Claims:

1. A liquid handling system comprising:

a reusable subsystem; and

a replaceable subsystem,

the reusable subsystem comprising:

a peristaltic pump;

a valve assembly comprising a plurality of valves;

two or more bubble sensors each arranged to detect bubbles in a fluid path;

a system controller configured to receive input from the bubble sensors, control operation of the peristaltic pump, and control operation of the valve assembly in accordance with a programmed processing protocol; and

case housing the peristaltic pump, and valve operation assembly, and

the single use, replaceable subsystem comprising:

a fluid path manifold comprising one or more fixed geometry fluid paths, at least one of the fluid paths being configured for engagement with the valve assembly whereby fluid paths can be selectively opened or closed by operation of the valve assembly, the fixed geometry of at least one fluid path being arranged to sit proximate the bubble sensors when secured in the housing such that the bubble sensors can identify bubbles within the fluid path;

a pump tube configured to enable operable engagement between the peristaltic pump and the fluid paths to cause fluid flow within the manifold by operation of the peristaltic pump;

a plurality of a plurality of liquid input ports each configured for connection to respective liquid supply components for delivery of respective liquids to the one or more fluid paths;

at least one gas inlet connected to at least one of the one or more fluid paths to enable gas to enter the fluid path; and

at least one outlet port in fluid communication with the one or more fluid paths to dispense fluid,

the replaceable subsystem providing a closed environment for mixing and dispensing liquid formulations,

wherein the controller determines a volume of liquid in one of the fluid paths based on action of the peristaltic pump and inputs from at least one bubble sensor associated with the respective fluid path.

2. A system as claimed in claim 1 wherein the combination of fixed geometry fluid manifold and bubble sensor arrangements enable measurement of a known volume in at least

one region within the fluid paths and the controller utilises the known volume measurement to calibrate the peristaltic pump.

3. A system as claimed in claim 2 wherein the peristaltic pump is automatically calibrated by the controller.

4. A system as claimed in claim 3 wherein the peristatic pump is dynamically calibrated during execution of the one or more processing protocols.

5. A system as claimed in any one of claims 2 to 4 based on bubble sensor input, the controller utilises the measurement of known volume to verify the volume of dispensed products.

6. A system as clamed in any one of claims 1 to 5 wherein bubbles in fluid lines are used to separate small volumes of liquid and volume of each small volume of liquid is verified in at least two different regions in the flow paths using bubble sensor data from each respective region.

7. A system as claimed in claim 6 wherein the verified volume data includes dispensed volume data.

8. A system as claimed in any one of claims 1 to 7 wherein the gas inlet is an air inlet.

9. A system as claimed in claim 8 wherein the air inlet comprises a sterile filter.

10. A system as claimed in any one of claims 1 to 9, wherein the system controller is further configured to determine, based on particle count in a liquid sample being processed, a dose formulation and number of doses to output, and controlling the system to mix the determined formulation and dispense the determined number of doses.

11. A system as claimed in claim 10 wherein the system controller includes an interpolation engine adapted to mathematically resolve dose and formulation variables based on target values and ranges for the formulation variables, particle count, and variable prioritisation rules.

12. A method of calibrating a peristaltic pump within a liquid handling system as claimed in claim 1, the method comprising the steps of:

introducing a volume of liquid into a flow path having a known volume between a first bubble sensor and a second bubble sensor;

introducing gas into the flow path, such that the volume of liquid is preceded and succeeded by a gas bubble;

operating the peristaltic pump to cause the volume of liquid to proceed through the flow path proximate the first bubble sensor to enable identification of a transition from liquid to bubble and recording the peristaltic pump position at the transition;

operating the peristaltic pump to cause the volume of liquid to be drawn through the know volume flow path to the second bubble sensor to enable identification of the same transition from liquid to bubble by the second sensor and recording the peristaltic pump position at the transition; and

calculating volume of fluid displaced for each index of the peristaltic pump based on the recorded positions and known fluid path volume.

13. A method as claimed in claim 12, further comprising a method of determining a volume of a tube between two bubble sensors comprises the steps of:

a) controlling introduction of an initial volume of liquid into the tube,

b) operating the peristaltic pump to progress the initial volume of liquid such that an edge of the fluid is identified proximate a first bubble sensor,

c) controlling introduction of further liquid into the tube until liquid is detected by the second bubble sensor, and

d) operate the peristaltic pump to transfer the total volume of liquid, comprising the initial volume of liquid and further volume of liquid into an external vessel.

14. A method of performing a mixing operation in a liquid handling system as claimed in claim 1, the method comprising the steps of:

a) operating the peristaltic pump to cause fluid flow through fluid paths;

b) actuating one or more valves to control selection and direction of fluid flow through the fluid paths;

c) monitor fluid flow through the fluid paths using the bubble sensors and determine fluid volumes based on fluid detection by at least one bubble sensor and operation of the peristaltic pump;

d) responsive to determining a target volume of the fluid has passed a bubble sensor, actuating at least one valve to introduce a bubble into the fluid flow path behind the target volume of the fluid and direct flow of the fluid within the fluid paths, including directing flow of the target volume of fluid to a mixing reservoir; and

e) repeat steps a) to d) for one or more further fluids and further target volumes whereby the fluids are mixed within the mixing reservoir.

15. The method as claimed in claim 14 further comprising the step of:

f) actuating one or more valves to recirculate the mixed fluid from the mixing reservoir through the fluid paths and back to the mixing reservoir.

16. The method as claimed in claim 13 or claim 14 further comprising the step of:

g) actuating one or more valves to cause the mixed fluid to flow though one or more fluid paths to an outlet and dispense a target volume of the mixed fluid based on operation of the pump and mixed fluid flow detected by a bubble sensor.

17. The method as claimed in claim 16, wherein the target volume dispensed is a sample volume of the mixed fluid.

18. A reusable subsystem of a liquid handling system,

the reusable subsystem comprising:

a peristaltic pump;

a valve assembly comprising a plurality of valves;

two or more bubble sensors each arranged to detect bubbles in a fluid path;

a system controller configured to receive input from the bubble sensors, control operation of the peristaltic pump, and control operation of the valve assembly in accordance with a programmed processing protocol; and

case housing the peristaltic pump, and valve operation assembly,

wherein the pump, valve assembly and bubble sensors are arranged to engage with a fluid path manifold comprising one or more fixed geometry fluid paths, whereby fluid paths can be selectively opened or closed by operation of the valve assembly, at least one fluid sits proximate each of the bubble sensors when secured in the housing such that the bubble sensors can identify bubbles within the fluid path, and the pump engage with a pump tube configured to enable operable engagement between the peristaltic pump and the fluid paths to cause fluid flow within the manifold by operation of the peristaltic pump,

wherein the controller determines a volume of liquid in one of the fluid paths based on action of the peristaltic pump and inputs from at least one bubble sensor associated with the respective fluid path.

19. A replaceable subsystem of a liquid handling system, the replaceable subsystem being configured to engage with a reusable subsystem comprising a peristaltic pump, a valve assembly comprising a plurality of valves, two or more bubble sensors each arranged to detect bubbles in a fluid path, a system controller configured to receive input from the bubble sensors, control operation of the peristaltic pump, and control operation of the valve assembly in

accordance with a programmed processing protocol; and a case housing the peristaltic pump, and valve operation assembly, the replaceable subsystem comprising:

a fluid path manifold comprising one or more fixed geometry fluid paths, at least one of the fluid paths being configured for engagement with the valve assembly whereby fluid paths can be selectively opened or closed by operation of the valve assembly, the fixed geometry of at least one fluid path being arranged to sit proximate the bubble sensors when secured in the housing such that the bubble sensors can identify bubbles within the fluid path;

a pump tube configured to enable operable engagement between the peristaltic pump and the fluid paths to cause fluid flow within the manifold by operation of the peristaltic pump;

a plurality of a plurality of liquid input ports each configured for connection to respective liquid supply components for delivery of respective liquids to the one or more fluid paths;

at least one gas inlet connected to at least one of the one or more fluid paths to enable gas to enter the fluid path; and

at least one outlet port in fluid communication with the one or more fluid paths to dispense fluid,

the replaceable subsystem providing a closed environment for mixing and dispensing liquid formulations,

wherein the controller determines a volume of liquid in one of the fluid paths based on action of the peristaltic pump and inputs from at least one bubble sensor associated with the respective fluid path.

20. A system as claimed in claim 1 wherein the controller utilises a known liquid volume measurement to calibrate the peristaltic pump.

21. A system as claimed in claim 20 wherein the peristaltic pump is automatically calibrated by the controller.

22. A system as claimed in claims 1, wherein based on bubble sensor input, the controller utilises a known liquid volume to verify the volume of fluid paths between bubble sensors.