

CLAIMS

What is claimed is:

1. A microorganism evaluation system for analyzing microorganisms within a fluid flow, comprising:

a microorganism stimulation section comprising a disorientation spiral having a spiral inner bore defining a first cross-sectional area and thereby allowing for a first flow rate therethrough of the fluid flow, the disorientation spiral configured for inducing a motive response in a living microorganism within the fluid flow passing therethrough; and

a viewing section in fluid communication with the microorganism stimulation section, the viewing section comprising a body having formed therein a body cavity defining a viewing port visible through a cavity first opening formed in the body so as to be in communication with the body cavity, a viewing section body inlet and an opposite viewing section body outlet both being further formed in the body so as to be in communication with the body cavity and provide an unobstructed flow path therebetween through the viewing port, the viewing section further comprising an optical system mounted relative to the body for viewing the fluid flow within the viewing port through the cavity first opening, the optical system being a camera-like device capable of acquiring image data; further wherein:

the viewing section is configured in cooperation with the optical system such that multiple frames of image data relating to the fluid flow and a discrete microorganism therein are acquired via the optical system for analysis, movement of a microorganism relative to the fluid flow in response to flow through the disorientation spiral as per the acquired image data being indicative of microorganism viability; and wherein:

the viewing port of the viewing section defines a second cross-sectional area, the second cross-sectional area being greater than the first cross-sectional area and thereby causing a second flow rate therethrough of the fluid flow to be less than the first flow rate, whereby the fluid flow through the viewing port is rendered relatively slow and laminar, thereby contributing to acquisition of the multiple frames of image data.

2. The system of claim 1 further comprising a hydraulic/mechanical excitation device.

3. The system of claim 2 wherein the hydraulic/mechanical excitation device is upstream of the viewing section.

4. The system of claim 2 wherein the hydraulic/mechanical excitation device is co-located with the viewing section.

5. The system of claim 1 further comprising a flow normalizing section in fluid communication between the microorganism stimulation section and the viewing section, the flow normalizing section comprising an inlet chute having a tapered inlet chute inner bore.

6. The system of claim 5 wherein:

the inlet chute is formed with an inlet chute first coupling configured for connecting to the microorganism stimulation section, the inlet chute inner bore also defining at the inlet chute first coupling the first cross-sectional area of the spiral inner bore of the disorientation spiral and thereby allowing for the first flow rate therethrough of the fluid flow; and

the inlet chute is further formed with an inlet chute second coupling configured for connecting to the viewing section and also defining at the inlet chute second coupling the second cross-sectional area of the viewing port and thereby allowing for the second flow rate therethrough of the fluid flow, whereby the inlet chute of the flow normalizing section receives the fluid flow at the first flow rate as delivered by the disorientation spiral of the microorganism stimulation section and delivers the fluid flow at the second flow rate to the viewing port of the viewing section.

7. The system of claim 5 wherein:

the inlet chute is formed in an inlet chute first plane and a perpendicular inlet chute second plane, the inlet chute first and second planes intersecting along an inlet chute central axis; and

the inlet chute inner bore is tapered in the inlet chute first plane greater than in the inlet chute second plane, whereby the inlet chute inner bore in the inlet chute second plane is substantially equivalent to the spiral inner bore.

8. The system of claim 7 wherein the viewing port of the viewing section defines a depth of field in the axis of the cavity first opening that is substantially equivalent to both the spiral inner bore and to the inlet chute inner bore in the inlet chute second plane.

9. The system of claim 1 wherein the viewing section further comprises an illuminator.

10. The system of claim 9 wherein:

the body is formed having at least one illumination port substantially communicating with the body cavity, the at least one illumination port being offset from the cavity first opening; and

the illuminator comprises an at least one light source positioned within the at least one illumination port.

11. The system of claim 1 further comprising a sample pre-conditioning section upstream of and in fluid communication with the microorganism stimulation section.

12. The system of claim 11 wherein the sample pre-conditioning section comprises:

an external sample tank; and

a main sample tank in fluid communication with the external sample tank and with the microorganism stimulation section.

13. The system of claim 1 wherein a primary microorganism stimulation section and viewing section are configured so as to be sampled by a secondary microorganism stimulation section and viewing section, the primary microorganism stimulation section being at least double the size of the secondary microorganism stimulation section and the primary viewing section being

on the order of five times the width and thirty times the cross-sectional area of the secondary viewing section.

14. The system of claim 1 wherein the fluid flow within the viewing port of the viewing section defines a transit time for each microorganism within the fluid flow of at least one second, the transit time being the amount of time each microorganism dwells within the viewing port so as to be visible to the optical system, whereby the transit time contributes to the acquisition of the multiple frames of image data.

15. The system of claim 1 wherein at least ten frames of image data are acquired for each microorganism.

16. A microorganism evaluation system for analyzing microorganisms within a fluid flow, comprising:

a means for inducing a motive response in a living microorganism within the fluid flow;

a flow normalizing section comprising an inlet chute having a tapered inlet chute inner bore; and

a viewing section in fluid communication with and downstream of the flow normalizing section, the viewing section comprising a body having formed therein a body cavity defining a viewing port visible through a cavity first opening formed in the body so as to be in communication with the body cavity, a viewing section body inlet and an opposite viewing section body outlet both being further formed in the body so as to be in communication with the body cavity and provide an unobstructed flow path therebetween through the viewing port, the viewing section further comprising an optical system mounted relative to the body for viewing the fluid flow within the viewing port through the cavity first opening; further wherein:

the viewing section is configured in cooperation with the flow normalizing section and the optical system such that multiple frames of image data relating to the fluid flow and a discrete microorganism therein are acquired via the optical system for analysis, movement of a

microorganism in response to the means for inducing as detected in the viewing section being indicative of microorganism viability.

17. The system of claim 16 wherein the means for inducing comprises at least one of a disorientation spiral and a hydraulic/mechanical excitation device co-located with a microorganism stimulation section in fluid communication with and upstream of the flow normalizing section.

18. The system of claim 16 wherein the means for inducing comprises the inlet chute co-located with the flow normalizing section.

19. The system of claim 16 wherein the means for inducing comprises at least one of a light source and a hydraulic/mechanical excitation device co-located with the viewing section.

20. The system of claim 16 wherein:

the inlet chute is formed with an inlet chute first coupling defining a first cross-sectional area of the inlet chute inner bore and thereby allowing for a first flow rate therethrough of the fluid flow; and

the inlet chute is further formed with an inlet chute second coupling configured for connecting to the viewing section and defining a second cross-sectional area of the inlet chute inner bore, the second cross-sectional area being greater than the first cross-sectional area and thereby causing a second flow rate therethrough of the fluid flow to be less than the first flow rate.

21. The system of claim 20 wherein:

the means for inducing further comprises a disorientation spiral having a spiral inner bore further substantially defining the first cross-sectional area; and

the viewing port further substantially defines the second cross-sectional area, whereby the inlet chute of the flow normalizing section receives the fluid flow at the first flow rate as

delivered by the disorientation spiral and delivers the fluid flow at the second flow rate to the viewing section.

22. The system of claim 16 wherein:

the inlet chute is formed in an inlet chute first plane and a perpendicular inlet chute second plane, the inlet chute first and second planes intersecting along an inlet chute central axis;

the inlet chute inner bore is tapered in the inlet chute first plane greater than in the inlet chute second plane; and

the viewing port of the viewing section defines a depth of field in the axis of the cavity first opening that is substantially equivalent to the inlet chute inner bore in the inlet chute second plane.

23. A microorganism evaluation system for analyzing microorganisms within a fluid flow, comprising:

a sample pre-conditioning section;

a microorganism stimulation section in fluid communication with the sample pre-conditioning section, the microorganism stimulation section comprising a disorientation spiral for inducing a motive response in a living microorganism within the fluid flow passing through the disorientation spiral;

a flow normalizing section in fluid communication with the microorganism stimulation section, the flow normalizing section comprising an inlet chute having a tapered inlet chute inner bore; and

a viewing section in fluid communication with the flow normalizing section, the viewing section comprising a body having formed therein a body cavity defining a viewing port visible through a cavity first opening formed in the body so as to be in communication with the body cavity, a viewing section body inlet and an opposite viewing section body outlet both being further formed in the body so as to be in communication with the body cavity and provide an unobstructed flow path therebetween through the viewing port, the viewing section further

comprising an optical system mounted relative to the body for viewing the fluid flow within the viewing port through the cavity first opening; further wherein:

the viewing section is configured in cooperation with the flow normalizing section and the optical system such that at least ten frames of image data relating to the fluid flow and a discrete microorganism therein are acquired via the optical system for analysis, movement of a microorganism in response to passing through the disorientation spiral as detected in the viewing section being indicative of microorganism viability.