlet for exit of treated waste connected via a conduit to a valve distal from the chamber, the valve controlling exit of waste from the outlet;

(ii) treating the waste, e.g. by heating the waste to an elevated temperature to effect pyrolysis of the waste and/or introducing oxygen into the chamber to effect gasification of the waste; and
(iv) flushing the treated waste through the outlet and valve,

wherein the process is carried out using apparatus according to any of embodiments 13 to 17 such that liquid plastic collects in the sump.

[0038] The invention is now illustrated in specific examples, with reference to the accompanying drawings, in which:

Fig. 1 shows a schematic view of a portion of a waste treatment chamber incorporating modification as per a first embodiment of the invention; and

Fig. 2 shows a schematic view of a chamber of a waste treatment chamber incorporating modifications as per a second embodiment of the invention.

Examples

[0039] Referring to fig. 1, detail is shown of modification by the invention to known waste treatment apparatus. This known apparatus is described e.g. in WO 2011/033113, WO 2010/073008 and WO 2007/104954, all of which are referred to for more specific detail and incorporated by reference. Briefly, such apparatus can treat waste by a combination of pyrolysis and gasification

and have a sealable chamber, a waste treatment zone in the chamber, a port for introducing waste into the chamber, a port (outlet) for the exit of treated waste, a heating element (e.g. electric or gas or other), means for cooling the chamber (such as water injector(s)), means for admitting water to the chamber to flush treated waste (ash) from the chamber (which optionally uses the same injector(s)) and a connection to e.g. a drain or sewer so that the treated waste can be flushed away into the sewage system. The maximum volume of the chamber is generally up to 2.0 m³ or up to 0.5 m³.

[0040] A control system is configured to control the apparatus to carry out the treatment process, which comprises introducing waste into the chamber, heating the waste to an elevated temperature to effect pyrolysis of the waste, then introducing oxygen into the chamber (usually as air) to effect gasification of the waste, cooling the chamber (passively or actively), and flushing the gasified waste from the chamber with water, wherein the temperature to effect pyrolysis is from 300-800°C and the temperature to effect gasification is at least 300°C.

[0041] In fig.1 only a partial section of a waste treatment apparatus is illustrated, and fig. 1 shows a lower portion of a chamber 100 at the base of which is located a sump 101 formed by the lower region of the chamber in combination with a flushing water outlet 102 raised above the level of that region. This outlet links the chamber contents via conduit 104, incorporating inverted U bend 103, to distal valve 106. Downstream of the distal valve is further conduit 107 and pump 108 which pumps flushing water carrying treated waste (ash) via further pipe 109 to the drain or sewer.

[0042] The system is operated in a first mode during waste treatment. In this first, insulating mode, the conduit upstream of the distal valve is filled with water to a level part of the way up or all the way up towards the inverted U bend. This provides a water column or water lock that is a gas seal between the chamber and the valve and also insulates the valve and other elements from chamber heat, e.g. convection by hot chamber gases and conduction through hot chamber and conduit sections. The conduit is thus closed and sealed, and neither gas nor treated waste can escape through the conduit to the valve and into the drain. In this mode the distal valve is preferably closed though this may not be necessary as the conduit is effectively sealed by the insulation water and having the pump turned off. It has been found that during operation effective insulation is achieved; some water may evaporate and the water generally does not need to be topped up but this is optional.

[0043] In a second mode, after the end of gasification the insulating water is removed and the distal valve is open; this can be achieved by opening the distal valve and operating the pump to pump the insulating water to the drain. Treated waste is then flushed from the chamber and pumped away to the drain through the outlet via the valve. This occurs generally after at least some chamber cooling either by allowing the chamber to cool or more

actively cooling chamber by introducing water and/or steam into the chamber, and then more water or high pressure air to flush away the ash.

[0044] Provision of the sump means liquid plastics collect during waste treatment, rather than entering the outlet and conduit and causing damage as described, and can then be removed between waste processing operations. The sump is of sufficient volume that it need only be emptied periodically and not after every operation.

[0045] Referring to fig. 2, detail is shown of modification by a further embodiment of the invention to known waste treatment apparatus. Again, the apparatus 210 treats waste by a combination of pyrolysis and gasification and has a sealable chamber (via lid 213), a waste treatment zone 215 in the chamber, a port 213 for introducing waste into the chamber, an exhaust outlet 218, a port (outlet) 202 for the exit of treated waste, a heating element (e.g. electric or gas or other) which in this case is divided into a top heater element 212, a middle heater element 214 and a base heater element 216, means for cooling the chamber (such as water injector(s)), means 231 for admitting water to the chamber to flush treated waste (ash) from the chamber (which optionally uses the same injector(s)) and a connection 209 to e.g. a drain or sewer so that the treated waste can be flushed away into the sewage system. The maximum volume of the chamber is generally up to 2.0 m³ or up to 0.5 m³. The apparatus also has temperature sensor 230, air and water injection port 231, base temperature sensor 232, base heater temperature sensor 233, chamber basket 234 to hold waste and chamber insulation 235.

[0046] A control system is configured to control the apparatus to carry out the treatment process as per the embodiment of fig. 1.

[0047] Fig. 2A shows a schematic section of a waste treatment apparatus, with fig 2B providing expanded detail of the inverted U bend and associated pipework to illustrate heating of an internal portion of the line and no heating of an external portion. In contrast to the embodiment of Fig. 1 the U bend is thus largely (and can be in further variants wholly) outside the chamber. Fig. 2A shows the chamber 200 at the base of which is located a sump 201 formed by the lower region of the chamber in combination with a flushing water outlet 202. This outlet opens into the flushing conduit which has ascending line 220 which connects via inverted U bend 203 raised above the level of the lower chamber region and then descending portion and conduit continuation 204, to distal (and normally closed) valve 206. Downstream of the distal valve is further conduit continuation 207 and chamber drain pump 208 which pumps flushing water carrying treated waste (ash) via further pipe 209 to the drain or sewer. Together, outlet 202, U bend 203 and conduits 220, 204, 207 and 209 form a chamber drain line.

[0048] Ascending portion 220 is located so that it becomes hot when the chamber is heated by base heater 216; in use this pipework remains hot and liquid plastics entering e.g. during pyrolysis of waste remain liquid and

drain away when the liquid plastic level drops during waste processing e.g. gasification. Liquid level may also increase during warm up and early pyrolysis as solid plastics melt and may decrease later in pyrolysis as the melted plastic becomes volatile in which case the level should decline before gasification begins. Referring to Fig. 2B in particular, the full vertical section of the ascending portion of the tube is entirely within the chamber, rather than in the insulation, so the hole in the wall of the chamber allowing the tube to exit the chamber corresponds to / is at the top of the inverted U-bend. Descending portion 204 is located outside of the chamber to minimise transfer of chamber heat to the insulating water column in this portion of the drain line.

[0049] A water injection line 222 with one way valve 236 connects the descending portion 204 close to where it meets the inverted U bend 203 to a water supply (not shown) via normally closed valve 224.

[0050] The system is operated in a first mode during waste treatment. In this first, insulating mode, the conduit 204 upstream of the distal valve is filled with water from injection line 222 to a level most of the way up and generally to the level of the inverted U bend. This provides a water column or water lock that is a gas seal between the chamber and the valve and also insulates the valve and other elements from chamber heat, e.g. convection by hot chamber gases and conduction through hot chamber and conduit sections. The conduit is thus closed and sealed, and neither gas nor treated waste can escape through the conduit to the valve and into the drain. In this mode the distal valve is preferably closed though this may not be necessary as the conduit is effectively sealed by the insulation water and having the pump turned off. It has been found that during operation effective insulation is achieved; some water may evaporate and the water generally does not need to be topped up but this is optionally achieved using the fill line: temperature sensor 225 monitors and reports temperature in the conduit 204. An increase in temperature above a prescribed limit triggers further supply of cold water into this region, e.g. if pipework has gotten too hot.

[0051] In a second mode, after the end of gasification the insulating water can be removed as for the embodiment of fig. 1. Another option for the fig. 2 apparatus is to supply further water via fill line 222 to backflush air etc from the inverted U bend and the ascending side 220 of the drain line, filling the line from the valve 206 all the way to the chamber, priming the line ready for draining when flushing water is introduced into the chamber. During flushing the distal valve 206 is open and pump 208 pumps water in the drain line and flushing water out of the chamber. After draining / flushing is complete, pump 208 is turned off and water fill line 222 used again to provide the insulating water column upstream of the valve ready for a next cycle of operation.

[0052] Provision of the sump with the heated conduit ascending portion means liquid plastics drain back into the sump when plastic levels reduce, rather than entering

the outlet and cooling and blocking the drain line. The water fill line enables provision of the insulating water column upstream of the valve 206 and then priming of the drain line for efficient chamber flushing.

[0053] The invention hence provides waste disposal apparatus.

Claims

1. A waste treatment apparatus, comprising:

- (i) a chamber to receive a waste;
- (ii) a heater to heat the waste in the chamber;
- (iii) an inlet for air;
- (iv) an outlet for exit of treated waste from the chamber, connected via a conduit to a valve distal from the chamber, the valve controlling exit of treated waste from the outlet; and
- (v) an insulating unit capable of (a) locating insulation between the outlet and the valve so that the valve is protected from chamber heat and (b) removing the insulation so that treated waste can exit the chamber.

2. Apparatus according to claim 1, wherein the insulation comprises an aqueous solution, e.g. water.

3. Apparatus according to claim 2, wherein the insulating unit is connected to a supply of the aqueous solution and can fill part of the conduit with the aqueous solution.

4. Apparatus according to any preceding claim, wherein the insulating unit can close the distal valve.

5. Apparatus according to any preceding claim, comprising a supply of aqueous solution, e.g. water, connected to the chamber and a control system so that treated waste can be flushed from the chamber using the solution.

6. Apparatus according to claim 5, comprising a supply of aqueous solution, e.g. water and optionally separate from the supply of claim 5, capable of filling the conduit between the outlet and the valve, to assist flushing of the chamber.

7. Apparatus according to any preceding claim, comprising a pump downstream of the distal valve to pump the solution, e.g. water, from the chamber.

8. Apparatus according to any preceding claim, comprising a sump in which liquids in the chamber collect and are prevented from flowing via the outlet to the valve.

9. Apparatus according to claim 8, wherein the outlet

is located at the base of the chamber and the conduit comprises an inverted U bend raised above the base of the chamber.

10. A process for waste treatment comprising:-

- (i) introducing waste into a chamber, wherein the chamber has an outlet for exit of treated waste connected via a conduit to a valve distal from the chamber, the valve controlling exit of waste from the outlet;
- (ii) locating insulation between the outlet and the valve;
- (iii) treating the waste, e.g. by heating the waste to an elevated temperature to effect pyrolysis of the waste and/or introducing oxygen into the chamber to effect gasification of the waste; and
- (iv) removing the insulation and flushing the treated waste through the outlet and valve.

11. A process according to claim 10, comprising treating waste by pyrolysis at 400-700°C and / or comprising treating waste by gasification at a temperature of at least 400°C.

12. A process according to any of claims 10 to 11, wherein the insulation comprises an aqueous solution and the process comprises filling a part of the conduit with the aqueous solution.

13. A process according to any of claims 10 to 12, wherein (iv) comprises flushing treated waste from the chamber using water.

14. A process according to claim 13, wherein (iv) comprises backfilling the conduit with water to prime the conduit for flushing treated waste from the chamber using water.

15. A process according to any of claims 10 to 14, carried out using apparatus according to any of claims 1 to 9.

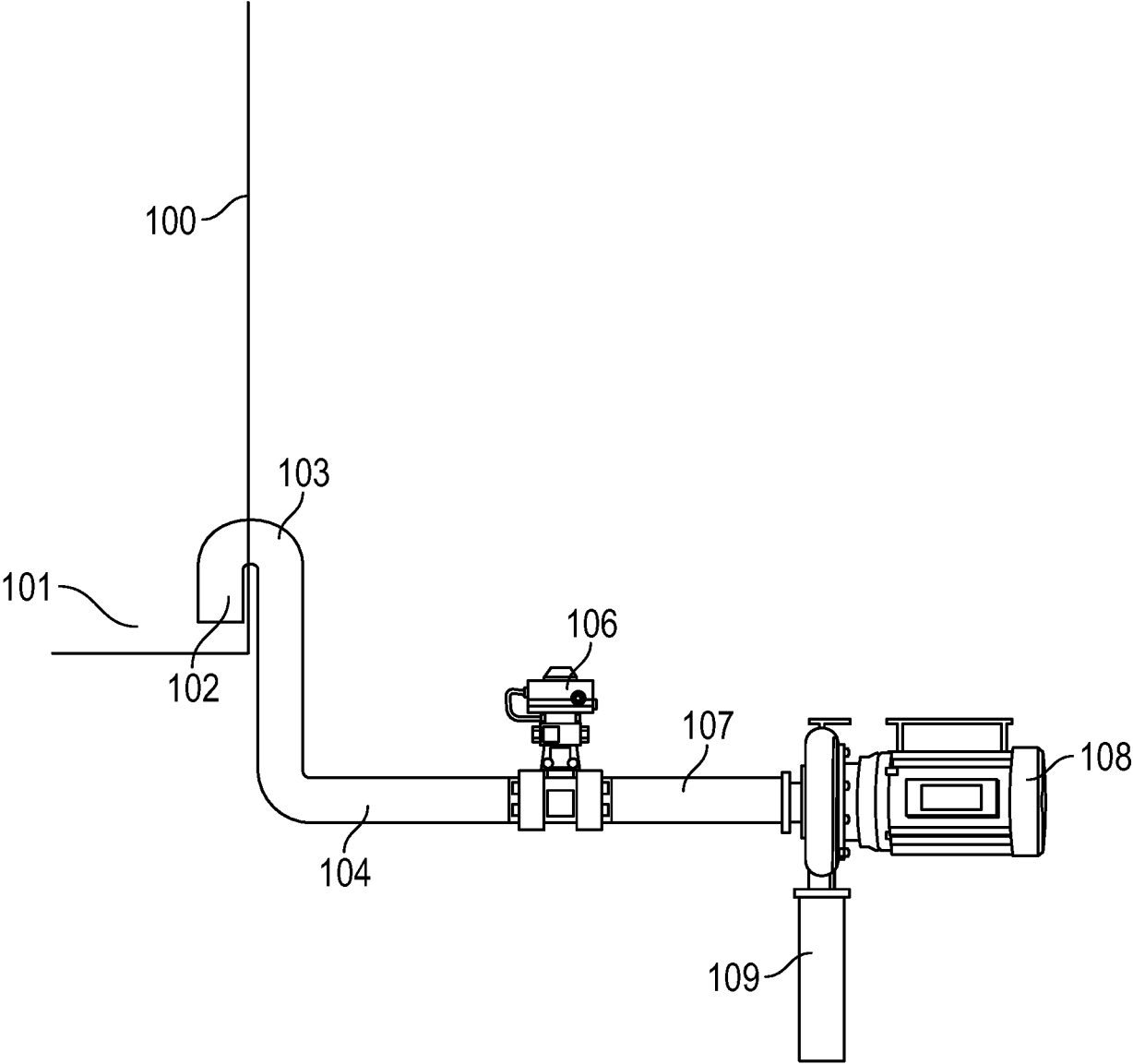


FIG. 1

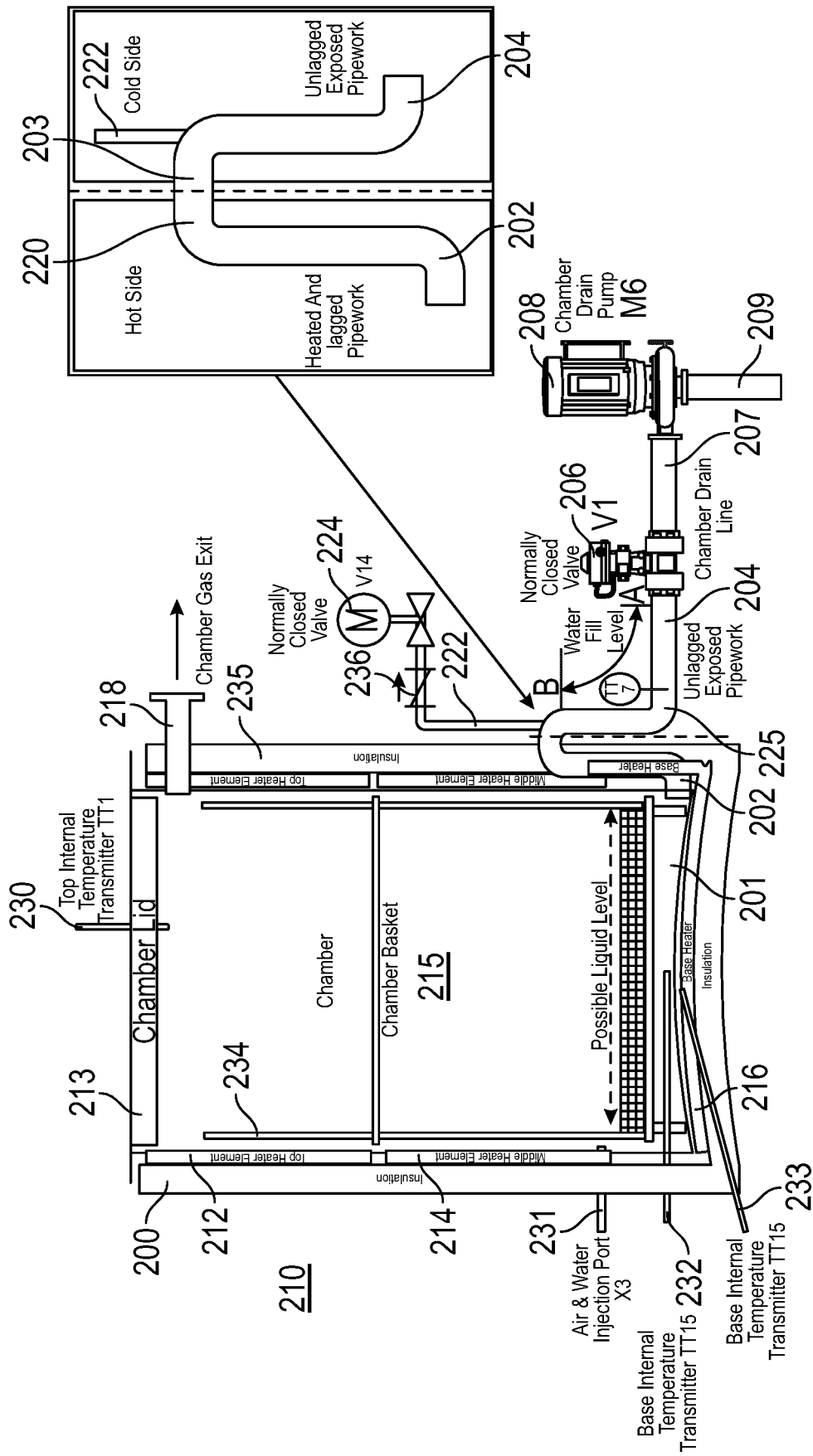


FIG. 2



EUROPEAN SEARCH REPORT

 Application Number
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DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X,D	WO 2007/104954 A2 (MORGAN EVERETT LTD [GB]; CLARKE HOWARD MORGAN [GB]; ELDER MICHAEL BENJ) 20 September 2007 (2007-09-20) * page 20; claim 1; figure 1 *	1-8, 10-15	INV. F23J9/00 F23J1/08 F23G5/00
A	* page 20; claim 1; figure 1 *	9	
A	US 1 957 583 A (FORESMAN ROBERT A) 8 May 1934 (1934-05-08) * lines 100-116 - page 1; figure 1 *	9	
A,D	WO 2010/073008 A2 (PYROPURE LTD [GB]; CLARKE HOWARD MORGAN [GB]; BARTL PETER [GB]) 1 July 2010 (2010-07-01) * the whole document *	1-15	
			TECHNICAL FIELDS SEARCHED (IPC)
			F23J F23G
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 27 July 2018	Examiner Christen, Jérôme
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	

 1
 EPO FORM 1503 03.02 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 18 15 7487

5 This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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27-07-2018

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2007104954 A2	20-09-2007	AU 2007226354 A1	20-09-2007
		BR PI0708723 A2	07-06-2011
		CA 2645346 A1	20-09-2007
		CN 101400948 A	01-04-2009
		EP 2005064 A2	24-12-2008
		ES 2586582 T3	17-10-2016
		GB 2441700 A	12-03-2008
		HK 1129444 A1	07-02-2014
		JP 5343187 B2	13-11-2013
		JP 2009529421 A	20-08-2009
		KR 20080113209 A	29-12-2008
		MY 144513 A	30-09-2011
		US 2009071382 A1	19-03-2009
		US 2013047901 A1	28-02-2013
		US 2016109120 A1	21-04-2016
		US 2018073735 A1	15-03-2018
		WO 2007104954 A2	20-09-2007
		ZA 200807619 B	27-01-2010

US 1957583 A	08-05-1934	NONE	

WO 2010073008 A2	01-07-2010	CY 1114042 T1	27-07-2016
		DK 2373927 T3	10-06-2013
		EP 2373927 A2	12-10-2011
		ES 2411684 T3	08-07-2013
		GB 2478238 A	31-08-2011
		HR P20130438 T1	30-06-2013
		PT 2373927 E	20-06-2013
		SI 2373927 T1	31-07-2013
		US 2011311423 A1	22-12-2011
		US 2016045865 A1	18-02-2016
		US 2017173528 A1	22-06-2017
		WO 2010073008 A2	01-07-2010

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- WO 2011033113 A [0002] [0039]
- WO 2010073008 A [0002] [0039]
- WO 2007104954 A [0002] [0039]