

MACERATOR

Technical Field

The present invention provides a macerator for macerating waste material. The present invention further provides a method of macerating the waste material.

Background

In conventional toilets, a large volume of water is used to complete a flush cycle to remove waste material from the bowl. Furthermore, such systems are inefficient and ill-equipped to deal with large quantities of waste material and/or waste material that is bulky and needs to be broken down to prevent blockage of pipes.

In certain circumstances, waste disposal facilities are required. For example, medical facilities (such as hospitals) often utilise sluicerooms with macerator devices to hygienically dispose of human waste (such as faeces, vomit and urine) as well as the single-use receptacles in which they are contained such as disposable bedpans, washbowls and urinals. The ability to be able to dispose of single-use receptacles with the waste contained therein provides a significantly more hygienic option than using reusable receptacles (such as stainless steel or plastic bed pans) as the need to clean and sterilise the receptacles is eradicated, thus minimising unpleasant tasks for healthcare professionals (freeing up more time for patient care) as well as reducing instances of cross-contamination or infection (from ineffectual cleaning).

Previous macerators known in the art mix effluent with water to produce an effluent that is drained through the sewage system. During the operating cycle, water is typically fed continuously into a macerating chamber as the macerator motor continuously operates. Typically, such devices have a cylindrical chamber with a chopping mechanism arranged at the bottom, typically on the perimeters of a disc or in a concentric or annular arrangement to allow progressive reduction until the small particles were of sufficient size to allow discharge.

Macerators known in the art are often very resource inefficient, requiring several litres of water in a cycle and requiring large amounts of energy. It is an object of the present invention to provide a macerator that has improved resource efficiency.

Summary of Invention

In a first aspect of the present invention, a macerator is provided. The macerator comprising:

- a chamber for receiving waste material to be macerated, wherein the chamber comprises:
 - a chopping system for chopping the waste material;
 - a fluid inlet for inputting a fluid into the chamber; and
 - a drain outlet for outputting an effluent formed by the waste material and the fluid from the chamber; and
- a sensor in fluid communication with, and downstream of, the drain outlet, wherein the sensor is configured to measure a characteristic of the effluent; and
- a controller configured to:
 - initiate a maceration cycle;
 - receive sensor data from the sensor, wherein the sensor data represents the characteristic measured by the sensor; and
 - modify the maceration cycle based on the sensor data.

The present invention thus provides a macerator device that may be used to macerate waste material (such as human waste and/or single-use receptacles) to provide an effluent (e.g. a pulp or slurry comprising the chopped waste material suspended in the fluid) which may be passed into a drain system via a drain outlet in the chamber. The provision of the sensor in communication with the drain outlet allows characteristics associated with the effluent to be measured. In so doing, the maceration cycle (e.g. comprising inserting water into the chamber and chopping the waste material) may be modified (e.g. shortened) based on the characteristics associated with the effluent being outlet. For example, if the effluent material comprises a low concentration of waste material (and thus the effluent material is substantially clear fluid) it may be indicated that further maceration is unnecessary and thus the maceration cycle may be modified to finish (or start a winding down or finishing phase). As such, in contrast to macerators that have fixed maceration cycles (e.g. usually pre-set cycles that can be based on a pre-determined quantity or number of waste material items), where there may be significant excess fluid used to ensure that all of the material is macerated within the cycle, the present invention allows the cycle to use the minimum amount of fluid and energy by modifying the maceration cycle based on the detected output from the maceration chamber. As such, the present invention provides a more resource (energy and fluid) and time efficient macerator.

The sensor may be any suitable and/or desirable sensor configured to measure any suitable and/or desirable measurable characteristic. For example, the measurable characteristic may

be concentration, turbidity, colour (e.g. absorbance), conductivity, resistivity, flow rate, (fluid) pressure or object detection or any other suitable measurable characteristic. As such, the sensor may, for example, be selected to be one or more of an optical sensor (e.g. for use with a light source to provide an absorption or reflectance spectroscopy measurement), a conductivity sensor, a resistivity sensor, a flow meter or flow rate sensor, a pressure sensor or a capacitive sensor. The characteristic measured by the sensor importantly must change as a function of the amount of waste material present in the effluent such that the change from a highly concentrated effluent (comprising a large quantity of waste material near the beginning of a cycle) to a low concentration or clear effluent (substantially fluid with little to no waste material near the end of a cycle) may be detected.

Optionally, the sensor comprises (e.g. is) a pressure sensor or a flow rate sensor. For example, a pressure sensor or a flow rate sensor may be used to detect a change in the flow rate of the effluent being output from the drain outlet. For example, at the beginning of a cycle, when the amount of waste material in the effluent is high, the flow rate of the effluent would be lower and thus the pressure of the effluent would be higher (due to the heavier waste material relative to water). Then, as the cycle continues and the amount of waste material in the effluent begins to decrease, the flow rate of the effluent would increase and the pressure of the effluent would decrease.

Optionally, the sensor comprises (e.g. is) a sensor configured to emit electromagnetic radiation, e.g. an optical sensor. Optionally, the sensor is a sensor configured to detect electromagnetic radiation. Optionally, the sensor is configured to detect changes in the electromagnetic radiation emitted, e.g. an optical sensor. For example, the sensor may compare electromagnetic radiation received (e.g. reflected) to the electromagnetic radiation emitted to determine a change in the signal (e.g. amplitude, e.g. phase, e.g. absorption).

Optionally, the sensor is a sensor for detecting solid material or objects (e.g. the solid waste material suspended in the fluid). For example, the sensor may be a capacitive sensor configured to detect the presence of an object (e.g. the waste material), such as a capacitive proximity sensor. Any suitable and/or desirable capacitive (proximity) sensor may be used.

Optionally, the (e.g. capacitive) sensor is configured to measure the presence of waste material within a pre-set range (e.g. sensing operating distance) of the sensor. Preferably, the sensing operating distance is tuneable or variable. Optionally, the capacitive sensor has an operating distance of from 1 mm to 20 mm, e.g. from 1 mm to 10 mm, e.g. from 1 mm to 5 mm, e.g. from 1 mm to 4 mm, e.g. from 1 mm to 3 mm, e.g. from 1 mm to 2 mm.

Preferably the capacitive sensor can detect objects (e.g. has an operating distance) that are present across the full width of a conduit through which the effluent flows (e.g. extending from the drain outlet of the chamber to a macerator outlet). The operating distance is thus defined at the threshold distance at which the presence of an object (e.g. solid waste material) would not be detected by the sensor (e.g. the change in the signal would fall within the noise of the sensor data).

Optionally, the sensor data output from the (e.g. capacitive) sensor represents a frequency at which (e.g. solid) waste material is detected within the effluent output from the drain outlet. For example, the (e.g. capacitive) sensor may be configured to count the number of times an object (e.g. solid waste material) is detected within the operating distance within a pre-set period of time. As such, the frequency measurement by the sensor may be considered to correspond to a pseudo-concentration of waste material in the effluent. As such, as the frequency of detected material decreases, the lower the concentration of waste material there is in the effluent and the clearer (e.g. tending towards being formed from substantially 100% fluid) the effluent becomes.

Optionally, sensor data is calibrated or standardized. For example, the sensor data is compared to or calibrated against sensor data measured from pure fluid running out of the drain outlet (e.g. without any waste material suspended therein). As such, the sensor data recorded during the macerator cycle may be compared to a pre-set frequency threshold value (e.g. a calibration threshold, e.g. a value associated with 100% fluid measurements) to determine whether waste material is present within the effluent and being output from the macerator chamber.

Optionally, the (e.g. capacitive) sensor comprises a probe (e.g. an electrode or plate). Preferably the probe is positioned within a conduit extending from the drain outlet of the chamber to a macerator outlet (e.g. which may be in contact with a sewage line or drain). Optionally, the probe (e.g. electrode or plate) may be in contact with the effluent material. Optionally, the probe may not be in physical contact with the effluent material.

Optionally, the chopping system is formed by one or more blades configured to chop the waste material into a plurality of pieces. Optionally, the chopping system is connected to a motor that is configured to rotate the one or more blades and thus chop waste material contacting therewith. Optionally, the chopping system comprises a primary chopper, wherein the primary chopper has one or more (e.g. two, e.g. three, e.g. four, e.g. a primary set of) blades configured to chop the waste material into a plurality of pieces. The one or more (e.g.

primary set of) blades may be configured to extend out radially from a central position (e.g. a central blade body), wherein the axis of the blades lie in substantially the same plane.

Optionally, the one or more blades of the primary chopper are distributed evenly around a central blade body. For example, a primary chopper comprising three blades extending from a central blade body may have each of the three blades arranged at approximately 120° with respect to the other blades of the primary chopper. For example, a primary chopper comprising four blades extending from a central blade body may have each of the four blades arranged at approximately 90° with respect to the other blades of the primary chopper.

Optionally, the chopping system further comprises a secondary chopper comprising one or more (e.g. two, e.g. three, e.g. four, e.g. a secondary set of) blades. The one or more blades may be configured to extend out radially from a central position (e.g. a central blade body), wherein the axis of the blades lie in substantially the same plane. Optionally, the one or more blades of the secondary chopper are distributed evenly around a central blade body. Preferably, the secondary chopper has the same number of blades as the primary chopper. For example, a chopping system having a primary chopper comprising three blades and a secondary chopper having three blades (wherein both sets of blades extend out from a central blade body) may have each of the three primary blades arranged at approximately 120° with respect to the other blades of the primary chopper and each of the three secondary blades arranged at approximately 120° with respect to the other blades of the primary chopper, wherein the primary blades and the secondary blades are offset from each other by 60° . For example, a chopping system having a primary chopper comprising four blades and a secondary chopper having four blades (wherein both sets of blades extend out from a central blade body) may have each of the three primary blades arranged at approximately 90° with respect to the other blades of the primary chopper and each of the three secondary blades arranged at approximately 90° with respect to the other blades of the primary chopper, wherein the primary blades and the secondary blades are offset from each other by 45° .

Optionally, the chopping system (e.g. the primary chopper and, optionally, the secondary chopper) is arranged to be proximate to the drain outlet. For example, the (e.g. primary and/or secondary) blades may be configured to skim the walls of the macerator chamber around the drain outlet. As such, only material that is small enough to pass through the chopping system may form part of the effluent that is passed out of the drain outlet.

Optionally, the primary set of blades of the primary chopper extend out further radially than the secondary set of blades of the secondary chopper. For example, the length of the blades of the primary chopper may be from 5 to 25 cm, e.g. from 10-15 cm. For example, the length of the blades of the secondary chopper may be from 1 cm to 7 cm, e.g. preferably from 3 cm to 6 cm. In such embodiments (e.g. when the chopper comprises a primary chopper with a secondary chopper provided at a more radially inward position) the primary chopper may be considered to provide a plurality of pieces having a first size (which can then pass through the primary chopper) and the secondary chopper may be considered to provide a plurality of pieces having a second size (which can then pass through the secondary chopper and out through the drain outlet), wherein the second size is smaller than the first size. In other words, the primary chopper chops the waste material into a plurality of chunky pieces whilst the secondary chopper chops the chunky pieces into a plurality of smaller pieces that may pass through the macerator without causing blockages. This provides a more efficient chopping system.

Optionally, each of the primary set of blades (e.g. of the primary chopper) comprise a tip portion that extends out of the plane defined by the axis of the blades (wherein the central blade body may also lie in the plane defined by the axis of the blades). Optionally, each of the secondary set of blades (e.g. of the primary chopper) comprise a tip portion that extends out of the plane defined by the axis of the blades (wherein the central blade body may also lie in the plane defined by the axis of the blades). Optionally, the tips of the primary set of blades and the tips of the secondary set of blades extend in opposing directions. Optionally, the tips of the primary set of blades extend towards the centre (or macerating volume) of the chamber. As such, the primary set of blades act to chop the waste material into large pieces. Optionally, the tips of the secondary set of blades extend away from the centre of the chamber, e.g. towards the drain outlet. As such, the secondary set of blades act to further chop the pieces that are small enough to pass through the primary set of blades into smaller pieces.

Optionally, the macerator further comprises a lid. Optionally, the lid is configured to seal the chamber, e.g. provide an enclosed macerator volume (i.e. the volume in which the effluent is generated) defined by the chamber and the lid. Optionally, the chamber is disposed within (e.g. enclosed by, e.g. held within) a housing. Optionally, the lid is coupled to the housing. Optionally, the lid is pivotably attached to the housing and is movable between a closed position and an open position.

Optionally the lid is in communication with an opening mechanism. For example, the opening mechanism may be a foot pedal, wherein when force is applied to the foot pedal (e.g. by a user's foot) the lid of the macerator is opened (e.g. by upwards movement of a rod connected to the lid and the foot pedal, or any other suitable and/or desirable means). Additionally or alternatively, the opening mechanism may comprise a non-contact switch which, when activated, causes the lid of the macerator to open. For example, the non-contact switch may comprise a capacitive sensor or an infrared sensor for detecting the presence of a user (e.g. their hand or foot). The sensor may be located in any suitable and/or desirable place on the macerator. For example, the sensor may be located near the base of the macerator to detect the presence of a foot or a leg of a user. For example, the sensor may be located near the top of the macerator (e.g. proximate to the lid) and may be used to detect the presence of a user's torso or hand.

For example, the macerator may comprise an IR sensor configured to open the lid when an object (e.g. a users hand, foot or other body part) is detected within a detection range of the IR sensor. Optionally, the detection range may be less than or equal to 15 cm, e.g. from 0.5 cm to 15 cm, e.g. from 1 cm to 13 cm, e.g. from 2 cm to 10 cm, e.g. from 5 cm to 8 cm.

For example, the macerator may comprise a beam sensor or ultrasonic sensor, wherein the beam sensor or ultrasonic sensor are configured to open the lid when an object (e.g. a users hand, foot or other body part) is detected. An object may be detected by a beam sensor when the beam is interrupted or broken and thus the signal detected by a receiver is altered. An object may detected by an ultrasonic sensor when the echo (e.g. reflected signal) of an emitted beam is detected at a receiver.

Optionally, the opening mechanism may be in communication with the controller of the macerator. In other words, the opening mechanism may be controllable by the controller. For example, the controller may be configured to actuate the opening mechanism to open the lid (and thus provide access to the chamber). For example, the controller may be configured to actuate the opening mechanism (e.g. upon receipt of a signal indicating that an object has been detected) to open the lid. Similarly, the controller may be configured to hold the lid open. For example, the controller may be configured to deactivate the opening mechanism to close the lid. Optionally, the controller may be configured to actuate the opening mechanism in response to a signal received from the non-contact switch indicating the presence of a user or in response to a manual input, such as the press of a button or the press of a foot pedal. Optionally the controller may be configured to hold the lid open for a pre-determined period of time, e.g. for from 2 to 10 seconds, e.g. from 2 to 5 seconds, e.g.

from 5 to 10 seconds, e.g. approximately 2 seconds, e.g. approximately 5 seconds, e.g. approximately 10 seconds.

Optionally, the macerator comprises a sensor configured to detect when the lid is closed. For example, the macerator may comprise a magnet (e.g. magnetic switch), electrical switch or hall effect sensor configured to indicate when the lid is closed. Optionally, the macerator comprises a locking mechanism configured to prevent the lid from re-opening. Optionally, the macerator comprises a locking mechanism configured to prevent the lid from re-opening within a pre-determined period of time after the lid has been opened.

Optionally, the controller is configured to initiate the maceration cycle when the lid is closed. Optionally, the controller is configured to initiate the maceration cycle based on receipt of a signal (e.g. from the magnetic switch, electrical switch or hall effect sensor) to indicate that the lid is closed. Optionally, the controller is configured to initiate the maceration cycle after the locking mechanism has been engaged. Optionally, the controller is configured to initiate the maceration cycle upon receipt of a manual input from a user (e.g. selection of a pre-set cycle, e.g. pressing a start button on a control panel).

Optionally, the maceration cycle comprises a plurality of stages. Optionally, modifying the maceration cycle based on the sensor data comprises transitioning the maceration cycle from one stage to another stage in the cycle. Optionally, the maceration cycle comprises a first stage, a second stage and a third stage.

Optionally, the first stage may comprise inputting fluid (e.g. water) into the chamber via the fluid inlet. For example, the first stage may comprise actuating a pump configured to pump fluid (e.g. water) into the chamber via the fluid inlet. Optionally, the (e.g. first) pump is in fluid communication with the chamber and a fluid (e.g. water) source. Optionally, the first stage may comprise pumping the fluid (e.g. water) into the chamber at a given flow rate. For example, the fluid (e.g. water) may be pumped in at a rate of from 2 to 20 L/min, e.g. from 5 to 15 L/min, e.g. from 7 to 14 L/min.

Optionally, the first stage may comprise activating the chopping system to an active (e.g. running, e.g. on, e.g. rotating) state. For example, the first stage may comprise providing power to the motor coupled to the chopping system. Optionally, when the chopping system comprises one or more blades (e.g. the primary and/or second chopper) the motor is configured to rotate the blades at a speed of from 1000 to 1500 RPM, e.g. from 1100 to

1400 RPM, e.g. from 1200 to 1300 RPM, e.g. from 1400 to 1600 RPM, e.g. from 1450 to 1550 RPM, e.g. approximately 1500 RPM.

Optionally, the second stage of the maceration cycle may be initiated at a pre-determined time after the initiation of the first stage. In other words, the first stage is allowed to run for a pre-determined period of time before the maceration cycle is transitioned to the next (e.g. second) stage. Optionally, the predetermined period of time may be between 30 seconds and 3 minutes, e.g. between 45 seconds and 2 minutes, e.g. approximately 60 seconds.

Optionally, the second stage comprises the controller being configured to receive sensor data from the sensor. For example, when the second stage is initiated, the controller is configured to open a line of communication to the sensor such that sensor data may be transmitted from the sensor to the controller. Optionally, when the second stage is initiated, the controller is configured to provide power to the sensor such that the sensor is activated. Optionally, when the second stage is initiated, the controller is configured to transmit a request for sensor data to the sensor.

By only starting to receive sensor data from the sensor in the second stage (and thus by not receiving sensor data from the sensor in the first stage), there is a delay between the start of the maceration cycle (e.g. when the chopping is initiated, the fluid is input and the effluent is started to be output) and the sensing from the sensor. This is advantageous because it might be anticipated that, at the beginning of the maceration cycle, there will be very little waste material that has been chopped to a sufficient size to allow it to pass through the chopping system. As such, at the very beginning of the maceration cycle, there may be a volume of effluent which is output from the chamber that is substantially entirely fluid (e.g. it comprises very little waste material). Thus, if the sensor was activated, the beginning of the cycle may be misinterpreted as being the end of a cycle and the maceration cycle may be stopped prematurely, leaving a large amount of unmacerated material in the chamber. In contrast, by providing a delay between the start of the maceration cycle (stage 1) and the start of the sensing by the sensor (stage 2), the system is provided sufficient time to allow waste material to be chopped to a size such that the effluent comprises waste material and false positives results (indicated an end to the cycle) are prevented.

Optionally, the second stage comprises the controller being configured to determine a characteristic value based on the sensor data. For example, the controller may be configured to determine the frequency at which waste material is detected in the effluent output from the chamber based on the sensor data. Optionally, the second stage comprises

the controller being configured to compare the (e.g. determined, e.g. measured) characteristic value to a threshold (e.g. calibration) value. Optionally, the second stage comprises the controller being configured to determine whether the (e.g. determined, e.g. measured) characteristic value indicates that the effluent comprises substantially no waste material (e.g. is substantially entirely fluid).

Optionally, when the sensor data indicates that the sensor data and/or the characteristic associated with the sensor data has fallen below the threshold (e.g. calibration) value, the controller is configured to transition the maceration cycle from the second stage to the third stage. Optionally, the third stage comprises the controller being configured to input a disinfectant fluid (e.g. a (chemical) disinfectant) into the chamber. The disinfectant may be input through the fluid input. As such, the fluid input may be in fluid communication with both a fluid (e.g. water) source and a disinfectant fluid source. Alternatively, the disinfectant may be input through a disinfectant fluid distinct from the fluid input. Optionally, the macerator may comprise a second pump in fluid communication with the chamber and the disinfectant fluid source. The disinfectant fluid may be any suitable and/or desirable disinfectant. The disinfectant thus acts to disinfect and/or sterilise the chamber at the end of a maceration cycle for its next use.

Optionally, the third stage may comprise the controller being configured to control the first pump to input a pre-determined volume (e.g. a flushing volume) of fluid (e.g. water) into the chamber. This allows any waste material attached to the walls of the chamber to be washed through the system such that the chamber is clean for the next use.

In a second aspect of the invention, a method for macerating waste material is provided. The method comprises:

- inserting waste material to a chamber comprising:

- a chopping system for chopping the material;
 - a fluid inlet for inputting a fluid into the chamber;
 - a drain outlet for outputting a effluent from the chamber;

- initiating a maceration cycle, wherein the maceration cycle comprises:

- chopping the waste material in the chamber using the chopping system; and
 - mixing the waste material with a fluid within the chamber;
 - outputting the effluent through the drain outlet;
 - sensing, using a sensor, a characteristic of the effluent output via the drain

- outlet; and

- modifying the maceration cycle based on the sensor data.

The second aspect of the present invention thus may be appreciated to use the macerator of the first aspect. In other words, the macerator of the first aspect performs the method of the second aspect. As such, the advantages, features and embodiments described above in relation to the first aspect apply equally to the second aspect.

Optionally, the method further comprises sensing the presence of waste material within the effluent output from the chamber. As such, the characteristic may be considered to be the frequency at which waste material is detected within the effluent output from the drain outlet.

Optionally, the method further comprises moving a lid from a closed position to an open position to provide access to the chamber to insert the waste material. Optionally the lid is coupled to a housing, wherein the chamber is disposed (e.g. located, e.g. held) within the housing. Optionally, the method comprises holding (e.g. manually or via an opening mechanism) the lid in the open position for a pre-set period of time, e.g. for from 2 to 10 seconds, e.g. approximately 5 seconds. Optionally, the method may comprise automatically closing the lid after the pre-set period of time has elapsed.

Optionally, the maceration cycle comprises a plurality of stages, and the step of modifying the maceration cycle based on the sensor data comprises transitioning the maceration cycle from one stage to another stage. Optionally, the maceration cycle comprises a first stage, a second stage and a third stage.

Optionally, the method further comprises initiating the first stage of the maceration cycle. For example, the maceration cycle may be initiated after the lid has closed and/or upon receipt of a signal indicating that the lid is closed. Optionally, the maceration cycle may be initiated upon receipt of a manual input (such as the press of a start button on a control panel).

Optionally, the step of initiating the first stage may comprise inputting fluid (e.g. water) into the chamber via the fluid inlet. For example, the step of initiating the first stage may comprise actuating a pump configured to pump fluid (e.g. water) into the chamber via the fluid inlet. Optionally, the (e.g. first) pump is in fluid communication with the chamber and a fluid (e.g. water) source. Optionally, the step of initiating first stage may comprise pumping the fluid (e.g. water) into the chamber at a give flow rate. For example, the fluid (e.g. water) may be pumped in at a rate of from 2 to 20 L/min, e.g. from 5 to 15 L/min, e.g. from 7 to 14 L/min.

Optionally, the step of initiating the first stage may comprise activating the chopping system to an active (e.g. running, e.g. on, e.g. rotating) state. For example, the step of initiating the first stage may comprise providing power to the motor coupled to the chopping system. Optionally, when the chopping system comprises one or more blades (e.g. the primary and/or second chopper) the motor is configured to rotate the blades at a speed of from 1000 to 1500 RPM, e.g. from 1100 to 1400 RPM, e.g. from 1200 to 1300 RPM, e.g. from 1400 to 1600 RPM, e.g. from 1450 to 1550 RPM, e.g. approximately 1500 RPM.

Optionally, the method further comprises initiating the second stage at a predetermined time period after the initiation of the first stage, e.g. from 30 second to 3 minutes after the first stage has started, e.g. from 45 seconds to 2 minutes after the first stage has started, e.g. approximately 1 minute after the first stage has started.

Optionally, the step of initiating the second stage comprises initiating sensing at the sensor and outputting sensor data measured by the sensor. Optionally, the step of initiating the second stage comprises receiving sensor data (at the controller) from the sensor. For example, the step of initiating the second stage may comprise transmitting sensor data from the sensor to the controller. Optionally, the step of initiating the second stage comprises providing power to the sensor such that the sensor is activated. Optionally, the step of initiating the second stage comprises transmitting a request for sensor data to the sensor (e.g. from the controller).

Optionally, the step of initiating the second stage comprises maintaining the chopping system in an active state, e.g. continuing to supply power to the motor coupled to the chopping system. Optionally, the step of initiating the second stage comprises inputting fluid into the chamber (e.g. at a predetermined flow rate).

Optionally, the step of initiating the second stage comprises determining a characteristic value based on the sensor data. For example, the step of initiating the second stage comprises determining the frequency at which waste material is detected in the effluent output from the chamber based on the sensor data. Optionally, the step of initiating the second stage comprises comparing the (e.g. determined, e.g. measured) characteristic value to a threshold (e.g. calibration) value. Optionally, the step of initiating the second stage comprises determining whether the (e.g. determined, e.g. measured) characteristic value indicates that the effluent comprises substantially no waste material (e.g. is substantially entirely fluid).

Optionally, the method further comprises initiating the third stage when the sensor data meets or falls below a threshold value. Optionally the step of initiating the third stage comprises disinfecting the chamber. Optionally, the step of disinfecting the chamber comprises inputting (e.g. pumping) a disinfectant fluid (e.g. a (chemical) disinfectant) into the chamber.

Optionally, the step of initiating the third stage comprises flushing the chamber with fluid. Optionally, the step of flushing the chamber may comprise inputting a pre-determined volume (e.g. a flushing volume) of fluid (e.g. water) into the chamber.

Description of Figures

Embodiments of the present invention will now be described by way of example only and with reference to the accompanying drawings, in which:

Figure 1 shows a macerator in accordance with an embodiment of the present invention;

Figure 2 shows a macerator at the beginning of a maceration cycle in accordance with an embodiment of the present invention;

Figure 3 shows a macerator during a maceration cycle in accordance with an embodiment of the present invention;

Figure 4 shows a macerator during a maceration cycle in accordance with an embodiment of the present invention;

Figure 5 shows a macerator towards the end of a maceration cycle in accordance with an embodiment of the present invention;

Figure 6 shows a method for macerating a waste material in accordance with an embodiment of the present invention; and

Figure 7 shows a method for macerating a waste material in accordance with an embodiment of the present invention.

Detailed Description

The following description presents particular examples and, together with the drawings, serves to explain principles of the disclosure. However, the scope of the invention is not intended to be limited to the precise details of the examples, since variations will be apparent to a skilled person and areas deemed to be covered by the description. Terms for components used herein should be given a broad interpretation that also encompasses equivalent functions and features. In some cases, alternative terms for structural features may be provided but such terms are not intended to be exhaustive.

Descriptive terms should also be given the broadest possible interpretation; e.g. the term "comprising" as used in this specification means "consisting at least in part of" such that interpreting each statement in this specification that includes the term "comprising", features other than that or those prefaced by the term may also be present. Related terms such as "comprise" and "comprises" are to be interpreted in the same manner.

The description herein refers to examples with particular combinations of features, however, it is envisaged that further combinations and cross-combinations of compatible features between embodiments will be possible. Indeed, isolated features may function independently as an invention from other features and not necessarily require implementation as a complete combination.

Figures 1 to 5 show a macerator 100 as it progresses through a macerator cycle. The macerator 100 is formed by a housing 170 which forms the external shell of the macerator 100. The housing 170 has disposed within it a chamber 110 into which waste material 120 such as single use human waste receptacles can be placed.

The chamber 110 is sealed by a lid 180 which is coupled to the housing 170. The chamber comprises a chopping system 130 formed by a plurality of blades configured to chop the waste material into a plurality of pieces during the macerator cycle. The chopping system 130 is located at the bottom of the chamber 110 and skims the walls of the chamber 110 such that the chopping system 130 only allows waste material 120 that has been chopped into small enough pieces to pass through the chopping system 130 and out of the drain outlet 140 as the effluent.

A sensor 150 is disposed within a drain conduit 160 such that the sensor 150 is in communication with the drain outlet 140 and can measure a measurable characteristic of the effluent output from the chamber 110. The effluent is then output from the macerator 100 through the macerator outlet 190.

Figure 1 shows the macerator 100 immediately after the waste material 120 (i.e. material to be macerated) has been inserted into the chamber 120.

Figure 2 shows the macerator 100 during the first stage of the macerator cycle where the chopping system 130 has been actuated, the waste material 120 is being chopped into a plurality of pieces 122 and water 124 is being input into the chamber to dissolve and/or suspend the pieces 122. In the example shown, the chopping system 130 is formed by a primary set of blades 132 and a secondary set of blades 134, where the primary set of blades 132 project towards the centre of the chamber 120 and the secondary set of blades 134 project away from the centre of the chamber 120 towards the drain outlet 140.

The primary set of blades 132 is configured to chop the waste material 120 into a plurality of pieces 122. Once the pieces are sufficiently small (e.g. a first size), the pieces 126 are able to pass through the primary set of blades 132 where the pieces 136 are then further chopped into even smaller pieces 128 (shown in Figure 3) having a second size by the secondary set of blades 134. The smaller pieces 128 are small enough to pass through secondary set of blades 134, such that the pieces 128 may pass out of the drain outlet 140 as the effluent (i.e. waste material 120 (cut into small pieces 126) suspended in water to provide a macerated pulp).

Eventually (as shown in Figures 3 and 4), the waste material 120 is consumed by the macerator such that the amount of waste material 120 remaining in the chamber decreases. As a result, the amount of waste material 120 being output via the drain outlet 140 is also reduced and the concentration of waste material 120 in the effluent is decreased. This change in the effluent can be detected by the sensor 150 which is configured to measure one or more characteristics of the effluent. In a preferred example, the sensor 150 is a proximity capacitive sensor that is configured to measure the instances where waste material comes within the operating range of the sensor (e.g. probe). As such, the sensor 150 preferably provides a measure corresponding to the concentration of the waste material in the effluent.

When the sensor 150 detects that there is very little or substantially no waste material present in the effluent (i.e. the number of instances in which waste material is detected within the operating range of the sensor falls below a threshold frequency), it may be determined that substantially all of the material has been macerated and the macerator cycle may be transitioned to a finishing stage (e.g. stage three) in the cycle. As such, the present

invention allows each macerator cycle to be bespoke to the amount of material without having to provide any input indicating the volume or weight of the material and/or selecting a specific cycle. The present invention can thus provide improved resource efficiency with minimal human error or input. The present invention also provides time savings as the macerator 100 is running only as long as is necessary.

Figures 4 and 5 thus show the final stage in the macerator cycle (e.g. after the sensor 150 has detected that a threshold value has been reached or exceeded and thus the amount of waste material in the effluent has fallen below a given level). In this stage, a disinfectant 125 is introduced into the chamber (Figure 4) and mixed around therein (e.g. by the movement (i.e. vortex) created by the chopper system 130) such that the water 124 and the disinfectant 125 clean and sterilise the walls of the chamber 110 and flush any remaining waste material that may be stuck to the walls towards the chopper system 130.

The disinfectant 125 and the fluid 124 are then flushed out of the macerator 100 via the conduit 160 extending between the drain outlet 140 and the macerator outlet 190 (as shown in Figure 5). The macerator 100 may then be used again to perform a further cycle.

Figures 6 shows method 200 for macerating the waste material 120. First, in step 210, the waste material is inserted into the chamber 110. The maceration cycle is then initiated in step 220 which includes chopping 230 and mixing 240 the waste material 120 in the chamber 110 using the chopping system 130. The effluent is then output from chamber 110 in step 240 through the drain outlet 140.

In step 250 the characteristic of the material is sensed using the sensor 150. When the characteristic measured is about a threshold, the macerator cycle is continued. However, when the characteristic measure indicates that the amount of waste material within the effluent has fallen below a threshold level, the maceration cycle is modified in step 260.

Figure 7 shows a method 300 which corresponds to method 200. As such, method steps 210, 220, 230 and 240 correspond to method steps 310, 320, 330 and 340 which in turn correspond to the first stage in method 300.

After a pre-determined period of time, such as 60 seconds, the second stage of the maceration cycle is initiated. In this stage, the sensing is initiated and sensor data is received from the sensor 150 at the controller in step 350. The controller then determines the characteristic value from the sensor data in step 360 such that the characteristic value

can be compared to a threshold value in step 370. This allows the effluent to be monitored over time and ensures such that the most efficient time to end the maceration cycle can be identified.

If it is determined that the measurable characteristic does not meet the threshold value, the maceration cycle of chopping the waste material 120 and mixing the waste material 120 with water 124 within the chamber 110 is continued until such a time that the threshold is met.

Once the threshold is met, the maceration cycle moves to the third stage. The third stage comprises disinfecting and flushing the chamber 120 with a disinfectant and water in step 380 and then stopping the maceration cycle in step 390. It will be appreciated that stopping the maceration cycle comprises performing the steps necessary to allow a user to reuse the macerator 100 and start the cycle over. For example, step 390 may comprise deactivating the chopping system, stopping the input of fluid and/or disinfectant into the chamber and/or unlocking the lid.

The above description is intended to be exemplary in nature. The scope of the present invention is defined only by the appended claims.

CLAIMS

1. A macerator comprising:
 - a chamber for receiving waste material to be macerated, wherein the chamber comprises:
 - a chopping system for chopping the waste material;
 - a fluid inlet for inputting a fluid into the chamber;
 - a drain outlet for outputting an effluent formed by the waste material and the fluid from the chamber;
 - a sensor in fluid communication with, and downstream of, the drain outlet, wherein the sensor is configured to measure a characteristic of the effluent; and
 - a controller configured to:
 - initiate a maceration cycle;
 - receive sensor data from the sensor, wherein the sensor data represents the characteristic measured by the sensor; and
 - modify the maceration cycle based on the sensor data.
2. The macerator of claim 1, wherein the sensor is configured to emit and/or detect electromagnetic radiation.
3. The macerator of claim 1 or claim 2, wherein the sensor is a sensor for detecting the presence of waste material within the effluent.
4. The macerator of claim 3, wherein the sensor is selected to be one or more of a capacitive sensor, an optical sensor or a pressure sensor.
5. The macerator of any preceding claim, wherein the capacitive sensor has an operating distance of from 1 mm to 20 mm.
6. The macerator of any preceding claim, wherein the sensor has a switching frequency of from 5 Hz to 200 Hz.
7. The macerator of any preceding claim, wherein the sensor data output from the sensor represents a frequency at which waste material is detected within the effluent output from the drain outlet.

8. The macerator of any preceding claim, wherein the sensor is positioned within a conduit extending from the drain outlet of the chamber to a macerator outlet for outputting the effluent from the macerator.

9. The macerator of any preceding claim, wherein the chopping system comprises a primary chopper comprising one or more blades, wherein the primary chopper is configured to chop the waste material into a plurality of pieces.

10. The macerator of claim 9, wherein the chopping system comprises a secondary chopper comprising one or more blades, wherein the secondary chopper is configured to chop the plurality of pieces into a plurality of smaller pieces.

11. The macerator of any preceding claim, wherein the chopping system is located at a position above the drain outlet such that the effluent that is output from the chamber via the drain outlet comprises waste material that has been chopped into pieces by the chopping system, wherein the pieces in the effluent are sized such that they can pass through the chopping system.

12. The macerator of any preceding claim, further comprising a lid configured to seal the chamber, wherein the lid is movable between a closed position and an open position.

13. The macerator of any preceding claim, wherein the maceration cycle comprises a plurality of stages, and modifying the maceration cycle based on the sensor data comprises transitioning the maceration cycle from one stage to another stage.

14. The macerator of claim 13, wherein the maceration cycle comprises a first stage, a second stage and a third stage, wherein the controller is configured to:

initiate the first stage of the maceration cycle;

initiate the second stage at a predetermined time period after the initiation of the first stage; and

initiate the third stage when the sensor data and/or the characteristic value represented by the sensor data meets or falls below a threshold value.

15. The macerator of claim 14, wherein the system further comprises a first pump in fluid communication with a fluid source and the fluid input, wherein initiating the first stage comprises the controller being configured to:

activate the chopping system to an active state; and

activate the first pump to input fluid from fluid source into the chamber via the fluid inlet.

16. The macerator of claim 14 or 15, wherein the second stage comprises the controller being configured to:

- receive sensor data from the sensor;
- determine a characteristic value based on the sensor data; and
- compare the characteristic value to the threshold value.

17. The macerator of claim 14, 15 or 16, further comprising a second pump in fluid communication with the chamber and a source of disinfectant, wherein initiating the third stage comprises the controller being configured to:

- activate the second pump to input a disinfectant from the source of disinfectant into the chamber; and
- control the first pump to input a flushing volume of fluid into the chamber.

18. The method for macerating waste material, the method comprising:

- inserting waste material to a chamber comprising:

- a chopping system for chopping the material;
 - a fluid inlet for inputting a fluid into the chamber;
 - a drain outlet for outputting a effluent from the chamber;

- initiating a maceration cycle, wherein the maceration cycle comprises:

- chopping the waste material in the chamber using the chopping system; and
 - mixing the waste material with a fluid within the chamber;
 - outputting the effluent through the drain outlet;
 - sensing, using a sensor, a characteristic of the effluent output via the drain

- outlet; and

- modifying the maceration cycle based on the sensor data.

19. The method of claim 18, wherein the sensor is configured to detect the presence of waste material within the effluent output from the chamber; and

- wherein the characteristic is the frequency at which waste material is detected within the effluent output from the drain outlet.

20. The method of claim 18 or 19, wherein the method further comprises:

- moving a lid from a closed position to an open position to provide access to the chamber; and

holding the lid in the open position for a pre-set period of time; and
automatically closing the lid after the pre-set period of time has elapsed.

21. The method of any one of claims 18, 19 or 20, wherein the maceration cycle comprises a plurality of stages, and the step of modifying the maceration cycle based on the sensor data comprises transitioning the maceration cycle from one stage to another stage.

22. The method of claim 21, wherein the maceration cycle comprises a first stage, a second stage and a third stage, and the method further comprises:
initiating the first stage of the maceration cycle;
initiating the second stage at a predetermined time period after the initiation of the first stage; and
initiating the third stage when the sensor data meets or falls below a threshold value.

23. The method of claim 22, wherein initiating the first stage comprises:
activating the chopping system to an active state; and
inputting fluid into the chamber via the fluid inlet.

24. The method of claim 22 or 23, wherein initiating the second stage comprises:
maintaining the chopping system in the active state;
inputting fluid into the chamber;
initiating sensing at the sensor and outputting sensor data measured by the sensor;
determining a characteristic value based on the sensor data; and
comparing the characteristic value to the threshold value.

25. The macerator of claim 22, 23 or 24, wherein, initiating the third stage comprises:
disinfecting the chamber; and
flushing the chamber with fluid.