

LOW TEMPERATURE BEVERAGE DELIVERY METHOD AND SYSTEMS**CROSS-REFERENCE TO RELATED APPLICATIONS**

[0001] Not Applicable

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STATEMENT RE: FEDERALLY SPONSORED RESEARCH/DEVELOPMENT

[0002] Not Applicable

BACKGROUND

10 **[0003]** 1. Field of the Invention

[0004] The present application relates to a refrigerated beverage delivery system. More specifically, the present application relates to an improved method of delivering a beverage for consumption at a consistent low temperature.

[0005] 2. Related Art

15 **[0006]** Beverage delivery systems have been developed throughout the years to dispense a beverage from a reservoir into some form of a cup or container from which someone may consume the beverage. In some instances, the beverage reservoir may be pressurized to allow for the beverage to be dispensed upon opening an outlet or valve, such as a tap, where someone may place their cup or container to receive the dispensed
20 beverage. An example of a beverage that has popular use in these types of systems is beer, where the beverage reservoir is a keg which can be connected to a tap from which users may dispense beer to the desired volume.

[0007] In many applications, it is desirable to serve beverages at a low temperature, typically in the -5 to 10 degrees Celsius range. Humans have evolutionarily adapted to
25 prefer colder beverages, and it has been known that applying cold stimuli to the mouth gives a pleasant response to humans since it gives the body a thirst and refreshing perception, resulting in a more pleasant and relaxing experience consuming the beverage. In the example of beer, while a subjective preference, many agree that cold beer tastes better than warm beer.

30 **[0008]** Cooling systems have thus been incorporated into beverage delivery systems to allow for a beverage to be quickly dispensed at a desirable low temperature. Notwithstanding, the beverage delivery/cooling systems currently employed have a

number of deficiencies that make them less than ideal for sustained usage. One exemplary system is known as a “Jockey Box”, wherein the beverage is flowed through a long coil surrounded in ice. Such a system requires a long residence time to cool the beer in the coil (which can be in the area of 15 minutes) and results in only the first beverage or two being delivered at the desired low temperature. The user must then either wait for more of the beer to cool before dispensing or to simply settle for warmer beer without the wait. This particular system also requires a large amount of ice or coolant to be used throughout its use. Another system is referred to as a “Flash Cooler”, wherein the beverage reservoir itself is directly cooled via a refrigerant. The flaws associated with this system are that the refrigerants tend to use pure water which forms an ice bank around the lines carrying the beverage (this being intentional) to cool and chill the beverage. However, after the beverage in the coil is used up and replaced with warmer beverages, this system can only supply chilled beverage at a very slow rate, resulting in a non-continuous delivery of beer. Users try to compensate for this by adjusting the temperature of the system, which usually ends up being below the freezing point of the beverage, which can cause the beverage in the lines to freeze into a solid block surrounded by a solid block of ice. This can take hours for the block to melt into a pourable beverage. Additionally, refrigerant flow may become clogged or pulsed due to unmonitored cooling, faulty control systems, etc. It’s a fragile system that is very prone to runaway cooling, making it unreliable and less than ideal.

[0009] The Glycol Power Pack is also a very common product sold on the market in an attempt to serve cold beverage from a beverage reservoir. The beverage reservoir, and as a result the beverage contained inside of it, is cooled directly via a refrigerant to bring the beverage to the cold desired temperature, in a similar manner to the previously discussed “Flash Coolers”. A large volume of a water/glycol mixture is also cooled via a refrigerant. The beverage is flowed through a beverage line to reach a faucet where the beverage is to be dispensed from, and this beverage line is flowed alongside another line carrying the water/glycol mixture to ensure that the beverage maintains the cold desired temperature upon dispensing from the faucet. The problems with this system are that in order to get effective heat exchange a large volume of water/glycol is needed (some products use around 2 gallons, but some others go up to 18 gallons of water/glycol). The refrigeration units use a large amount of energy and they require a

significant amount of time (~15 minutes) to cool the large volume of the water/glycol mixture from room temperature to the required cool temperature, and even then the heat exchange between the water/glycol mixture and the beverage is rather low and inefficient (small volumes of water glycol give 1150 BTUs/hr and large volumes of water glycol give 2900 BTUs/hr). Even if operated with precise operation and monitoring, the beverage is still at risk of warming up above the cold desired temperature before being dispensed from the faucet, and furthermore this system can be challenging to scale since the distance the beverage may travel before reaching the faucet may vary greatly, which can cause the temperature of the beverage to vary along the path to the faucet.

[0010] It is therefore desirable to use improved cool beverage delivery systems and methods that allow for beverages to be quickly dispensed at a consistent low temperature in a reliable system or method with relatively low volumes/amounts of supply needed for their operation.

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BRIEF SUMMARY

[0011] To solve these and other problems, methods and systems for consistently delivering low temperature beverages are disclosed and contemplated. According to certain embodiments of the present disclosure, it may be seen that aspects of these beverage cooling and delivery methods and systems allow for small and large volumes of a beverage to be dispensed when desired, with each beverage dispensed being delivered at a consistent, low, desired temperature. It can be seen further that the present disclosure provides beverage cooling and delivery systems and methods that work efficiently with little to no issues regarding operation and minimal resource supply needed throughout use, setting it apart from prior art beverage cooling and delivery systems and methods.

[0012] According to certain embodiments, the beverage delivery method comprises the steps of providing a primary heat exchanger defining a first inlet fluidly connected to a first outlet and a second inlet fluidly connected to a second outlet, flowing said beverage through said primary heat exchanger via said first inlet and said first outlet of said primary heat exchanger, flowing a cooling fluid at a cooling temperature through said primary heat exchanger via said second inlet and said second outlet of said primary

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heat exchanger, and delivering said beverage at said desired temperature via a dispensing unit, wherein the step of flowing of said cooling fluid at said cooling temperature through said primary heat exchanger is operative to lower the temperature of said beverage such that said beverage may be delivered by the dispensing unit at said
5 desired temperature.

[0013] In some embodiments, the desired temperature can be in the range of -3 to 6 degrees Celsius, -2 to 5 degrees Celsius, or -1 to 4 degrees Celsius. In some embodiments, the cooling temperature can be in the range of -3 to 6 degrees Celsius, -2 to 5 degrees Celsius, or -1 to 4 degrees Celsius.

10 **[0014]** In some embodiments, the beverage may be an alcoholic beverage selected from the group consisting of: ales, ciders, lagers, porters, stouts, blonde ales, brown ales, pale ales, India pale ales, wheats, pilsners, sour ales, or combinations thereof. The beverage may also comprise nonalcoholic beverages such as water, milk, carbonated drinks, juices, plant drinks, and the like. In certain embodiments, the cooling fluid can
15 be selected chosen from the group consisting of: water, deionized water, air, glycol/water solutions, dielectric fluids, silicones, ethylene glycols, propylene glycols, brines, or combinations thereof. Additives may be added to the cooling fluid as well to improve the properties of the cooling fluid, including surfactants which may be operative to enhance the transfer of heat to or from the cooling fluid as well as metals
20 which may be operative to enhance the cooling fluid's ability to retain and carry any heat absorbed.

[0015] In particular embodiments, the flowing of the cooling fluid and the beverage through the primary heat exchanger may be flowed in a configuration selected from one of the following: cocurrent flow, countercurrent flow, crossflow, or cross/counterflow.
25 The first heat exchanger may be a tube in tube heat exchanger.

[0016] Such embodiments may also include, the cooling fluid may be cooled to a chilling temperature via a refrigerant, with said chilling temperature being operative to allow for said cooling fluid to be at said cooling temperature prior to being introduced to said first heat exchanger. The refrigerant may be selected from the group consisting
30 of: ChloroFluoroCarbons (CFC), HydroChloroFluoroCarbons (HCFC), HydroFluoroCarbons (HFC), FluoroCarbons (FC), HydroCarbons (HC), ammonia, carbon dioxide, propane, or combinations thereof. The chilling temperature may be 0.01

to 5 degrees Celsius below said cooling temperature. In certain configurations, the refrigerant may be recycled via a refrigeration unit, with said refrigeration unit being selected from the group consisting of: evaporative cooling refrigerators, mechanical-compress refrigerators, absorption refrigerators, and thermoelectric refrigerators. The refrigerant may cool said cooling fluid to said chilling temperature by flowing said cooling fluid through a third inlet fluidly connected to a third outlet of a secondary heat exchanger, and flowing said refrigerant through a fourth inlet fluidly connected to a fourth outlet of said secondary heat exchanger, with said flowing of said refrigerant through said secondary heat exchanger being operative to cool said cooling fluid to said chilling temperature. Similar to the primary heat exchanger, the flowing of said cooling fluid and said flowing of said refrigerant through said secondary heat exchanger may flow in a configuration selected from one of the following: cocurrent flow, countercurrent flow, crossflow, or cross/counterflow. In some embodiments, the secondary heat exchanger may be a coaxial heat exchanger. In some embodiments, the second outlet of said primary heat exchanger may be fluidly connected to said third inlet of said secondary heat exchanger to define a fluidly-connected continuous loop of cooling fluid.

[0017] Such embodiments may also include a further step of flowing said cooling fluid through a beverage reservoir wrap, defining a reservoir fluid inlet fluidly connected to a reservoir fluid outlet, surrounding a beverage reservoir, the latter containing said beverage prior to said flowing said beverage through said primary heat exchanger, wherein said step of flowing said cooling fluid through said beverage reservoir wrap is operative to cool said beverage contained in said beverage reservoir. This step can take place at any time, such as before or after the cooling fluid flows through the primary heat exchanger, to name a couple of examples. The reservoir fluid inlet and reservoir fluid outlet may be fluidly connected to other unit(s), allowing for this step to be part of a fluidly-connected pathway for the cooling fluid or, if present, a fluidly-connected continuous loop of cooling fluid.

[0018] In particular embodiments, a further step may be provided of flowing said beverage through a cooling fluid bath wherein said step of flowing said beverage through said cooling fluid bath is operative to cool said beverage. This step can take place at any time, such as before or after the beverage flows through the primary heat

exchanger, to name a couple of examples. The inlet and outlet used by the beverage in this type of embodiment may be fluidly connected to other unit(s), allowing for this step to be part of a fluidly-connected pathway for the beverage.

- [0019]** In any of the embodiments, the flowing of said beverage, the flowing of said cooling fluid, and, if present, the flowing of said refrigerant, occur through pipes or tubing that are made of a first material comprising: steel, galvanized steel, stainless steel, cast iron, ductile iron, duriron, nickel alloys, cobalt alloys, titanium, carbon, brass, copper, aluminum, polyvinylchloride (PVC), polypropylene, polyvinyl chloride, polyethylene cross-linked (PEX), borosilicate glass, polytetrafluorethylene based compositions (including TeflonTM) or combinations thereof. The tubing may also have one or more additional layers wrapping around the tubing, either entirely or a portion thereof, with each layer being made of the same material as the initial tubing or made of different materials, the materials comprising: steel, galvanized steel, stainless steel, cast iron, ductile iron, duriron, nickel alloys, cobalt alloys, titanium, carbon, brass, copper, aluminum, polyvinylchloride (PVC), polypropylene, polyvinyl chloride, polyethylene cross-linked (PEX), borosilicate glass, polytetrafluorethylene based compositions (including TeflonTM) or combinations thereof. In some embodiments, said tubing further comprises an antimicrobial component. In additional embodiments, said tubing further comprises a hydrophilic component.
- [0020]** A controller may optionally be provided that controls said flowing of said cooling fluid and, if present, the flowing of refrigerant and the operation of a refrigeration unit such that said desired temperature may be selectively changed. Such controllers may receive information from one or more sensors that measure one or more of a temperature of said beverage before/after/while being flowed through said primary heat exchanger, a temperature of said cooling fluid before/after/while being flowed through said primary heat exchanger, a flow rate of the cooling fluid through the primary heat exchanger, a flow rate of the beverage through the primary heat exchanger, and, if present, a flow rate of the cooling fluid through the secondary heat exchanger, a flow rate of the refrigerant through the secondary heat exchanger, and the temperature of the refrigerant before/after/while being flowed through the second heat exchanger. The controllers may control the flow rate of the cooling fluid, the refrigerant, and the beverage via operating pumps.

[0021] It is also contemplated that the aforementioned methods may be configured into a beverage cooling delivery system, said system comprising a primary heat exchanger defining a first inlet fluidly connected to a first outlet and a second inlet fluidly connected to a second outlet, a beverage reservoir containing a beverage, a cooling fluid bath containing a cooling fluid, a refrigeration unit, and a dispensing unit, said primary heat exchanger being operative to receive said beverage via said first inlet and being further operative to receive a cooling fluid at a cooling temperature via said second inlet, said primary heat exchanger being further operative to allow for said cooling fluid to cool said beverage via said cooling fluid absorbing heat from said beverage, said dispensing unit being operative to receive said beverage being further operative to deliver said beverage at said desired temperature, said refrigeration unit being operative to supply a refrigerant to cool said cooling fluid to a chilling temperature operative to provide said cooling fluid at said cooling temperature prior to said cooling fluid being received from said second inlet of said primary heat exchanger.

[0022] All of these embodiments are contemplated to be within the scope of the invention herein disclosed. These and other embodiments will become readily apparent to those skilled in the art from the following detailed description of the preferred embodiments having reference to the attached figures, the invention not being limited to any particular preferred embodiments disclosed.

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BRIEF DESCRIPTION OF THE DRAWINGS

[0023] These and other features and advantages of the various embodiments disclosed herein are better understood with respect to the following descriptions and drawings, in which:

[0024] FIG. 1 is an exemplary embodiment of a beverage cooling and delivery method/system;

[0025] FIG. 2 is exemplary embodiment of a more preferred beverage cooling and delivery method/system 20; and

[0026] FIG. 3 is an alternative embodiment and configuration for the cooling bath unit.

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DETAILED DESCRIPTION

- [0027] Disclosed herein are methods and systems for delivering beverages at a desired temperature. According to the preferred embodiment, the methods and systems allow for a beverage to be consistently delivered at a selectively low temperature by
- 5 flowing the beverage and a cooling fluid, with the cooling fluid being at a cooling temperature, through a primary heat exchanger, and delivering the beverage out from a dispensing unit, wherein the flowing of the cooling fluid at the cooling temperature through the primary heat exchanger is operative to cool the beverage such that it may be dispensed from the dispensing unit at the desired temperature.
- 10 [0028] The disclosed methods and systems allow for efficient cooling of the beverage while additionally allowing for the beverage to be delivered quickly at a desirable low temperature with little-to-no issues in operation, thus allowing for small and large volumes of beverages to be delivered and subsequently consumed by people at the same consistent low temperature. It can therefore be seen that this gives an improvement over
- 15 prior art methods of beverage cooling and delivery currently employed.
- [0029] In some aspects the cooling temperature of the cooling fluid may be at or below the desired temperature of the beverage when dispensed. It can be seen that the selection of the cooling temperature of the cooling fluid will affect the desired temperature of the beverage when it is delivered from the dispensing unit. Based on
- 20 different methods of operation and systems, a different cooling temperature range for the cooling fluid will be selected to result in a different desired temperature range of the beverage. Depending on the embodiment, the temperature range of the cooling temperature of the cooling fluid is ideally close to or identical to the temperature range of the desired temperature of the beverage. If operated ideally, the beverage when
- 25 exiting the primary heat exchanger will be a bit above or at the cooling fluid temperature. The beverage, after exiting the primary heat exchanger won't be able to be cooled below the cooling fluid temperature, and therefore the beverage won't be at risk of freezing if the cooling temperature range is above the freezing temperature of the beverage (as is the case in a preferred embodiment). In this case, even if the
- 30 beverage is sits for long periods of time in the heat exchanger or in any of the units used in the disclosed systems and methods (which can be the case in pulsed operation), the beverage will not be able to freeze. In one preferred embodiment, the cooling

temperature of the cooling fluid can range from -3 to 6 degrees Celsius. In a more preferred embodiment, the cooling temperature of the cooling fluid can range from -2 to 5 degrees Celsius. In a most highly preferred embodiment, the cooling temperature of the cooling fluid can range from -1 to 4 degrees Celsius. In one preferred embodiment, the desired temperature of the beverage can range from -3 to 6 degrees Celsius. In a more preferred embodiment, the desired temperature of the beverage can range from -2 to 5 degrees Celsius. In a most highly preferred embodiment, the desired temperature of the beverage can range from -1 to 4 degrees Celsius.

[0030] The beverage to be delivered can be any beverage suitable for consumption. Beverages can include water, milk, carbonated drinks, juices, plant drinks, alcoholic drinks, or combinations thereof. The disclosed methods and systems are particularly suitable for dispensing alcoholic beverages at the desired temperature. Examples of the types of alcoholic beverages include ales, ciders, lagers, porters, stouts, blonde ales, brown ales, pale ales, India pale ales, wheats, pilsners, sour ales, or combinations thereof. In a preferred embodiment, beer such as an ale is used as the beverage. It is to be understood that the types of beverages that can be utilized in the disclosed systems and methods are virtually unlimited and may include beverages that are not explicitly stated in this disclosure.

[0031] The cooling fluid can be a fluid that transfers heat efficiently enough to allow the beverage to be dispensed at the desired temperature. Typical desired properties of the cooling fluid to be used in the disclosed systems and methods include reduced viscosity at lower temperatures to allow for ease of flowing, high thermal conductivity and specific heat, low toxicity, relatively cheap cost, and other beneficial properties as recognized in the art. Cooling fluids may include, but are not limited to, water, deionized water, air, glycol/water combinations, silicones, ethylene-glycol-based fluids, propylene glycols, brines, or combinations thereof. In particular, glycol/water combinations have been found to be the most effective as the cooling fluid for the disclosed methods and systems. Glycol/water combinations consist of a solution of water with a glycol, such as ethylene glycol, diethylene glycol, propylene glycol, and combinations thereof to name a few examples. A preferred embodiment has a glycol/water mixture of 10-50% glycol component and 50-90% water component. Depending on the system and the cooling fluid chosen, the cooling fluid, after flowing

through the primary heat exchanger and absorbing heat from the beverage, may be restored by cooling it back down to the cooling temperature, allowing for the cooling fluid to be used again and reintroduced to the primary heat exchanger to cool down more of the beverage. It can be seen that in some embodiments the cooling fluid itself
5 may be replaced and recycled over the use of the cooling system or method, but in other more preferred embodiments the cooling fluid can be cycled through the system several times via cooling it back down to the cooling temperature as described earlier without the need to replace the cooling fluid. The preferred cooling fluid of a water/glycol mixture, for instance, allows for continuous use in the disclosed methods and systems
10 without the need to recycle or replace for decades. Additives may be added as well to improve the properties of the cooling fluid. For example, a surfactant can be incorporated into the cooling fluid, which may allow for the cooling fluid to come closer to the surface of the tubing/piping/walls/structures that the cooling fluid will be exchanging heat through, serving to enhance the transfer of heat to or from the cooling
15 fluid. Additionally, metals may be added to the cooling fluid to allow the cooling fluid to better retain and carry any heat absorbed.

[0032] In some embodiments, a beverage reservoir may be provided to contain the beverage prior to it being introduced to one of the units of the disclosed methods and systems, and may take the form of any conventional reservoir, such as a keg. The
20 beverage reservoir can be any type of container or reservoir that is operative to store the beverage prior to the beverage being introduced or flowed through another unit such as an inlet of the primary heat exchanger. The beverage reservoir may be fluidly connected to the primary heat exchanger to create a passageway for the beverage to travel through from the beverage reservoir to the primary heat exchanger. The reservoir
25 may be pressurized so as to allow for the beverage to flow through the primary heat exchanger and out through the dispensing unit with ease. In a working embodiment, a CO₂ powered Flojet® diaphragm beer pump may be utilized, although nearly any gas, including atmospheric air, could be used to power the pump. A pressure regulator may be connected to the CO₂ canister to regulate the gas pressure and therefore the flow of
30 the beverage dispensed. The systems and methods can be designed in certain embodiments to allow for the beverage in the pressurized beverage reservoir to be transported by creating an opening via operation of the dispensing unit, such as opening

a faucet or tap for the beverage to be dispensed and collected from. In this example, the faucet or tap may then be closed to stop the beverage from being dispensed once a desired amount is dispensed; the faucet may then be reopened later when more beverage is desired to be dispensed. In other embodiments, the beer pump may be operated by
5 some switch or activation mechanism found on the dispensing unit which allows the beverage to be pumped through the units and dispensed on command.

[0033] As discussed above, the beverage reservoir can be a keg that alcoholic beverages such as beer may be stored in. A benefit of the beverage reservoir employed in the disclosed systems and methods is that the beverage in this beverage reservoir
10 does not need to be cooled down a significant amount prior to being flowed through the system.

[0034] In this respect, the beverage may be at or hovering somewhere near room temperature in the beverage reservoir, or at some ambient temperature wherever the beverage reservoir may be stored, but the beverage will still be dispensed at the desired
15 temperature. This removes the need for a robust and/or energy intensive cooling means that serves to cool down the beverage in the beverage reservoir directly, a benefit that gives the disclosed methods and systems both flexibility in application while retaining the ability to consistently deliver beverages at the desired low temperature. The beverage reservoir itself may still be cooled in certain embodiments, as to be discussed
20 later in the disclosure herein.

[0035] In certain embodiments, the cooling fluid may be stored in a cooling fluid bath that acts as a reservoir or some other suitable container to hold the cooling fluid prior to it being introduced to the heat exchanger. The cooling fluid bath may be configured into different shapes, sizes and volumes, the benefits of which will be discussed later
25 in the disclosure. The cooling fluid bath may be fluidly connected to the heat exchanger to create a passageway for the cooling fluid to travel through from the cooling fluid bath to the heat exchanger. The cooling fluid may be introduced to the heat exchanger via operation of a circulation pump, for example. Commercial pumps that can be used include those made by YOUNTREE®, Flojet®, and Aquatec®. As to be described later
30 in this disclosure, this cooling fluid bath can be used as a vessel to cool down the cooling fluid to the cooling temperature, or a chilling temperature cooler than the cooling temperature, such that the cooling fluid is ready to be used to cool the beverage down

when introduced to the heat exchanger. The cooling fluid bath may be fluidly connected to an inlet of the primary heat exchanger such that the cooling fluid may easily and efficiently flow from the cooling fluid bath to the primary heat exchanger. In some embodiments, it may be satisfactory to cool the cooling fluid in the cooling fluid bath to the cooling temperature, as it may then immediately, or soon afterwards, be introduced to the heat exchanger. In other embodiments it may be necessary to cool the cooling fluid in the cooling fluid bath to the chilling temperature, as the cooling fluid may flow through a series of pipes or through other units (as to be described in detail later in the disclosure), which may result in the cooling fluid heating up before being introduced to the heat exchanger. Cooling the cooling fluid to this chilling temperature below the cooling temperature in the cooling fluid bath (or elsewhere as to be described later herein) may be necessary so that heat absorbed by the cooling fluid will bring it to the proper cooling temperature when it reaches the heat exchanger. The chilling temperature will depend directly on the cooling temperature and will be in the range of 0.01-5 degrees Celsius cooler than the cooling temperature.

[0036] The primary heat exchanger is operative to have inlets and outlets to allow for the cooling fluid and the beverage to exchange heat with one another via thermal contact. The cooling fluid and the beverage are thus not in direct contact with one another and therefore not mixing together; they are merely touching each other through the piping, walls, or other structures of the heat exchanger such that heat can be transferred between the cooling fluid and the beverage. The inlets of this heat exchanger may be fluidly connected to the beverage reservoir and cooling fluid bath as described earlier if those units are included. The primary heat exchanger and the tubing found therein, from which the cooling fluid and the beverage will flow through, may be made from a variety of materials, including, but not limited to, steel, galvanized steel, stainless steel, cast iron, ductile iron, duriron, nickel alloys, cobalt alloys, titanium, carbon, brass, copper, aluminum, polyvinylchloride (PVC), polypropylene, polyvinyl chloride, polyethylene cross-linked (PEX), borosilicate glass, polytetrafluorethylene based compositions (including Teflon™) or combinations thereof. It is to be understood that this may also include other materials not explicitly disclosed that may be suited for the disclosed methods and systems, and this includes materials that have not yet been discovered that would support the function of this heat exchanger. The tubing may also

have one or more additional layers wrapping around the tubing, either entirely or a portion thereof, with each layer being made of the same material as the initial tubing or made of different materials. One example of this, which is used in one preferred embodiment, is a PEX-AL-PEX tube with inside and outside layers made of PEX and a middle layer sandwich between them made of aluminum. The purpose of this middle layer of aluminum in this embodiment is used to help keep the shape of the tube when rolled up. Depending on the operation of heat exchanger and pumps operating the flow of the cooling fluid and the beverage, the cooling fluid and the beverage may each be continuously flowed through the primary heat exchanger, pulsed through the system, or a combination thereof.

[0037] The primary heat exchanger contemplated herein allows for the cooling fluid and the beverage to be flowed through the primary heat exchanger in several configurations, including cocurrent flow, countercurrent flow, crossflow, or cross/counter flow. In a preferred embodiment, a tube in tube heat exchanger is used as the primary heat exchanger, and in other preferred embodiments a flat plate heat exchanger and a coaxial heat exchanger have been utilized as the primary heat exchanger. A tube in tube heat exchanger has been found to allow for the highest degree of heat transfer between the cooling fluid and the beverage when they are flowed through the primary heat exchanger, which allows for embodiments with higher flow rates of beverage and cooling fluid to be employed and less tubing within the primary heat exchanger to be needed. The preferred embodiment of this heat exchanger comprises a tube in tube heat exchanger with an internal tubing made of SS316 (stainless steel grade 316) which carries the beverage and outer tubing made with this PEX-A tubing (PEX type A) which carries the cooling fluid.

[0038] The residence time of the cooling fluid and the beverage in the heat exchanger as well as the flow configuration used will determine how much heat will be transferred between the cooling fluid and the beverage and, as a result, what temperature the cooling fluid and the beverage will be when they exit the heat exchanger. As such it can be seen that differently sized heat exchangers, different flow rates of the beverage and cooling fluid, and different beverage and cooling fluid choices will require different cooling temperatures of the cooling fluid to be chosen in order to dispense the beverage at the desired temperature. That being said, this system has been shown to be extremely

effective at cooling down the beverage by flowing it through this heat exchanger, allowing it to be effectively dispensed at the desired temperature.

[0039] The dispensing unit can be any suitable outlet for the beverage to be delivered from at the desired temperature. The dispensing unit can be, but is not limited to, a faucet or a tap. The dispensing unit may be fluidly connected to the outlet of the heat exchanger corresponding to the beverage to allow for quick and convenient delivery of the beverage right after being cooled to the desired temperature. The beverage can be delivered to a cup, glass, or some other small container from which the beverage will be consumed by someone directly, or into a larger container, keg, or reservoir.

[0040] In one embodiment, the cooling fluid may be cooled to its cooling temperature, or to the chilling temperature, by a refrigerant. The refrigerant may be any suitable or commercially used refrigerant, and it may contain the ChloroFluoroCarbons (CFC), HydroChloroFluoroCarbons (HCFC), HydroFluoroCarbons (HFC), FluoroCarbons (FC), HydroCarbons (HC), ammonia, carbon dioxide, propane, or combinations thereof. It is to be understood that the types of refrigerants to be used in these systems and methods are not restricted to the refrigerants explicitly disclosed herein and can therefore include refrigerants not listed or otherwise not yet discovered that are suitable for use in the disclosed methods and systems. In a working embodiment, the refrigerant R134a was used, but in a couple of preferred embodiments it is contemplated that R290 or R744 may be used as the refrigerant.

[0041] In another embodiment, the refrigerant may be brought to a refrigeration unit to restore the refrigerant such that it may be used again to cool the cooling fluid to the cooling temperature or the chilling temperature. The refrigeration unit can include, but it is not limited to, any of the following types of typically used refrigeration systems: evaporative cooling refrigerators, mechanical-compress refrigerators, absorption refrigerators, and thermoelectric refrigerators. In a preferred embodiment, the refrigerant, after absorbing heat from the cooling fluid, is introduced to a compressor wherein the refrigerant is recompressed to restore its ability to absorb heat from the cooling fluid. One working embodiment has been developed which uses a ½ horsepower Emerson R134a compressor and condenser, which can be hooked up to a standard household circuit.

[0042] In another embodiment, the refrigerant may cool the cooling fluid to the cooling temperature or the chilling temperature by directly cooling the cooling fluid bath described earlier which holds the cooling fluid.

[0043] In another embodiment, a secondary heat exchanger may be provided similar
5 in operation and configuration to the primary heat exchanger previously described wherein the refrigerant and the cooling fluid are flowed through this secondary heat exchanger such that the refrigerant is operative to cool the cooling fluid to the cooling temperature or the chilling temperature. In some embodiments which include a cooling fluid bath, the cooling fluid bath can be found before this secondary heat exchanger
10 (wherein the cooling fluid is flowed from the cooling bath, then through this secondary heat exchanger, and finally through the primary exchanger), or the cooling fluid bath can be found after this secondary heat exchanger (wherein the cooling fluid is first flowed through the secondary heat exchanger, then introduced to the cooling fluid bath, then flowed through the primary heat exchanger), as is the case in a preferred
15 embodiment. The secondary heat exchanger, like the primary heat exchanger, can operate in cocurrent flow, countercurrent flow, crossflow, or cross/counter flow. In a preferred embodiment, this secondary heat exchanger is a flat plate heat exchanger, although other types of heat exchangers, such as coaxial heat exchangers and tube in tube heat exchangers have been shown to be effective as well. The residence time of
20 the refrigerant and the cooling fluid in the secondary heat exchanger as well as the flow configuration used will determine how much heat will be transferred between the cooling fluid and the refrigerant and, as a result, what temperature the cooling fluid and the refrigerant will be when they exit the secondary heat exchanger. As such it can be seen that differently sized heat exchangers, different flow rates, and different cooling
25 fluid and refrigerant choices will eventually result in a different desired temperature of the beverage to be delivered. Therefore, these parameters will need to be chosen carefully to dispense the beverage at the desired temperature.

[0044] In other embodiments, the cooling fluid exiting from the second outlet of the primary heat exchanger may be fluidly connected to an inlet of the cooling fluid bath
30 or the inlet of the secondary heat exchanger to allow for the cooling fluid to be continuously cycled through the disclosed systems and methods. In order for the disclosed systems and methods to continue to deliver the beverage at the desired

temperature, the cooling fluid will need to be cooled down back to the cooling temperature before being flowed through the original heat exchanger again. This can be done via the techniques discussed earlier, such as using a refrigerant to cool the cooling fluid bath directly or, in a preferred embodiment, flowing a refrigerant and the cooling fluid through the secondary heat exchanger. This fluidly-connected continuous loop may allow the cooling fluid to flow continuously and constantly through the loop, which results in many great benefits. The volume of the cooling fluid contained in the loop may be relatively low compared to prior methods, and additionally the cooling fluid is allowed to exchange heat in both heat exchangers quickly and efficiently.

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10 **[0045]** In another embodiment, the cooling fluid may be flowed around the beverage reservoir such that the cooling fluid may absorb some heat from the beverage reservoir prior to the beverage being flowed out from the beverage reservoir via thermal contact between the cooling fluid and the beverage. In one embodiment, this can be done with a beverage reservoir wrap surrounding the beverage reservoir, such as a 5-gallon pail

15 made by North Slope Chiller® of Salt Lake City, UT. This serves as a practical and efficient way to get the beverage to the desired temperature, as the locations of the primary heat exchanger and the beverage reservoir may be very close to one another, allowing for the cooling fluid to wrap around the beverage reservoir in this manner after leaving from the primary heat exchanger. This also lowers the work and energy

20 requirements of the compressor and allows for the flow of beverage and cooling fluid through the disclosed methods and systems to be higher since there is now a lower temperature difference between the cooling temperature of the cooling fluid and the now cooler beverage entering the first heat exchanger. Here, the beverage would not be able to cool below the temperature of the cooling fluid, with the temperature of the

25 cooling fluid being at or above the cooling temperature at this stage. Therefore, the issue of the beverage reservoir freezing over as discussed in the “Flash Cooler” prior art may be avoided if the cooling temperature and/or the flow of the beverage and cooling fluid are carefully selected. In a preferred embodiment, the cooling temperature range would lie above the freezing point of the beverage, which would prevent any risk

30 of freezing the beverage in the beverage reservoir, allowing for the cooling fluid and the beverage to be flowed and pulsed through the disclosed systems and methods at any rate without any risk of freezing the beverage in the beverage reservoir. An additional

beverage reservoir holding more of the beverage can be set next to the original beverage reservoir to allow for the cooling fluid to be wrapped around both of the beverage reservoirs in a daisy chain configuration. This allows the secondary “standby” beverage reservoir to be cooled and more ready to replace the original beverage reservoir when the beverage runs out. This beverage reservoir wrap may also serve as an insulating wrap for the beverage reservoir, being operative to keep the beverage cool. A bypass route may be added to give another path for the cooling fluid to travel through to avoid this step of passing through the beverage reservoir wrap. In this embodiment, a bypass valve may be added to change which route the cooling fluid will flow through. This would allow for one to reroute the cooling fluid and keep it contained while one beverage reservoir is replaced with another.

[0046] In another embodiment, the beverage may be flowed through or around the cooling fluid bath such that the cooling fluid and the beverage may exchange heat between each other via thermal contact. This can be done by a cooling fluid bath wrap similar to the wrap and manner described above, by directing the piping of the beverage through the cooling fluid in the cooling fluid bath, by directing the piping of the beverage alongside the walls of the cooling fluid bath or alongside piping of the cooling fluid, or in another manner as would be understood by those skilled in the art. The piping of the beverage and the size, shape, volume, and configuration of the cooling fluid bath and/or cooling fluid piping may be modified such as to create multiple sites where the cooling fluid and the beverage may exchange heat between each other (such as flowing the piping of the cooling fluid alongside the piping of the beverage and then wrapping the cooling fluid piping back around the piping of the beverage). As such the cooling fluid bath may not be in the shape or form of a typical bath or tub unit, as is the case in preferred embodiments. In this respect, the cooling fluid could take the form of, for example, one or more sections of the piping that carry the cooling fluid. The beverage can be flowed through or around the cooling fluid bath in this manner either before the beverage is flowed through the primary heat exchanger or, in a preferred embodiment, after the beverage is flowed through the primary heat exchanger but before being delivered via the dispensing unit. Similar to above, this can reduce the amount of work the compressor needs to do and allows for faster flowing of the beverage through the system without compromising the desired temperature when

dispensed. In this type of embodiment, it may be necessary to cool the cooling fluid to the chilling temperature, such that any heat absorbed by the cooling fluid at this step would allow for the cooling fluid to be at the proper cooling temperature when it is to be introduced to the first heat exchanger. If a cooling fluid bath wrap is used, it may also serve as an insulating wrap for the cooling fluid bath, being operative to keep the cooling fluid cool.

[0047] In certain embodiments, a controller can be implemented to control the desired temperature of the beverage upon the beverage's delivery. The controller can be used to configure the flow of the cooling fluid, the flow of the beverage, and, if present, the flow of the refrigerant and the operation of the refrigeration unit. The function of the controller may allow for the beverage to reach the desired temperature, in which said desired temperature may be configured, set, or changed by someone operating the controller. The controller can be hooked to sensors that may track the beverage temperature, beverage flow rate, cooling fluid temperature, cooling fluid flow rate, and, if present, the flow of the refrigerant, the temperature of the refrigerant, and the energy input of the compressor, with the flow and temperature sensors being operative to be placed anywhere in the system or methods (such as within the units or any piping connecting them). Multiple temperature and flow sensors may be placed that track the same variable at different points in the disclosed systems and methods (for example, measuring the temperature of the cooling fluid both before entering the primary heat exchanger and after exiting the primary heat exchanger). The sensors may also track other variables such as spillage, leaks, the volume level of the beverage reservoir, volume of beverage dispensed, need for maintenance or cleaning, and more. The controller may be linked to a device such as a phone or a computer to allow for someone to operate the controller in response to this information. The controller can be any suitable controller known in the art, such as a PID controller (proportional, integral, derivative controller as known in the art).

[0048] In certain embodiments, the beverage, the cooling fluid, and the refrigerant may be flowed through the aforementioned methods and systems, and the units found therein, through piping or tubing that is operative to allow for heat transfer between the fluids when necessary via thermal contact, while preventing the fluids from contacting each other directly and mixing together. The piping may be made of any

suitable material, including, but not limited to, steel, galvanized steel, stainless steel, cast iron, ductile iron, duriron, nickel alloys, cobalt alloys, titanium, carbon, brass, copper, aluminum, polyvinylchloride (PVC), polypropylene, polyvinyl chloride, polyethylene cross-linked (PEX), borosilicate glass, polytetrafluorethylene based compositions (including Teflon™) or combinations thereof. It is to be understood that the material of the piping of the disclosed methods and systems are not limited to the materials disclosed and can thus include other materials that are not explicitly disclosed herein that would be suitable for the disclosed systems and methods, including undiscovered materials that could prove useful in the piping disclosed herein. The tubing may also have one or more additional layers wrapping around the tubing, either entirely or a portion thereof, with each layer being made of the same material as the initial tubing or made of different materials. A preferred embodiment may include PVC flexible tubing surrounded by stainless steel. The piping or tubing may have antimicrobial properties via, for example, an antimicrobial component or coating, which can help to, for example, keep the beverage line clean and prevent bacterial build up. The piping or tubing may also have hydrophilic properties via, for example, a hydrophilic component or coating. This can help to pull water towards the inner surface of the piping, which has been shown to enhance heat transfer and help remove bacterial deposits that may accumulate on the inner surface of the piping. Water has a tendency to come close to but not fully touch the inner surfaces of piping on a microscopic level when flowed through these types of pipes, and a hydrophilic coating on the piping may be used to pull the water towards these surfaces in order to enhance the aforementioned heat transfer effects and dislodging of foreign species.

[0049] The systems and methods described herein are scalable and can therefore be used in several applications. For example, a relatively small beverage reservoir with a small beverage volume can be used alongside smaller heat exchangers, compressors, etc., which could define a smaller, portable system that is suitable for smaller scale events such as a backyard gathering, while a larger beverage reservoir with a large volume of beverage will require larger accompanying units, which could define a system suitable for a large-scale dispensary such as a bar serving larger crowds. The system can be configured to be portable and the piping connecting the disclosed units may be manually attached and detached to each other when desired, which may allow

the units to be changed and replaced with relative ease while also allowing for one to change the fluid interconnection of the units, which can change the order of the units that the cooling fluid and the beverage will flow through. The heat exchanger may also be configured so as to have multiple beverage inlets and outlets in order to allow for multiple beverage reservoirs to be fluidly connected to that single heat exchanger. In this embodiment, multiple dispensing units can be used to correspond to different beverages being dispensed from that particular dispensing unit, such as the case for beer taps in a bar.

[0050] The systems and methods described herein also allow for cleaning and maintenance if necessary. The beverage, cooling fluid, and refrigerant may be purged from the system and the fluid interconnections between those units removed to allow for parts to be replaced or fixed, or to allow for a cleaning solution to be flushed through the units and tubing. The cleaning solution may alternatively use the same piping or tubing used by the beverage, cooling fluid, and refrigerant and pumped through the units for ease of cleaning.

[0051] The described methods and systems are best understood by the accompanying figures. The figures are intended to show certain embodiments of the aforementioned methods and systems and to better illustrate certain aspects described in detail above, and as such they are not meant to limit the scope of the methods and systems.

[0052] Referring now to the Figures and initially to FIG. 1, there is shown an exemplary embodiment of a beverage cooling and delivery method/system 10. A beverage 102 stored in beverage reservoir 100 is fluidly connected to a heat exchanger 112 via an outlet 104 of the beverage reservoir 100 being fluidly connected to a first inlet 108 of the heat exchanger 112. A cooling fluid bath 150 is also provided which stores cooling fluid 122. The cooling fluid bath 150 is fluidly connected to the heat exchanger 112 via a first outlet 138 of the cooling fluid bath 150 fluidly connected to a second inlet 118 of the heat exchanger 112. When operated, the beverage 102 flows through outlet 104 of the beverage reservoir 100 and into the first inlet 108 of the heat exchanger 112 in a direction of flow 106 and the cooling fluid 122 flows from the first outlet 138 of the cooling fluid bath 150 into the second inlet 118 of the heat exchanger 112 in a direction of flow 116. In this embodiment, the direction of flow of the beverage 106 and the direction of flow of the cooling fluid 116 are in opposite directions, but in

other embodiments the direction of flow can be in the same direction, perpendicular directions, or any other orientation/configuration that is operative to allow for the cooling fluid 122 to cool the beverage 102 via heat exchange 152.

[0053] After the beverage 102 is flowed through the heat exchanger 112, it exits
5 through a first outlet 110 fluidly connected to both the first inlet 108 of the heat exchanger 112 and a dispensing unit 114, wherein the beverage 102 may be dispensed at the desired temperature. After the cooling fluid 122 flows through the heat exchanger 112, it exits through a second outlet 120 of the heat exchanger 112 fluidly connected to both the second inlet 118 of the heat exchanger 112 and to a first inlet 140 of the cooling
10 fluid bath 150.

[0054] The cooling fluid 122, being reintroduced to the cooling fluid bath 150 via this first inlet 140 of the cooling fluid bath 150, may then be recycled and flowed through this cycle again. In order to reuse the cooling fluid 122 in this particular embodiment, a refrigeration unit 130 is provided with refrigerant 132. The refrigerant
15 132 leaves through an outlet 134 of the refrigeration unit 130 and into a second inlet 126 of the cooling fluid bath 150, with the outlet 134 of the refrigeration unit 130 and the second inlet 126 of the cooling fluid bath 150 being fluidly connected to one another. The refrigerant 132 is flowed into the cooling fluid bath in a direction of flow 124. In this embodiment, the piping with the refrigerant 132 is emersed in the cooling
20 fluid bath 150 containing cooling fluid 122 such that the refrigerant 132 and the cooling fluid 122 are in thermal contact with one another, allowing the cooling fluid 122 to reach the cooling temperature or the chilling temperature which is operative to cool the beverage 102 such that it may be dispensed at the desired temperature.

[0055] After flowing through the cooling fluid bath 150, the refrigerant 132 flows out
25 from the cooling fluid bath 150 and back to the refrigeration unit 130 via a second outlet 128 of the cooling fluid bath 150 fluidly connected to both the second inlet 126 of the cooling fluid bath 150 and an inlet 136 of the refrigeration unit 130. The refrigeration unit 130 may then restore the refrigerant 132 prior to being reintroduced to the cooling fluid bath 150 such that the refrigerant 132 is operative to cool the cooling fluid 124
30 back down to the necessary cooling temperature or chilling temperature.

[0056] FIG. 2 is exemplary embodiment of an alternative beverage cooling and delivery method/system 20. A beverage reservoir 200 containing beverage 202 is

provided with an beverage reservoir wrap 206. In addition, a first heat exchanger 210, a second heat exchanger 224, a refrigeration unit 244, and a cooling fluid bath 250 are provided. A first outlet 204 of the beverage reservoir 202, a first inlet 212 of the first heat exchanger 210, a second inlet 214 of the first heat exchanger 210, a second inlet 260 of the cooling fluid bath 250, a second outlet 262 of the cooling fluid bath 250, and a dispensing unit 216 are all fluidly connected in that order in this embodiment, providing a pathway for the beverage 202 to travel through. For the cooling fluid 252, a pathway is provided via a first outlet 254 of the cooling fluid bath 250, a second inlet 226 of the first heat exchanger 210, a second outlet 228 of the first heat exchanger 210, an inlet 272 of the beverage reservoir wrap 206, a second outlet 274 of the beverage reservoir wrap 206, a first inlet 230 of the second heat exchanger 224, a first outlet 232 of the second heat exchanger 224, and the first inlet 256 of the cooling fluid bath 250 being fluidly connected to each other in that order, within this particular embodiment. The cooling fluid may flow through a bypass route 280, in place of flowing through the beverage reservoir wrap 206 via inlet 272 and outlet 274. The route in which the cooling fluid flows through may be changed from one route to the other by operation of a bypass valve 282. This can be used to remove the beverage reservoir 200 and replace it with another without having the cooling fluid 252 leak out of the continuous-fluidly connected loop. A final pathway is provided for the refrigerant 246 via an outlet 240 of the refrigeration unit 244, a second inlet 236 of the second heat exchanger 224, a second outlet 238 of the second heat exchanger 224, and an inlet 242 of the refrigeration unit 244 being fluidly connected to each other in that order, within this specific embodiment.

[0057] In this embodiment, the beverage 202 flows via the aforementioned beverage pathway into and out of the first heat exchanger 210 in a direction of flow 208. The cooling fluid 252 flows through the first heat exchanger 210 via the aforementioned cooling fluid pathway in a direction of flow 220. The beverage 202 and the cooling fluid 252 while flowing through the first heat exchanger 210 are allowed to exchange heat 272 between each other. In this embodiment, the direction of flow of the beverage 208 and the direction of flow of the cooling fluid 220 are in opposite directions, but these directions of flow can be modified in a similar manner described in the discussion of FIG. 1. Afterwards, the cooling fluid 252 flows through the beverage reservoir wrap 206 such that the cooling fluid 252 and the beverage 202 are in thermal contact with

each other via piping 248. In an actual embodiment, the tubing 248 would be wrapping around the beverage reservoir 200, but for simplicity of the figures the tubing 248 is depicted as shown to highlight the heat transfer between the beverage 202 and the cooling fluid 252 occurring through the piping 248. In a similar manner, the beverage 5 202, after exiting from the first heat exchanger 210, flows around the cooling fluid bath 250 such that the beverage 202 and the cooling fluid 252 are in thermal contact with each other via piping 258, prior to the beverage being dispensed out from the dispensing unit 216 into a container 218.

[0058] These units and their operation in this embodiment are operative such that the 10 beverage 202 may be cooled such that it may be dispensed from the dispensing unit 216 at the desired temperature via the temperature of the beverage 202 being cooled by the cooling fluid 252 in the beverage reservoir 200, in the first heat exchanger 210, and in the cooling fluid bath 250. The cooling fluid 252, after exiting from the beverage reservoir 202, is introduced to the second heat exchanger 224 in a direction of flow 222. 15 The cooling fluid 252 is then introduced to the cooling fluid bath 250 and then reintroduced to the first heat exchanger 210, allowing for a continuous loop for the cooling fluid 252 to travel through this embodiment. The cooling fluid 252, in this embodiment, may need to be lowered to a chilling temperature when flowing through the second heat exchanger 224, as the flow of beverage 202 through the cooling fluid 20 bath 250 will cause the cooling fluid 252 to absorb some heat; as such it may be necessary to set the chilling temperature such that the cooling fluid 252 will be heated up to the proper cooling temperature upon entering the first heat exchanger 210.

[0059] The flow of the refrigerant 246 via the aforementioned pathway from the refrigeration unit 244 into the second heat exchanger 224 and back to the refrigeration 25 unit 244 as well as the operation of the refrigeration unit 244 will be operative to cool the cooling fluid 252 to the cooling temperature or the chilling temperature necessary for the beverage 202 to be dispensed at the desired temperature. The refrigerant 246 flows in a direction of flow 234 opposite to the direction of flow of the cooling fluid 222, but as discussed in FIG 1., these directions of flow may also be modified to several 30 different configurations.

[0060] FIG. 3 illustrates an alternative embodiment and configuration of the cooling bath unit 30 that may be implemented in the disclosed systems and methods. This can

be used in place of, for example, cooling bath 250 in FIG. 2. The cooling fluid bath 300 is shaped and configured in this embodiment to create two sites of heat transfer 306 and 308 between the cooling fluid 302 and the beverage 304. As can be seen, the cooling fluid bath 30 is not shaped like a traditional bath or tub unit, and as such the cooling fluid bath may be shaped and configured into several different shapes, volumes, and sizes. The cooling fluid 302 and the beverage 304 have a first site in which they exchange heat 308 between the sections of piping 320 and 322. The beverage 304 flows in a direction of flow of 314 and the cooling fluid 302 flows in a direction of flow of 316, which in this embodiment is of a cocurrent flow configuration. The cooling fluid 302 and the beverage 304 then have a second site in which they exchange heat 306 between the sections of piping 318 and 322. The beverage 304 flows in a direction of flow 312 and the cooling fluid 302 flows in a direction of flow 310, which in this embodiment is of a countercurrent flow configuration. Ideally, both sites of heat transfer 306 and 308 would serve to cool down the beverage 302, so that it may be eventually dispensed from the dispensing unit at the desired temperature. The spacing between the piping in this figure are used for convenience to better show the heat transfer and the direction of flow of the beverage and the cooling fluid, and in actual embodiments the piping may ideally be closer together such that they are touching, which would promote a higher degree of heat transfer. Those skilled in the art would understand that more than two sites of heat exchanger could be envisioned via configuring the piping of the beverage 322 and the piping of the cooling fluid 318 and 320.

[0061] As will be appreciated by those skilled in the art, the embodiments shown in FIG. 1, FIG. 2, and FIG. 3 may be changed and rearranged into several different embodiments by changing the order of units in which cooling fluid and beverage flow through. For example, the cooling fluid may be flowed from the cooling fluid bath to the beverage reservoir then to the second heat exchanger followed by the first heat exchanger, or the cooling fluid may be flowed into the beverage reservoir multiple times via separate inlets and outlets provided by the beverage reservoir, such as once after exiting from the first heat exchanger and again after exiting from the second heat exchanger. As such, it can be seen that the disclosed systems and methods give way to several configurations that go beyond what is explicitly stated in the disclosure herein.

As discussed earlier, the fluid interconnections of these systems can be configured to allow for them to be moved and reconnected into different units, allowing for a user to efficiently change the order and configuration of these units easily.

- [0062]** An exemplary working embodiment of an embodiment similar to the one disclosed in FIG. 2 is described herein for illustrative purposes. A tube in tube heat exchanger is used as the primary heat exchanger utilizing tubing of SS316 (stainless steel grade 316) 3/8" with 0.035" of wall tubing acting as the inner tube carrying the beverage with an outer tube 3/4" of PEX-A 60 feet of coil is used in the tube in tube heat exchanger. A cooling fluid pump applies 50 psi of pressure to the cooling fluid to flow it through the circulation path at a flow rate of 100 gallons per hour. 1/2 a gallon of water/glycol was flowed through the continuous loop in this system, and it took 30 second for the water/glycol mixture to cool to the cooling temperature. This resulted in the dispensing unit delivering beer at a desired temperature range of -1 to 4 degrees Celsius.
- [0063]** The above description is given by way of example, and not limitation. Given the above disclosure, one skilled in the art could devise variations that are within the scope and spirit of the invention disclosed herein. Further, the various features of the embodiments disclosed herein can be used alone, or in varying combinations with each other and are not intended to be limited to the specific combinations with each other and are not intended to be limited to the specific combination disclosed herein. Thus, the scope of the claims is not to be limited by the illustrated embodiments. Additional modifications and improvements of the present invention may also be apparent to those of ordinary skill in the art. Thus, the particular combination of parts and steps described and illustrated herein is intended to represent only certain embodiments of the present invention, and is not intended to serve as limitations of alternative systems and methods within the spirit and scope of the invention.

WHAT IS CLAIMED IS:

1. A method of delivering a beverage at a desired temperature, the method comprising the steps of:
 - a) providing a primary heat exchanger defining a first inlet fluidly
5 connected to a first outlet and a second inlet fluidly connected to a second outlet;
 - b) flowing said beverage through said primary heat exchanger via said first inlet and said first outlet of said primary heat exchanger, while;
 - c) flowing a cooling fluid at a cooling temperature through said
10 primary heat exchanger via said second inlet and said second outlet of said primary heat exchanger; and
delivering said beverage at said desired temperature via a dispensing unit;
 - d) wherein during step c) said flowing of said cooling fluid at said
15 cooling temperature through said primary heat exchanger is operative to lower the temperature of said beverage such that said beverage may be delivered in step d) at said desired temperature.
2. The method of Claim 1, wherein said desired temperature is in the range of -3 to 6 degrees Celsius.
3. The method of Claim 1, wherein said cooling temperature is in the range
20 of -3 to 6 degrees Celsius.
4. The method of Claim 1, wherein said beverage is an alcoholic beverage selected from the group consisting of: ales, ciders, lagers, porters, stouts, blonde ales, brown ales, pale ales, India pale ales, wheats, pilsners, sour ales, or combinations thereof.
- 25 5. The method of Claim 1, wherein said cooling fluid is chosen from the group consisting of: water, deionized water, air, glycol/water solutions, dielectric fluids, silicones, ethylene glycols, propylene glycols, brines or combinations thereof.
6. The method of Claim 1, wherein said primary heat exchanger is a tube in tube heat exchanger.
- 30 7. The method of Claim 1, further comprising a step of cooling said cooling fluid to a chilling temperature via a refrigerant, the refrigerant being selected from the group consisting of: ChloroFluoroCarbons (CFC), HydroChloroFluoroCarbons

(HFCF), HydroFluoroCarbons (HFC), FluoroCarbons (FC), HydroCarbons (HC), ammonia, carbon dioxide, propane or combinations thereof.

8. The method of Claim 7, wherein said chilling temperature is 0.01 to 5 degrees Celsius below said cooling temperature.

5 9. The method of Claim 7, wherein said refrigerant may be recycled and reused in said step of cooling said cooling fluid to said chilling temperature via a refrigeration unit, said refrigeration unit being selected from the group consisting of: evaporative cooling refrigerators, mechanical-compress refrigerators, absorption refrigerators, and thermoelectric refrigerators.

10 10. The method of Claim 7, wherein said refrigerant cools said cooling fluid to said chilling temperature by flowing said cooling fluid through a third inlet fluidly connected to a third outlet of a secondary heat exchanger, and flowing said refrigerant through a fourth inlet fluidly connected to a fourth outlet of said secondary heat exchanger, with said flowing of said refrigerant through said secondary heat exchanger
15 being operative to cool said cooling fluid to said chilling temperature.

11. The method of Claim 10, wherein said secondary heat exchanger is a coaxial heat exchanger.

12. The method of Claim 10, wherein said second outlet of said primary heat exchanger is fluidly connected to said third inlet of said secondary heat exchanger to
20 define a fluidly-connected continuous loop of cooling fluid.

13. The method of Claim 1, further comprising a step of flowing said cooling fluid through a beverage reservoir wrap defining a reservoir fluid inlet fluidly connected to a reservoir fluid outlet, said beverage reservoir wrap surrounding a beverage reservoir, said beverage reservoir containing said beverage prior to said
25 flowing said beverage through said primary heat exchanger, wherein said step of flowing said cooling fluid through said beverage reservoir wrap is operative to cool said beverage contained in said beverage reservoir.

14. The method of Claim 1, further comprising a step of flowing said beverage through a cooling fluid bath said cooling fluid bath containing said cooling
30 fluid, wherein said step of flowing said beverage through said cooling fluid bath is operative to cool said beverage.

15. The method of Claim 1, wherein the flowing of said beverage and the flowing of said cooling fluid occur through pipes that are made of a first material comprising: steel, galvanized steel, stainless steel, cast iron, ductile iron, duriron, nickel alloys, cobalt alloys, titanium, carbon, brass, copper, aluminum, polyvinylchloride (PVC), polypropylene, polyvinyl chloride, polyethylene cross-linked (PEX), borosilicate glass, polytetrafluorethylene based compositions or combinations thereof.

16. The method of Claim 15, wherein at least a portion of said pipes are wrapped in a one or more layers of additional materials comprising: steel, galvanized steel, stainless steel, cast iron, ductile iron, duriron, nickel alloys, cobalt alloys, titanium, carbon, brass, copper, aluminum, polyvinylchloride (PVC), polypropylene, polyvinyl chloride, polyethylene cross-linked (PEX), borosilicate glass, or combinations thereof.

17. The method of Claim 15, wherein said pipes further comprise an antimicrobial material.

18. The method of Claim 1, wherein a controller is provided that controls said flowing of said cooling fluid such that said desired temperature may be selectively changed.

19. The method of Claim 17, wherein said controllers receive information from one or more sensors that measure one or more of a temperature of said beverage prior to being flowed through said primary heat exchanger, a temperature of said beverage after being flowed through said primary heat exchanger, a temperature of said beverage while being flowed through said primary heat exchanger, a temperature of said cooling fluid before being flowed through said primary heat exchanger, a temperature of said cooling fluid after flowed through said primary heat exchanger, a temperature of said cooling fluid while being flowed through said primary heat exchanger, a flow rate of the cooling fluid through the primary heat exchanger.

20. A system for delivering a beverage at a desired temperature, said system comprising a primary heat exchanger defining a first inlet fluidly connected to a first outlet and a second inlet fluidly connected to a second outlet, a beverage reservoir containing a beverage, a cooling fluid bath containing a cooling fluid, a refrigeration unit, and a dispensing unit, said primary heat exchanger being operative to receive said beverage via said first inlet and being further operative to receive a cooling fluid at a

- cooling temperature via said second inlet, said primary heat exchanger being further operative to allow for said cooling fluid to cool said beverage via said cooling fluid absorbing heat from said beverage, said dispensing unit being operative to receive said beverage and being further operative to deliver said beverage at said desired
- 5 temperature, said refrigeration unit being operative to supply a refrigerant to cool said cooling fluid to a chilling temperature operative to provide said cooling fluid at said cooling temperature prior to said cooling fluid being received from said second inlet of said primary heat exchanger.