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MULTIPHASE MIXING SYSTEM FOR HOMOGENOUS MIXING OF SOLID AND LIQUID COMPONENTS

Abstract

Multiphase mixing systems and methods for creating homogenous mixtures of solid and liquid components. A system includes an inlet pump tube configured to be disposed within a mixing vessel. The system includes a pump in fluid communication with the inlet pump tube, wherein the pump extracts a solution from the mixing vessel when the inlet pump tube is disposed within the mixing vessel. The system includes a three-way valve in fluid communication with the pump. The system includes a differential pressure outlet configured to be disposed within the mixing vessel, wherein the differential pressure outlet is in fluid communication with the pump and the three-way valve. The system is such that the extracted solution is processed through the pump and ejected into the mixing vessel through the differential pressure outlet.

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Background/Summary

CROSS-REFERENCE TO RELATED APPLICATIONS [0001] This disclosure claims the benefit of U.S. Provisional Patent Application No. 63/553,557, filed Feb. 14, 2024, titled "MULTIPHASE MIXING SYSTEM FOR HOMOGENOUS MIXING OF SOLID AND LIQUID COMPONENTS," which is incorporated herein by reference in its entirety, including but not limited to those portions that specifically appear hereinafter, the incorporation by reference being made with the following exception: In the event that any portion of the above-referenced provisional patent application is inconsistent with this disclosure, this disclosure supersedes the above-referenced provisional patent application.

TECHNICAL FIELD
[0002] The disclosure relates generally to mixing fluids and more particularly to systems and methods for homogenous mixing of solid and liquid components.
BACKGROUND
[0003] Frozen confectionaries such as snow cones and shaved ice are commonly combined with a flavoring syrup that is a mixture of sugar, water, flavoring, and other additives. In many cases, a provider of frozen confections may wish to prepare these flavoring syrups onsite rather than purchase premade flavoring syrups. When the flavoring syrups are purchased premade, the consumer may pay higher costs in shipping and storage. Additionally, the consumer has little or no ability to customize the flavoring syrups or control the freshness of the flavoring syrups. In these cases, the consumer may benefit from preparing the flavoring syrups onsite on an as-needed basis.
[0004] However, it can be difficult to prepare flavoring syrups for sale because the process requires preparing a homogenous mixture of large quantities of solid and liquid components. Traditional mixing methods may lead to incomplete dissolution, wherein solid sugar cannot fully dissolve within the water solvent. Consumers may have difficulty with mixing sugar in cold water due to limited molecular movement. Consumers may experience significant clumping of solid sugar components and may further experience settling wherein solid sugar components settle at the bottom of the water solvent rather than fully dissolving within the water solvent. The process may be time consuming, labor intensive, and messy.
[0005] What is needed are improved systems, methods, and devices for preparing a homogenous mixture of solid and liquid components, and specifically for preparing a homogenous mixture of sugar and water. In view of the foregoing, described herein are systems, methods, and devices for multiphase mixing to prepare homogenous solutions comprising a solid component dissolved within a liquid solvent.

Description

BRIEF DESCRIPTIONS OF THE DRAWINGS
[0006] Non-limiting and non-exhaustive implementations of the disclosure are described with reference to the following figures, wherein like reference numerals refer to like parts throughout the various views unless otherwise specified. Advantages of the disclosure will become better understood with regard to the following description and accompanying drawings where:

[0007] FIG. **1** is a schematic block diagram of a system for multiphase mixing of solid and liquid components, and further for solvent capture and processing;
[0008] FIG. **2** is a schematic illustration of a solution preparation system including a pump system and a solvent system for multiphase mixing of solid and liquid components, and further for solvent capture and processing;
[0009] FIG. **3** is a schematic illustration of a system for multiphase mixing of solid and liquid components, and further for solvent capture and processing;
[0010] FIG. **4**A is a schematic illustration of a mixing process for mixing and churning the mixing fluids disposed within a mixing vessel according to the principles and teachings of the disclosure;
[0011] FIG. **4**B is a schematic illustration of a mixing process for mixing and churning the mixing fluids disposed within a mixing vessel according to the principles and teachings of the disclosure;
[0012] FIG. **5** is a schematic illustration of a pump system for multiphase mixing of solid and liquid components, wherein a solvent is received from a pressurized water source;
[0013] FIG. **6**A is a schematic illustration of a straight-on side view of a differential pressure nozzle;
[0014] FIG. **6**B is a schematic illustration of a cross-sectional straight-on side view of a differential pressure nozzle;
[0015] FIG. **7** is a schematic illustration of a straight-on side view of a system for preparing and dispensing frozen confections; and
[0016] FIG. **8** is a schematic flow chart diagram of a method for mixing a composition according to the principles and teachings of the disclosure.

DETAILED DESCRIPTION

[0017] Described herein are systems, methods, and devices for multiphase mixing to prepare a homogenous solution comprising solid components dissolved within a liquid solvent. The systems, methods, and devices described herein may specifically be utilized to dissolve relatively high quantities of sugar in a water solvent. The resultant sugar-water solution may be mixed with additional additives to create a flavored syrup for use with frozen confections such as snow cones or shaved ice.
[0018] Specifically disclosed herein are systems, methods, and devices, for mixing a liquid component and a solid component within a mixing vessel. A method includes preparing a mixing composition including a liquid solvent and a solid solute, wherein the mixing composition is disposed within a mixing vessel. The method includes submerging at least a portion of a first tube in the mixing composition and disposing at least a portion of a second tube within the mixing vessel, wherein the first tube and the second tube are in fluid communication with a pump. The method includes actuating the pump to generate a vacuum in the first tube such that at least a portion of the mixing composition is extracted from the mixing vessel through the first tube. The method includes mixing the mixing composition with a pressurized jet stream output through the second tube, wherein a differential pressure nozzle is attached to a distal end of the second tube.
[0019] In the following description of the disclosure, reference is made to the accompanying drawings, which form a part hereof, and in which is shown by way of illustration specific implementations in which the disclosure may be practiced. It is understood that other implementations may be utilized, and structural changes may be made without departing from the scope of the disclosure.
[0020] Before the methods, systems, and devices of the disclosure are disclosed and described, it is to be understood that this disclosure is not limited to the particular configurations, process steps, and materials disclosed herein as such configurations, process steps, and materials may vary somewhat. It is also to be understood that the terminology employed herein is used for the purpose of describing particular implementations only and is not intended to be limiting since the scope of the disclosure will be limited only by the appended claims and equivalents thereof.
[0021] In describing and claiming the disclosure, the following terminology will be used in

accordance with the definitions set out below.

[0022] It must be noted that, as used in this specification and the appended claims, the singular forms “a,” “an,” and “the” include plural referents unless the context clearly dictates otherwise.

[0023] As used herein, the terms “comprising,” “including,” “containing,” “characterized by,” and grammatical equivalents thereof are inclusive or open-ended terms that do not exclude additional, unrecited elements or method steps.

[0024] As used herein, the phrase “consisting of” and grammatical equivalents thereof exclude any element, step, or ingredient not specified in the claim.

[0025] As used herein, the phrase “consisting essentially of” and grammatical equivalents thereof limit the scope of a claim to the specified materials or steps and those that do not materially affect the basic and novel characteristic or characteristics of the claimed disclosure.

[0026] As used herein, the terms “shaved ice” and/or “snow cone” refer broadly to the large family of ice-based desserts or confections made from the fine shavings of ice or finely crushed ice. It will be appreciated that shaved ice and/or snow cones may often include a flavoring that may be a syrup or other sweetened condiment that is added to the shaved ice or snow cone. Similarly, the terms “ice shaving” or “snow cone” in reference to a machine are intended broadly to include all machines used to make or produce the large family of ice-based desserts or confections that may be classified as shaved ice or snow cone products.

[0027] Referring now to the figures, FIG. **1** is a schematic block diagram of a system **100** for multiphase mixing and solvent capture. The system **100** is configured to efficiently agitate a solution to dissolve a solid solute within a liquid solvent. The system **100** may specifically be utilized to efficiently dissolve sugar in a water solvent. The system **100** may be equipped with only food-grade components, such that the resultant solution may be provided to users for consumption.

[0028] The system **100** includes a solution preparation system **102**, which includes at least a pump system **104** and a solvent system **106**. The solvent system **106** may receive a solvent **116** from a pressurized fluid source **108**. The solution preparation system **102** includes a three-way valve to permit the solvent system **106** to provide the solvent **116** to the pump system **104**. The solvent system **106** may further deposit the solvent **116** in a secondary vessel **112**. The pump system **104** agitates and mixes a solution **114** within a mixing vessel **110**.

[0029] The solvent **116** may include any suitable liquid solvent and may specifically include water. The pressurized fluid source **108** may include one or more of a hose, faucet, reservoir, tap, bottle, or any other source dispensing a fluid under pressure. In some cases, the solvent **116** is water that is supplied from a fresh water source.

[0030] The solution **114** includes the solvent **116** and additionally includes one or more solid solutes. The solution **114** may additionally include one or more liquid or gaseous solutes. The solution **114** is disposed within the mixing vessel **110**. The pump system **104** is configured to extract the solution **114** from the mixing vessel **110** and then eject the solution **114** back into the mixing vessel **110**.

[0031] FIGS. **2** and **3** are schematic illustrations of components of the system **100** for multiphase mixing and solvent capture. FIG. **2** is a schematic illustration of the solution preparation system **102**, including the pump system **104** and the solvent system **106**. FIG. **3** is a schematic illustration of the system for multiphase mixing and solvent capture, including the solution preparation system **102**, the mixing vessel **110**, and the secondary vessel **112**.

[0032] The solution preparation system **102** includes the solvent system (see **106** at FIG. **1**). The solvent system **106** may include at least an inlet **204**, filter **208**, conditioner **210**, filtered fluid tube **212**, three-way junction **214**, secondary output tube **216**, valve **218**, and a three-way valve **220**.

[0033] The solution preparation system **102** includes the pump system (see **104** at FIG. **1**). The pump system **104** may include at least an inlet pump tube **226**, pump **226**, outlet pump tube **230**, three-way valve **220**, differential pressure tube **222**, and differential pressure nozzle **224**. The three-way valve **220** provides a means for a solvent **116** from the solvent system **106** to enter components of the pump system **104**, and thus, the three-way valve **220** may be considered a component of each of the solvent system **106** and the pump system **104**.

[0034] The solvent system **106** is utilized to receive the solvent **116** from a pressurized fluid source (see **108** at FIG. **1**) and process the solvent **116** with one or more of the filter **208** or the conditioner **210**. The solvent system **106** additionally permits the solvent **116** to flow into one or more of the mixing vessel **110** or the secondary vessel **112** via the secondary output tube **216** and the valve **218**. The solvent system **106** additionally permits the solvent **116** to flow into the mixing vessel **110** via the differential pressure tube **222** and differential pressure nozzle **224**.

[0035] The pump system **104** extracts the solution **114** from the mixing vessel **110** and deposits the solution **114** back into the mixing vessel **110** via a differential pressure outlet, which comprises the differential pressure tube **222** and the differential pressure nozzle **224**. The pump system **104** may receive the solvent **116** from the mixing vessel **110** and/or the solvent system **106** via the three-way valve **220**.

[0036] The solvent system **106** includes the inlet **204**, which provides a means to receive the solvent **116** from the pressurized fluid source **108**. The solvent system **106** may additionally include an inlet tube **202** that feeds into the inlet **204**. The inlet tube **202** may receive the solvent **116** from a pressurized fluid source and may specifically receive a water solvent from a pressurized freshwater source. In some cases, the inlet **204** is a threaded inlet configured to receive a standard hose. In these cases, the inlet **204** may include, for example, one-half inch threaded inlet, five-eighths inch threaded inlet, three-fourths inch threaded inlet, and so forth. The solvent **116** passes through the inlet tube **202** and inlet **204** and is then fed into the solvent **116** tube **206**.

[0037] The solvent system **106** processes the solvent **116** through one or more of the filter **208** and the conditioner **210**. The solvent processing systems disposed within the filter **208** and the conditioner **210** may include, for example, sediment filters, carbon filters, and so forth.

[0038] After the solvent **116** has passed through the filter **208** and the conditioner **210**, the processed solvent is then fed into the filtered fluid tube **212**. The filtered fluid tube **212** is downstream from the filter **208** and the conditioner **210**. The filtered fluid tube **212** leads the filtered solvent **116** to a three-way junction **214**. The three-way junction **214** includes a junction inlet **250** that receives the solvent **116** output by the pressurized fluid source **108**. The three-way junction **214** includes a first junction outlet **246** that feeds the solvent **116** to the three-way valve **220**, wherein the solvent **116** may then be permitted to exit through the differential pressure tube **222** and differential pressure nozzle **224**. The three-way junction **214** includes a second junction outlet **248** that outputs the solvent **116** to the secondary output tube **216**. If the valve **218** is open, then the solvent **116** may be permitted to exit the secondary output tube **216** where it may be deposited into one or more of the mixing vessel **110** or the secondary vessel **112**. A user may open the valve **218** to allow the solvent **116** to pass through the secondary output tube **216** and into one or more of the mixing vessel **110** or the secondary vessel **112**. The user may close the valve **218** to stop the flow of the solvent **116** through the secondary output tube **216**.

[0039] The pump system **104** includes a pump **228** that creates a vacuum to extract the solution **114** from the mixing vessel **110**. The pump **228** is in fluid communication with an inlet pump tube **226** that may be disposed within the mixing vessel **110**. A user may press an actuator **240** to turn on the pump **228** and cause the pump to a create a vacuum, and this causes the solution **114** to be drawn up through the inlet pump tube **226** and into the pump **228**. The solution **114** exits the pump **228** via the outlet pump tube **230**.

[0040] The outlet pump tube **230** carries the solution **114** to the three-way valve **220**, where the solution **114** enters the three-way valve **220** via a mixing pump valve port **234**. If the three-way valve **220** is open, then the solution **114** passes through the three-way valve **220** and out via the output port **236** of the three-way valve **220**. The solution **114** may then exit the pump system **104** by way of the differential pressure outlet, which comprises the differential pressure tube **222** and the differential pressure nozzle **224**. The solution **114** may be ejected from the differential pressure nozzle **224** back into the mixing vessel **110**.

[0041] The solution preparation system **102** includes a housing **238**. The housing **238** may include rigid sidewalls disposed around the components of the solution preparation system **102**, including each of the pump system **104** and the solvent system **106**. The housing **238** may include one or more holes or channels cut through the sidewalls of the housing **238**. These holes or channels may be utilized to feed tubing into the interior space of the housing **238** for storage. This ensure that the ends of tubing (see, e.g., the ends of **202**, **226**, **224**, **216**) are not exposed to outside contaminant when the solution preparation system **102** is not in use.

[0042] Each of the filter **208**, conditioner **210**, three-way valve **220**, three-way junction **214**, and pump **228** may be disposed within an interior space defined by sidewalls of the housing **238**. Each of the inlet pump tube **226**, differential pressure tube **222**, and secondary output tube **216** may be partially disposed within the interior space defined by the housing **238** and partially disposed exterior to the housing **238**. The housing **238** may include one or more holes for permitting the inlet pump tube **226**, differential pressure tube **222**, and secondary output tube **216** to exit the interior space defined by the housing **238**.

[0043] The housing **238** may be a relatively small, portable box that is approximately the size of a briefcase. The housing **238** may include a handle (not shown) and can support an external actuator **240** for controlling the pump **228** and an external valve switch (not shown) for opening and closing the three-way valve **220**. The housing **238** may also include a mechanism to reel in the tubing and secure the tubing during transport.

[0044] The solution preparation system **102** includes an actuator **240** in electrical communication with the pump **228**. The actuator **240** includes a switch, button, or other means for turning the pump **228** on and off. When the pump **228** is turned on a by a user, the pump **228** will begin to create a vacuum within the inlet pump tube **226**. If a portion of the inlet pump tube **226** is submerged within a fluid when the pump **228** is turned on, then the fluid will begin to be “sucked up” the inlet pump tube **226** due to the vacuum created by the pump **228**. The pump **288** will further push the fluid into the outlet pump tube **230** and ultimately out through the differential pressure nozzle **224**.

[0045] As illustrated in FIG. **3**, the pump system **104** is configured to mix and churn the solution **114** disposed within the mixing vessel **110**. The pump system **104** accomplishes this by sucking the solution **114** into the inlet pump tube **226** with the pump **228**, and then pushing the solution **114** into the outlet pump tube **230** with the pump **228**. The pump **228** further pushes the solution **114** through the three-way valve **220** by way of the pump valve port **234** and out through the outlet port **236**. The solution **114** continues through the differential pressure tube **222** and the differential pressure nozzle **224**. The solution **114** is then again taken up by the pump **228**, and the process continues until the pump is turned off by a user.

[0046] Further as shown in FIG. **3**, in some implementations, the solution preparation system **102** may be simultaneously used to mix the contents of the mixing vessel **110** and also fill a secondary vessel **112** with solvent **116**. In this implementation, the solution **114** within the mixing vessel **110** is mixed and churned by cycling the solution **114** through the pump **228** and the differential pressure nozzle **224** as previously disclosed. At the same time, fresh solvent **116** may pass through the inlet **204**, the filter **208** and/or the conditioner **210**, through the filtered fluid tube **212**, through the three-way junction **214**, through the secondary output tube **216**, and through the valve **218** (i.e., if the valve **218** is in the open position).

[0047] When the pump **228** is turned on, and when the ends of the inlet pump tube **226** and differential pressure tube **222** are disposed within the mixing vessel **110**, the solution preparation system **102** creates a “stir circuit” within the mixing vessel **110**. The stir circuit is utilized to stir, mix, and churn the solution **114** disposed within the mixing vessel **110**. The stir circuit causes the solution **114** to be comprehensively mixed due to the movement of fluid within the mixing vessel **110**. The liquid jet stream output through the differential pressure nozzle **224** is sufficiently strong to reach the corners of the mixing vessel **110** where the certain contents may be most difficult to mix. By contrast to other methods, this method does not rely on any tool that may break, need cleaning, damage the mixing vessel **110**, or spill. The liquid jet stream output through the differential pressure nozzle **224** becomes a tool that mixes the solution **114**. Also, the device may be left running for the few minutes it takes to complete the mix, leaving the operator free for other tasks.

[0048] FIGS. **4**A and **4**B are schematic illustrations of a mixing process **400** for mixing and churning the mixing fluids disposed within the mixing vessel **110**. FIG. **4**A illustrates wherein mixing components are in their original form, and FIG. **4**B illustrates a final dissolved solution.

[0049] As shown in FIG. **4**A, the mixing vessel **110** may include at least a liquid component **402** and a solid component **404**. It should be appreciated that the mixing vessel **110** may include any number of liquid components **402** and solid components **404** as deemed necessary by a user. The liquid component **402** may include the solvent **116** and may additionally include one or more other liquid components. In an exemplary use-case, the mixing vessel **110** includes a water solvent (i.e., a liquid component **402**), a solid sugar solute (i.e., a solid component **404**), a solid or liquid flavoring solute, and one or more solid or liquid preservative solutes. The contents of the mixing vessel **110** will vary depending on the intended use of the systems, methods, and devices described herein.

[0050] The mixing process **400** includes sucking up the mixing fluid (i.e., a mixture of the liquid component **402** and/or the solid component **404**) through the inlet pump tube **226** due to the vacuum created by the pump **228**. As discussed in connection with FIGS. **2-3**, the pump **228** is responsible for extracting the mixing fluid from the mixing vessel **110**. The mixing process **400** additionally includes pressurized ejection of the mixing fluid back into the mixing vessel **110** through the differential pressure tube **222** and differential pressure nozzle **224**. This creates agitation of the solution **406**, which reduces the time required to fully mix the liquid and solid components **402**, **404** to generate the solution **114**.

[0051] The solution preparation system **102** can therefore quickly, efficiently, and cleanly create a homogeneous mixture of water, sugar, and any other ingredient needed. An operator can use the following actions to create the homogeneous mixture. The operator puts sugar into the mixing vessel **110**. In some embodiments the mixing vessel **110** is relatively large, such as a 10-gallon or 20-gallon container. The mixing vessel **110** may hold a large amount of sugar, such as an entire 25-pound bag. The mixing vessel **110** may be more than halfway full of the sugar. Additives, such as citric acid, flavoring, and/or preservatives can then be added to the mixing vessel **110**. The mixing vessel **110** may include a spout that holds the inlet and outlet lines and preferably does not leave a large opening to prevent spillage, splatter, or drips.

[0052] The result of the mixing procedure is a homogeneous dissolved solution **114** disposed within the mixing vessel **110** as shown in FIG. **4**B. By contrast to previous designs, the mixing procedure of the disclosure is capable of mixing substantial amounts of sugar, water, and additives in a relatively brief time. The mixing procedure of this disclosure is also much less resource intensive and less prone to mess and loss due to spillage. In the business of selling confectioneries such as frozen confectioneries, the speed at which each customer is served is a limiting factor for the amount of money that can be earned with such a device. The time saved due to the water dispensing and sugar mixing devices of the disclosure result in an immediate cost and time savings. Furthermore, the devices allow for a custom mix to be made, and the flavor mixture can be mixed on site without requiring the shop to close while more flavoring is obtained from a store, a warehouse, or the like. The time savings are particularly important at large events such as sporting events and festivals where there are large numbers of people who will line up to buy a refreshing frozen confectionery. The water dispensing and sugar mixing devices of the disclosure increase the amount of money that can be made at such establishments.

[0053] FIG. **5** is a schematic block diagram of a system **500** for multiphase mixing, and specifically a system **500** for homogenous mixing of solid and liquid components. The system **500** includes the pump system **104** and the mixing vessel **110**. The system **500** additionally includes a pressurized water source **502** in fluid communication with the pump system **104**. The pressurized water source **502** may comprise a valve **504** for releasing or blocking the flow of water from the pressurized water source. The inlet tube **202** of the solution preparation system **102** may directly connected to the pressurized water source **502** to receive water from the pressurized water source **502** and then feed the water **502** through components of the solution preparation system **102** (e.g., the filter **208** and conditioner **210**) prior to depositing the water into the mixing vessel **110**.

[0054] FIGS. **6**A-**6**B are schematic illustrations of a nozzle **600**. The nozzle **600** may specifically include a Venturi eductor or Venturi ejector. The nozzle **600** may serve as the differential pressure nozzle **224** of the differential pressure outlet of the pump system **104** as described herein. FIG. **6**A is a schematic illustration of a straight-on side view of the nozzle **600**. FIG. **6**B is a schematic illustration of a cross-sectional straight-on side view of the nozzle **600**.

[0055] The nozzle **600** includes an inlet **602** comprising an inlet fluid passageway for receiving a fluid, wherein the inlet fluid passageway comprises an inlet diameter. The nozzle **600** includes an outlet **608** comprising an outlet fluid passageway for ejecting a fluid, wherein the outlet fluid passageway comprises an outlet diameter. The inlet **602** is disposed at a proximal end of the nozzle **600** (i.e., the end attached to the differential pressure tube **222**). The outlet **608** is disposed at the distal end of the nozzle **600**.

[0056] The nozzle **600** comprises a converging section **604** and a diverging section **606**. The converging section **604** comprises a high pressure tap **610** and a low pressure tap **612**. The converging section **604** includes a narrowing fluid passageway. The narrowest portion of the narrowing fluid passageway may be referred to as the narrow diameter.

[0057] The diverging section **606** is disposed in between the converging section **604** and the outlet **608**. The diverging section **606** comprises a widening fluid passageway comprising a plurality of diameters, wherein the narrowest diameter of the widening fluid passageway is disposed adjacent to the converging section **610**, and the widest diameter of the widening fluid passageway is disposed adjacent to the outlet **606**.

[0058] The narrow diameter of the converging section **604** is smaller than the inlet diameter of the inlet **602**. The narrow diameter of the converging section **604** is also smaller than the outlet diameter of the outlet **608**.

[0059] Fluid flows through the nozzle **600** as shown in the cross-sectional view of FIG. **6**B. The nozzle **600** works based on the Venturi effect, which states that when a fluid flows through a constricted section of a pipe (i.e., the converging section **604**), the velocity of the fluid will increase while the pressure of the fluid will decrease. Fluid passes into the converging section **604** at the low pressure tap **610** which causes the fluid to speed up due to conservation of mass. The fluid passes into the narrowest point where it reaches its highest velocity and lowest pressure, which can create suction. The fluid passes into the diverging section **606** where the passage widens again, which slows down the fluid and restores pressure.

[0060] The differential pressure nozzle **224**, which may specifically include the nozzle **600** as described in connection with FIGS. **6**A-**6**B, enables the pump **228** to take advantage of surrounding mixing fluid within the mixing vessel **110** to generate a high-velocity flow yield. The differential pressure nozzle **224** takes advantage of the Venturi effect, which occurs when a fluid flows through a converging-diverging section. A motive stream of the mixing fluid enters the differential pressure nozzle **224** and accelerates as the mixing fluid passes through the narrowing section of the differential pressure nozzle **224**. Thus, a velocity of the mixing fluid increases significantly at the throat of the differential pressure nozzle **224**. According to the principle of conservation of mass, the high-velocity flow creates a region of low static pressure. Consequently, a pressure difference arises between the mixing fluid at the throat of the differential pressure nozzle **224**, and the surrounding mixing fluid disposed within the mixing vessel **110**.

[0061] The differential pressure nozzle **224** may include any differential pressure nozzle **224** known in the art, and need not include the same geometry, dimensions, or configuration as the exemplary differential pressure nozzle **224** illustrated in FIGS. **6**A-**6**B.

[0062] FIG. **7** is a schematic illustration of a straight-on side view of a system **700** for preparing and dispensing frozen confections. The system **700** may be utilized to prepare frozen confections, prepare flavoring syrups for frozen confections, store flavoring syrups for frozen confections, and dispense flavoring syrups for frozen confections. The system **700** may include the system **100** first described in connection with FIG. **1** and may specifically include the solution preparation system **102** for preparing flavoring syrups onsite on as-needed basis.

[0063] The system **700** includes a mobile edifice **702**, which may specifically include one or more of a van, truck, trolley, kiosk, cart, or other suitable mobile edifice for preparing and dispensing frozen confections. The **700** includes a power source **704** in electrical communication with the mobile edifice **702** itself and/or components within the mobile edifice **702**. The power source **704** may comprise a mobile power source such as a generator, battery, solar panels, and so forth. The power source **704** may comprise a non-mobile power source **704**, and the mobile edifice **702** or one or more components within the mobile edifice **702** may be plugged into the non-mobile power source **704**. The power source **704** may be provided by the mobile edifice **702** itself and may comprise one or more of a battery or engine associated with the mobile edifice **702**.

[0064] The system **700** includes the solution preparation system **102** in electrical communication with the power source **704**. The system **700** may additionally include other components of the system **100** first described in connection with FIG. **1**, including the mixing vessel **110** and the secondary vessel **112**. The mixing vessel **110** and the secondary vessel **112** may be releasably in fluid communication with the solution preparation system **102**. The system **700** may include a solvent **116**, which may comprise a stored solvent **116** and/or a fresh source for the solvent **116**, such as a freshwater tap.

[0065] The system **700** may include one or more primary reservoirs **712** stored within the mobile edifice **702**. The system **700** may optionally additionally include one or more secondary reservoirs **716** stored within the mobile edifice **702**. The primary reservoirs **712** are in fluid communication with a fluid dispenser **706** that enables consumers to withdraw a fluid from the primary reservoirs **712** on demand. The secondary reservoirs **716** store additional stock of fluids to be withdrawn from the fluid dispenser **706**. The secondary reservoirs **716** may be emptied into the primary reservoirs **712** as needed and/or the secondary reservoirs **716** may be connected in fluid communication with the fluid dispenser **706** to serve as primary reservoirs when the original primary reservoirs **712** are empty.

[0066] Each of the primary reservoirs **712** and secondary reservoirs **716** may store a flavoring syrup to be utilized in connection with a frozen confection, wherein the flavoring syrup includes a solid component dissolved within a liquid component. The flavoring syrups may include water, sugar, flavoring, and other additives. In some cases, the system **700** may include a primary reservoir **712** and a secondary reservoir **716** for each flavor to be dispensed from the fluid dispenser **706** of the mobile edifice **702**. The flavoring syrups stored within the primary reservoirs **712** and/or secondary reservoirs **716** may be mixed with the solution preparation system **102** described herein.

[0067] In some cases, the system **700** includes one or more of the mixing vessel **110** or the secondary vessel **112** in addition to the primary reservoir **712** and secondary reservoir **716** as shown in FIG. **7**. In such cases, the primary reservoirs **712** and/or the secondary reservoirs **716** may have different size constraints than the mixing vessel **110** and/or the secondary vessel **112**. In these cases, a user may utilize the secondary vessel **112** to store a water solvent to prepare flavoring syrups. Additionally, in these cases, the user may utilize the mixing vessel **110** to prepare flavoring syrups with the solution preparation system **102**. The user may then transfer the resultant flavoring syrups from the mixing vessel **110** to the primary reservoirs **712** and/or secondary reservoirs **716** as needed.

[0068] In other cases, two or more of the mixing vessel **110**, secondary vessel **112**, primary reservoir **712**, and secondary reservoir **716** are interchangeable. In these cases, the mixing vessel **110** may specifically be interchangeable with the primary reservoir **712** and the secondary reservoir **716** such that the same container may be utilized when mixing a flavoring syrup (i.e. a mixing vessel **110**), when storing backup stock of a flavoring syrup (i.e., a secondary reservoir **716**), or when dispensing a flavoring syrup through the fluid dispenser **704** (i.e., a primary reservoir **712**). In these cases, the containers may be sized to enable the differential pressure tube (see **222**) and inlet pump tube (see **226**) of the solution preparation system **102** to be disposed within the container such that the container may be utilized as a mixing vessel **110**. Additionally, the containers may be equipped with a valve enabling the container to be hooked up to the fluid dispenser **704** such that the containers may be utilized as a primary reservoir **712**.

[0069] The primary and/or secondary reservoirs **712**, **716** may be utilized as dispensing and/or storage reservoirs and may additionally be utilized as a mixing vessel and/or secondary vessel to be utilized directly with the solution preparation system **102**. This may enable a user to agitate ingredients for a flavoring syrup (see **406** at FIGS. **4**A-**4**B) with the solution preparation system **102** directly within a primary reservoir **712** and/or secondary reservoir **716**. This may eliminate the need for the user to transfer a dissolved solution (see **408** at FIG. **4**B) from a mixing vessel to a different primary and/or secondary reservoir **712**, **716**. This may further enable a user to dispense a solvent directly into the primary reservoir **712** and/or secondary reservoir **716**, rather than utilizing an additional secondary vessel **112**. In these cases, the primary and/or secondary reservoirs **712**, **716** may be sized such that they are suitable to be used directly with the solution preparation system **102**. In these cases, all reservoirs within the mobile edifice may be interchangeable to be used as a mixing vessel, secondary vessel, primary reservoir, or secondary reservoir as described herein.

[0070] The system **700** may include the fluid dispenser **706** mounted to a mounting arm **708** and disposed within an edifice recess **710** of the mobile edifice **702**. The fluid dispenser **706** may be in fluid communication with each of the primary reservoirs **712**.

[0071] The system **700** may include a coolant provider **714** disposed within the mobile edifice **702** and configured to cool solutions stored within the primary and/or secondary reservoirs **712**, **716**. The coolant provider **714** may comprise a tank containing a type of liquid or gaseous coolant. The coolant may be routed via separate tubing to the primary and/or secondary reservoirs **712**, **716** through the mounting arm **708** to the fluid dispenser **706**, or to both simultaneously. The coolant tubing (not shown) may interact with tubing from the primary reservoirs **712** to cool and maintain the temperature of the flavoring syrups.

[0072] The mobile edifice **702** may be a truck, van, or another vehicle. While a truck is shown in FIG. **7** as an example it is not necessary for the mobile edifice **702** to be a motorized vehicle. The present disclosure may also extend to carts, wagons, hand trucks, or other such vehicles to which a fluid dispenser **706** and arm **708** may be mounted. The present disclosure may additionally extend to kiosks, stands, or other standing structures that could be transported by truck from one location to another.

[0073] The arm **708** may be disposed within an edifice recess **710**. The mobile edifice recess **710** may comprise an opening extending into the interior of the mobile edifice **702** or may have one or more back and sidewalls defining the edifice recess as a cavity within a sidewall of the mobile edifice **702**. Within the mobile edifice recess **710** may be a number of mechanisms, such as a locking mechanism **718**, a deployment mechanism **722**, or both. The locking mechanism **718** may comprise a button, lever, or comparable means to facilitate locking the mounting arm **708** to a particular position. A mounting arm **708** may be fully disposed within the edifice recess **710** in a stored position, as seen in FIG. **7**. The mounting arm **708** may also extend from the edifice recess **710** away from the mobile edifice **702** in a deployed position.

[0074] The mounting arm **708** may additionally feature a secondary dispenser **720**. The secondary dispenser **720** may comprise a faucet, spigot, nozzle, a hole, or other mechanism configured to

dispense a fluid from a source within the mobile edifice **702**. The source may be one of the primary reservoirs **712** or a secondary reservoir **716** independent from primary reservoirs **712**. In some implementations secondary dispenser **720** may be in fluid communication with secondary reservoir **716** via tubing. In other implementations the secondary dispenser **720** may dispense fluid from within the mounting arm **708**, like, for example, water, from melted ice deposited into a chute within the mobile edifice **702**. The secondary dispenser **720** may comprise a knob, handle, or other similar means that, when manipulated, permits the secondary dispenser **720** to dispense a fluid, depending on the source. In implementations where the secondary dispenser **720** is a hole, the fluid may continuously run or drip from secondary dispenser **720**.
[0075] While FIG. **7** shows a single secondary dispenser **720** located centrally on arm **708**, it will be appreciated that this disclosure is not limited to any number or positioning of secondary dispensers **720**. Depending on the implementation, a mounting arm **708** may feature multiple secondary dispensers **720** located at various positions along a length of a mounting arm **708**. In features utilizing multiple mounting arms **708**, a user may have one or more secondary dispensers **720** on one or several of the multiple mounting arms **708** located at various positions along any of the mounting arms **708**. In other implementations a user may forego a secondary dispenser **720** altogether.
[0076] The mounting arm **708** may be mounted to the mobile edifice **702** by a mount **716**.
[0077] The mount **716** may comprise a ball joint, a linkage, a hinge, or other similar mechanism that permits a user to mount the mounting arm **708** to the mobile edifice **702** while retaining some degree of movement depending on the mount **716** utilized. The mount **716** may retain the mounting arm **708** in a way such that the mounting arm **708** may move between a closed position or open position. In some implementations the mount **716** may be mounted to a sidewall of the mobile edifice, while in other implementations may be mounted to another structure, such as a rack or shelf which may itself be mounted to the mobile edifice. A rack or shelf may or may not be utilized in a situation where a user may desire to use mount **716** to mount a mounting arm **708** to a roof or underside of the mobile edifice **702**. In other implementations a user may mount arm **708** via mount **716** to a roof or underside of the mobile edifice **702** directly.
[0078] FIG. **8** is a schematic flow chart diagram of a method **800** for mixing a composition. The method **800** includes preparing at **802** a mixing composition comprising a liquid solvent and a solid solute, wherein the mixing composition is disposed within a mixing vessel. The method **800** includes submerging at **804** at least a portion of a first tube in the mixing composition, wherein the first tube is in fluid communication with a pump. The method **800** include disposing at least a portion of a second tube in the mixing vessel, wherein the second tube is in fluid communication with the pump. The method **800** includes actuating at **808** the pump to generate a vacuum in the first tube such that at least a portion of the mixing composition is extracted from the mixing vessel through the first tube. The method **800** includes mixing at **810** the mixing composition with a pressurized jet stream output through the second tube, wherein a differential pressure nozzle is attached to a distal end of the second tube.
Examples
[0079] The following examples pertain to further embodiments. [0080] Example 1 is a system for mixing a solution. The system includes an inlet pump tube configured to be disposed within a mixing vessel. The system includes a pump in fluid communication with the inlet pump tube, wherein the pump extracts a solution from the mixing vessel when the inlet pump tube is disposed within the mixing vessel. The system includes a three-way valve in fluid communication with the pump. The system includes a differential pressure outlet configured to be disposed within the mixing vessel, wherein the differential pressure outlet is in fluid communication with the pump and the three-way valve. The system is such that the extracted solution is processed through the pump and ejected into the mixing vessel through the differential pressure outlet. [0081] Example 2 is a system as in Example 1, wherein the differential pressure outlet comprises: a differential pressure

tube attached to the three-way valve and in fluid communication with the pump; and a differential pressure nozzle attached to a distal end of the differential pressure tube and configured to be disposed within mixing vessel. [0082] Example 3 is a system as in any of Examples 1-2, wherein, in response to the pump generating a vacuum to extract the solution from the mixing vessel, the solution passes through the differential pressure tube at a first velocity; wherein the differential pressure nozzle causes the solution to exit the differential pressure nozzle at a second velocity; and wherein the second velocity is faster than the first velocity. [0083] Example 4 is a system as in any of Examples 1-3, wherein the differential pressure nozzle comprises: an inlet comprising an inlet fluid passageway; an outlet comprising an outlet fluid passageway; a converging section comprising a narrow fluid passageway, wherein the narrow fluid passageway comprises a diameter that is smaller than a diameter of the inlet fluid passageway; and a diverging section comprising a widening fluid passageway, wherein the diverging section is disposed in between the converging section and the outlet, and wherein a largest diameter of the widening fluid passageway is greater than the diameter of the narrow fluid passageway. [0084] Example 5 is a system as in any of Examples 1-4, wherein the differential pressure outlet comprises: a differential pressure nozzle; and a differential pressure tube comprising a proximal end and a distal end; wherein the differential pressure nozzle is attached to the differential pressure tube at the distal end of the differential pressure tube; and wherein the differential pressure tube is attached to the three-way valve at the proximal end of the differential pressure tube. [0085] Example 6 is a system as in any of Examples 1-5, wherein the differential pressure outlet comprises a Venturi nozzle. [0086] Example 7 is a system as in any of Examples 1-6, wherein the three-way valve comprises: a first inlet valve port in fluid communication with a fluid source; a second inlet valve port in fluid communication with the pump; and an outlet valve port in fluid communication with the differential pressure outlet. [0087] Example 8 is a system as in any of Examples 1-7, further comprising an inlet configured to be coupled to a pressurized fluid source, wherein the pressurized fluid source outputs a solvent. [0088] Example 9 is a system as in any of Examples 1-8, further comprising a fluid filter and a fluid conditioner, wherein each of the fluid filter and the fluid conditioner is in fluid communication with the inlet such that the solvent output from the pressurized fluid source passes through each of the fluid filter and the fluid conditioner prior to reaching the three-way valve. [0089] Example 10 is a system as in any of Examples 1-9, further comprising a three-way junction, wherein the three-way junction comprises: a junction inlet that receives the solvent output by the pressurized fluid source; a first junction outlet that outputs the solvent to the three-way valve; and a second junction outlet that outputs the solvent to one or more of the mixing vessel or a secondary vessel. [0090] Example 11 is a system as in any of Examples 1-10, further comprising a two-way valve in fluid communication with the second junction outlet, wherein closing of the two-way valve causes the solvent to exit through the first junction outlet and into the three-way valve. [0091] Example 12 is a system as in any of Examples 1-11, further comprising an inlet comprising a hose fitting, wherein the hose fitting is configured to be coupled to a standardized hose in fluid communication with a pressurized fluid source. [0092] Example 13 is a system as in any of Examples 1-12, wherein the solution comprises a liquid solvent and a solid solute, and wherein the mixing of the solution comprises dissolving the solid solute within the liquid solvent. [0093] Example 14 is a system as in any of Examples 1-13, wherein the solution comprises water and sugar. [0094] Example 15 is a system as in any of Examples 1-14, wherein the differential pressure outlet comprises a differential pressure tube and a differential pressure nozzle, and wherein each of the inlet pump tube and the differential pressure tube is configured to be at least partially submerged within the solvent within the mixing vessel. [0095] Example 16 is a system as in any of Examples 1-15, further comprising a housing, wherein the three-way valve is disposed within an interior space defined by the housing, and wherein an external valve switch for opening and closing the three-way valve is attached to an external side of the housing. [0096] Example 17 is a system as in any of Examples 1-16, further comprising a housing, wherein each of the pump and the three-way valve is disposed within an

interior space defined by the housing, wherein a proximal end of the inlet pump tube is attached to the pump within the interior space, wherein a distal end of the inlet pump tube is disposed external to the housing, and wherein the inlet pump tube exits the housing through a hole within the housing. [0097] Example 18 is a system as in any of Examples 1-17, further comprising a housing, wherein each of the pump and the three-way valve is disposed within an interior space defined by the housing, wherein a proximal end of the differential pressure outlet is attached to the three-way valve within the interior space, wherein a distal end of the differential pressure outlet is disposed external to the housing, and wherein the differential pressure outlet exits the housing through a hole within the housing. [0098] Example 19 is a system as in any of Examples 1-18, further comprising: a housing, wherein the pump is disposed within the housing; and an actuator in electrical communication with the pump that permits or prevents electricity from passing to the pump; wherein the actuator is attached to the housing such that the actuator is accessible from an exterior of the housing. [0099] Example 20 is a system as in any of Examples 1-19, wherein the pump generates a vacuum in response to the actuator permitting the electricity to pass to the pump.
[0100] Example 21 is a system. The system includes a mixing vessel. The system includes a pump system, wherein the pump system includes any of the components or features of any combination of any of Examples 1-20. [0101] Example 22 is a system as in Example 21, wherein the system further includes a secondary vessel. [0102] Example 23 is a system as in any of Examples 21-22, wherein the system further includes a mobile edifice for preparing and/or distributing a frozen confection, and wherein the pump system is disposed within and/or attached to the mobile edifice.
[0103] It will be appreciated by those skilled in the art that, while several implementations are described and shown in the exemplary figures herein, one implementation may have any number of features shown. The figures shown herein are intended to be exemplary and non-limiting, and some figures show some features that other figures do not simply for clarity and readability. In other words, it is contemplated that one implementation of the disclosure may feature each and every feature disclosed, or an implementation may feature a subset combination of the features shown without departing from the scope of the disclosure.
[0104] In various implementations, a stand for holding or otherwise housing reservoirs and tubes, hoses or lines may be located outside of the mobile edifice. The stand may be a metal stand or made from another material and may be configured to fit inside the mobile edifice for transport to a location.
[0105] The foregoing description has been presented for the purposes of illustration and description. It is not intended to be exhaustive or to limit the disclosure to the precise form disclosed. Many modifications and variations are possible in light of the above teaching. Further, it should be noted that any or all of the aforementioned alternate implementations may be used in any combination desired to form additional hybrid implementations of the disclosure.
[0106] Further, although specific implementations of the disclosure have been described and illustrated, the disclosure is not to be limited to the specific forms or arrangements of parts so described and illustrated. The scope of the disclosure is to be defined by the claims appended hereto, any future claims submitted here and in different applications, and their equivalents.
[0107] In the foregoing Detailed Description, various features of the disclosure are grouped together in a single implementation for the purpose of streamlining the disclosure. This method of disclosure is not to be interpreted as reflecting an intention that the claimed disclosure requires more features than are expressly recited in each claim. Rather, as the following claims reflect, inventive aspects lie in less than all features of a single foregoing disclosed implementation. Thus, the following claims are hereby incorporated into this Detailed Description by this reference, with each claim standing on its own as a separate implementation of the disclosure.
[0108] It is to be understood that the above-described arrangements are only illustrative of the application of the principles of the disclosure. Numerous modifications and alternative arrangements may be devised by those skilled in the art without departing from the spirit and scope

of the disclosure and the appended claims are intended to cover such modifications and arrangements. Thus, while the disclosure has been shown in the drawings and described above with particularity and detail, it will be apparent to those of ordinary skill in the art that numerous modifications, including, but not limited to, variations in size, materials, shape, form, function and manner of operation, assembly and use may be made without departing from the principles and concepts set forth herein.

[0109] Reference throughout this specification to “an example” means that a particular feature, structure, or characteristic described in connection with the example is included in at least one embodiment of the disclosure. Thus, appearances of the phrase “in an example” in various places throughout this specification are not necessarily all referring to the same embodiment.

[0110] As used herein, a plurality of items, structural elements, compositional elements, and/or materials may be presented in a common list for convenience. However, these lists should be construed as though each member of the list is individually identified as a separate and unique member. Thus, no individual member of such list should be construed as a de facto equivalent of any other member of the same list solely based on its presentation in a common group without indications to the contrary. In addition, various embodiments and examples of the disclosure may be referred to herein along with alternatives for the various components thereof. It is understood that such embodiments, examples, and alternatives are not to be construed as de facto equivalents of one another but are to be considered as separate and autonomous representations of the disclosure.

[0111] Although the foregoing has been described in some detail for purposes of clarity, it will be apparent that certain changes and modifications may be made without departing from the principles thereof. It should be noted that there are many alternative ways of implementing both the processes and apparatuses described herein. Accordingly, the present embodiments are to be considered illustrative and not restrictive.

[0112] Those having skill in the art will appreciate that many changes may be made to the details of the above-described embodiments without departing from the underlying principles of the disclosure. The scope of the disclosure should, therefore, be determined only by the following claims.

Claims

1. A system for mixing a solution, the system comprising: an inlet pump tube configured to be at least partially disposed within a mixing vessel; a pump in fluid communication with the inlet pump tube, wherein the pump extracts the solution from the mixing vessel when the inlet pump tube is disposed within the mixing vessel; a three-way valve in fluid communication with the pump; and a differential pressure outlet configured to be at least partially disposed within the mixing vessel, wherein the differential pressure outlet is in fluid communication with the three-way valve; wherein the extracted solution is processed through the pump and ejected into the mixing vessel through the differential pressure outlet.

2. The system of claim 1, wherein the differential pressure outlet comprises: a differential pressure tube attached to the three-way valve and in fluid communication with the pump; and a differential pressure nozzle attached to a distal end of the differential pressure tube and configured to be disposed within mixing vessel.

3. The system of claim 2, wherein, in response to the pump generating a vacuum to extract the solution from the mixing vessel, the solution passes through the differential pressure tube at a first velocity; wherein the differential pressure nozzle causes the solution to exit the differential pressure nozzle at a second velocity; and wherein the second velocity is faster than the first velocity.

4. The system of claim 2, wherein the differential pressure nozzle comprises: an inlet comprising an inlet fluid passageway; an outlet comprising an outlet fluid passageway; a converging section comprising a narrow fluid passageway, wherein the narrow fluid passageway comprises a diameter that is smaller than a diameter of the inlet fluid passageway; and a diverging section comprising a widening fluid passageway, wherein the diverging section is disposed in between the converging section and the outlet, and wherein a largest diameter of the widening fluid passageway is greater than the diameter of the narrow fluid passageway.

5. The system of claim 1, wherein the differential pressure outlet comprises: a differential pressure nozzle; and a differential pressure tube comprising a proximal end and a distal end; wherein the differential pressure nozzle is attached to the differential pressure tube at the distal end of the differential pressure tube; and wherein the differential pressure tube is attached to the three-way valve at the proximal end of the differential pressure tube.

6. The system of claim 1, wherein the differential pressure outlet comprises a Venturi nozzle.

7. The system of claim 1, wherein the three-way valve comprises: a first inlet valve port in fluid communication with a fluid source; a second inlet valve port in fluid communication with the pump; and an outlet valve port in fluid communication with the differential pressure outlet.

8. The system of claim 1, further comprising an inlet configured to be coupled to a pressurized fluid source, wherein the pressurized fluid source outputs a solvent.

9. The system of claim 8, further comprising a fluid filter and a fluid conditioner, wherein each of the fluid filter and the fluid conditioner is in fluid communication with the inlet such that the solvent output from the pressurized fluid source passes through each of the fluid filter and the fluid conditioner prior to reaching the three-way valve.

10. The system of claim 8, further comprising a three-way junction, wherein the three-way junction comprises: a junction inlet that receives the solvent output by the pressurized fluid source; a first junction outlet that outputs the solvent to the three-way valve; and a second junction outlet that outputs the solvent to one or more of the mixing vessel or a secondary vessel.

11. The system of claim 10, further comprising a two-way valve in fluid communication with the second junction outlet, wherein closing of the two-way valve causes the solvent to exit through the first junction outlet and into the three-way valve.

12. The system of claim 1, further comprising an inlet comprising a hose fitting, wherein the hose fitting is configured to be coupled to a standardized hose in fluid communication with a pressurized fluid source.

13. The system of claim 1, wherein the solution comprises a liquid solvent and a solid solute, and wherein the mixing of the solution comprises dissolving the solid solute within the liquid solvent.

14. The system of claim 1, wherein the solution comprises water and sugar.

15. The system of claim 1, wherein the differential pressure outlet comprises a differential pressure tube and a differential pressure nozzle, and wherein each of the inlet pump tube and the differential pressure tube is configured to be at least partially submerged within the solvent within the mixing vessel.

16. The system of claim 1, further comprising a housing, wherein the three-way valve is disposed within an interior space defined by the housing, and wherein an external valve switch for opening and closing the three-way valve is attached to an external side of the housing.

17. The system of claim 1, further comprising a housing, wherein each of the pump and the three-way valve is disposed within an interior space defined by the housing, wherein a proximal end of the inlet pump tube is attached to the pump within the interior space, wherein a distal end of the inlet pump tube is disposed external to the housing, and wherein the inlet pump tube exits the housing through a hole within the housing.

18. The system of claim 1, further comprising a housing, wherein each of the pump and the three-way valve is disposed within an interior space defined by the housing, wherein a proximal end of the differential pressure outlet is attached to the three-way valve within the interior space, wherein a distal end of the differential pressure outlet is disposed external to the housing, and wherein the differential pressure outlet exits the housing through a hole within the housing.

19. The system of claim 1, further comprising: a housing, wherein the pump is disposed within the housing; and an actuator in electrical communication with the pump that permits or prevents electricity from passing to the pump; wherein the actuator is attached to the housing such that the actuator is accessible from an exterior of the housing.

20. The system of claim 19, wherein the pump generates a vacuum in response to the actuator permitting the electricity to pass to the pump.