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LIQUID LEVEL CONTROL OF EXPANSION VALVES IN CLIMATE CONTROL SYSTEMS

Abstract

An example method of controlling a component of a climate control system includes discharging a multiphase fluid from a condenser of the climate control system. In addition, the method includes flowing the multiphase fluid though a conduit that is downstream of the condenser, the multiphase fluid including a liquid portion and a gas portion and diverting a portion of the multiphase fluid out of the conduit and into a receptacle. Further, the method includes determining a parameter of the multiphase fluid in the receptacle, the parameter corresponding to a composition of the liquid portion and the gas portion of the multiphase fluid. Still further, the method includes controlling the component of the climate control system based at least in part on the parameter.

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Background/Summary

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] Not applicable.

BACKGROUND

[0002] A climate control system may circulate a refrigerant to condition (e.g., cool and/or heat) the air within a conditioned space. The conditioned space may be the interior of a home, office, retail center, manufacturing space, a storage container, etc.

[0003] At an industrial or commercial level, a climate control system may include a chiller which transfers heat between the conditioned space and the outer environment via the refrigerant circuit and one or more additional fluid circuits. For instance, a chiller may utilize a chilled water circuit to transfer heat between the refrigerant and the indoor space, and may utilize an additional fluid to transfer heat between the refrigerant and the outer environment. When the additional fluid circuit includes water (or an aqueous solution), the chiller may be referred to as a “water-cooled” chiller, and when the additional fluid circuit includes air, the chiller may be referred to as an “air-cooled” chiller.

BRIEF SUMMARY

[0004] Some embodiments disclosed herein are directed to a method of controlling a component of a climate control system. In some embodiments, the method includes discharging a multiphase fluid from a condenser of the climate control system and flowing the multiphase fluid though a conduit that is downstream of the condenser, the multiphase fluid including a liquid portion and a gas portion. In addition, the method includes diverting a portion of the multiphase fluid out of the conduit and into a receptacle. Further, the method includes determining a parameter of the multiphase fluid in the receptacle, the parameter corresponding to a composition of the liquid portion and the gas portion of the multiphase fluid. Still further, the method includes controlling the component of the climate control system based at least in part on the parameter.

[0005] Some embodiments disclosed herein are directed to a climate control system. In some embodiments, the climate control system includes a condenser that is configured to at least partially condense a refrigerant, an actuatable component that is configured to adjust a flow characteristic of the refrigerant, and a conduit in fluid communication with an outlet of the condenser and positioned upstream of the actuatable component such that the conduit is configured to channel the refrigerant discharged out of the condenser toward the actuatable component. In addition, the climate control system includes a receptacle in fluid communication with the conduit such that at least a portion of the refrigerant flowing through the conduit is diverted into the receptacle. Further, the climate control system includes a sensor configured to detect a parameter indicative of a liquid level of the refrigerant in the receptacle. Still further, the climate control system includes a controller communicatively coupled to the sensor and the actuatable component, wherein the controller is configured to actuate the actuatable component based at least in part on an output from the sensor.

[0006] Some embodiments disclosed herein are directed to a chiller for conditioning an indoor space. In some embodiments, the chiller includes an evaporator configured to at least partially vaporize a refrigerant, a compressor downstream of the evaporator that is configured to compress the refrigerant, and a condenser downstream of the compressor that configured to at least partially condense the refrigerant. In addition, the chiller includes an economizer in fluid communication between the condenser and the evaporator that is configured to divert gaseous refrigerant to the compressor in bypass of the evaporator, a conduit that connects the condenser to the economizer, and an expansion valve positioned along the conduit. Further, the chiller includes a stand tube in fluid communication with the conduit and positioned upstream of the expansion valve and a sensor configured to detect a parameter indicative of a refrigerant liquid level in the stand tube. Still

further, the chiller includes a controller communicatively coupled to the sensor and the expansion valve, wherein the controller and configured to adjust a position of the expansion valve based at least in part on an output from the sensor.
[0007] Embodiments described herein comprise a combination of features and characteristics intended to address various shortcomings associated with certain prior devices, systems, and methods. The foregoing has outlined rather broadly the features and technical characteristics of the disclosed embodiments in order that the detailed description that follows may be better understood. The various characteristics and features described above, as well as others, will be readily apparent to those having ordinary skill in the art upon reading the following detailed description, and by referring to the accompanying drawings. It should be appreciated that this disclosure may be readily utilized as a basis for modifying or designing other structures for carrying out the same purposes as the disclosed embodiments. It should also be realized that such equivalent constructions do not depart from the spirit and scope of the principles disclosed herein.

Description

BRIEF DESCRIPTION OF THE DRAWINGS
[0008] For a detailed description of various embodiments, reference will now be made to the accompanying drawings in which:
[0009] FIG. **1** is a schematic view of a climate control system including a receptacle for detecting a liquid height of refrigerant according to some embodiments disclosed herein;
[0010] FIG. **2** is an enlarged, schematic view of a portion of the climate control system of FIG. **1** according to some embodiments disclosed herein;
[0011] FIG. **3** is an enlarged cross-sectional view of a portion of a conduit and the receptacle of the climate control system of FIG. **1** according to some embodiments;
[0012] FIG. **4** is a block diagram of a method for controlling a component of a climate control system is shown according to some embodiments disclosed herein;
[0013] FIG. **5** is a schematic view of a climate control system including a receptacle for detecting a liquid height of refrigerant according to some embodiments disclosed herein;
[0014] FIG. **6** is a schematic view of a climate control system including a receptacle for detecting a liquid height of refrigerant according to some embodiments disclosed herein; and
[0015] FIG. **7** is an enlarged, schematic view of a portion of the climate control system of FIG. **1** according to some embodiments disclosed herein.
DETAILED DESCRIPTION
[0016] A climate control system, such as a chiller, may utilize a refrigerant circuit to transfer heat between an outer environment and a conditioned space. Efficient operation of the refrigerant circuit in a chiller (or other climate control system) may include achieving and maintaining a fluid balance of refrigerant throughout the refrigerant circuit. Otherwise, some components may be flooded with excess refrigerant while others may be starved of refrigerant, which may ultimately lead to operational inefficiencies and potential increased risk of components wear or failure.
[0017] Thus, one or more actuatable components (e.g., valves) may be positioned along the refrigerant circuit to control the flow of refrigerant during operations. However, control of these actuatable components may be difficult for some climate control systems. For instance, in some cases, an expansion valve in a refrigerant circuit may be controlled based on an amount of liquid refrigerant located in the condenser. However, measurement of a liquid level inside the condenser may require additional refrigerant volume in the refrigerant circuit which is costly-especially for larger capacity chillers. Thus, one may wish to control a valve using a similar liquid volume or level measurement in the piping or conduit of the refrigerant circuit; however, the volatile, two-phase nature of the refrigerant within these conduits may make an accurate measurement or

detection of the liquid level extremely difficult or even impossible during operations.
[0018] Accordingly, embodiments disclosed herein include systems and methods for detecting an effective level or amount of liquid refrigerant in a conduit of a climate control system for use in controlling an actuatable component (e.g., an expansion valve). For instance, the systems may include a receptacle that is separate from and in fluid communication with the main conduit of the refrigerant circuit. During operations, the receptacle may temporarily hold a volume of the refrigerant flowing along the main conduit so that an accurate determination or measurement of the liquid level therein may be made. The liquid level (or value indicative thereof) may then be used to control the actuatable component to ensure sufficient flow of refrigerant throughout the circuit. Accordingly, through use of the embodiments disclosed herein, an actuatable component of a climate control system (e.g., such as a chiller) may be accurately controlled so as to ensure a balance of refrigerant in the refrigerant circuit and thereby efficient operation of climate control system during operations.
[0019] Referring now to FIG. **1**, a climate control system **10** according to some embodiments disclosed herein is shown. As shown in FIG. **1**, the climate control system **10** comprises a chiller unit that is configured to cool or heat a conditioned space (e.g., such as the interior of an office building, retail store, convention center, an industrial process, etc.). Thus, the climate control system **10** may be referred to herein as a "chiller unit."
[0020] Generally speaking, the chiller unit **10** includes a refrigerant circuit **20** that is configured to circulate a refrigerant to exchange heat between the conditioned space and an ambient environment (e.g., such as the outdoor environment that surrounds the conditioned space), so as to cool or heat the conditioned space. The refrigerant may include a condenser **22** and an evaporator **24**. The condenser **22** and evaporator **24** are both heat exchangers (e.g., shell and tube heat exchangers, plate heat exchangers, fin-tube heat exchangers, etc.) that are configured to transfer heat between the refrigerant circulating within the refrigerant circuit **20** and one or more other fluids or environments. Specifically, the condenser **22** is configured to exchange heat between the refrigerant and a working fluid **44** of an ambient heat exchange assembly **40**, and the evaporator **24** is configured to exchange heat between the refrigerant and a working fluid **54** of a conditioned space heat exchange assembly **50**.
[0021] In some embodiments, the working fluid **54** of the conditioned space heat exchange assembly **50** may comprise water (or a suitable aqueous mixture). The working fluid **54** may circulate between the evaporator **24** of the refrigerant circuit **20** and the conditioned space heat exchange assembly **50** to exchange heat between the refrigerant and the conditioned space during operations. In some embodiments, the conditioned space heat exchange assembly **50** may comprise one or more heat exchangers (e.g., air handler units) that are configured to exchange heat between the working fluid **54** and the conditioned space. In some embodiments, the working fluid **54** may comprise a fluid other than water, such as, for instance air (e.g., air that is directly provided to the conditioned space).
[0022] The working fluid **44** of the ambient heat exchange assembly **40** may comprise water or any other suitable aqueous mixture such as previously described above for the working fluid **54**. Alternatively, the working fluid **44** may comprise air. When the working fluid **44** is water, the chiller unit **10** may be referred to as a "water-cooled" chiller unit, and when the working fluid is air, the chiller unit **10** may be referred to as an "air-cooled" chiller unit. Regardless, the working fluid **44** may circulate between the condenser **22** of the refrigerant circuit **20** and the ambient heat exchange assembly **40** to exchange heat between the refrigerant and the ambient environment. In some embodiments, the ambient heat exchange assembly **40** comprises one or more heat exchangers (e.g., water cooling towers, radiators, fin-fan coolers, etc.) that are configured to transfer heat between the ambient environment and the working fluid **44**. In some embodiments, such as in the case of air-cooled chiller units, the ambient heat exchange assembly **40** may be integrated and combined with the condenser **22** so that heat is directly exchanged between the

refrigerant and an airflow that is sourced from and provided back to the ambient environment.

[0023] In addition to the condenser **22** and the evaporator **24**, the refrigerant circuit **20** may include a compressor **26**, an economizer **28**, and a plurality of actuatable expansion valves **30**, **32**. The compressor **26** may be in fluid communication between the evaporator **24** and condenser **22** (specifically, downstream of the evaporator **24** and upstream of the condenser **22**) so that during operations, the compressor **26** may receive a flow of refrigerant from the evaporator **24** and may discharge a compressed refrigerant to the condenser **22** during operations.

[0024] Likewise, the economizer **28** may also be in fluid communication between the condenser and evaporator, opposite the compressor **26**. Specifically, the economizer **28** may be downstream of the condenser **22** and generally upstream of the evaporator **24**. During operations, the condenser **22** may discharge refrigerant to the economizer **28**, and the economizer **28** may in turn discharge refrigerant to the evaporator **24**.

[0025] The expansion valves **30**, **32** may comprise actuatable components of the refrigerant circuit **20** that may be used to control one or more flow parameters of the refrigerant circulating through the refrigerant circuit **20** during operations. For instance, the expansion valves **30**, **32** may be opened or closed to affect one or more of a pressure, temperature, or flow rate of the refrigerant along one or more points or portions of the refrigerant circuit **20**. Specifically, the expansion valves **30**, **32** include a first expansion valve **30** that is positioned along a first conduit **60** connecting an outlet **22***a* of the condenser **22** to the economizer **28**, and a second expansion valve **32** that is positioned along a second conduit **62** connecting the economizer **28** to the evaporator **24**. The expansion valves **30**, **32** may be actuated-such as electrically actuated, pneumatically actuated, hydraulically actuated, etc. so as to allow for active control of the refrigerant flow through the conduits **60**, **62** and throughout the refrigerant circuit **20** during operations. In some embodiments, one or more of the expansion valves **30**, **32** may be replaced with a static flow expansion device, such as an orifice plate or other suitable component.

[0026] During operations, the refrigeration circuit **20** may be operated to circulate the refrigerant as shown in FIG. **1** to transfer heat from the conditioned space (e.g., via the conditioned space heat exchange assembly **50**) to the ambient environment (e.g., via the ambient heat exchange assembly **40**). Specifically, the refrigerant (which may be in a vapor or semi-vapor state) may be compressed by the compressor **26** and delivered to the condenser **22**. Within the condenser **22**, heat is transferred from the refrigerant to the working fluid **44**, which cools the refrigerant and at least partially condenses the refrigerant to a liquid. Heat is then transferred from the heated working fluid **44** to the ambient environment via the ambient heat exchange assembly **42** of the ambient heat exchange assembly **40** as previously described.

[0027] The at least partially condensed refrigerant is then expelled from the condenser **22** and flowed to the economizer **28** via the first expansion valve **30**. The first expansion valve **30** may be actuated so as to controllably expand the refrigerant within the conduit **60**. This expansion may cause the refrigerant to at least partially vaporize to form a plurality of gas bubbles **34**. Without being limited to this or any other theory, remaining heat carried in the refrigerant downstream of the condenser **22** may be concentrated (at least partially) in the plurality of gas bubbles **34**, so that a temperature of the liquid component of the refrigerant, downstream of the first expansion valve **30** may be reduced.

[0028] The at least partially expanded refrigerant may then be flowed into the economizer **28** via the conduit **60**, downstream of the first expansion valve **30**. The economizer **28** may function as a vapor-liquid separator that allows the gas bubbles **34** in the refrigerant to separate from the liquid remainder. The separated gas bubbles **34** may flow back to the compressor **26** via a gas vent line **64**, so that the separated, vaporized refrigerant may be re-compressed and further cooled via the condenser **22** as previously described. Accordingly, the vaporized refrigerant exiting the economizer **28** may bypass the evaporator **24** and flow back to the compressor **26** directly via the gas vent line **64**. As a result, rerouting the separated vapor portion of the refrigerant to the compressor **26** and condenser **22** may allow this additional heat to be transferred (or at least partially transferred) to the ambient environment via the ambient heat exchange assembly **40** and working fluid **44** as previously described, which may improve the efficiency of the refrigerant circuit **20** overall.

[0029] Liquid (or substantially liquid) refrigerant may then flow out of the economizer **28** to the second expansion valve **32** via the second conduit **62**. The second expansion valve **32** may again expand the refrigerant so as to partially vaporize and cool the refrigerant. The expanded and cooled refrigerant is then flowed to the evaporator **24**. Within the evaporator **24**, heat is transferred from the working fluid **54** to the refrigerant, which continues to boil (or vaporize) the refrigerant. The cooled working fluid **54** is then used to cool the conditioned space via the conditioned space heat exchange assembly **52** of the conditioned space heat exchange assembly **50** as previously described. The vaporized (or substantially vaporized) refrigerant may then be returned to the compressor **26** to restart the process described above.

[0030] Referring still to FIG. **1**, during operation with the chiller unit **10**, the expansion valves **30**, **32** may be actuated not only to controllably expand and vaporize the refrigerant to support and facilitate the transfer of heat within the condenser **22** and evaporator **24**, but also to control the distribution of refrigerant through the refrigerant circuit **20**. Specifically, the first expansion valve **30** may be actuated (e.g., closed, opened, or partially opened) to adjust a flow rate of refrigerant out of the condenser **22** and ultimately into the evaporator **24**. An improper positioning of the first expansion valve **30** (relative to a flow rate of refrigerant through the compressor **26**) may cause a fluid imbalance in the refrigerant circuit **20** which thereby causes either excessive vapor refrigerant flow past the expansion valve **30** or inadequate liquid refrigerant supply to the evaporator **24**. Both of these outcomes ultimately result an increased load on the compressor **26** and reduced operating efficiency for the climate control system **10**).

[0031] The climate control system **10** may be configured to operate at full capacity while maintaining a suitable fluid balance through the refrigerant circuit **20**. However, changing conditions, such as changing temperature in the ambient environment, may lead to or cause a change in the operating speed of the compressor **26**, which may in turn alter the flow rate of refrigerant flowing into the condenser **22**.

[0032] Thus, the expansion valve **30** may be controlled to maintain a desired or target flow rate of refrigerant therethrough to help ensure substantial balance of refrigerant flow throughout the refrigerant circuit **20**. Specifically, the expansion valve **30** may be controlled to match a flow rate of refrigerant out of the condenser **22** to a discharge flow rate from the compressor **26** to substantially equalize flow across the condenser **22** and refrigerant circuit **20** more broadly. Alternatively, the expansion valve **30** may be controlled (e.g., closed, opened, or partially opened) based on a liquid level of the refrigerant inside of the condenser **22**. However, maintaining a consistent and measurable liquid level of refrigerant inside of the condenser **22** may require additional cooling capacity in the condenser **22** (e.g., via a sub cooler or other suitable device or system) and larger charge of refrigerant-both of which would increase the cost and complexity of the chiller unit **10**. As a result, an alternative strategy is to avoid collecting substantial liquid refrigerant in the condenser **22** and to instead measure or detect a liquid level of refrigerant in the first conduit **60**, upstream of the first expansion valve **30**. However, the flow of refrigerant emitted from the condenser **22** into the first conduit **60** is two-phase and is highly turbulent and dynamic. As a result, useful and accurate direct measurement of a liquid level in the conduit **60**, upstream of the first expansion valve **30** is difficult.

[0033] Accordingly, the chiller unit **10** includes a separate receptacle **100** that is in fluid communication with the conduit **60** and that receives and temporarily holds a volume of refrigerant flowing through the conduit **60** during operations. As will be described in more detail below, the receptacle **100** may temporarily hold a volume of liquid refrigerant therein under less dynamic conditions than are present in the conduit **60** so that a sensor **102** coupled to the receptacle **100** may be used to measure or detect the liquid level (or one or more values or parameters indicative thereof) within the receptacle **100** during operations. The liquid level within the receptacle **100** may be utilized as a representative substitute for the liquid level in the conduit **60**, which may then be used (at least partially) to control an opening position of the expansion valve **30** for providing a fluid balance within the refrigerant circuit **20**.

[0034] A controller **80** may be communicatively coupled (via any suitable wired and/or wireless connection) to the sensor **102** and the expansion valve **30** (or a motor, driver, or individual controller thereof). The controller **80** may be configured to receive the output from the sensor **102** and the actuate the expansion valve **30** to a desired position based at least partially on the sensor output to achieve or maintain a desired liquid level upstream of the valve **30** (and therefore a refrigerant fluid balance throughout the refrigerant circuit **20**).

[0035] The controller **80** may be (or may be incorporated within) a main or master controller for the chiller unit **10**, or the controller **80** may be a standalone controller **80** for controlling the opening position of the first expansion valve **30**. Regardless, the controller **80** may be described and referred to herein as being a part of the chiller unit **10**.

[0036] The controller **80** may comprise one or more computing devices, such as a computer, tablet, smartphone, server, circuit board, or other computing device(s) or system(s). Thus, controller **80** may include a processor **82** and a memory **84**.

[0037] The processor **82** may include any suitable processing device or a collection of processing devices. In some embodiments, the processor **82** may include a microcontroller, central processing unit (CPU), graphics processing unit (GPU), timing controller (TCON), scaler unit, or some combination thereof. During operations, the processor **82** executes machine-readable instructions (such as machine-readable instructions **86**) stored on memory **84**, thereby causing the processor **82** to perform some or all of the actions attributed herein to the controller **80**. In general, processor **82** fetches, decodes, and executes instructions (e.g., machine-readable instructions **86**). In addition, processor **82** may also perform other actions, such as, making determinations, detecting conditions or values, etc., and communicating signals. If processor **82** assists another component in performing a function, then processor **82** may be said to cause the component to perform the function.

[0038] The memory **84** may be any suitable device or collection of devices for storing digital information including data and machine-readable instructions (such as machine-readable instructions **86**). For instance, the memory **84** may include volatile storage (such as random-access memory (RAM)), non-volatile storage (e.g., flash storage, read-only memory (ROM), etc.), or combinations of both volatile and non-volatile storage. Data read or written by the processor **82** when executing machine-readable instructions **86** can also be stored on memory **84**. Memory **84** may include “non-transitory machine-readable medium,” where the term “non-transitory” does not include or encompass transitory propagating signals.

[0039] The processor **82** may include one processing device or a plurality of processing devices that are distributed within (or communicatively coupled to) controller **80** or more broadly within chiller unit **10**. Likewise, the memory **84** may include one memory device or a plurality of memory devices that are distributed within (or communicatively coupled to) controller **80** or more broadly within chiller unit **10**. Thus, the controller **80** may comprise a plurality of individual “controllers” distributed throughout the chiller unit **10**.

[0040] Referring now to FIG. **2**, a portion of the chiller unit **10** is shown, so as to better illustrate the first conduit **60**, receptacle **100**, and function thereof according to some embodiments. The conduit **60** (or at least the portion of the conduit **60** extending from the condenser to the expansion valve **30**) may include a first portion **66** that is connected to the condenser **22** and a second portion **68** that is connected to the expansion valve **30**. The first portion **66** may be oriented substantially vertically (or generally along the direction of gravity), and the second portion **68** may be oriented substantially horizontally or laterally (or generally perpendicular to the direction of gravity). An elbow (e.g., a 90° elbow) **67** connects the first portion **66** to the second portion **68** so as to transition the flow of refrigerant from a substantially vertical direction (within the first portion **66**) to a substantially horizontal direction (within the second portion **68**).

[0041] The receptacle **100** may comprise a stand tube that is connected to and in fluid communication with the first portion **66** of the conduit **60** (thus, the receptacle **100** may be referred to herein as "stand tube **100**"). The stand tube **100** may be oriented substantially parallel with the first portion **66** of the conduit **60** so that the stand tube **100** may, itself also be oriented substantially vertically. The stand tube **100** may include a pair of ports **104**, **106** that are spaced from one another, with a first port **104** of the pair of ports **104**, **106** being positioned vertically higher than a second port **106** of the pair of ports **104**, **106**. The ports **104**, **106** may be in fluid communication with the conduit **60** via corresponding flow tubes or pipes **108**. During operations, the refrigerant flowing within the conduit **60** may generally flow into and out of the stand tube **100** via the ports **104**, **106** and pipes **108**. Generally speaking, the condensed and condensing refrigerant may coalesce into a liquid as it flows toward the expansion valve **30**. As a result, primarily liquid refrigerant may flow into the stand tube **100** via the vertically lower, second port **106** to establish a liquid level or height **110** within the stand tube **100** that is generally related or correlated to the liquid height in the conduit **60** itself. The refrigerant may then flow back into the first portion **66** of conduit **60** via the first port **104**.

[0042] The sensor **102** may be configured to measure or detect the liquid height **110** or a value or parameter indicative of the liquid height **110** during operations. For example, the sensor **102** may comprise a float sensor, an optical sensor (or sensor array), energy wave (e.g., ultrasonic) sensor, etc. that is configured to directly detect or measure a liquid height **110** (or liquid-vapor interface) in the stand tube **100** during operations. In some embodiments, the sensor **102** may comprise a capacitance sensor that includes a probe inserted within the stand tube **100** to contact the liquid refrigerant contained therein. As the liquid height **110** rises or falls within the stand tube **100**, the contact surface area between the liquid refrigerant and the probe changes, which in turn changes an electrical capacitance of the probe during operations. The output signal may include a capacitance reading of the probe which then may be converted (e.g., by the controller **80**) into the liquid height **110** value.

[0043] Alternatively, in some embodiments, the sensor **102** may be configured to measure or detect other parameters that may correspond or be related to the liquid height **110** in the stand tube **100**. For instance, the sensor **102** may be configured to measure a mass of the refrigerant within the stand tube **100**. In some specific examples, the sensor **102** may comprise or include a load sensor that is configured to measure a mass of the stand tube **100** and refrigerant contained therein, and the controller **80** may calculate a liquid volume and thereby a liquid height **110** within the stand tube **100** based at least partially on the measured mass (and the known densities of the liquid and vapor portions the two-phase refrigerant flow).

[0044] In some embodiments, additional valve (not shown) may be utilized to quickly isolate the refrigerant contained in the stand tube **100**. Thereafter, the refrigerant trapped within the stand tube **100** may be drained to or through a separate measurement device (e.g., flow meter) that is configured to measure a liquid flow rate out of the stand tube **100**. The measured flow rate (e.g., mass flow rate) may then be used (e.g., by the controller **80**) to determine the liquid volume (and therefore liquid height **110**) that was previously captured within the stand tube **100**.

[0045] Regardless of the method or technique utilized to measure the liquid height **110** (or indicative value/parameter), the controller **80** may actuate the expansion valve **30** to a position that is configured to adjust or maintain the liquid height **110** at a desired level for efficient operation of the refrigerant circuit **20** (FIG. **1**). For instance, the liquid height **110** may be controlled to a target value by the controller **80** so that if the liquid height **110** rises sufficiently above the target liquid height **110** (e.g., to an increased liquid height **110***a* shown in FIG. **2**), the controller **80** may, in response, actuate the expansion valve **30** to open (or increase a flow rate therethrough) and thereby

reduce the liquid height **110** back to the target value. If, on the other hand, the liquid height **110** decreases sufficiently below the target liquid height **110** (e.g., to a decreased liquid height **110***b* shown in FIG. **2**), the controller **80** may, in response, actuate the expansion valve **30** to close (or reduce a flow rate therethrough) and thereby increase the liquid height **110** back to the target value.
[0046] The controller **80** may utilize any suitable control mechanism, algorithm, or technique for maintaining the target liquid level **110** in the stand tube **100**. For instance, in some embodiments, the controller **80** may utilize a PID (proportional, integrating, and derivative) feedback control loop that is configured to reduce an error between the measured/detected liquid height **110** and the target value to zero (or a suitable range about zero). However, other control schemes are contemplated.
[0047] Referring again to FIG. **1**, in some embodiments, the controller **80** may also adjust a position of the second expansion valve **32** based at least in part on the liquid height **110** in the stand tube **100**. For instance, the controller **80** may adjust a position of the second expansion valve **32** as a function of the position of the first expansion valve **30**, which (as previously described) may be a function of the liquid height **110** in stand tube **100**. In some embodiments, the controller **80** may determine a mass flow rate of refrigerant through the first expansion valve **30** based on an adjusted positioned thereof, and then may adjust the position of the second expansion valve **32** so as to ensure a sufficient or desired mass flow rate of refrigerant into the evaporator **24** based at least in part on the mass flow rate determined based on the position of the first expansion valve **30**.
[0048] Referring now to FIG. **3**, an enlarged cross-sectional view of the first portion **66** of conduit **60** and the stand tube **100** is shown according to some embodiments. The stand tube **100** may (according to some embodiments) comprise a cylindrical body **120** having a central or longitudinal axis **125** (or more simply "axis **125**"), a first or upper end **120***a*, and a second or lower end **120***b* spaced from the upper end **120***a* along the axis **125**.
[0049] As previously described, the stand tube **100** may be generally oriented parallel to the first portion **66** of the conduit **60**. Specifically, as shown in FIG. **3**, the axis **125** of the body **120** may be generally parallel to a central axis **65** of the conduit **60** within the first portion **66**. As a result, the axis **125** of the body **120** may be oriented substantially vertically (or substantially along the direction of gravity). In addition, as is also previously described, the first port **104** may be positioned vertically higher than the second port **106**. As a result, the first port **104** may be more proximate the upper end **120***a* than the lower end **120***b*, and the second port **106** may be more proximate the lower end **120***b* than the upper end **120***a*. Thus, the first port **104**, and second port **106** may be axially spaced from one another along the axis **125**.
[0050] The body **120** defines a generally cylindrically shaped chamber **122** therein. The chamber **122** may include a length L.sub.122 that extends axially along the axis **125** and a diameter D.sub.122 that extends radially (relative to axis **125**) between the inner walls within body **120** defining chamber **122**. Thus, the diameter D.sub.122 may be an inner diameter of the cylindrical body **120**. The length L.sub.122 and diameter D.sub.122 may define a volume within the chamber **122** that may receive refrigerant during operations. The volume and/or one or both of the length L.sub.122 and diameter D.sub.122 may be selected to allow the liquid height **110** in the stand tube **100** to remain sufficiently stable in order to allow for the measurement thereof, while preventing the liquid level **110** in stand tube **100** from lagging too far behind actual conditions in the conduit **60**.
[0051] In some embodiments, the diameter D.sub.122 of the chamber **122** in stand tube **100** may range from about 0.25 to about 2.5 times the inner diameter of the first portion **66** of the conduit **60**.
[0052] The first port **104** and the second port **106** may be axially spaced from one another relative to the axis **125** by a distance L.sub.104-106. In some embodiments, the length L.sub.104-106 may range from about one (1) to about four (4) times an inner diameter of the first portion **66** of the conduit **60**. In some specific embodiments, the distance L.sub.104-106 may be at least 15 or at least about 20 inches in some embodiments in order to allow a measurable liquid level **110** to form in the

chamber **122** during operations.

[0053] The first port **104** and the second port **106** may be in fluid communication with the first portion **66** of conduit **60** via pipes **108** as previously described. Each of the pipes **108** may have a diameter D.sub.108 (e.g., an inner diameter) and a length L.sub.108 that generally extends perpendicularly to the axis **125** (and also the axis **65** within the first portion **66** of conduit **60**). In some embodiments, the length L.sub.108 and diameter D.sub.108 may be selected so as to reduce a pressure drop in the refrigerant as it flows along the conduit **60** and/or through the pipes **108** during operations. In some embodiments, the diameter D.sub.108 may range from about 0.025 to about 0.25 times the inner diameter of the first portion **66** of the conduit **60**. In some embodiments, the diameter may range from about 0.5 inches to about 0.75 inches, and the length L.sub.108 may be about 20 inches or less; however, other values are contemplated.

[0054] In addition, the pipes **108** may remain open so as to maintain fluid communication between the first portion **66** of conduit **60** and chamber **122** of stand tube **100**. As a result, the pipes **108** may be substantially free of flow restrictions or obstructions in some embodiments. For instance, pipes **108** may be free from valves or other flow control devices in some embodiments.

[0055] In some embodiments, the sensor **102** may include a probe **103** that extends through the upper end **120***a* and into the chamber **122**. The probe **103** may be a component of the sensor **102** that directly interacts or engages with the refrigerant in stand tube **100**. For instance, the probe **103** may comprise the probe of a capacitance sensor for measuring the liquid height **110** in the stand tube **100** as previously described. In some embodiments, sensor **102** may not include a probe **103** or the probe **103** may be differently shaped, arranged, positioned, sized, etc. Regardless of the size or type of sensor **102** (and/or probe **103**), the sensor **102** may be configured such that the detection/measurement range covers the range of expected liquid heights **110** within the stand tube **100** during operations.

[0056] Referring now to FIG. **4**, a method **200** for controlling a component of a climate control system is shown according to some embodiments. In some embodiments, the method **200** may be performed to control an actuatable component, such as one or more of the expansion valves **30**, **32** previously described for climate control system **10** (FIG. **1**). In addition, in some embodiments, at least some steps of method **200** may be performed (at least partially) by a controller (e.g., controller **80**) or other computing device. Thus, in describing the features of method **200**, continuing reference is made to the climate control system **10** (and components thereof) shown in FIGS. **1-3** and described herein; however, such continuing reference should not be interpreted as limiting all potential embodiments of method **200**.

[0057] Initially, method **200** includes discharging a multiphase fluid from a condenser of a climate control system into a conduit at block **202**. The multiple fluid includes a liquid portion and a gas portion, and may comprise a refrigerant (e.g., one or more chlorofluorocarbons, hydrochlorofluorocarbons, hydrocarbons, ammonia, etc.). For instance, as shown in FIGS. **1** and **2** and described herein, refrigerant may be at least partially condensed in the condenser **22** and flowed out of the condenser **22** into a conduit **60**. The refrigerant flow in the conduit **60** may be two-phase (including both liquid and gas refrigerant therein), and may be highly turbulent and dynamic in nature. As previously described, in some embodiments, the conduit that receives the two-phase fluid may be downstream of the condenser and other components of the climate control system. For instance, in some embodiments, the conduit may extend downstream of an economizer of the climate control system.

[0058] In addition, method **200** includes diverting a portion of the multiphase fluid out of the conduit and into a receptacle at block **204**. For instance, as described herein for the climate control system **10** (FIG. **1**), a portion of the two-phase fluid exiting the condenser **22** into the conduit **60** is diverted into the stand tube **100** via one or both of the port **104**, **106** so that liquid refrigerant may collect therein.

[0059] Further, method **200** includes determining a parameter of the multiphase fluid in the receptacle at block **206**. The parameter may be indicative of a composition of the liquid portion and the gas portion of the multiphase fluid in the conduit. For instance, the parameter may comprise a liquid level, height, depth, etc. of the refrigerant in the receptacle. As previously described, the liquid level in the receptacle may correspond or relate to an effective liquid level of the refrigerant in the conduit **60** and a relative composition of the liquid portion and gas portion of refrigerant in the conduit **60**. For instance, the liquid level in the stand tube **100** may correspond to a general relative composition of the liquid and gas portions of the refrigerant in the conduit **60** and may be representative or at least corresponds to an effective liquid level of refrigerant in the conduit **60** during operations. The liquid level may be measured or determined in any suitable manner at block **206**. For instance, the liquid level or height may be measured directly via a suitable sensor or sensors (e.g., capacitance sensors, float sensors, level height sensor array, etc.). In addition, the liquid level or height may be measured indirectly via a suitable sensor or sensors (e.g., mass sensor, liquid flow rate sensor, etc.).

[0060] Still further, method **200** includes controlling a component of the climate control system based at least in part on the parameter in block **208**. For instance, the component may comprise an expansion valve of the climate control system, and controlling the expansion valve may comprise adjusting a position (e.g., opening or closing) the expansion valve to adjust a flow rate of refrigerant therethrough. In addition, as previously described, the parameter may comprise a liquid height of the refrigerant in the receptacle (e.g., stand tube **100**). Thus, block **208** may generally include opening or closing an expansion valve based at least in part on a liquid level or height in the receptacle. For instance, in some embodiments, if a liquid height increases (e.g., increases above a target value or range), then block **208** may comprise opening (or increasing an opening amount or percentage) of the expansion valve to increase a flow rate of refrigerant therethrough and thereby reduce the liquid level or height back toward to the target value or range. Conversely, in some embodiments, if a liquid height decreases (e.g., decreases below a target value or range), then block **208** may comprise closing (or decreasing an opening amount or percentage) of the expansion valve to decrease a flow rate of refrigerant therethrough and thereby increase the liquid level or height back toward to the target value or range.

[0061] While the climate control system **10** shown in FIG. **1** illustrates the stand tube **100** connected to the conduit **60** extending between the condenser **22** and the first expansion valve **30**, it should be appreciated that the stand tube **100** may be positioned in other positions of the climate control system **10** according to other embodiments. For instance, referring now to FIG. **5**, in some embodiments, the stand tube **100** may be connected to the second conduit **62** downstream of the economizer **28** and upstream of the evaporator **24**.

[0062] Specifically, the stand tube **100** may be connected and oriented parallel to a vertical portion of the second conduit **62** that extends downward between the economizer and second expansion valve **32**. During operations, the liquid level in the stand tube **100** shown in FIG. **5**, may be used to control a position of the first valve **30** and/or the second valve **32** so as to help achieve a substantial balance of refrigerant throughout the refrigerant circuit **20**. For instance, in some embodiments, the controller **80** may actuate the first expansion valve **30** to close and/or actuate the second expansion valve **32** to open when a liquid level in the stand tube **100** shown in FIG. **5** (connected to the second conduit **62**) is above a target value. Conversely, in some embodiments, the controller **80** may actuate the first expansion valve **30** to open and/or actuate the second expansion valve to close when a liquid level in the stand tube **100** shown in FIG. **5** (connected to the second conduit **62**) is below a target value.

[0063] Referring now to FIG. **6**, in some embodiments, the economizer **28** and first expansion valve **30** may be omitted from the refrigerant circuit **20** so that the first conduit **60** may extend from the condenser **22** to the second expansion valve **32**. The controller **80** may adjust a position of the second expansion valve **32** based at least in part on the liquid level **110** in the stand tube **100** as previously described for the first expansion valve **30**, and thereby help ensure a mass balance of refrigerant throughout the refrigerant circuit **20** during operations. For instance, the controller **80** may actuate the second expansion valve **32** to open when a liquid level in the stand tube **100** increases above a target value, and may actuate the second expansion valve **32** to close when a liquid level in the stand tube **100** decreases below a target value.

[0064] Referring now to FIG. **7**, in some embodiments, the vertical height of the first portion **66** of the first conduit **60** may be insufficient to allow for the desired vertical separation (e.g., length L.sub.104-106 shown in FIG. **3**) between the ports **104**, **106** in the stand tube **100**. As a result, the first port **104** may be connected directly to the condenser **22** so as to provide a sufficient separation of the ports **104**, **106** (e.g., length L.sub.104-106). The second port **106** may still be connected to the first portion **66** of the conduit **60**. As a result, control operations for the first expansion valve **30** via the controller **80** may be substantially the same as previously described for the embodiment of stand tube **100** shown in FIG. **7**. In addition, it should be appreciated that a similar arrangement may be employed for an embodiment of the stand tube **100** that is connected to the second conduit **62** between the economizer **28** and second expansion valve **32** (e.g., such as shown in FIG. **5**), when a vertical height of a vertical portion of the second conduit **62** is insufficient for a desired separation of the ports **104**, **106** of stand tube **100**. Specifically, the first port **104** of the stand tube **100** may be connected directly to the economizer **28** while the second port **106** may be connected to a vertical portion of the second conduit **66** in at least some of these embodiments.

[0065] The embodiments disclosed herein include systems and methods for detecting an effective level or amount of liquid refrigerant in a conduit of a climate control system for use in controlling an actuatable component (e.g., an expansion valve). The liquid level (or value indicative thereof) may then be used to control the actuatable component to ensure sufficient flow of refrigerant throughout the circuit. Accordingly, through use of the embodiments disclosed herein, an actuatable component of a climate control system (e.g., such as a chiller) may be accurately controlled so as to ensure a balance of refrigerant in the refrigerant circuit and thereby efficient operation of climate control system during operations.

[0066] As explained above and reiterated below, the present disclosure includes, without limitation, the following example implementations.

[0067] Clause 1: A method of controlling a component of a climate control system, the method comprising: discharging a multiphase fluid from a condenser of the climate control system; flowing the multiphase fluid though a conduit that is downstream of the condenser, the multiphase fluid including a liquid portion and a gas portion; diverting a portion of the multiphase fluid out of the conduit and into a receptacle; determining a parameter of the multiphase fluid in the receptacle, the parameter corresponding to a composition of the liquid portion and the gas portion of the multiphase fluid; and controlling the component of the climate control system based at least in part on the parameter.

[0068] Clause 2: The method of any of the Clauses, wherein the receptacle is a stand tube coupled to the conduit, and wherein the parameter is a liquid level of the multiphase fluid in the stand tube.

[0069] Clause 3: The method of any of the Clauses, wherein the receptacle includes a capacitance sensor that is configured to measure the liquid level in the stand tube.

[0070] Clause 4: The method of any of the clauses, wherein the multiphase fluid includes a refrigerant, wherein the component comprises an expansion valve that is in fluid communication with the conduit, and wherein controlling the component comprises controlling a position of the expansion valve based at least in part on the liquid level.

[0071] Clause 5: The method of any of the Clauses, wherein the conduit includes at least a first portion connected to the condenser and a second portion connected to the expansion valve, wherein the first portion is oriented substantially vertically; and wherein diverting the portion of the multiphase fluid includes diverting the portion from the first portion of the conduit.

[0072] Clause 6: The method of any of the Clauses, wherein the stand tube extends substantially parallel to the first portion of the conduit.

[0073] Clause 7: The method of any of the Clauses, wherein stand tube includes a first port and a second port that are spaced from one another such that the first port is vertically lower than the second port; wherein diverting the portion of the multiphase fluid comprises diverting the portion into the first port; and wherein the method further comprises routing the portion of the multiphase fluid from the stand tube to the first portion of the conduit via the second port.
[0074] Clause 8: The method of any of the Clauses, wherein the first port and the second port are spaced from one another by a vertical distance that is in a range of about one to about four times an inner diameter of the first portion of the conduit.
[0075] Clause 9: The method of any of the clauses, wherein the stand tube has an inner diameter that is in a range of about 0.25 to about 2.5 times the inner diameter of the first portion of the conduit.
[0076] Clause 10: The method of any of the Clauses, wherein the component is an electronic expansion valve; and wherein controlling the component includes controlling an opening position of the electronic expansion valve to thereby control a flow of the multiphase fluid discharged from the condenser.
[0077] Clause 11: A climate control system comprising: a condenser that is configured to at least partially condense a refrigerant; an actuatable component that is configured to adjust a flow characteristic of the refrigerant; a conduit in fluid communication with an outlet of the condenser and positioned upstream of the actuatable component such that the conduit is configured to channel the refrigerant discharged out of the condenser toward the actuatable component; a receptacle in fluid communication with the conduit such that at least a portion of the refrigerant flowing through the conduit is diverted into the receptacle; a sensor configured to detect a parameter indicative of a liquid level of the refrigerant in the receptacle; and a controller communicatively coupled to the sensor and the actuatable component, wherein the controller is configured to actuate the actuatable component based at least in part on an output from the sensor.
[0078] Clause 12: The climate control system of any of the Clauses, wherein the actuatable component comprises an expansion valve, and wherein the controller is configured to open or close the expansion valve based at least in part on the output from the sensor.
[0079] Clause 13: The climate control system of any of the Clauses, wherein the receptacle comprises a substantially vertical stand tube that extends substantially parallel with at least a portion of the conduit.
[0080] Clause 14: The climate control system of any of the Clauses, wherein the sensor is configured to measure a mass of the refrigerant in the stand tube, and the controller is configured to convert the mass to the liquid level.
[0081] Clause 15: The climate control system of any of the Clauses, further comprising: a compressor that is configured to compress the refrigerant upstream of the condenser; an evaporator that is configured to at least partially vaporize the refrigerant upstream of the compressor; an economizer that is in fluid communication between the expansion valve and the evaporator, wherein the economizer is configured to divert at least some gaseous refrigerant to the compressor in bypass of the evaporator; and an expansion device in fluid communication between the economizer and the evaporator.
[0082] Clause 16: The climate control system of any of the Clauses, wherein the expansion device comprises a second actuatable expansion valve.
[0083] Clause 17: A chiller for conditioning an indoor space, the chiller comprising: an evaporator configured to at least partially vaporize a refrigerant; a compressor downstream of the evaporator that is configured to compress the refrigerant; a condenser downstream of the compressor that configured to at least partially condense the refrigerant; an economizer in fluid communication between the condenser and the evaporator that is configured to divert gaseous refrigerant to the compressor in bypass of the evaporator; a conduit that connects the condenser to the economizer; an expansion valve positioned along the conduit; a stand tube in fluid communication with the

conduit and positioned upstream of the expansion valve; a sensor configured to detect a parameter indicative of a refrigerant liquid level in the stand tube; and a controller communicatively coupled to the sensor and the expansion valve, wherein the controller and configured to adjust a position of the expansion valve based at least in part on an output from the sensor.
[0084] Clause 18: The chiller of any of the Clauses, wherein the stand tube is oriented substantially vertically and is substantially parallel with at least a portion of the conduit.
[0085] Clause 19: The chiller of any of the Clauses, wherein the stand tube is in fluid communication with a pair of ports that are spaced from one another along the conduit.
[0086] Clause 20, The chiller of any of the Clauses, wherein the sensor includes a probe and is configured to detect a capacitance of the probe as a result of contact with liquid refrigerant in the stand tube.
[0087] The preceding discussion is directed to various exemplary embodiments. However, one of ordinary skill in the art will understand that the examples disclosed herein have broad application, and that the discussion of any embodiment is meant only to be exemplary of that embodiment, and not intended to suggest that the scope of the disclosure, including the claims, is limited to that embodiment.
[0088] The drawing figures are not necessarily to scale. Certain features and components herein may be shown exaggerated in scale or in somewhat schematic form and some details of conventional elements may not be shown in interest of clarity and conciseness.
[0089] In the discussion herein and in the claims, the terms “including” and “comprising” are used in an open-ended fashion, and thus should be interpreted to mean “including, but not limited to . . . ” Also, the term “couple” or “couples” is intended to mean either an indirect or direct connection. Thus, if a first device couples to a second device, that connection may be through a direct connection of the two devices, or through an indirect connection that is established via other devices, components, nodes, and connections. In addition, as used herein, the terms “axial” and “axially” generally mean along or parallel to a given axis (e.g., central axis of a body or a port), while the terms “radial” and “radially” generally mean perpendicular to the given axis. For instance, an axial distance refers to a distance measured along or parallel to the axis, and a radial distance means a distance measured perpendicular to the axis. Further, when used herein (including in the claims), the words “about,” “generally,” “substantially,” “approximately,” and the like, when used in reference to a stated value mean within a range of plus or minus 10% of the stated value.
[0090] While exemplary embodiments have been shown and described, modifications thereof can be made by one skilled in the art without departing from the scope or teachings herein. The embodiments described herein are exemplary only and are not limiting. Many variations and modifications of the systems, apparatus, and processes described herein are possible and are within the scope of the disclosure. Accordingly, the scope of protection is not limited to the embodiments described herein, but is only limited by the claims that follow, the scope of which shall include all equivalents of the subject matter of the claims. Unless expressly stated otherwise, the steps in a method claim may be performed in any order. The recitation of identifiers such as (a), (b), (c) or (1), (2), (3) before steps in a method claim are not intended to and do not specify a particular order to the steps, but rather are used to simplify subsequent reference to such steps.

Claims

1. A method of controlling a component of a climate control system, the method comprising: discharging a multiphase fluid from a condenser of the climate control system; flowing the multiphase fluid though a conduit that is downstream of the condenser, the multiphase fluid including a liquid portion and a gas portion; diverting a portion of the multiphase fluid out of the conduit and into a receptacle; determining a parameter of the multiphase fluid in the receptacle, the parameter corresponding to a composition of the liquid portion and the gas portion of the

multiphase fluid; and controlling the component of the climate control system based at least in part on the parameter.
2. The method of claim 1, wherein the receptacle is a stand tube coupled to the conduit, and wherein the parameter is a liquid level of the multiphase fluid in the stand tube.
3. The method of claim 2, wherein the receptacle includes a capacitance sensor that is configured to measure the liquid level in the stand tube.
4. The method of claim 2, wherein the multiphase fluid includes a refrigerant, wherein the component comprises an expansion valve that is in fluid communication with the conduit, and wherein controlling the component comprises controlling a position of the expansion valve based at least in part on the liquid level.
5. The method of claim 4, wherein the conduit includes at least a first portion connected to the condenser and a second portion connected to the expansion valve, wherein the first portion is oriented substantially vertically; and wherein diverting the portion of the multiphase fluid includes diverting the portion from the first portion of the conduit.
6. The method of claim 5, wherein the stand tube extends substantially parallel to the first portion of the conduit.
7. The method of claim 6, wherein stand tube includes a first port and a second port that are spaced from one another such that the first port is vertically lower than the second port; wherein diverting the portion of the multiphase fluid comprises diverting the portion into the first port; and wherein the method further comprises routing the portion of the multiphase fluid from the stand tube to the first portion of the conduit via the second port.
8. The method of claim 7, wherein the first port and the second port are spaced from one another by a vertical distance that is in a range of about one to about four times an inner diameter of the first portion of the conduit.
9. The method of claim 8, wherein the stand tube has an inner diameter that is in a range of about 0.25 to about 2.5 times the inner diameter of the first portion of the conduit.
10. The method of claim 1, wherein the component is an electronic expansion valve; and wherein controlling the component includes controlling an opening position of the electronic expansion valve to thereby control a flow of the multiphase fluid discharged from the condenser.
11. A climate control system comprising: a condenser that is configured to at least partially condense a refrigerant; an actuatable component that is configured to adjust a flow characteristic of the refrigerant; a conduit in fluid communication with an outlet of the condenser and positioned upstream of the actuatable component such that the conduit is configured to channel the refrigerant discharged out of the condenser toward the actuatable component; a receptacle in fluid communication with the conduit such that at least a portion of the refrigerant flowing through the conduit is diverted into the receptacle; a sensor configured to detect a parameter indicative of a liquid level of the refrigerant in the receptacle; and a controller communicatively coupled to the sensor and the actuatable component, wherein the controller is configured to actuate the actuatable component based at least in part on an output from the sensor.
12. The climate control system of claim 11, wherein the actuatable component comprises an expansion valve, and wherein the controller is configured to open or close the expansion valve based at least in part on the output from the sensor.
13. The climate control system of claim 12, wherein the receptacle comprises a substantially vertical stand tube that extends substantially parallel with at least a portion of the conduit.
14. The climate control system of claim 13, wherein the sensor is configured to measure a mass of the refrigerant in the stand tube, and the controller is configured to convert the mass to the liquid level.
15. The climate control system of claim 13, further comprising: a compressor that is configured to compress the refrigerant upstream of the condenser; an evaporator that is configured to at least partially vaporize the refrigerant upstream of the compressor; an economizer that is in fluid

communication between the expansion valve and the evaporator, wherein the economizer is configured to divert at least some gaseous refrigerant to the compressor in bypass of the evaporator; and an expansion device in fluid communication between the economizer and the evaporator.

16. The climate control system of claim 15, wherein the expansion device comprises a second actuatable expansion valve.

17. A chiller for conditioning an indoor space, the chiller comprising: an evaporator configured to at least partially vaporize a refrigerant; a compressor downstream of the evaporator that is configured to compress the refrigerant; a condenser downstream of the compressor that configured to at least partially condense the refrigerant; an economizer in fluid communication between the condenser and the evaporator that is configured to divert gaseous refrigerant to the compressor in bypass of the evaporator; a conduit that connects the condenser to the economizer; an expansion valve positioned along the conduit; a stand tube in fluid communication with the conduit and positioned upstream of the expansion valve; a sensor configured to detect a parameter indicative of a refrigerant liquid level in the stand tube; and a controller communicatively coupled to the sensor and the expansion valve, wherein the controller and configured to adjust a position of the expansion valve based at least in part on an output from the sensor.

18. The chiller of claim 17, wherein the stand tube is oriented substantially vertically and is substantially parallel with at least a portion of the conduit.

19. The chiller of claim 18, wherein the stand tube is in fluid communication with a pair of ports that are spaced from one another along the conduit.

20. The chiller of claim 17, wherein the sensor includes a probe and is configured to detect a capacitance of the probe as a result of contact with liquid refrigerant in the stand tube.