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(54) **AUTOMATED VACUUM WASTE HANDLING SYSTEM**

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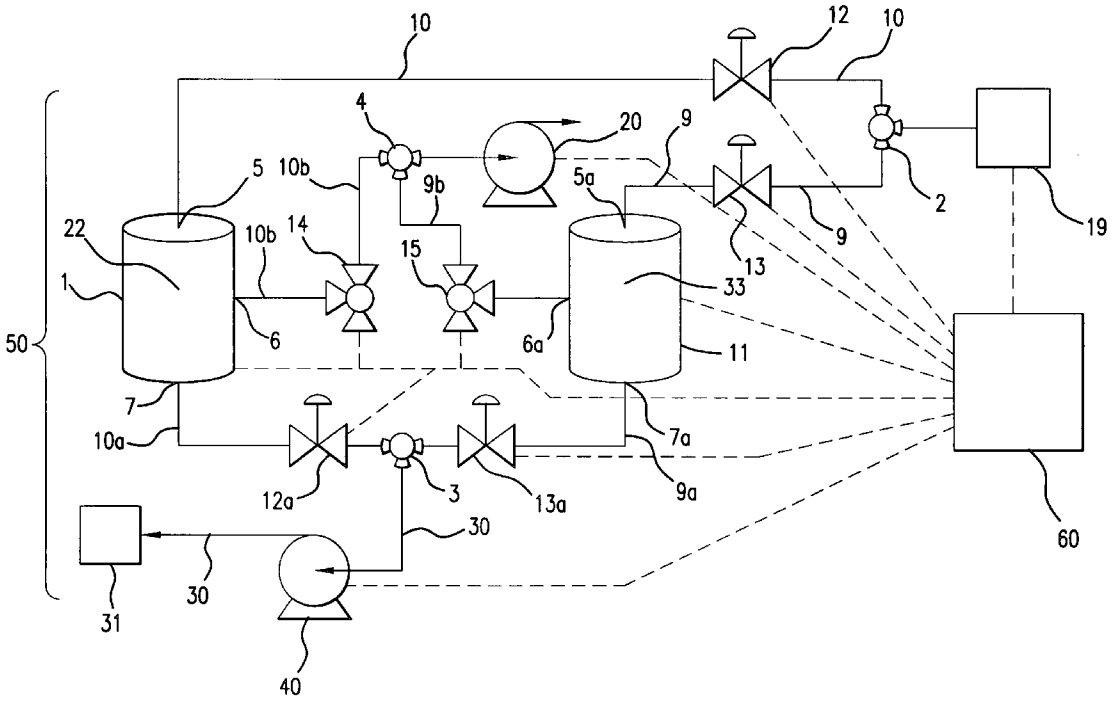
(57) **ABSTRACT**

This invention relates to an automated vacuum liquid waste handling system having two or more waste vessels, with a liquid-level sensor, a means for filling the waste vessels with waste, a means for switching from the first waste vessel, once full, to one or more other waste vessels that are not full, and a means for simultaneously removing said waste from the first full waste vessel to output holding stations and filling another waste vessel so that waste collection is not interrupted.



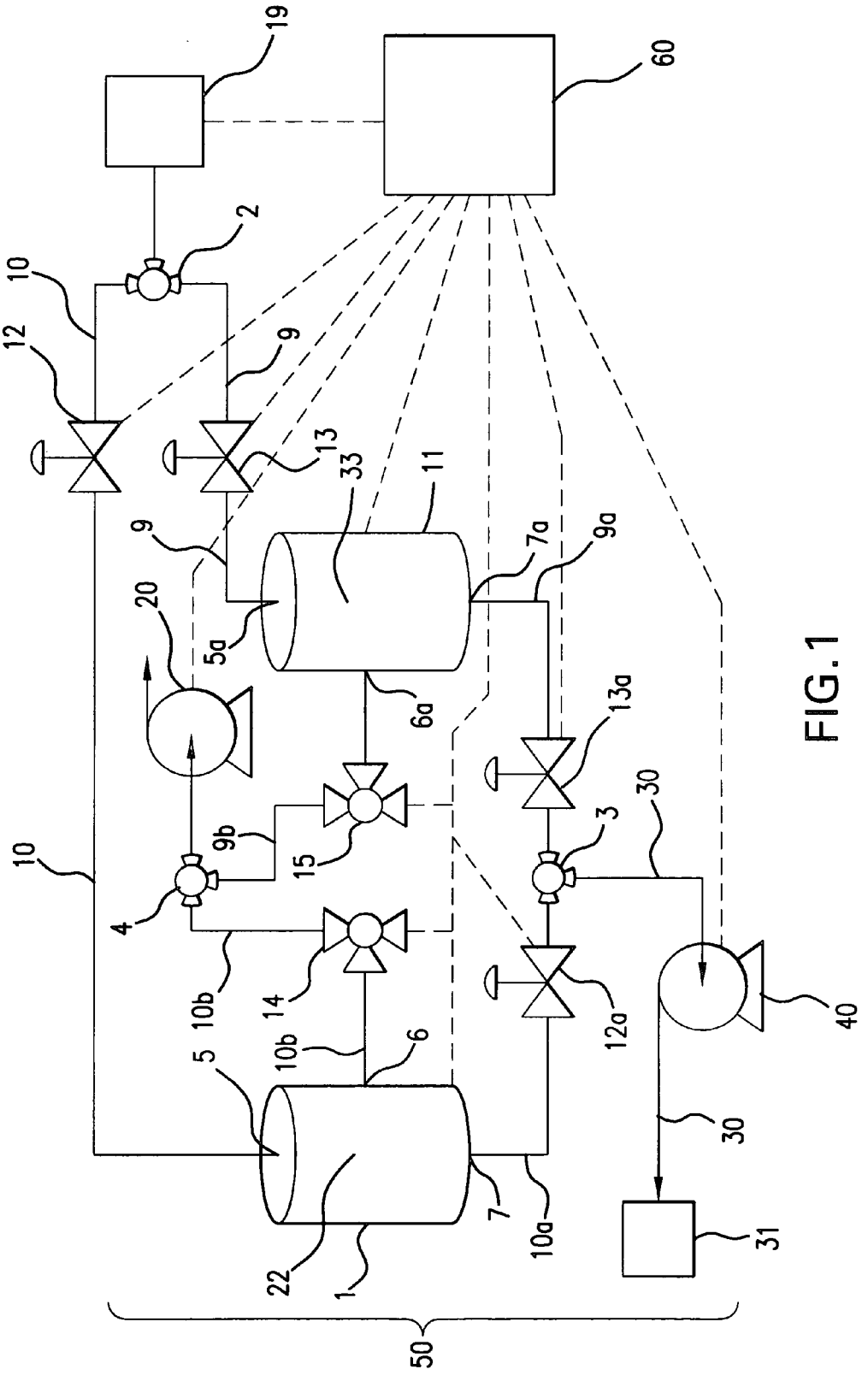

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FIG. 1

AUTOMATED VACUUM WASTE HANDLING SYSTEM

BACKGROUND OF THE INVENTION

[0001] The collection of depleted and contaminated chemicals from chemical processing equipment is an important facet of all manufacturing processes that utilize such chemicals. Where hazardous waste chemicals are not properly controlled the manufacturing facilities that utilize the chemicals can be shut down, resulting in significant and expensive losses of material and equipment. Also, high-levels of volatile organic compounds (VOCs) can be generated by waste chemicals, and the control of such VOCs is a significant problem. Therefore, a need exists for reliable, automated waste chemical collection systems, and particularly systems such as those liquid waste collection systems disclosed in U.S. Pat. Nos. 5,148,945 and 6,148,846. However, there is a need for improvement of these systems.

[0002] As an example, high throughput screening instruments generate a large volume of liquid waste. With existing high throughput screening instruments, the large volumes of liquid waste generated must be constantly monitored and collected into waste bottles for disposal. Some disadvantages with high throughput screening liquid waste disposal are that it is currently a manual process and it can require waste disposal when robotics operators are not on-site.

[0003] Thus, a need still exists for a liquid waste management system with no human contact with waste and the waste bottles are emptied automatically at any time of the day, without requiring the presence of a robotics operator.

SUMMARY OF THE INVENTION

[0004] This invention relates to an automated vacuum liquid waste handling system having two or more waste vessels, with a liquid-level sensor, a means for filling the waste vessels with waste, a means for switching from the first waste vessel, once full, to one or more other waste vessels that are not full, and a means for simultaneously removing said waste from the first full waste vessel to output holding stations and filling another waste vessel so that waste collection is not interrupted. The automated vacuum liquid waste handling system can to switch back and forth, as needed, to one or more of the waste vessels as each becomes either full or is emptied.

[0005] This invention also relates to an automatic process for handling liquid waste that minimizes human contact with waste and allows full waste vessels to be emptied automatically at any time of the day, without requiring an operator to be present. The automated vacuum liquid waste handling system comprises using a vacuum and pressure system. The vacuum system draws the liquid waste from the liquid waste production source into the waste vessel. As the fluid accumulates in the vessel the liquid level rises engaging liquid-level sensor when the vessel is full. An electronic system controller is connected to the liquid-level sensor in the waste vessel as well as to the 2-way and 3-way control valves which control the flow of liquid waste throughout the system. The 2-way and 3-way control valves are controlled by the electronic system controller that alters the flow of liquid waste between a plurality of waste vessels. When a high liquid level alarm signal is received from the liquid-level sensor the electronic system controller engages the appropriate control valves so that the flow of liquid waste is stopped at the full vessel and the liquid waste in the full vessel is emptied at the holding station using a removal pump. The flow of the liquid waste is then activated and sent to an unfilled vessel thereby filling the unfilled vessel. After the full vessel is emptied the liquid-level sensor signals the electronic system controller to engage the appropriate control valves to isolate the emptied vessel from the removal pump. This and other aspects of the invention are realized upon a review of the specification as a whole.

BRIEF DESCRIPTION OF THE DRAWINGS

[0006] **FIG. 1** is a diagram of the automated vacuum liquid waste handling system utilizing two waste vessels.

DETAILED DESCRIPTION OF THE INVENTION

[0007] The present invention relates to an automated vacuum liquid waste handling system that minimizes human contact and allows full waste vessels to be emptied automatically at any time of the day, without requiring an operator to be present.

[0008] As shown in **FIG. 1** (illustrating a system with 2 waste vessels), the automated vacuum waste handling system (**50**) comprises liquid waste production source (**19**), liquid waste supply lines (**9**) and (**10**) each having at least one 2-way control valve (**12**) and (**13**), liquid waste vessels (**1**) and (**11**) each having liquid-level sensors (**22**) and (**33**), respectively, and three openings (**5**), (**6**) and (**7**) and (**5***a*), (**6***a*) and (**7***a*), respectively, liquid waste output lines (**10***a*) and (**9***a*) each having at least one 2-way control valve (**12***a*) and (**13***a*), removal pump (**40**), vacuum source lines (**10***b*) and (**9***b*), each vacuum source line having a 3-way control valve (14) and (15) attached thereto, vacuum pump (**20**) and T-joints (**2**), (**3**) and (**4**).

[0009] The liquid waste production source (**19**) is connected to liquid waste supply lines (**9**) and (**10**) by a T-joint (**2**). The 2-way control valve (**13**) and (**12**) on each liquid waste supply line (**9**) and (**10**) is located after T-joint (**2**) and before waste vessels (**1**) and (**11**), respectively.

[0010] Liquid waste vessel (**1**) and (**11**) each have three openings, (**5**), (**6**) and (**7**) and (**5***a*), (**6***a*) and (**7***a*), respectively. Liquid waste supply line (**10**) is attached to liquid waste vessel (**1**) through opening (**5**). Liquid waste output line (**10***a*) is connected to liquid waste vessel (**1**) through opening (**7**). Vacuum source line (**10***b*) is connected to liquid waste vessel (**1**) through opening (**6**). Liquid waste output line (**10***a*) containing at least one 2-way control valve (**12***a*) attached thereto and is connected to a removal pump (**40**) by T-joint (**3**). Vacuum source line (**10***b*) having at least one 3-way control valve (**14**) attached thereto and is connected to vacuum pump (**20**) by T-joint (**4**).

[0011] Liquid waste supply line (**9**) is attached to liquid waste vessel (**11**) through opening (**5***a*). Liquid waste output line (**9***a*) is connected to liquid waste vessel (**11**) through opening (**7***a*). Vacuum source line (**9***b*) is connected to liquid waste vessel (**11**) through opening (**6***a*). Liquid waste output line (**9***a*) containing at least one 2-way control valve (**13***a*) attached thereto and is connected to removal pump (**40**) by T-joint (**3**). Vacuum source line (**9***b*) having at least one 3-way control valve (**15**) attached thereto and is connected to vacuum pump (**20**) by T-joint (**4**).

[0012] Removal pump (40) is connected to dump line (30), which is connected to an output holding station (31). The liquid-level sensors (22) and (33), 2-way control valves (12), (13), (12*a*), (13*a*) and 3-way control valves (14) and (15) are connected to an electronic system controller (60) that controls the flow of liquid waste throughout the waste handling system. The electronic system controller (60) engages the appropriate control valves so that liquid waste vessel (1) or (11) is emptied when full or filled when empty, which ever is appropriate.

[0013] In operation, the automated vacuum liquid waste handling system (50) pumps liquid waste through liquid waste supply lines depending upon which line is open. When one liquid waste supply line is open the other(s) is closed.

[0014] Using **FIG. 1** as a model, when liquid waste supply line (10) is opened, generally this means 2-way control valve (12) is open, 3-way control valve (14) is open to vacuum pump (20) and 2-way control valve (12*a*) is closed to removal pump (40). Liquid waste is then pumped, using vacuum pump (20) from liquid waste production source (19) through liquid waste supply line (10) to liquid waste vessel (1). Liquid waste is collected in liquid waste vessel (1) until it becomes full at which time the liquid-level sensor(22) is activated. This signals the electronic control system (60) to close 2-way control valve (12); switch 3-way control valve (14) to release the vacuum on liquid vessel (1); open 2-way control valve (13) to accept liquid waste and send it to liquid vessel (11); switch 3-way control valve (15) to vacuum pump (20) to provide vacuum to liquid waste vessel (11); open 2-way control valve (12*a*); and activate removal pump (40) to draw waste from liquid waste vessel (1). Once liquid waste vessel (1) is empty liquid-level sensor(22) is activated signaling the electronic controll system (60) to close 2-way control valve (12*a*) and shut off removal pump (40).

[0015] Once liquid waste vessel (11) becomes full the liquid-level sensor means (33) is activated, which signals the electronic control system (60) to close 2-way control valve (13), switch 3-way control valve to release the vacuum on liquid vessel (11); open 2-way control valve (12) to accept waste to liquid waste vessel (1); open 3-way control valve (14) to vacuum pump (20) allowing vacuum to liquid vessel (1); open 2-way control valve (13*a*) and activate removal pump (40) to draw waste from liquid waste vessel (11). Once liquid waste vessel (11) is empty liquid-level sensor (33) is activated thereby signalling 2-way control valve (13*a*) to close and shutting off removal pump (40).

[0016] The automated vacuum liquid waste handling system of the claimed invention is comprised of at least two liquid waste vessels. When there are three or more liquid waste vessels the system can be set up to fill and/or empty the vessels in succession or some other pre-determined order. Alternatively, the liquid waste handling system can be set up to operate by modules. For example, it can have two modules, module A, having liquid waste vessels **1** and **2** and module B, having liquid waste vessels **3** and **4**. In this example liquid waste vessel **1** can collect liquid waste until it is filled at which point it stops collecting and liquid waste vessel **2** begins to collect waste until it is filled. Once liquid waste vessel **2** is filled Module A can be trigger to begin emptying the vessels and liquid vessel **3** of module B can begin collecting liquid waste until it is filled at which point liquid waste vessel **4** begins collecting liquid waste. Each module can be controlled by a separate electronic system controller, or a single electronic system controller can be used. As one skilled in the art can imagine, there are many ways that the liquid waste can be collected with a multi-waste vessel system.

[0017] Liquid-level sensor means that can be used in this invention are those known in the art. Examples are those that have a 2-point float switch, ultrasonic sensor, magnetostrictive sensor or any other continuous liquid level measurement sensors. Generally, the 2-point sensor has a float switch that rises as the waste vessel is filled with liquid waste, such that when the float switch reaches the top of the vessel, the sensor is activated. Additionally, when the waste vessel is emptied, the float switch falls, such that when the float switch is at the bottom of the vessel the sensor is activated and signals that the waste vessel is empty. An example of a 2-point sensor is GEMS LS-700. The liquid-level-capacity sensor serves to detect when the liquid level in the vessel is empty or full. Thus, the sensor has a dual function. When a waste vessel is empty, the sensor in this vessel signals the electronic system controller to open the control valves responsible for filling the vessel. When a waste vessel is full the sensor in this vessel signals the electronic system controller to close the control valves responsible for filling the vessel and open the control valves responsible for emptying the vessel.

[0018] Electronic system controller that can be used in this invention are known in the art and are analog, digital, or a combination. When the liquid-level-capacity sensor is activated the electronic system controller (60) engages the appropriate control valves so that the flow of liquid waste throughout the system is controlled.

[0019] Examples of known two-way and three-way control valves that can be used in this invention are solenoid, ball valve, elliptical valve, diaphragm valve, needle valve and the like. The control valve should be one that is resistant to caustic fluids, if caustic fluids are being used. The ASCO Valve is an example of a two-way control valve.

What is claimed is:

1. An automated vacuum liquid waste handling system comprising:

a plurality of waste vessels, each having a liquid-level sensor and three openings,

a means for filling a first waste vessel with liquid waste,

a means for switching from the first waste vessel, once full, to a second waste vessel that is not full, and

a means for simultaneously removing said waste from the first full waste vessel to an output holding station and filling the second waste vessel; said automated vacuum waste handling system being able to switch back and forth, as needed, to two or more waste vessels as each becomes full or is emptied.

2. An automated vacuum liquid waste handling system according to claim 1, wherein the means for filling the first waste vessel comprises:

(1) a liquid waste production source,

(2) a vacuum pump,

(3) a first waste supply line having a first 2-way control valve,

(4) a first waste output line having a second 2-way control valve,

(5) a first vacuum source line having a 3-way control valve, and

(6) at least one T-joint;

said first waste supply line for providing access to or isolating the first waste vessel from the liquid waste production source, and being connected to the liquid waste production source by a first T-joint; said first waste supply line connected to the first liquid waste vessel through a first opening in said first liquid waste vessel; said first waste output line, being connected through a second opening in the first liquid waste vessel for retaining or releasing the liquid waste in the first liquid waste vessel; said first vacuum source line for providing or releasing vacuum to the first liquid waste vessel and being connected to the first liquid waste vessel through a third opening in the first liquid waste vessel; said vacuum pump connected to the first vacuum source line, having the 3-way control valve, by a third T-joint for pumping liquid waste from the liquid waste production source to the liquid waste vessels; and said first T-joint for connecting the liquid waste production source to the second waste vessel.

3. An automated vacuum liquid waste handling system according to claim 1, wherein said switching means comprises:

(1) a liquid-level sensor located within each of the liquid waste vessel(s), and

(2) an electronic system controller,

said liquid-level sensor signals the electronic system controller that the liquid waste vessel is full or empty; said electronic system controller engages the appropriate control valves so that the liquid waste vessels are emptied when full and filled when emptied.

4. An automated vacuum liquid waste handling system according to claim 1, wherein the means for simultaneously removing said waste from the first full waste vessel to an output holding station and filling the second liquid waste vessel comprises:

(1) a first liquid waste output line having a second 2-way control valve,

(2) one or more T-joints

(3) a removal pump,

(4) a liquid waste production source,

(5) a vacuum pump,

(6) a second liquid waste supply line having a third 2-way control valve,

(7) a second liquid waste output line having a fourth 2-way control valve,

(8) a second vacuum source line having a 3-way control valve,

said first liquid waste output line having the ssecond 2-way control valve, being connected to the removal pump by a second T-joint through a dump line; said removal pump for removing the liquid waste from a first liquid waste vessel through the liquid waste output line through the dump line to the output holding station; said second 2-way control valve for retaining or releasing the liquid waste in a first liquid waste vessel; said second T-joint further connected to the second liquid waste output line having the fourth 2-way control valve for retaining or releasing the liquid waste in the second liquid waste vessel, and being connected to the second liquid waste vessel through a second opening in the second liquid waste vessel; said second liquid waste supply line having the third 2-way control valve for providing access to or isolating the second waste vessel from the liquid waste production source, and being connected to the liquid waste production source by a first T-joint; said second liquid waste vessel being connected to the second waste supply line through a first opening in the second liquid waste vessel; said second vacuum source line having a 3-way control valve, the 3-way control valve for providing or releasing vacuum to the second liquid waste vessel and being connected to the second liquid waste vessel through a third opening in the second liquid waste vessel; said vacuum pump connected to the second vacuum source line by a third T-joint for pumping liquid waste from the liquid waste production source to the second liquid waste vessel; and said first T-joint for connecting the liquid waste production source to a first liquid waste vessel and the second liquid waste vessel.

5. An automated vacuum liquid waste handling system comprising:

(1) a liquid waste production source,

(2) vacuum pump,

(3) a first waste supply line having a first 2-way control valve,

(4) a first waste output line having a second 2-way control valve,

(5) a first vacuum source line having a 3-way control valve, and

(6) at least one T-joint;

(7) a plurality of liquid waste vessels each having a liquid level sensor,

(8) an electronic system controller,

(9) a second liquid waste supply line having a third 2-way control valve,

(10)a second liquid waste output line having a fourth 2-way control valve, and

(11)a second vacuum source line having a 3-way control valve,

said first waste supply line having the first 2-way control valve for providing access to or isolating the first waste vessel from the liquid waste production source, and being connected to the liquid waste production source by a first T-joint; said first waste supply line connected to the first liquid waste vessel having the liquid level sensor through a first opening in said first liquid waste vessel; said first waste output line having the second 2-way control valve, for retaining or releasing the liquid waste in the first liquid waste vessel, and being connected through a second opening in the first liquid waste vessel; said first vacuum source line having the 3-way control valve for providing or releasing vacuum to the first liquid waste vessel and being connected to

the first liquid waste vessel through a third opening in the first liquid waste vessel; said vacuum pump connected to the first vacuum source line by a third T-joint for pumping liquid waste from the liquid waste production source to the liquid waste vessels; said first T-joint for connecting the liquid waste production source to the second of waste vessel, having a liquid level sensor; said second liquid waste supply line for providing access to or isolating the second liquid waste vessel from the liquid waste production source through use of the third 2-way control valve, and being connected to the liquid waste production source by the first T-joint; said second waste supply line connected to the second liquid waste vessel through a first opening in said second liquid waste vessel; said second waste output line having the fourth 2-way control valve, for retaining or releasing the liquid waste in the second liquid waste vessel, and being connected to the second liquid waste vessel through a second opening in the second liquid waste vessel; said second vacuum source line having the second 3-way control valve for providing or releasing vacuum to the second liquid waste vessel and being connected to the second liquid waste vessel through a third opening in the second liquid waste vessel; said vacuum pump connected to the second vacuum source line by a third T-joint for pumping liquid waste from the liquid waste production source to the second liquid waste vessel; said first T-joint for connecting the liquid waste production source to the first and second liquid waste vessels, said liquid-level sensor for signalling the electronic system controller that the liquid waste vessel is full or empty; and said electronic system controller for engaging appropriate control valves so that the liquid waste vessels are emptied when full or filled when emptied.

6. An automated vacuum liquid waste handling system according to claim 5 wherein the liquid-level sensor in the first liquid waste vessel signals the electronic system controller, when the first waste vessel is full, to close the first 2-way control valve, switch the first 3-way control valve so that it releases vacuum from the first liquid waste vessel, switch the second 3-way control valve to provide vacuum to the second liquid waste vessel, open the third 2-way control valve so that liquid waste from the liquid waste production source goes into the second liquid waste vessel and begins filling it, open the second 2-way control valve to release the liquid waste from the first liquid waste vessel into a liquid waste output holding station; said second 2-way control valve closing once liquid-level sensor in the first liquid waste vessel signals the electronic system controller that first liquid waste vessel is empty, when the second liquid waste vessel is full the liquid-level sensor in the second liquid waste vessel signals the electronic system controller to close the third 2-way control valve, switch the second 3-way control valve so that it releases vacuum from the second liquid waste vessel, switch the first 3-way control valve to provide vacuum to the first liquid waste vessel, open the first 2-say control valve so that liquid waste from the liquid waste production source goes into the first liquid waste vessel and begins filling it, open the fourth 2-way control valve to release the liquid waste from the second liquid waste vessel into a liquid waste output holding station thereby starting the process over again; said fourth 2-way control valve closing once liquid-level sensor in the second liquid waste vessel signals the electronic system controller that second liquid waste vessel is empty.

7. An automated vacuum liquid waste handling system according to claim 2 wherein the 2-way and 3-way control valves are independently selected from the group consisting of solenoid valve, ball valve, elliptical valve, diaphragm valve, and needle valve.

8. An automated vacuum liquid waste handling system according to claim 3 wherein the liquid level capacity sensor means is selected from the group consisting of 2 point float switch, ultrasonic sensor, magnetostrictive sensor or any continuous liquid level measurement sensor.

9. A process for handling liquid waste automatically comprising

(1) pumping liquid waste from a liquid waste production source through a first liquid waste supply line to a first liquid waste vessel having a liquid-level sensor, a first waste output line and a first vacuum source line, said first liquid waste supply line and waste output line having a first 2-way and second 2-way control valve, respectively and said first vacuum source line having a 3-way control valve;

(2) collecting the liquid waste in the first waste vessel until it is full;

(3) switching to a second liquid waste vessel thereby stopping the collection of liquid waste in the first waste vessel;

(4) collecting the liquid waste in a second liquid waste vessel until it is full;

(5) emptying the first liquid waste vessel while liquid waste is collecting in the second liquid waste vessel,

wherein the switching to a second waste vessel is controlled by an electronic system controller activated by the liquid-level sensor, said liquid-level sensor for detecting when the first waste vessel is empty or full, said electronic system controller closing the first 2-way control valve to prevent liquid waste from entering the first full liquid waste vessel, opening the second 2-way control valve that is linked to a removal pump and switching the first 3-way control valve to release vacuum on the first liquid waste vessel so that it is emptied to a liquid waste output holding station, said electronic system controller at the same time closes the first 2-way control valve, opens a third 2-way control valve and switches a second 3-way control valve to supply vacuum to the second liquid waste vessel so that it begins to fill with liquid waste, once the second liquid waste vessel is full the liquid-level sensor in the second waste vessel causes the electronic system controller to close the third 2-way control valve to prevent liquid from entering the second liquid waste vessel, open a fourth 2-way control valve that is linked to the removal pump and switch a second 3-way control valve to release vacuum on the second liquid waste vessel so that it is emptied to a liquid waste output holding station; said electronic system controller signaling the first 2-way control valve and third 3-way control valve to begin filling the first empty waste vessel and thereby providing a continuous liquid waste handling system.

10. A process according to claim 9 which contains two or more liquid waste vessels, four or more 2-way control valves and two or more 3-way control valves.

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