SMALL VOLUME MIXING DEVICE HARDWARE

BACKGROUND

[0001] Mixing vessels are mounted to mixer bases for use and have many applications, including in particular in the field of bioprocessing. However, different mixing vessels have different shapes and/or configurations and can require specialized mixer bases and other equipment for use. There exists a need for improved bioprocess mixer systems which are capable of rapid mixing of a wide range of volumes of process fluids, preferably with a small laboratory footprint which are easy to use by an operator.

[0002] The present disclosure provides for ameliorating at least some of the disadvantages of the prior art. These and other advantages of the present invention will be apparent from the description as set forth below.

SUMMARY OF THE INVENTION

[0003] An embodiment of the instant disclosure provides a bioprocess mixer system, comprising: a mixer base assembly comprising: (a) a body having: (i) an upper end including a mating face for mixing vessel connection; (ii) a lower end including a cavity; (iii) a plurality of side walls, the plurality of side walls comprising a rounded side wall and a flat side wall; (iv) an inlet port arranged in one of the one or more side walls; (v) an outlet port arranged in one of the one or more side walls; (vi) at least one probe port arranged in one of the one or more side walls; and, (vii) a fluid mixing chamber having a bottom wall; (b) an impeller seat arranged in the cavity in the lower end of the body; and, (c) an impeller arranged in the impeller seat; and a mixer drive system comprising: (a) a drive system configured to drive the impeller; and (b) a housing containing the drive system, the housing comprising a locking mechanism configured to lock the mixer base assembly into an aligned position when connected to the housing.

[0004] Another embodiment of the instant disclosure provides method for mixing fluid, the method comprising: 1) connecting a mixer base assembly comprising: (a) a body having: (i) an upper end including a mating face for mixing vessel connection; (ii) a lower end including a cavity; (iii) a plurality of side walls, the plurality of side walls comprising a rounded side wall

and a flat side wall; (iv) an inlet port arranged in one of the one or more side walls; (v) an outlet port arranged in one of the one or more side walls; (vi) at least one probe port arranged in one of the one or more side walls; and, (vii) a fluid mixing chamber having a bottom wall; (b) an impeller seat arranged in the cavity in the lower end of the body; and, (c) an impeller arranged in the impeller seat; to a mixer drive system comprising: (a) a drive system configured to drive the impeller; and (b) a housing containing the drive system, the housing comprising a locking mechanism configured to lock the mixer base assembly into an aligned position when connected to the housing; and 2) introducing fluid into the fluid mixing chamber; and 3) rotating the impeller to mix the fluid in the fluid mixing chamber.

BRIEF DESCRIPTION OF THE DRAWINGS

[0005] FIG. 1A shows a frontal view of a bioprocess mixer system according to an embodiment described herein which includes an enclosure body encompassing a jacketed mixing vessel housing which encloses a mixing vessel, the mixing vessel mated to a mixer base assembly with a connected probe and tubing, a rotating ring lock locking the mixer base assembly to the bioprocess mixer system, a drive housing enclosing a mixer drive system, and supporting feet.

[0006] FIG. 1B shows an isometric frontal view of an embodiment of a support structure of a bioprocess mixer system described herien including an enclosure body supported above the drive housing.

[0007] FIG. 1C shows an isometric rear view of an embodiment of a support structure of a bioprocess mixer system including ports in the rear of the enclosure body.

[0008] FIG. 1D shows an isometric frontal view of an embodiments of a deconstructed support structure of a bioprocess mixer system including an enclosure body supported above a drive housing, the drive housing supporting on a base plate and comprising a load cell.

[0009] FIG. 1E shows a side view of an embodiment of a bioprocess mixer system with various internal components shown, including various ports and associated piping, the mixer drive system, and load cell.

[0010] FIG. 1F shows a side view of an alternative embodiment of a bioprocess mixer system with various internal components shown, including various ports and associated piping, the mixer drive system, and load cell.

[0011] FIG. 2A shows an isometric view of a bottom side of an embodiment of a mixer base assembly described herein showing a flat side wall.

[0012] FIG. 2B shows an isometric view of a bottom side of an embodiment of a mixer base assembly described herein showing a rounded side wall.

[0013] FIG. 2C shows a view of a top side of an embodiment of a mixer base assembly described herein.

[0014] FIG. 2D shows an isometric view of a top side of an embodiments of a mixer base assembly described herein.

[0015] FIG. 2E shows a view of a top side of an embodiment of a mixer base assembly described herein.

[0016] FIG. 2F shows a side view of a cross section of an embodiment of a mixer base assembly described herein.

[0017] FIG. 2G shows a side view of an embodiment of a mixer base assembly described herein.

[0018] FIG. 2H shows a view of a bottom side of an embodiment of a mixer base assembly described herein.

[0019] FIG. 2I shows a side view of a cross section of an embodiment of a mixer base assembly described herein, including an impeller, shaft, and shaft cap.

[0020] FIG. 2J shows a cross sectional view of an embodiment of an impeller, shaft, and shaft cap described herein.

[0021] FIG. 2K shows an isometric view of a bottom side of an embodiment of a mixer base assembly mated with an uninflated flexible bag mixing vessel.

[0022] FIG. 2L shows an isometric view of a top side of an embodiment of a mixer base assembly mated with an inflated flexible bag mixing vessel.

[0023] FIG. 3A shows a top view of an embodiment of a rotating ring lock positioned around a mixer base assembly in an unlocked position.

[0024] FIG. 3B shows a top view of an alternative embodiment of a rotating ring lock positioned around a mixer base assembly in an unlocked position.

[0025] FIG. 3C shows a top view of an embodiment of a rotating ring lock positioned around a mixer base assembly in a locked position, with the rotating ring lock shown as transparent.

[0026] FIG. 3D shows a side view of an embodiment of a rotating ring lock positioned around a mixer base assembly, with the rotating ring lock shown as transparent.

[0027] FIG. 3E shows an isometric view of an embodiment of a bioprocess mixer system showing the position of the rotating ring lock positioned around a mixer base assembly in a locked position on the drive housing of the device.

[0028] FIG. 3F shows an additional isometric view of an embodiment of a bioprocess mixer system showing the position of the rotating ring lock positioned around a mixer base assembly in a locked position on the drive housing of the device.

[0029] FIG. 4A shows an isometric view of a bottom side of an embodiment of a jacketed mixing vessel housing described herein.

[0030] FIG. 4B shows an isometric view of an embodiment of a jacketed mixing vessel housing showing an interior space defined by the three jacketed walls into which a mixing vessel can be deposited.

[0031] FIG. 4C shows a cross sectional side view of an embodiment of a jacketed mixing vessel housing depicting the internal cavity and fluid flow path of the jacketed mixing vessel housing in operation.

[0032] FIG. 4D shows an isometric view of an embodiment of a jacketed mixing vessel housing with an exemplary dimple configuration.

[0033] FIG. 4E shows a side view of an embodiment of a jacketed mixing vessel housing with an exemplary dimple configuration.

[0034] FIG. 4F shows a cross sectional side view of an embodiment a bioprocess mixer system, with the support structure depicted as transparent and showing the location of the jacketed mixing vessel housing.

[0035] FIG. 5A shows a close-up view of an embodiment of a probe support holder described herein holding a probe.

[0036] FIG. 5B shows the opening motion of the probe support holder during insertion of the probe.

[0037] FIG. 5C shows a deconstructed view of the components of an embodiment of a probe support holder described herein.

[0038] FIG. 5D shows a cross sectional view of an embodiment of a probe support holder described herein comprising a mounting body and a retention latch (depicted as transparent).

[0039] FIG. 6A shows an embodiment of a drive housing of a bioprocess mixer system as described herein.

[0040] FIG. 6B shows an embodiment of a base plate of a bioprocess mixer system as described herein.

[0041] FIG. 6C shows an alternative embodiment of a base plate of a bioprocess mixer system as described herein.

DETAILED DESCRIPTION

[0042] Described herein in detail is a bioprocess mixer system and it associated components, including a mixer base assembly, locking mechanism (*e.g.*, a rotating ring lock described herein), jacketed mixing vessel housing, and other features, which provide substantial advantages over the prior art. For example, the use a bioprocess mixer system as described herein and/or a mixer base assembly described herein allows a user to mix process fluids (in particular bioprocess fluids) at a wide range of volume at a wide range of temperatures within a single device. Additionally, further features described herein contribute to the ease of use of the system, including ease of assembly and operation in a manner which provides robust protection against process failure due to misalignment of the components and leakage and/or spills of process fluids. All these features are combined within one bioprocess mixer system with a small laboratory footprint (*e.g.*, about 40 cm x 40 cm with a height of about 60 cm or less).

[0043] In accordance with an embodiment of the instant disclosure, a bioprocess mixer system is provided, comprising: a mixer base assembly which comprises: (a) a body having: (i) an upper end including a mating face for mixing vessel connection; (ii) a lower end including a cavity; (iii) a plurality of side walls, the plurality of side walls comprising a rounded side wall and a flat side wall; (iv) an inlet port arranged in one of the one or more side walls; (v) an outlet port arranged in one of the one or more side walls; (vi) at least one probe port arranged in one of the one or more side walls; (vii) a fluid mixing chamber having a bottom wall; (b) an impeller seat arranged in the cavity in the lower end of the body; and (c) an impeller arranged in the impeller seat; and a mixer drive system comprising: (a) a drive system configured to drive the impeller; and (b) a housing containing the drive system, the housing comprising a locking mechanism configured to lock the mixer base assembly into an aligned position when connected to the housing.

[0044] In some embodiments, the locking mechanism is a rotating ring lock. In some embodiments, the rotating ring lock comprises a handle, a ring-portion conformed to the rounded side wall of the mixer base assembly, and a hook portion conformed to the flat side wall of the mixer base assembly. In some embodiments, the rotating ring lock is configured to rotate about the mixer base assembly between unlocked and locked positions. In some embodiments, the rotating ring lock is attached to the housing by a plurality of fasteners

positioned through the ring-portion of the rotating ring lock, the plurality of fasteners configured to allow rotation of the rotating ring lock between locked and unlocked positions. In some embodiments, in the locked position, the rotating ring lock covers one or more protrusions from the rounded side wall and/or the flat side wall of the mixer base assembly, and wherein the one or more protrusions are not covered by the rotating ring lock in the unlocked position. In some embodiments, the rotating ring lock covers a first protrusion on the rounded side wall of the mixer base assembly and a second protrusion on the flat side wall of the mixer base assembly in the locked position.

[0045] In some embodiments, the bioprocess mixer system comprises a probe support holder configured to hold a probe in the probe port at a predetermined angle. In some embodiments, the probe support holder is mounted to an enclosure body configured to encase the mixing vessel positioned above the mixer drive system. In some embodiments, the probe support holder comprises a mounting body, a retention latch, and a torsion spring positioned to close the retention latch and hold the retention latch against the probe. In some embodiments, the mounting body and retention latch are two separate parts with the torsion spring positioned at an interface of the two parts. In some embodiments, the retention latch comprises a wedge structure configured to open the retention latch during insertion of the probe. In some embodiments, the probe support holder comprises a rounded portion to support the probe.

[0046] In some embodiments, the bioprocess mixer system comprises at least one probe insertable into the at least one probe port. In some embodiments, the probe measures at least one of pH, conductivity, temperature, or dissolved oxygen.

[0047] In accordance with an additional aspect of the instant disclosure, a jacketed mixing vessel housing is provided, comprising: (a) three jacketed side walls, each of the three jacketed side walls connected to at least one of the other jacketed side walls, each of the jacketed side walls defining an interior cavity, wherein each of the interior cavities is in fluid connection with the others; (b) a base supporting the three jacketed side walls at a bottom side of the three jacketed side walls; (c) an inlet port on the bottom side of one of the jacketed side walls in fluid connection with the interior cavity; and (d) an outlet port on one of the jacketed side walls in fluid connection with the interior cavity at a top side of the interior cavity; wherein the bottom side of the jacketed wall side wall containing the inlet slopes downwardly in a direction towards the inlet port, and wherein the three interior cavities of the three jacketed side walls are

configured such that the three interior cavities are substantially filled by a fluid entering the jacketed mixing vessel housing before the fluid reaches the outlet port.

[0048] In some embodiments, the three jacketed side walls are arranged in a U-configuration with an interior jacketed side wall connected to the other two jacketed side walls, and wherein the interior jacketed side wall comprises the outlet port, and wherein the other two jacketed side walls each comprises an inlet port. In some embodiments, the three jacketed side walls comprise a unitary panel which is wrapped to form the three jacketed side walls. In some embodiments, at least one of the three jacketed side walls comprises a plurality of dimples in the surface of the wall. In some embodiments, the three interior cavities of the three jacketed side walls form a single continuous interior cavity across the three jacketed side walls. In some embodiments, the three jacketed side walls further comprise an insulator. In some embodiments, the three jacketed side walls are arranged to at least partially enclose a mixing vessel.

[0049] In some embodiments, the base of the jacketed mixing vessel housing comprises a bottom jacket defining a bottom interior cavity, a bottom inlet port in fluid connection with the bottom interior cavity, and a bottom outlet port in fluid connection with the bottom interior cavity and the inlet port on the bottom side of one of the jacketed side walls. In some embodiments, the base comprises a corner bracket connecting the base to one of the jacketed side walls. In some embodiments, the jacketed mixing vessel housing further comprises a top plate attached to a top side of the three jacketed side walls, the top plate providing a surface which overhangs an exterior region defined by the three jacketed side walls.

[0050] In preferred embodiments, the inlet and outlet of the jacketed mixing vessel housing are in fluid connection with a fluid source configured to be heated and/or cooled by a heating/cooling unit. Many such heating/cooling sources are known in the art and include, for example, the Integral T 1200 Temperature Control Unit (TCU) manufactured by LAUDA.

[0051] In some embodiments, the jacketed mixing vessel housing is disposed within an enclosure body of a bioprocess mixer system further comprising a mixer drive system with i) a drive system; and ii) a drive housing containing the drive system and comprising a seat for a mixer base assembly comprising an impeller configured to be driven by the drive system. In some embodiments, the enclosure body is positioned above the mixer drive system. In some

embodiments, the enclosure body further comprises an inlet port in fluid connection with the inlet port of the jacketed mixing vessel housing and an outlet port in fluid connection with the outlet port of the jacketed mixing vessel housing. In some embodiments, the enclosure body comprises a probe support holder as described herein.

[0052] In some embodiments, the bioprocess mixer system in which the jacketed mixing vessel housing resides further comprises a mixer base assembly as described herein. In some embodiments, the mixer base assembly comprises (a) a mixer base body having: (i) an upper end including a mating face for mixing vessel connection; (ii) a lower end including a cavity; (iii) one or more side walls; (iv) an inlet port arranged in one of the one or more side walls; (v) an outlet port arranged in one of the one or more side walls; (vi) at least one probe port arranged in one of the one or more side walls; and, (vii) a fluid mixing chamber having a bottom wall; (b) an impeller seat arranged in the cavity in the lower end of the body; and (c) the impeller arranged in the impeller seat.

[0053] In some preferred embodiments, a bioprocess mixer system described herein comprises a weighing system configured to weigh an amount of process fluid placed within the mixer base assembly and/or a mixing vessel disposed thereon.

[0054] In accordance with another aspect of the instant disclosure, a mixer base assembly is provided, comprising: (a) a body having: (i) an upper end including a mating face for mixing vessel connection; (ii) a lower end including a cavity; (iii) a fluid mixing chamber having a bottom wall; (iv) a rounded side wall and a flat side wall, wherein the rounded side wall at a first part is the only wall encasing the fluid mixing chamber and at a second part joins with the flat side wall to encase the fluid mixing chamber; (v) an inlet port arranged in one of the side walls; (vi) an outlet port arranged in one of the side walls, and; (vii) at least one probe port arranged in one of side walls; (b) an impeller seat arranged in the cavity in the lower end of the body; and, (c) an impeller arranged in the impeller seat. In some embodiments, the impeller is a levitating magnetic impeller comprising a magnet, a base, and at least two blades. In some embodiments, the mixer base assembly is present in the seat of the drive housing of the bioprocess mixer system.

[0055] In some embodiments, the mixer base assembly further comprises an alignment marker on one of the side walls configured to denote if the mixer base assembly is in a proper

orientation for connection with the mixing vessel and/or a seat on a housing containing a drive system configured to drive the impeller. In some embodiments, the alignment marker is a protrusion or notch in one of the side walls. In some embodiments, the alignment marker is a protrusion on the flat side wall configured to interact with a rotating ring lock on the housing containing the drive system.

[0056] In some embodiments, the inlet port and/or the outlet port of the mixer base assembly is disposed on the rounded side wall. In some embodiments, the bottom wall of the mixing chamber slopes downwardly in a direction from the inlet port toward the outlet port. In some embodiments, the impeller is a levitating magnetic impeller comprising a magnet, a base, and at least two blades. In some embodiments, the levitating magnetic impeller comprises a central cavity, wherein the impeller seat comprises a shaft protruding through the central cavity of the levitating magnetic impeller, and a shaft cap configured to prevent the levitating magnetic impeller from becoming dislodged from the shaft. In some embodiments, the shaft cap has a greater diameter than the central cavity of the levitating magnetic impeller. In some embodiments, the levitating magnetic impeller is configured to rotate around the shaft. In some embodiments, the shaft cap is heat staked to the shaft.

[0057] In some embodiments, the probe port is positioned to position a probe into the fluid mixing chamber at a desired angle. In some embodiments, the mixer base assembly further comprises the least one probe inserted into the at least one probe port. In some embodiments, the probe measures at least one of pH, conductivity, temperature, or dissolved oxygen.

[0058] In some embodiments, the mixer base assembly is mated with the mixing vessel. In some embodiments, the mixing vessel is a flexible bag. In some embodiments, the flexible bag has a maximum working volume of at least 5 L. In some embodiments, the body is mated with the flexible bag. In some embodiments, the mixer base assembly has a hold up volume of less than 20 mL. In some embodiments, the inlet port and outlet port are mated in fluid connection with flexible tubing. In some embodiments, the flexible tubing mated in fluid connection with the outlet port comprises a tube junction comprising a sample port.

[0059] Also provided herein is a method for mixing fluid, the method comprising: 1) connecting a mixer base assembly to a mixer drive system, the mixer base assembly comprising (a) a body having: (i) an upper end including a mating face for mixing vessel connection; (ii) a

lower end including a cavity; (iii) a plurality of side walls, the plurality of side walls comprising a rounded side wall and a flat side wall; (iv) an inlet port arranged in one of the one or more side walls; (v) an outlet port arranged in one of the one or more side walls; (vi) at least one probe port arranged in one of the one or more side walls; (vii) a fluid mixing chamber having a bottom wall; (b) an impeller seat arranged in the cavity in the lower end of the body; and (c) an impeller arranged in the impeller seat; and the mixer drive system comprising: (a) a drive system configured to drive the impeller; and (b) a housing containing the drive system, the housing comprising a locking mechanism configured to lock the mixer base assembly into an aligned position when connected to the housing; and 2) introducing fluid into the fluid mixing chamber; and 3) rotating the impeller to mix the fluid in the fluid mixing chamber.

[0060] In some embodiments, the method comprises measuring the pH and/or conductivity of the fluid in the fluid mixing chamber. In some embodiments, the method comprises sampling the fluid in the fluid mixing chamber by removing a sample of the fluid by a sample port in fluid connection with the outlet port. In some embodiments, connecting the mixer base assembly to the mixer drive system comprises locking the mixer base assembly to the mixer drive system. In some embodiments, locking the mixer base assembly to the mixer drive system comprises rotating a rotating ring lock about the mixer base assembly. In some embodiments, the method comprises heating or cooling the fluid in the fluid mixing chamber. In some embodiments, the method comprises draining the fluid from the fluid mixing chamber via the outlet port, wherein the fluid mixing chamber has a hold-up volume of less than 30 mL. In some embodiments, the mixer base assembly is connected to the mixing vessel. In some embodiments, the mixing vessel is a flexible bag having a maximum working volume of at least 5 L. In some embodiments, the method comprises inserting a probe into a probe support holder mounted to an enclosure body configured to encase the mixing vessel positioned above the mixer drive system. In some embodiments, the method further comprises monitoring one or more parameter selected from impeller RPM, temperature, pH, and/or weight during the mixing. In some embodiments, the method further comprises recording one or more parameter selected from impeller RPM, temperature, pH, and/or weight during the mixing.

[0061] Advantageously, embodiments of the present disclosure can be used with a variety of mixing vessels having different shapes and/or configurations, though flexible bags are preferred. Among shapes of flexible bags used as mixing vessels, substantially cuboidal is preferred. Homogenized mixing of a wide range of liquid volumes (e.g, about 20 mL to about

10,000 mL) and/or a liquids having wide range of viscosities (*e.g.*, about 1 to about 25 Centipoise (cP)) can be achieved. Embodiments of the invention are particularly advantageous for applications such as for mixing heavy powders, as vortexes are formed, which assist in efficient mixing. Moreover, the use of a levitating magnetic impeller significantly reduces shear force, and eliminates rubbing of parts, thus reducing or eliminating particle shed that could contaminate the fluid. Embodiments of the invention can be used with low volume mixing vessels, and if desired, can be connected to aseptic sampling devices (manual or automatic).

[0062] Preferably, a mixer base assembly described herein is single-use.

[0063] In some instances, the bioprocess mixer system according to the instant disclosure is capable of rapid mixing of components even at high viscosities. For example, in some embodiments, the bioprocess mixer system is capable of completely mixing 10 L of a process fluid of 25 centipoise (cP) within a time of less than about 60 seconds, less than about 30 seconds, less than about 20 second, or less than about 15 seconds (*e.g.*, in a configuration wherein the mixing vessel mated to the mixer base assembly is a flexible bag having a working volume of 10 L). In some embodiments, the bioprocess mixer system is capable completely mixing any volume of process fluid from about 1 L to about 10 L with a viscosity of 1 to 25 cP within 300 seconds or less. Methods of measuring mixing completeness are known in the art and can include, for example, adding a bolus addition of strong acid or base to a fluid of known viscosity within the bioprocess mixer system, rotating the impeller, and assessing the amount of time taken to achieve a stable pH change from initial pH. Such tests are preferably performed at a mixing speed which is just below a vortex speed of the process fluid.

[0064] Additionally, a bioprocess mixer system according to the instant disclosure is preferably able to heat and/or cool a process fluid at a rapid rate (*e.g.*, achieve a transition from room temperature (22°C) to a temperature of about 40°C or to a temperature of about 4°C within 120 minutes for a 10 L sample of water).

[0065] Further details of a bioprocess mixer system and components thereof will now be described in more detail below, wherein like components have like reference numbers.

[0066] FIG. 1A shows a frontal view of a bioprocess mixer system **100** according to an embodiment described herein. The embodiment depicted includes an enclosure body **120** which contains or supports a jacketed mixing vessel housing **400**. The jacketed mixing vessel housing **400** encloses on three sides a mixing vessel **240.** The mixing vessel **240** is mated to a mixer base assembly **200**. The mixer base assembly is configured with a probe **550** and tubing **102**. The mixer base assembly **200** is inserted into a slot in drive housing **110** which contains a drive system configured to drive an impeller present within mixer base assembly **200**. The mixer base assembly **200** is held into its position by a rotating ring lock **300**. The probe **550** is held in place and supported at a desired or optimal angle by probe support holder **500** which is mounted to enclosure body **120**. The bioprocess mixer system **100** rests on supporting feet **104**.

[0067] Preferably, enclosure body **120** and drive housing **110** are made from a material with sufficient strength to support the weight of itself and the enclosed materials (*e.g.*, stainless steel) and configured to withstand fatigue over the product life cycle.

[0068] FIG. 1B shows an embodiment of the structural components of the bioprocess mixer system **100** which hold and/or support the active functional components of the device of a bioprocess mixer system **100**, in an isometric frontal view. The embodiment depicted includes enclosure body **120**. Enclosure body **120** is configured to contain (*i.e.*, at least partially surround) a mixing vessel during operation of the device. The enclosure body **120** includes access **124** positioned at the front of the device, which allows a user to easily reach within the enclosure body **120**, such as for insertion or manipulation of a mixing vessel and/or mixer base assembly within the apparatus. Access **124** is depicted as an open window structure in FIG. 1B, but this can take the form of alternative structures, such as openable door or window, or the front wall of enclosure body **120** can be omitted entirely to allow ease of access to a user.

[0069] Preferably, the enclosure body **120** also contains a heating and/or cooling element (such as a jacketed mixing vessel housing as described elsewhere herein). The enclosure body **120** includes rest shelf **122** positioned its top which can be used to support the heating and/or cooling element during operation or during assembly. After placing the heating and/or cooling element on rest shelf **122**, the element can be fixed into place, such as by welding or other suitable method.

[0070] The enclosure body **120** is supported above drive housing **110** which contains a drive system capable of driving an impeller on a mixer base assembly during operation. A mixer base assembly is placed within a position on upper face **111** of the drive housing **110** during operation in a position aligned with the drive system such that components are in proper orientation for proper functioning. Preferably, upper face **111** is sloped such that it matches a corresponding slope on a mixer base assembly **200** discussed elsewhere herein.

[0071] FIG. 1C shows a rear isometric view of an embodiment of bioprocess mixer **100**, in which upper face **111** can be viewed along with access **124** and rest shelf **122**. Also shown in FIG. 1C are ports **130**, **132**, and **134** which can be used to transport desired fluids to and/or from the bioprocess mixer **100**. Ports **130**, **132**, and **134** can each independently be in fluid connection with corresponding ports on another part of bioprocess mixer system **100**, such as a jacketed mixing vessel housing as described elsewhere herein. While shown with three ports **130**, **132**, and **134**, the system can contain any desired number of ports (*e.g.*, 0, 1, 2, 3, 4, 5, or more ports as desired). Additionally, rather than having its own ports and corresponding piping and/or tubing, enclosure body **120** can instead provide cavities which allow access to the ports of other components of bioprocess mixer system **100**, such as the jacketed mixing vessel housing. Thus, the ports **130**, **132**, and/or **134** shown in FIG. 1C can be in fluid connection with other corresponding ports or can be coextensive with other suitable ports described herein.

[0072] FIG. 1D shows an isometric frontal view of an embodiments of a deconstructed support structure of a bioprocess mixer system **100** including an enclosure body **120** supported above a drive housing **110**. The center of the enclosure body **120** is position directly above upper face **111** of the drive housing **100**. Rest shelf **122** is shown at the top of enclosure body **120**, upon which a jacketed mixing vessel as described elsewhere herein could be rested. Also depicted on enclosure body **120** is window **125** which allows a user to see a mixing vessel placed within enclosure body **120** during operation of the device. The window can be any suitable transparent or semi-transparent material which can allow line of sight into the central area defined by enclosure body **120**. When present, window **125** is preferably configured to open and close to allow access to a mixing vessel enclosed therein.

[0073] The drive housing **110** is supported on a base plate **116** to which the supporting feet **104** are attached. The system also comprises a load cell **114** which is configured to measure weight contained in a mixing vessel used in the system, thus allowing a user to calculate volume

delivered to a mixing vessel or drained from a mixing vessel during operation of the bioprocess mixer system **100**. In some embodiments, an alternative weighing system can be used within a bioprocess mixer system **100**, such as a scale or balance. The drive housing **110** can also contain one or more vents **112** to provide air flow to prevent overheating of any electronics or other components held within the drive housing **110**. Preferably, the vents **112** can maintain the drive housing temperature below 65°C for at least 8 hours of operation of the bioprocess mixer system.

[0074] FIG. 1E shows a side view of an embodiment of a bioprocess mixer system **100** with various internal components shown. For example, various ports **130**, **132**, and **134** and associated piping are shown as attached to further internal components contained within enclosure body **120** (*e.g.*, a jacketed mixing vessel housing as described elsewhere herein). Also shown is mixer drive system **140** which is configured to drive an impeller when appropriately placed within rotating ring lock **300** on top of drive housing **110** (including an impeller such as a levitating magnetic impeller, such as those described herein in connection with mixer base assemblies provided herein). The drive system can be any suitable drive system and can include, for example, a motor, an input/output (TO) module, a power supply, fans, wiring and connections. A variety of motors for spinning (and, as appropriate, magnetically levitating) the impellers are known in the art. Commercially available motors include those available from Pall Corporation (Port Washington, N.Y.; *e.g.*, LEVMIXER® SYSTEM) and Levitronix GmbH (Zurich, Switzerland). The drive system **140** is also favorably configured to run at different controllable impeller speeds which are capable of being monitored. The drive system **140** can also optionally contain a weighing system. Preferred embodiments such as depicted in FIG. 1E contain a load cell **114** for weighing materials on the bioprocess mixer system **100**. The load cell **114** can be placed, for example and as shown, attached to base plate **116** and drive housing **100**. The weighing system desirably has a high degree of measurement accuracy and precision, such as an error of less than 5% and more preferably and error of less than 0.1%. FIG. 1F shows an alternative embodiment with a modified baseplate **116**, as further discussed below with regard to FIG 6C.

[0075] Turning to FIGs. 2A-2L, also provided herein is a mixer base assembly **200** which is compatible with a bioprocess mixer system **100** as described herein. As would be apparent to one of ordinary skill in the art, mixer base assembly **200** and/or features thereof described herein can also be compatible with alternative bioprocess mixer systems and are not limited to

uses with bioprocess mixer system **100** provided herein, or with substantially analogous systems.

[0076] A mixer base assembly **200** described herein in certain embodiments contains (a) a body having: (i) an upper end **202** including a mating face **203** for connection to mixing vessel **240**; (ii) a lower end **204** including a cavity **214;** (iii) one or more side walls **210, 220**; and (iv) a fluid mixing chamber **212** having a bottom wall **205.** The mixer base assembly **200** optionally contains one or more ports selected from (i) an inlet port **208** arranged in one of the one or more side walls; (ii) an outlet port **207** arranged in one of the one or more side walls; and (iii) at least one probe port **209** arranged in one of the one or more side walls. The body can be fabricated from any suitable rigid impervious material, including any impervious thermoplastic material, which is compatible with the fluid being processed. The mixer base assembly **200** is preferably a single-use element designed to be discarded after use. Additionally, mixer base assembly **200** can preferably be pre-packaged in a sterilized form for use by the end user.

[0077] In some embodiments, the mixer base assembly comprises a rounded side wall **220** and a flat side wall **210**. In some embodiments, the rounded side wall **220** at a first part (*e.g.*, an upper portion) is the only wall encasing the fluid mixing chamber and at a second part (*e.g.*, a lower portion) joins with the flat side wall **210** to encase the fluid mixing chamber. Thus, the fluid mixing chamber at certain elevations of the device (*e.g.*, moving from a lower end **204** to an upper end **202**) has a perimeter of different shapes, with the perimeter shape of the fluid mixing chamber **212** at the first part being circular or substantially circular and the perimeter shape at the second part being circular or substantially circular except for an omitted portion defined by a chord of the circle (*i.e.*, where rounded side wall **220** meets flat side wall **210**). In some embodiments, the inlet port and/or the outlet port is disposed on the rounded side wall. In some embodiments, the bottom wall **205** of the mixing chamber **212** slopes downwardly in a direction from the inlet port **208** toward the outlet port **207**. In some embodiments, the probe port **209** is positioned to position a probe **550** into the fluid mixing chamber **212** at a desired angle. In some embodiments, the mixer base assembly comprises at least one probe **550** insertable into the at least one probe port. In some embodiments, the probe measures at least one of pH, conductivity, temperature, or dissolved oxygen.

[0078] In some embodiments, the mixer base assembly further comprises an alignment marker **206** on one of the side walls configured to denote if the mixer base assembly is in a proper

orientation for connection with the mixing vessel **240** and/or a seat **115** on a housing **110** containing a drive system configured to drive the impeller **236**. In some embodiments, the alignment marker **206** is a protrusion or notch in one of the side walls. In some embodiments, the alignment marker is a protrusion **211** on the flat side wall **210** configured to interact with a rotating ring lock **300** on the housing **110** containing the drive system **140**. In some embodiments, the alignment marker is a protrusion which denotes when the mixer base assembly is in proper orientation for alignment with a flexible bag mixing vessel, thereby assuring proper mating of the flexible bag.

[0079] The mixer base assembly **200** can also contain an impeller seat **230** arranged in the cavity **214** in the lower end of the body; preferably with an impeller **236** (*e.g.*, a levitating magnetic impeller) arranged in the impeller seat **230**. In some embodiments, the impeller **236** is a levitating magnetic impeller comprising a magnet, a base, and at least two blades. In some instances, use of a levitating magnetic impeller is preferred as it significantly reduces shear force and eliminates rubbing of parts, thus reducing or eliminating particle shed that could contaminate the fluid compared to other impellers. In some embodiments, the levitating magnetic impeller comprises a central cavity **235**, wherein the impeller seat comprises a shaft **232** protruding through the central cavity of the levitating magnetic impeller, and a shaft cap **234** configured to prevent the levitating magnetic impeller from becoming dislodged from the shaft. In some embodiments, the shaft cap **234** has a greater diameter than the central cavity **235** of the levitating magnetic impeller. The levitating magnetic impeller is configured to rotate around the shaft **232**. In some embodiments, the shaft cap **232** is heat staked to the shaft.

[0080] The mixer base assembly body preferably has a volume (*e.g.*, a fluid mixing chamber volume) of about 200 to 800 mL, more preferably 300 mL to 700 mL, and most preferably 400 mL to 500 mL.

[0081] The features of the mixer base assembly **200** described herein allow for favorable mixing at both low working volumes and with low hold-up volume. In some embodiments, the mixer base assembly **200** has a minimum work volume of at most 100 mL, at most 75 mL, at most 50 mL, at most 45 mL, at most 40 mL, at most 35 mL, at most 30 mL, or at most 25 mL. In some embodiments, the mixer base assembly **200** has a hold-up volume of at most 50 mL, at most 45 mL, at most 40 mL, at most 35 mL, at most 30 mL, at most 25 mL, at most 20 mL, at most 15 mL, at most 10 mL, or at most 5 mL. As is apparent to one of ordinary skill in the

art, the hold-up volume can depend on the viscosity of the process fluid within the vessel. Here, the mixer base assembly preferably has a hold-up volume of a 1 cP process fluid of less than 20 mL, and that such a hold-up volume can be achieved with minimal manipulation of the mixer base assembly and/or associated mixing vessel.

[0082] In some embodiments, the mixer base assembly **200** is mated with a mixing vessel **240**. The mixing vessel can be any suitable mixing vessel compatible with the desired process fluid, but is preferably a flexible bag for bioprocess applications. In some embodiments, the mixing vessel has a maximum working volume of at least 0.5 L, at least 1 L, at least 2.5 L, at least 5 L, or at least 10 L.

[0083] Accordingly, the combination of the low minimum working volume of the mixer base assembly **200** described herein and the maximum working volume of the mixing vessel **240** compatible with said mixer base assembly **200** thus provides an bioprocess mixer system capable of working with a wide dynamic range of working volumes ranging from a few mLs (*e.g.*, 25 mL) to 10 L, all within a single set-up.

[0084] FIG. 2A shows an isometric view of a lower end **204** of an embodiment of a mixer base assembly **200.** Mixer base assembly **200** comprises a flat side wall **210** which comprises probe port **209**. The probe port **209** is preferably configured to hold a probe **550** at a desired angle compatible with optimal probe functioning within the mixer base assembly **200.** Also shown is flat side wall **210** optionally including a flat side wall protrusion **211.** Flat side wall protrusion **211** is position such that it can interact with a rotating ring lock as described elsewhere herein. Mixer base assembly **200** also contains rounded side wall **220**. Notably, rounded side wall **220** contains one portion which defines the entire perimeter of mixer base assembly **200** from upper end **202** until reaching the top of flat side wall **210**, which traverses the remaining height of mixer base assembly **200** to lower end **204**. Rounded side wall **220** and flat side wall **210** together define the perimeter of mixer base assembly for the remaining portion of mixer base assembly **200** (*i.e.*, from the top of the flat side wall **210** to lower end **204)**. Flat side wall **210** and rounded side wall **220** thus both form edges with lower end **204** and with each other. Preferably, these edges are rounded, in particular on the interior of the device to minimize fluid retention around the edges and corners therein.

[0085] Also disposed on rounded side wall **220** is outlet port **207**. Outlet port **207** is positioned on side wall **220** such that it is near or contacting lower end **204** to allow for maximum drainage of the device in operation. Desirably, probe port **209** is positioned on flat side wall **210** near or adjacent to outlet port **207** to allow an inserted probe to work with a minimum working volume. As will be shown in more detail in subsequent figures, the structure of mixer base assembly **200** contains a slope in a downward direction toward the outlet port **207** such that outlet port **207** is at substantially the lowest point of the device in operation in order to allow maximum drainageand minimize the amount of hold-up volume (also known as "carry-over volume" in the art) of the device.

[0086] Also depicted in FIG. 2A is alignment marker **206**, which is a protrusion incorporated onto the exterior surface (here, rounded side wall **220** at the interface of the wall and upper end **202**) of mixer base assembly **200**. Alignment marker **206** provides a physical means on the device to ensure that mixer base assembly **200** is in proper orientation or alignment for connection with a mixing vessel **240** prior to attachment of the mixing vessel **240**. In manufacturing, the presence of the alignment marker **206** can be aligned with a corresponding structural landmark on the mixing vessel **240** to ensure that the attachment is performed to the desired point and in the proper orientation for final use. While depicted as a protrusion in FIG. 2A, an alignment marker **206** could instead be a different feature on the device, such as a notch. Preferably, the mixer base assembly **200** is manufactured in a manner which ensures that alignment marker is always present at the desired location (*e.g.*, using a mold). Additionally or alternatively, other elements of mixer base assembly **200** can also serve as alignment markers in a similar capacity, such as one of protrusions **211** and/or **221**. Additional alignment markers **206** could also be incorporated, such as to denote if mixer base assembly **200** is in proper orientation for connection with a seat **115** on drive housing **110**. Alternatively, alignment marker **206** as depicted could also serve this or another purpose as well.

[0087] Also depicted in FIG. 2A is impeller seat **230**, which is disposed in the lower end **204** of the mixer base assembly **200**. In operation, the lowest point of impeller seat **230** extends below the plane defined by lower end **204**, but is preferably as shallow as possible in order to minimize hold up volume of fluid within the area occupied by the impeller **236**. The diameter of impeller seat **230** is also favorably small for substantially identical reasons (*i.e.*, the diameter of the impeller seat **230** only slight larger than that of impeller **236**, such as at most 20%, at most 15%, at most 10%, or at most 5% larger). In some embodiments, impeller seat **230** is

manufactured with the other components of mixer base assembly **200** (*e.g.*, as a single, injection-molded part). Alternatively, it can be tightly sealed to the bottom wall of the fluid mixing chamber as a separate part.

[0088] As shown in FIG. 2A, the rounded side wall **220** at an upper portion of mixer base assembly **200** is the only wall encasing the fluid mixing chamber for that portion of the device. Additionally, at a lower portion of mixer base assembly **200**, rounded side wall **220** joins with the flat side wall **210** to define the perimeter of the device. Thus, the fluid mixing chamber **212** disposed within the interior of the device at certain elevations of the mixer base assembly **200** (*e.g.*, moving from a lower end **204** to an upper end **202**) has a perimeter of different shapes, with the perimeter shape of a cross section of the fluid mixing chamber **212** at the first part being circular or substantially circular and the perimeter shape at the second part being circular or substantially circular except for an omitted portion defined by a chord of the circle (*i.e.*, where rounded side wall **220** meets flat side wall **210**). Use of such a shape within the device in some instances is beneficial for insertion of mixer base assembly **200** into a seat on drive housing **110** in the proper orientation for alignment with the drive system as the mixer base assembly **200** may only fit into the device in the proper orientation owing to the overall geometry of mixer base assembly **200**.

[0089] FIG. 2B similarly shows an isometric view of lower end **204** of mixer base assembly **200** and showing a different portion of a rounded side wall **220** than that depicted in FIG. 2A. As in FIG. 2A, FIG. 2B also shows outlet port **207**, probe port **209**, impeller seat **230**, and portions of upper end **202**. The mixer base assembly **200** is also depicted as attached to mixing vessel **240**. The mixing vessel **240** to which mixer base assembly **200** is attached is depicted as a flexible bag, but other mixing vessels (*e.g.*, hard shell mixing vessels) are also contemplated as within the scope of the instant disclosure.

[0090] In addition to the features depicted in FIG. 2A, FIG. 2B further shows rounded wall protrusion **211** which also interacts with a rotating ring lock as described elsewhere herein. Also incorporated into rounded side wall **220** is inlet port **208** which can be used to fill the mixing vessel or add one or more of the desired components to be mixed.

[0091] FIG. 2C shows a top side view of mixer base assembly **200**. FIG. 2C thus shows the interior space defined by the perimeter of flat side wall **210** and/or rounded side wall **220**, as

well as the interior faces of both of these walls, with upper end **202** being the nearest end of the device to the viewer. Shown on upper end **202** is mating face **203** to which a mixing vessel **240** as described herein can be mated. The mating can be by any suitable means, including via welding, adhesives, or other suitable methods. Preferably, mating face **203** is joined to the mixing vessel **240** via a weld, such as a weld with a flexible bag mixing vessel. Also shown is bottom wall **205** which defines the bottom of the interior portion, with the exception of impeller seat **230** also depicted and described. Within impeller seat **230** is shaft **232** around which impeller **236** (shown and described later herein) can freely rotate.

[0092] FIG. 2D shows an isometric view of a top side of mixer base assembly **200**, shown from a direction including flat side wall **210** shown in the figure along with its corresponding protrusion **211**. Like FIG. 2C, upper end **202** is nearest the viewer and mating face **203** can be seen. The interior surface of rounded side wall **220** is shown, with the cavity defined by inlet port **208** clearly shown. Bottom wall **205** and impeller shaft **232** are also shown.

[0093] FIG. 2E shows another top side view of mixer base assembly **200** from directly above. As in FIGs. 2C and 2D, bottom wall **205**, impeller seat **230**, impeller shaft **232**, and mating face **203** can be seen. The interior surfaces of rounded side wall **220** and flat side wall **210** can also be seen. The walls are depicted as sloping slightly inward as they descend from upper end **202** to lower end **204**.

[0094] FIG. 2F shows a side view of a cross section of an embodiment of a mixer base assembly **200**. Upper end **202** is shown at the top of the figure and mixer base assembly **200** is being viewed from a view looking directly towards where flat side wall **210** would be present if depicted. Rounded side wall **220** is shown as defining the interior space which makes up fluid mixing chamber **212**, the lower portion of which is defined by the plane of bottom wall **205**. Impeller shaft **232** placed on impeller seat **230** is also shown, as is the cavity **214** in bottom wall **205** which will hold the impeller when present.

[0095] FIG. 2G shows a side view of mixer base assembly **200** viewing parallel to the plane defined by side wall **210**, in which side wall protrusion **211** can be seen, and viewing directly into outlet port **207**. Probe port **209** is omitted from the figure. Upper end **202** is shown at the top of the figure and lower end **204** positioned near the bottom. Rounded side wall **220** is shown

and rounded side wall protrusion **221** can be seen, along with inlet port **208** and alignment marker **206**. The exterior of impeller seat **230** is also shown.

[0096] FIG. 2H shows a view of a bottom side of mixer base assembly **200** in which the exterior of impeller seat **230** is positioned nearest the viewer above bottom wall **205** whose exterior is shown. Alignment marker **206** is shown connected to rounded side wall **220** along with rounded side wall protrusion **221** and inlet port **208** and outlet port **207.** Probe port **209** is omitted. Flat side wall **210** is shown to the right of the figure.

[0097] FIG. 2I shows a side view of a cross section of mixer base assembly **200** with flat side wall **210** omitted from the image except for probe port **209** which contains a probe **550**. FIG. 2I shows the details of fluid mixing chamber **212** including an impeller **236**, impeller shaft **232**, and shaft cap **234** within impeller seat **230**. In operation, the impeller **236**, which is preferably a levitating magnetic impeller, is capable of driving fluid mixing within fluid mixing chamber **212** as well as within mixing vessel **240** (not shown in FIG. 2I) which is mated with mating face **203** on upper end **202** through the hole in upper end **202** which allows for fluid connection between fluid mixing chamber **212** and mixing vessel **240**.

[0098] The impeller is disposed on impeller seat **230** and comprises a magnet and at least two blades (*e.g.*, 2, 3, 4, 5, or 6 blades). The blades preferably extend from the impeller seat **230** and into fluid mixing chamber **212**.

[0099] Also clearly depicted in FIG. 2I is the orientation of outlet port **207** relative to the rest of the device and how the mixer base assembly **200** is preferably oriented in operation (*e.g.*, when inserted into a bioprocess mixer system **100** as described herein). As discussed above, the mixer base assembly **200** is configured such that outlet port **207** occupies the lowest point of elevation along bottom wall **205**, thereby allowing maximal draining of fluid from the vessel and contributing to minimal fluid loss after completion of operation. As shown, bottom wall **205** of the mixing chamber slopes downwardly in a direction toward the outlet port **207**. This downward angle (as measured between the intersection of planes defined by mating face **203** and bottom wall **205**) is selected to be sufficient to minimize fluid retention within the mixer base assembly upon draining of fluid via outlet port **207** (*e.g.*, at least 1, 2, 3, 4, or 5 degrees, and from about 5 to 20 degrees). In operation, upper end **202** is preferably oriented substantially parallel to the ground (or other surface upon which bioprocess mixer system **100** or other

analogous system is placed) and with a bottom face of enclosure body **120** of a bioprocess mixer system **100**. Also depicted in FIG. 2I is fill line **213** which indicates the minimum working volume of the mixer base assembly.

[00100] FIG. 2J shows an exploded cross sectional view of an impeller **236** (*i.e.*, a levitating magnetic impeller) having a central cavity **235** having the indicated diameter, an impeller shaft **232**, and shaft cap **234** attached to shaft **232**. The impeller **236** is disposed around shaft **232**, with the shaft protruding through the central cavity **235**. The impeller **236** is configured to rotate around the shaft **232**. The shaft **232** is taller than the blades of impeller **236** and has a smaller diameter than that of central cavity **235**. Affixed to the top of shaft **232** is shaft cap **234** which is configured to prevent the levitating magnetic impeller from becoming dislodged from the shaft **232**. In particular, a diameter of the shaft cap **234** (with diameter here referring to the maximum length across from tip to tip of the cap as the shaft cap **234** can be shapes other than circular) is greater than that of central cavity **235**. Thus, when the impeller **236** is lifted during operation, it is prevented from leaving the shaft. In addition to preventing the impeller from being dislodged during operation, the shaft cap **234** also ensures that the impeller **236** remains positioned correctly during transport and shipping of a mixer base assembly **200.** Such a consideration is of high importance in embodiments where the mixer base assembly **200** is pre-assembled and shipped to an end user in a sterile state, as manipulation of the mixer base assembly to re-position a dislodged impeller **236** could introduce contamination. The shaft cap **234** can be added to an existing shaft **232** by a variety of methods, but is preferably added by a heat-staking process, which allows for the shaft to be added at a late stage in manufacturing after the impeller has been inserted.

[00101] FIG. 2K shows a mixer base assembly **200** welded to mixing vessel **240**, which in this instance is an uninflated flexible bag having ports **241**. Such a configuration is advantageous for shipping and pre-sterilization of the components, which can then be used by an end user at a later date. FIG. 2L likewise shows a mixer base assembly **200** welded to mixing vessel **240** comprising ports **241**. However, in FIG. 2L the flexible bag is inflated and mating face **203** can be seen welded to the mixing vessel **240**. While the embodiments of mixer base assembly **200** described herein utilize a flat surface as the mating face **203**, alternative embodiments with different faces for mixing vessel connection are contemplated, such as threading for a threaded connection with a suitable mixing vessel.

[00102] Additionally, the mixing vessel **240** shown as connected to mixer base assembly **200** herein is depicted as a flexible bag. However, other types of mixing vessels are compatible with the instant disclosure, such as rigid container mixing vessels (*e.g.*, those made from thermoplastic materials), though flexible bags are preferred. The volume of the mixing vessel connected to mixer base assembly **200** can be many volumes, including those up to 10 L. In some embodiments, a mixing vessel connected to mixer base assembly **200** (*e.g.*, a flexible bag) has a working volume of at least 0.5, at least 1, at least 2, at least 3, at least 4, at least 5, at least 7.5, or at least 10 L.

[00103] Additionally, while depicted herein with only three ports (outlet port **207**, inlet port **208**, and probe port **209**), the use of additional ports to mixer base assembly **200** (*e.g.*, a sample port) is compatible with the instant disclosure. Alternatively, a sample port can be added in fluid connection with one of the existing ports depicted on mixer base **200**, preferably in fluid connection with the outlet port **207**. For example, a sampling manifold (*e.g.*, one comprising a sample port plug, sample port nut, and a sampling port) can be connected to outlet port **207** by appropriate tubing. Such a manifold is advantageously connected to such tubing by a junction (*e.g.*, at T- or Y-connector) so as to allow sampling during operation while still allowing draining out of the same line upon completion of mixing. In some embodiments, the inlet port **208** and outlet port **207** are mated in fluid connection with flexible tubing **250**. In some embodiments, the flexible tubing **250** mated in fluid connection with the outlet port **207** comprises a tube junction comprising a sample port.

[00104] Additionally, a mixer base assembly **200** which lacks one or more of the three ports illustrated is also contemplated as being within the scope of the instant disclosure. For example, in systems or configurations for processes where a probe is not necessary, probe port **209** can be omitted from the mixer base assembly, or the probe port **209** can simply be plugged with an appropriate plug. Additionally or alternatively, inlet port **207** could in some instance be omitted from the design for use in a process where it is appropriate to use the outlet port **208** to also pump in a desired process fluid.

[00105] In some embodiments, a bioprocess mixing system as described herein comprises a locking mechanism which is configured to lock a mixer base assembly into an aligned position (*e.g.*, that an impeller is appropriately aligned with a drive system) when connected to the drive housing. This ensures that during operation of the device the mixer base

assembly remains in the correct orientation for optimal performance and to ensure the mixer base assembly does not become dislodged, particularly in view of potential vibrations and other motion of the system due to movement of the drive system to drive the impeller of the device.

[00106] Accordingly, described herein is a rotating ring lock locking mechanism comprising a handle, a ring portion, and a hook portion. In some embodiments, the ring portion is conformed to the rounded side wall of a mixer base assembly described herein. In some embodiments, the hook portion is conformed to the flat side wall of the mixer base assembly. In some instances, the rotating ring lock is attached to housing of a bioprocess mixer described herein (*e.g.*, a drive housing **110** of a bioprocess mixer system **100**). Preferably, the rotating ring lock is attached by a plurality of fasteners positioned through ring-portion of the rotating ring lock. The plurality of fasteners are configured to allow rotation of the rotating ring lock between locked and unlocked positions. In some embodiments, in the locked position, the rotating ring lock covers one or more protrusions on one of the side walls of the mixer base assembly (*e.g.*, a protrusion from the rounded side wall and/or the flat side wall of the mixer base assembly), and wherein the one or more protrusions are not covered by the rotating ring lock in the unlocked position.

[00107] Turning to FIGs. 3A-3E, a rotating ring lock **300** is depicted which can be used to ensure a mixer base assembly, such as mixer base assembly **200**, is effectively held and locked into place within a bioprocess mixer system such as bioprocess mixer system **100**. The rotating ring lock **300** depicted therein comprises a handle **301**, a ring portion **302** which conforms to the rounded side wall **220** of the mixer base assembly **200**, and a hook portion **303**.

[00108] FIG. 3A shows a top view of rotating ring lock **300** positioned around a mixer base assembly **200** in an unlocked position. This figure shows handle **301** connected to ring-portion **302** attached to hook portion **303**. The ring portion **302** conforms to at least part of the rounded side wall **220** of the mixer base assembly **200**. As reference points to mixer base assembly **200** discussed above, FIG. 3A shows probe port **209** with probe **550** inserted and outlet port **207** (with tubing **250** attached by cable ties **251** as denoted in FIG. 3B) of mixer base assembly **200**, as well as impeller **236**.

[00109] In some instances, the ring-portion **302 is** substantially semi-circular (*e.g.*, encompassing about 180 degrees of a circle), but other circumferential portions are

contemplated and compatible with the instant disclosure (*e.g.*, encompassing at least about or about 90 degrees, 120 degrees, 150 degrees, 180 degrees, or 210 degrees of a circle). The hook portion **303** and handle **301** are preferably placed at opposite ends of the ring-portion **302**. The hook portion **303** is angled towards the interior of the round area defined by the ring-portion **302** at an angle which will allow the hook portion to contact or cover a portion of the mixer base assembly **200** in the locked position and thereby aid in preventing the mixer base assembly **200** from moving from the upper face **111** of drive housing **110** during operation. Preferably and as depicted, the hook portion **303** makes contact with a portion of flat side wall **210** of mixer base assembly **200**. In FIG. 3A, the hook portion **303** is adjacent to but not covering flat side wall protrusion **211** in the unlocked position but will act to cover flat side wall protrusion **211** once moved to the locked position (FIG. 3B). The hook portion **303** can angle inwards at any suitable angle from the ring portion **301** (*e.g.*, from about 30 degrees to about 120 degrees), but preferably conforms to the angle of the edge of rounded side wall **220** and flat side wall **210** of mixer base assembly **200**.

[00110] The handle **301** is angled in an outward direction from the round area defined by the ring-portion **302**. The angle selected is preferably approximately perpendicular to the ring-portion at the point at which the handle **301** begins on ring-portion **302**, but other angles are contemplated as within the scope of the instant disclosure (*e.g.*, any angle, such as from about 30 degrees to about 150 degrees, is allowable, so long as an operator is able to rotate rotating ring lock **300** using the handle **301**). The handle **301**, ring-portion **302**, and hook **303** are preferably fabricated as a single-piece construction (*e.g.*, manufactured from a single mold).

[00111] The rotating ring lock **300** is configured to rotate about the mixer base assembly **200** between unlocked and locked positions. Upper face **111** can include a position indicator **305** as shown in FIG. 3A which denotes whether the rotating ring lock **300** is in a locked or unlocked position. Upper face **111** also includes mixer base support **113** which provides additional support for mixer base assembly **200** when inserted into upper face **111**. Mixer base support **113** can also be configured to ensure proper orientation of mixer base assembly **200** within the device.

[00112] The ring portion **302** also contains ring notch **304** as shown in FIG. 3A. Ring notch **304** is positioned to slot over rounded side wall protrusion **221** of mixer base assembly **200** in the open configuration (and during insertion into the bioprocess mixer system **100**).

Upon rotation of rotating ring lock **300** to the locked position, the ring notch **304** will also rotate, resulting in rounded side wall protrusion **221** becoming covered and/or contacted by ring portion **302** of the rotating ring lock **300**, thus providing an additional (or, in certain embodiments, an alternative) point of contact with mixer base assembly **200** in order to effectuate the desired locking.

[00113] Further depicted on rotating ring lock **300** in FIG. 3A are caps **306** which cover slots **307** (as shown in FIG. 3C discussed below).

[00114] FIG. 3B illustrates an alternative embodment of ring lock **300**. As shown, ring lock **300** includes an alternative shape for slots **307** and omits caps **306**. In this embodiment, the ring lock **300** can include holding features **310** (e.g., clips) located in the slots **307** for releasably holding the fasteners 308 when the ring lock **300** is rotated.

[00115] The ring lock **300** can be manufactured in a variety of ways. In one embodiment, the ring lock **300** is made by machining. In alternative and more preferred embodiments, the ring lock **300** is a unitary component and configured to be manufactured by additive manufacturing.

[00116] FIG. 3C shows a top view of rotating ring lock **300** positioned around a mixer base assembly **200** in a locked position in an exploded view relative to FIG. 3A. The rotating ring lock **300** and other components depicted in FIG. 3C are substantially identical to those of FIG. 3A, except handle **301**, ring-portion **302**, and hook portion **303** are depicted as transparent; caps **306** have been omitted to reveal slots **307** and fasteners **308**; and rotating ring lock **300** is rotated relative to FIG. 3A to place it in a locked position. As can be seen, hook portion **303** now covers and/or contacts flat side wall protrusion **211** and ring notch **304** is no longer slotted over rounded side wall protrusion **221**, thus preventing mixer base assembly **200** from becoming dislodged.

[00117] Ring portion **302** of rotating ring lock **300** is secured to upper face **111** by fasteners **308** through slots **307**, which are configured to allow rotation of rotating ring lock **300**. The fasteners **308** depicted in the figures are screws, though other alternative fasteners could also be used. Ring portion **302** is depicted as being attached via three sets of slots **307**

and fasteners **308**, though other numbers of sets of slots **307** and fasteners **308** are possible (*e.g.*, 2, 3, 4, 5, or more sets).

[00118] The slots **307** are configured to allow a desired amount of rotation to rotating ring lock **300** in order to move between locked and unlocked positions. The degree of rotation can be any suitable degree which is allows for the change in covering and/or contact points of rotating ring lock **300** and mixer base assembly **200** (*e.g.*, a rotation of from about 5 degrees to about 90 degrees, such as about 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65, 70, 75, 80, 85, or 90 degrees), though preferably the degree of rotation allowed is relatively small (*e.g.*, less than 60 degrees).

[00119] FIG. 3D shows a side view of rotating ring lock **300** positioned around mixer base assembly **200** in an unlocked position on upper face **111** with the handle **301** and ring portion **302** shown as transparent, in an embodiment. Within slots **307** is shown how fasteners **308** (again depicted as screws, which are preferred fasteners) secure ring portion **302** to upper face **111**, including use of optional washers **309** (*e.g.*, triple wave washers). Also shown is the position of rounded side wall protrusion **221** and inlet port **208** of mixer base assembly **200** connected to tubing **250** by cable ties **251**. As seen in FIG. 3D, rotating ring lock **300** contacts mixer base assembly **200** at a location below inlet port **208**.

[00120] FIG. 3E shows an isometric view of a bioprocess mixer system showing the position of the rotating ring lock **300** positioned around a mixer base assembly **200** in a locked position on upper face **111** of the drive housing **110** of the device. Also further depicted in FIG. 3E are position indicator **305** and mixer base support **113** on upper face **111**. Enclosure body **120** is also shown, with mixing vessel **240** shown deposited therein and with probe support holder **500** also shown thereon. Tubing **250** with various accessories (*e.g.*, clamps, T-valves, Y-connectors, etc.) is also depicted as connected to various ports.

[00121] FIG. 3F shows an additional view of a bioprocess mixer system showing the position of the rotating ring lock **300** positioned around a mixer base assembly **200** in a locked position on upper face **111** of the drive housing **110** of the device and supported by mixer base support **113**. Flat side wall **210** and probe port **209** are clearly visible, with hook portion **303** visibly contacting flat side wall **210**. Ring portion **302** is also shown contacting rounded side wall **220**, with outlet port **207** shown thereon. Handle **301** is depicted as pointed to the locked

position on position indicator **305**. Mixer base assembly **200** is also shown as contacting enclosure body **120** above it.

[00122] In some embodiments, a bioprocess mixing system as described herein comprises a jacketed mixing vessel housing which is configured to at least partially surround (*e.g.*, surround in at least three directions) a mixing vessel. The jacketed mixing vessel housing comprises internal cavities which can be at least partially filled with a fluid which can be heated and/or cooled, preferably in a manner which allows the fluid to be recirculated (*e.g.*, the jacketed mixing vessel housing contains suitable piping and connections with an external fluid heating/cooling source, such as a heating/cooling unit). This allows the fluid to regulate the temperature of a process fluid disposed within a mixing vessel in the interior of the jacketed mixing vessel housing.

[00123] Accordingly, provided herein is a jacketed mixing vessel housing comprising three jacketed side walls, each of the three jacketed side walls connected to at least one of the other jacketed side walls, and each of the jacketed side walls defining an interior cavity, and each of the interior cavities is in fluid connection with the others. The jacketed mixing vessel housing can further comprise a base supporting the three jacketed side walls at a bottom side of the three jacketed side walls. The jacketed mixing vessel housing can also comprise an inlet port on the bottom side of one of the jacketed side walls in fluid connection with the interior cavity and/or an outlet port on one of the jacketed side walls in fluid connection with the interior cavity at a top side of the interior cavity. In some instances, the bottom side of the jacketed side wall containing the inlet slopes downwardly in a direction towards the inlet port. In some embodiments, the three interior cavities of the three jacketed side walls are configured such that the three interior cavities are substantially filled by a fluid entering the jacketed mixing vessel housing before the fluid reaches the outlet port.

[00124] According to some embodiments, the three jacketed side walls are arranged in a U-configuration with an interior jacketed side wall connected to the other two jacketed side walls, and wherein the interior jacketed side wall comprises the outlet port, and wherein the other two jacketed side walls each comprises an inlet port. Additionally, in some instances, the three jacketed side walls comprise a unitary panel which is wrapped to form the three jacketed side walls. In some embodiments, the three interior cavities of the three jacketed side walls form a single continuous interior cavity across the three jacketed side walls. In some

embodiments, at least one of the three jacketed side walls comprises a plurality of dimples in the surface of the wall. In some embodiments, the three jacketed side walls further comprise an insulator. In some embodiments, the three jacketed side walls are arranged to at least partially enclose a mixing vessel.

[00125] In some embodiments, the base of the jacketed mixing vessel housing comprises a bottom jacket defining a bottom interior cavity, a bottom inlet port in fluid connection with the bottom interior cavity, and a bottom outlet port in fluid connection with the bottom interior cavity and the inlet port on the bottom side of one of the jacketed side walls. In some instances, the base comprises a corner bracket connecting the base to one of the jacketed side walls. In some embodiments, the base is configured to support the mixing vessel when present within the jacketed mixing vessel housing. In some embodiments, the jacketed mixing vessel housing further comprises a top plate attached to a top side of the three jacketed side walls, the top plate providing a surface which overhangs an exterior region defined by the three jacketed side walls.

[00126] The jacketed mixing vessel housing described herein is favorably held within an enclosure body as described herein within a bioprocess mixer system.

[00127] A jacketed mixing vessel housing according to the instant disclosure is preferably coupled to a heating/and or cooling unit. Accordingly, in some instances, the inlet and outlet of the jacketed mixing vessel housing are in fluid connection with a fluid source configured to be heated and/or cooled by a heating/cooling unit. The fluid source used is preferably a mixture of ethylene glycol and water for optimal heating/cooling properties, such as a 1:1 mixture of ethylene glycol and water (v/v).

[00128] FIGs. 4A-4F herein describe an exemplary jacketed mixing vessel housing according to the instant disclosure. A jacketed mixing vessel housing **400** comprises a plurality of jacketed side walls (*e.g.*, three jacketed side walls **401, 402, 403**). Preferably, each of the jacketed side walls is connected to at least one of the other jacketed side walls. Each of the jacketed side walls defines an interior cavity **404**, which is configured to receive a fluid which can preferably be heated and/or cooled (*e.g.*, the fluid is configured to be recirculated with a heating/cooling unit). Preferably, each of the plurality of jacketed side walls is in fluid connection with the others, thus defining a single flow path through the jacketed mixing vessel housing. The plurality of walls of jacketed mixing vessel housing **400** can each be prepared as

individual components but are preferably prepared from a single panel which is wrapped into the surrounding configuration. Thus, the "plurality of jacketed side walls" or a recitation of a specific number of jacketed side walls (*e.g.*, three jacketed side walls) can refer to a single panel which is wrapped or folded into the surrounding configuration described herein. Additionally, the jacketed side walls can also further comprise an insulator in order to help retain heat during operation and potentially increase the rate at which process fluid in the mixing vessel heats during operation.

[00129] Preferably, at least one (and more preferably, at least two) of the jacketed side walls comprise an inlet port **408** on the bottom side **414** of the jacketed side wall in fluid connection with the interior cavity. At least one of the jacketed side walls (and preferably only one) comprises an outlet port **406** in fluid connection with the interior cavity **404** at or near a top side **409** of the jacketed side wall. This allows the heated and/or cooled fluid to traverse the jacketed mixing vessel housing in bottom-up flow path. Preferably, the plurality of jacketed side walls define a single internal cavity **404** without internal piping, thus allowing the internal cavity **404** to fill from the bottom up simultaneously rather than sequentially through individual jacketed side walls. The jacketed side walls are preferably sloped with inlet port **408** at the lowest point (*e.g.*, a slope of about 2 degrees) to ensure proper filling of internal cavity **404** with heating/cooling fluid during operation. Additionally, placement of outlet port **406** in fluid communication at the top side **409** of the cavity allows all of the internal cavity **404** to become filled before the heating/cooling fluid leaves the jacketed mixing vessel housing **400**. These features allow for uniform heating/cooling of process fluid within a mixing vessel which can be placed within the jacketed mixing vessel housing **400**.

[00130] The jacketed mixing vessel housing can comprise a base **410** supporting the plurality jacketed side walls at a bottom side of the plurality jacketed side walls. The base **410** can also be jacketed with an interior cavity which is also in fluid communication with the interior cavities of the plurality of jacketed side walls. In such a configuration, the jacketed base **410** is configured to be first filled by a fluid which can be heated and/or cooled, at which point the fluid will exit the jacketed base **410** at at least one point and enter inlet port(s) **408** in the jacketed side wall(s) (preferably, into two separate jacketed side walls). Thus, this configuration allows for additional heating of a process fluid in a mixing vessel disposed within jacketed mixing vessel housing **400** from an additional side (the bottom side) while still allowing front access to the mixing vessel.

[00131] In a most preferred configuration of a jacketed mixing vessel housing **400** (as shown in, for example, FIG. 4B), a flow path of heating or cooling fluid flows through jacketed mixing vessel housing by first entering inlet port **411** of jacketed mixing vessel housing base **410** through bottom interior cavity **412** and wrapping around the bottom side **414** of the jacket side walls. The fluid then leaves jacketed base **410** and enters inlet ports **408** of two separate jacketed side walls **401** and **403** at a bottom side **414**. The bottom side **414** slopes downwardly in a direction towards inlets **408** (*e.g.*, about 2 degrees). The three interior cavities **404** (which effectively form a single continuous interior cavity across the three jacketed side walls **401, 402,** and **403**) are then uniformly filled across the bottom side as fluid continues to enter the inlets **408** until the fluid level reaches the outlet in fluid communication with the cavity **404** at the top side of middle jacketed side wall **402**, thereby substantially filling each of the jacketed side walls **401**, **402**, and **403** with fluid for heating and/or cooling.

[00132] FIG. 4A shows an isometric view of a bottom side jacketed mixing vessel housing **400**. Three jacketed side walls **401**, **402**, and **403** are depicted as substantially surrounding in three directions an interior space into which a mixing vessel can be placed. Jacketed mixing vessel housing **400** is depicted with a jacketed mixing vessel housing base **410** placed at the bottom sides **414** of jacketed side walls **401**, **402**, and **403**. Jacketed mixing vessel housing base **410** is in this figure depicted as itself jacketed and comprising bottom inlet port **411** into which a fluid for heating and/or cooling can be delivered. The end of the flow path of a delivered fluid for heating and/or cooling through jacketed mixing vessel housing is shown in outlet **406** in fluid connection with a top side **409** of jacketed side wall **402**. Also in fluid connection with outlet **406** is air purge **407**, which ensures that any air trapped in the jacketed mixing vessel housing fluid flow path is able to be sparged during operation. The jacketed side walls are also pictured with dimples **405** in the side walls. In some embodiments, the presence of dimples **405** can result in enhanced heat transfer and/or uniformity of heat transfer to process fluid within a mixing vessel enclosed within the jacketed side walls **401**, **402**, and **403**. The jacketed side walls **401** and **403** are mounted to the base at least through corner brackets **420** to provide additional support. The jacketed mixing vessel housing **400** also contains top plate with overhangs **415** which comprises overhangs oriented await from the interior space into which a mixing vessel can be placed. Top plate with overhangs **420** provide a contact surface through which the jacketed mixing vessel housing **400** can be placed into enclosure body **120** of a bioprocess mixer system **100** as described herein, such as by resting the overhangs on rest shelf **122**. During operation, a mixing vessel can be rested on top of base **410**.

[00133] FIG. 4B shows the same jacketed mixing vessel housing **400** with a view of an interior space defined by the three jacketed side walls **401**, **402**, and **403** into which a mixing vessel can be deposited. In this figure, the flow path of a fluid for heating and/or cooling of a mixing vessel is depicted, wherein the flow of the fluid beings in base **410** through cavity **412**, which then exits base **410** and enters inlets **408** of jacketed side walls **401** and **403** to fill the cavity defined by the three jacketed side walls **401**, **402**, and **403.** Dimples **405** can be seen on each of jacketed side walls **401**, **402**, and **403**. Air purge **407** can also be seen in the rear of the jacketed mixing vessel housing **400**.

[00134] FIG. 4C shows a cross sectional side view of jacketed mixing vessel housing **400** depicting the internal cavity **404** and fluid flow path of the jacketed mixing vessel housing **400** in operation. The cross section of jacketed side wall **401** is depicted revealing the internal structure of internal cavity **404**, which contains no internal piping or other structure and is uninterrupted except for dimples **405**. Such a configuration with no internal piping or other structure of the internal cavity **404** is preferred, though internal structure can be compatible with the instant disclosure (*e.g.*, the addition of baffles or other structure to alter or guide the flow path through jacketed mixing vessel housing **400**). To follow the flow path of a fluid for heating and/or cooling, the fluid enters at bottom inlet port **411** and traverses through bottom interior cavity **412** of base **410** until reaching bottom outlet port **413** of base **410**. The fluid then enters inlet port **408** of jacketed side wall **401** (and, simultaneously, inlet port **408** at a corresponding position of jacketed side wall **403** not shown in the image). Each of jacketed side walls **401**, **402**, and **403** then become filled with the fluid from the bottom up, aided by the downward slope of the bottom of jacketed side walls **401**, **402**, and **403** towards inlet ports **408**. The downward slope can have any desired angle, but is preferably a gentle angle of less than 10 degrees, more preferably less than 5 degrees, and most preferably about 2 degrees or less. Upon filling interior cavity **404**, the fluid travels out of the device at outlet **406** in fluid communication with the top of interior cavity **404**, with any trapped air allowed to escape via air purge **407**. Top plate with overhangs **415** is also shown.

[00135] FIG. 4D shows an isometric view a jacketed mixing vessel housing **400** with an alternative configuration of dimples **405**. FIG. 4E likewise shows a side view of a jacketed mixing vessel housing **400** with another configuration of dimples **405**. Any configuration of dimples **405** is compatible with the instant disclosure, and indeed each jacketed side wall of the device can have a different dimple configuration.

[00136] FIG. 4F shows a cross sectional side view of bioprocess mixer system **100**, with features and connections of jacketed mixing vessel **400** thereto emphasized. Enclosure body **120** is depicted as transparent and showing the location of jacketed mixing vessel housing **400** disposed therein placed above drive housing **110**. All the features of FIG. 4C of jacketed mixing vessel housing **400** are shown, including base **410**, bottom inlet port **411**, bottom interior cavity **412,** bottom outlet port **413** with connection to inlet port **408**, outlet **406** in fluid communication with the top of interior cavity **404**, air purge **407**, and dimples **405.**

[00137] As shown in FIG. 4F, bottom inlet port **411**, outlet port **406**, and air purge **407** are depicted as part of jacketed mixing vessel **400** and extending through enclosure body **120**. In an alternative embodiment, jacketed mixing vessel housing **400** can instead have an outlet port **406** in fluid connection with an additional port and corresponding piping present on the enclosure body **120** (*e.g.*, with port **132** depicted in FIG. 1C) and/or bottom inlet port **411** can be in fluid connection with an additional port and corresponding piping present on the enclosure body **120** (*e.g.*, with port **134** depicted in FIG. 1C). In such embodiments, the outlet port **406** and/or the bottom inlet port **411** would refer to the portion of the jacketed mixing vessel housing **400** which contacts and is mated with the corresponding piping of enclosure body **120**.

[00138] In some embodiments, a bioprocess mixing system as described herein comprises a probe support holder. A probe support holder as described herein is able to hold and support a probe during operation of the device. Preferably, the probe support holder is able and configured to hold a probe within a probe port at a predetermined and/or desired angle. Such a property is desirable when used in conjunction with certain probes that must be operated at a specific angle for proper functioning and where the shape and/or structure of a mixer base assembly makes it difficult to support such a probe by itself and retain the probe in the desired configuration. A probe support holder as provided herein can favorably be mounted to a bioprocess mixing system as described herein, such as to an enclosure body described herein.

[00139] In some embodiments, a probe support holder described herein can comprise a mounting body, a retention latch, and a torsion spring. The torsion spring is positioned and/or configured to close the retention latch and thereby hold the retention latch against a probe. The mounting body and retention latch can be two separate parts with the torsion spring position an interface of the two parts. The retention latch can also favorably comprise a wedge structure

configured to open the retention latch during insertion of the probe into the probe support holder. The probe support holder also favorably comprises a surface which conforms to the shape of the probe, such as a rounded portion to support a rounded probe. The probe which can be mounted using the probe support holder can be any desirable probe, including without limitation probes to measure at least one of pH, conductivity, dissolved oxygen (or other gas), or any other salient feature of a process fluid.

[00140] Turning to FIGs. 5A-5D, also provided herein is probe support holder **500** which is compatible with a bioprocess mixer system **100** as described herein. As would be apparent to one of ordinary skill in the art, probe support holder **500** described herein can also be compatible alternative bioprocess mixer systems and are not limited to uses with bioprocess mixer system **100** provided herein, or with substantially analogous systems.

[00141] FIG. 5A shows a close-up view of probe support holder **500** described herein. Probe support holder **500** is depicted as mounted to an enclosure body **120** above upper face **111** of a bioprocess mixer system described herein. Probe support holder **500** is shown holding probe **550** in place within probe port **207** on mixer base assembly **200**. The probe support holder **500** is shown in a closed latch position.

[00142] FIG. 5B shows a close-up view of the same probe support holder **500** shown in FIG. 5A in an open latch position and with the opening motion denoted. As shown, probe support holder **500** comprises a portion (retention latch **510** shown in FIG. 5C and 5D) which is configured to move downward during insertion of the probe **550** into the holding position of probe support holder **500**.

[00143] FIG. 5C shows an exploded view of the components of probe support holder **500** described herein. Specifically, probe support holder **500** comprises two parts which make up the exteriors of the device. These two parts include mounting body **501** which is capable of being mounted to a desired surface (*e.g.*, enclosure body **120**) through mounting holes **502**, which can be used in conjunction with suitable fasteners (*e.g.*, screws) to mount probe support holder **500** to the desired surface. The second exterior part of probe support holder **500** is retention latch **510**. Retention latch **510** includes an insertion wedge **513** which acts to drive retention latch in a downward direction during insertion of a probe **550** into probe support holder **500** when probe **500** moves into probe support surface **503** in a lateral direction across

the device. Probe support surface **503** is conformed to the shape of the desired probe and preferably comprises a rounded portion in order to be compatible with most commercially available probes. Upon moving of probe **550** past insertion wedge **513** during insertion, torsion spring **507** acts to snap retention latch **510** back into the closed position, thereby securing the probe **550** in place.

[00144] FIG. 5C also depicts the hardware and other features which are used to assemble the device and includes screw **504**, washer **505**, torsion spring **507**, sleeve bushing **508**, and dowel **509** inserted into the relevant holes of the device. Specifically, screw **504** traverses through hole **506** in the mounting body **501**, torsion spring **507**, and sleeve bushing **508** before finally entering receiving hole **511** on retention latch **510**. Dowel **509** is inserted into separate holes on the two parts. Importantly, torsion spring **507** is positioned at the interface of mounting body **501** and retention latch **510** such that when compressed, it will drive back the two components into the closed position and thereby secure probe **550** in place. FIG. 5D shows a cross sectional view of probe support holder **500** as fully assembled with mounting body **501** depicted as connected to retention latch **510** (depicted as transparent). The other associated hardware can be seen therein.

[00145] Turning to FIG. 6A, further details of an embodiment of drive housing **110** and associated features are shown. Drive housing **110** comprises a mixer base seat **115** on upper face **111** which is configured to receive a mixer base assembly (*e.g.*, mixer base assembly **200** described herein) and orient the mixer base assembly in a proper orientation for operation. Drive housing **110** also comprises vents **112** to allow air flow into drive housing **110** to reduce the risk of overheating of the various components placed therein, including drive system and/or other electronics **118**. The drive housing **110** preferably contains an access door **117** which can be opened in order to allow access to the electronics **118** and other materials stored inside. The access door **117** can also contain brackets **121** on which electronics **118** can be mounted. The exterior of the drive housing **110** also contains electrical ports **119** from which power can be supplied to various components of the device (*e.g.*, the drive system, probes, etc.). Drive housing **110** can be mounted on base plate **116** with support feet **104** contacting the surface on which the device is rested. Support feet **104** are optimally adjustable to allow appropriate balancing of the devise.

[00146] FIG. 6B shows additional details of base plate **116** and its components, in an embodiment. Base plate **116** comprises top plate **151** and welded base **150** which are connected by suitable fasteners which preferably include vibration damping isolators **154**. Load cell **114** is positioned between welded base **150** and top plate **151** and is held in place by load cell mounting fasteners/screws **153**. The load cell **114** is configured to be able to accurately weigh contents placed into mixer base assembly **200** and a corresponding mixing vessel in operation. FIG. 6C illustrates an alternative embodiment of the base plate **116**. As shown, the top plate **151** and base **150** have a generally "H" shape, with the load cell 114 fastened to the cross of the H with fasteners 153.

[00147] All publications, patents, and patent applications mentioned in this specification are herein incorporated by reference to the same extent as if each individual publication, patent, or patent application was specifically and individually indicated to be incorporated by reference.

[00148] Unless defined otherwise, all technical and scientific terms and any acronyms used herein have the same meanings as commonly understood by one of ordinary skill in the art in the field of the invention. Although any methods and materials similar or equivalent to those described herein can be used in the practice of the present invention, the exemplary methods, devices, and materials are described herein.

Definitions

[00149] As used herein, the terms "comprises," "comprising," "includes," "including," "has," "having," "contains", "containing," "characterized by," or any other variation thereof, are intended to encompass a non-exclusive inclusion, subject to any limitation explicitly indicated otherwise, of the recited components. For example, subject matter that "comprises" a list of elements (*e.g.*, components, features, or steps) is not necessarily limited to only those elements (or components or steps), but may include other elements (or components or steps) not expressly listed or inherent to the subject matter.

[00150] As used herein, the transitional phrases "consists of" and "consisting of" exclude any element, step, or component not specified. For example, "consists of" or "consisting of" used in a claim would limit the claim to the components, materials or steps

specifically recited in the claim. When the phrase "consists of" or "consisting of" appears in a clause of the body of a claim, rather than immediately following the preamble, the phrase "consists of" or "consisting of" limits only the elements (or components or steps) set forth in that clause; other elements (or components) are not excluded from the claim as a whole.

[00151] As used herein, the transitional phrases "consists essentially of" and "consisting essentially of" are used to define a subject matter that includes materials, steps, features, components, or elements, in addition to those literally disclosed, provided that these additional materials, steps, features, components, or elements do not materially affect the basic and novel characteristic(s) of the claimed subject matter. The term "consisting essentially of" occupies a middle ground between "comprising" and "consisting of".

[00152] When introducing elements of the present invention or the preferred embodiment(s) thereof, the articles "a", "an", "the" and "said" are intended to mean that there are one or more of the elements. The terms "comprising", "including" and "having" are intended to be inclusive and mean that there may be additional elements other than the listed elements.

[00153] The term "and/or" when used in a list of two or more items, means that any one of the listed items can be employed by itself or in combination with any one or more of the listed items. For example, the expression "A and/or B" is intended to mean either or both of A and B, *i.e.* A alone, B alone or A and B in combination. The expression "A, B and/or C" is intended to mean A alone, B alone, C alone, A and B in combination, A and C in combination, B and C in combination or A, B, and C in combination.

[00154] It is understood that aspects and embodiments of the disclosure described herein include "consisting" and/or "consisting essentially of" aspects and embodiments.

[00155] It should be understood that any description in range format is merely for convenience and brevity and should not be construed as an inflexible limitation on the scope of the claimed invention. Accordingly, the description of a range should be considered to have specifically disclosed all the possible sub-ranges as well as individual numerical values within that range. For example, description of a range such as from 1 to 6 should be considered to have specifically disclosed sub-ranges such as from 1 to 3, from 1 to 4, from 1 to 5, from 2 to

4, from 2 to 6, from 3 to 6 etc., as well as individual numbers within that range, for example, 1, 2, 3, 4, 5, and 6. This applies regardless of the breadth of the range. Values or ranges may be also be expressed herein as “about,” from “about” one particular value, and/or to “about” another particular value. When such values or ranges are expressed, other embodiments disclosed include the specific value recited, from the one particular value, and/or to the other particular value. Similarly, when values are expressed as approximations, by use of the antecedent “about,” it will be understood that the particular value forms another embodiment. It will be further understood that there are a number of values disclosed therein, and that each value is also herein disclosed as “about” that particular value in addition to the value itself. In embodiments, “about” can be used to mean, for example, within 10% of the recited value, within 5% of the recited value, or within 2% of the recited value.

What is claimed is:

1. A bioprocess mixer system, comprising:

a mixer base assembly comprising:

(a) a body having:

(i) an upper end including a mating face for mixing vessel connection;

(ii) a lower end including a cavity;

(iii) a plurality of side walls, the plurality of side walls comprising a rounded side wall and a flat side wall;

(iv) an inlet port arranged in one of the one or more side walls;

(v) an outlet port arranged in one of the one or more side walls;

(vi) at least one probe port arranged in one of the one or more side walls; and,

(vii) a fluid mixing chamber having a bottom wall;

(b) an impeller seat arranged in the cavity in the lower end of the body; and,

(c) an impeller arranged in the impeller seat; and

a mixer drive system comprising:

(a) a drive system configured to drive the impeller; and

(b) a housing containing the drive system, the housing comprising a locking mechanism configured to lock the mixer base assembly into an aligned position when connected to the housing.

2. The bioprocess mixer system of claim 1, wherein the locking mechanism is a rotating ring lock.

3. The bioprocess mixer system of claim 2, wherein the rotating ring lock comprises a handle, a ring-portion conformed to the rounded side wall of the mixer base assembly, and a hook portion conformed to the flat side wall of the mixer base assembly wherein the ring lock is a unitary component and configured to be manufactured by additive manufacturing.

4. The bioprocess mixer system of claim 3, wherein the rotating ring lock is attached to the housing by a plurality of fasteners positioned through ring-portion of the rotating ring lock, the plurality of fasteners configured to allow rotation of the rotating ring lock between locked and unlocked positions.

5. The bioprocess mixer system of claim 4, wherein, in the locked position, the rotating ring lock covers one or more protrusions from the rounded side wall and/or the flat side wall of the mixer base assembly, and wherein the one or more protrusions are not covered by the rotating ring lock in the unlocked position.

6. The bioprocess mixer system of claim 1, further comprising a probe support holder configured to hold a probe in the probe port at a predetermined angle.

7. The bioprocess mixer system of claim 6, wherein the probe support holder is mounted to an enclosure body configured to encase the mixing vessel positioned above the mixer drive system.

8. The bioprocess mixer system of claim 6, wherein the probe support holder comprises a mounting body, a retention latch, and a torsion spring positioned to close the retention latch and hold the retention latch against the probe.

9. The bioprocess mixer system of claim 8, wherein the mounting body and retention latch are two separate parts with the torsion spring positioned at an interface of the two parts.

10. The bioprocess mixer system of claim 8, wherein the retention latch comprises a wedge structure configured to open the retention latch during insertion of the probe.

11. A method for mixing fluid, the method comprising:

1) connecting (I) a mixer base assembly comprising:

(a) a body having:

(i) an upper end including a mating face for mixing vessel connection;

(ii) a lower end including a cavity;

(iii) a plurality of side walls, the plurality of side walls comprising a rounded side wall and a flat side wall;

(iv) an inlet port arranged in one of the one or more side walls;

(v) an outlet port arranged in one of the one or more side walls;

(vi) at least one probe port arranged in one of the one or more side walls; and,

(vii) a fluid mixing chamber having a bottom wall;

(b) an impeller seat arranged in the cavity in the lower end of the body; and,

(c) an impeller arranged in the impeller seat; to

(II) a mixer drive system comprising:

(a) a drive system configured to drive the impeller; and

(b) a housing containing the drive system, the housing comprising a locking mechanism configured to lock the mixer base assembly into an aligned position when connected to the housing; and

2) introducing fluid into the fluid mixing chamber; and

3) rotating the impeller to mix the fluid in the fluid mixing chamber.

12. The method of claim 11, further comprising measuring the pH, dissolved oxygen and/or conductivity of the fluid in the fluid mixing chamber.

13. The method of claim 11, further comprising sampling the fluid in the fluid mixing chamber by removing a sample of the fluid by a sample port in fluid connection with the outlet port.

14. The method of claim 11, wherein connecting the mixer base assembly to the mixer drive system comprises locking the mixer base assembly to the mixer drive system.

15. The method of claim 14, wherein locking the mixer base assembly to the mixer drive system comprises rotating a rotating ring lock about the mixer base assembly.

16. The method of claim 11, further comprising heating and/or cooling the fluid in the fluid mixing chamber.

17. The method of claim 11, further comprising draining the fluid from the fluid mixing chamber via the outlet port, wherein the fluid mixing chamber has a hold-up volume of less than 30 mL.

18. The method of claim 11, wherein the mixer base assembly is connected to the mixing vessel.

19. The method of claim 18, wherein the mixing vessel is a flexible bag having a maximum working volume of at least 5 liters.

20. The method of claim 11, further comprising inserting a probe into a probe support holder mounted to an enclosure body configured to encase the mixing vessel positioned above the mixer drive system.