

SYSTEM AND METHOD FOR MONITORING PURITY OF FLUID

FIELD OF INVENTION

- 5 The invention relates to purity monitoring. More particularly, the invention relates to a system and a method for monitoring the purity of fluid that involves the creation of an environment that is pressure regulated.

BACKGROUND OF THE INVENTION

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- Purity monitoring refers to a quality control procedure in which the purity of a fluid, being either in liquid or gaseous phase is monitored. In particular, such a procedure is of utmost importance to ensure that fluid has a purity level that meets purity requirements so that it is suitable for its intended application. Use cases may be, but
15 shall not be limited to, the production of a gas laser, refrigerants, flame retardants, cleaning agents, or the like. Should the purity level of the fluid fail to meet purity requirements, the impure fluid may seriously disrupt its intended application.

- There are a few disclosed technologies over the prior art relating to the monitoring of
20 purity of fluid. Among them is CN205746026U, which discloses a kind of system that monitors the purity of gas and directs it to be stored in different containers depending on the measured purity level of the gas.

- Another disclosed technology is US20060204910A1, which discloses a kind of fuel
25 injection system that monitors the purity of fluid. In particular, the fluid is directed into a branched pipeline for its purity level or concentration level to be measured through a plurality of sensors. Depending on the measured purity level or concentration level, a pressure regulator changes the pressure of the fluid within the main pipeline accordingly for the control of a combustion process.

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Even so, the purity monitoring systems of CN205746026U and US20060204910A1 do not take into consideration for their purity sensors to operate in an optimal manner, nor do they provide considerations for a system that can accommodate fluid in a liquid or gaseous phase. Accordingly, it would be desirable to have a monitoring system that
5 takes into consideration and creates an environment suitable for the sensor.

SUMMARY OF INVENTION

The main objective of the present invention is to provide a system and a method for
10 monitoring the purity of fluid that involves the creation of an environment that regulates the pressure of the fluid. The fluid is preferably gaseous carbon dioxide or liquid carbon dioxide. To achieve this objective, there is a computerised duct that takes a fluid portion from a fluid source as a sample, and further creates an environment in which the pressure of the fluid is regulated, so that its purity sensor measures a purity level of the
15 sample. The purity level of the sample shall correspond to the purity level of fluid flowing within the fluid source. There is also a phase conversion unit that may convert the sample from being in a liquid phase into a gaseous phase.

Advantageously, the present invention possesses portability, as it is easily incorporated
20 in various points along the body of the fluid source to be used. Also, the present invention provides the monitoring of fluid in real-time, especially for critical applications without assuming on purity uniformity of the fluid or relying on a static testing event. Also, the present invention provides a kind of system and method that is non-destructive toward the fluid. Also, the present invention provides an interlinked
25 and holistic approach to plant processes that adheres to the trend toward Industry 4.0. Also, the present invention is capable of being configured to measure the purity level of the fluid in a gaseous phase or liquid phase. Finally, the purity sensor, in conjunction with a computer of the system, is capable of identifying and differentiating constituents within the fluid whether they be in a solid, liquid or gas phase.

The invention intends to disclose a system for monitoring purity of fluid, comprising a duct connecting to a fluid source, which includes a first valve for directing the fluid flowing from the fluid source into the duct, or portions thereof, as a sample, a purity sensor disposed downstream of the first valve, and one or more pressure regulators for
5 controlling pressure within the duct, or portions thereof. The duct, or portions thereof, is of an environment with a desired pressure for measuring a purity level of the sample by the purity sensor.

Preferably, the duct further comprises a phase conversion unit located upstream of the
10 purity sensor for converting the sample from a liquid phase into a gaseous phase.

Preferably, the pressure regulators include any one or a combination of a first pressure regulator disposed downstream of the phase conversion unit for regulating the pressure of the sample after it passes through the phase conversion unit, and a second pressure
15 regulator disposed upstream of the purity sensor, for regulating the pressure of the sample before it passes through the purity sensor.

Preferably, wherein the desired pressure ranges from 0.9 bar to 5 bar.

20 Preferably, the duct further comprises a second valve located downstream of the purity sensor for purging the sample therefrom.

Preferably, the system further comprising at least one processor that operates a combination of modules that include a master control module for at least controlling
25 either one or a combination of the first valve, the second valve, a recorder module for recording the purity level of the sample and storing it in a memory unit, and a comparison module for comparing the purity level of the sample with a threshold.

Preferably, the processor further operates one or a combination of modules that include

a timing module, for controlling the frequency of monitoring, a security module, for protecting the system from unauthorized use, a user interface module, for compiling purity levels that were recorded through the recorder module for them to be displayed on a human-machine interface unit.

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Preferably, the system further comprises an alert unit that produces either one or both audio and visual stimuli when the purity level of the sample is below the threshold.

Preferably, wherein the duct further comprises a return structure provided upstream of the first valve and connected upstream of the fluid source that allows fluid that entered the duct to return to the fluid source.

Preferably, the fluid is either liquid carbon dioxide or gaseous carbon dioxide.

The invention also intends to disclose a method for monitoring purity of fluid, comprising the steps of directing the fluid from a fluid source into a duct of a system for monitoring the purity of fluid, as a sample, and measuring a purity level of the sample within the duct by a purity sensor. The duct, or portions thereof, is of an environment with a desired pressure for measuring the purity level of the sample by the purity sensor.

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Preferably, the method further comprises the step of converting the sample within the duct from a liquid phase into a gaseous phase by a phase conversion unit prior to measuring the purity level of the fluid by the purity sensor.

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Preferably, the method further comprises either one or both the steps of regulating the pressure of the sample after it passes through the phase conversion unit, by a first pressure regulator, and regulating the pressure of the sample before it passes through the purity sensor by a second pressure regulator.

Preferably, the desired pressure of the said method ranges from 0.9 bar to 5 bar.

Preferably, the method further comprises the step of purging the sample from the duct
5 through a second valve upon measuring the purity level of the fluid.

Preferably, the method further comprises the steps of controlling either one or both the
first valve and the second valve to open or shut, through a master control module,
recording the purity level of the sample, through a recorder module, and comparing the
10 purity level of the sample with a threshold, through a comparison module.

Preferably, the step of comparing the purity level of the sample with a threshold further
comprises the steps of determining that the purity level of the sample is below the
threshold, producing either one or both audio and visual stimuli using an alert unit, and
15 preventing further flow of the fluid into the fluid source.

Preferably, the method further comprises the step of compiling the purity levels that
were recorded by the recorder module to be displayed on a human-machine interface
unit, through a user interface module.

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One skilled in the art will readily appreciate that the invention is well adapted to carry
out the objects and obtain the ends and advantages mentioned, as well as those inherent
therein. The embodiments described herein are not intended as limitations on the scope
of the invention.

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BRIEF DESCRIPTION OF THE DRAWINGS

To facilitate an understanding of the invention, there are illustrated in the accompanying
drawings the preferred embodiments from an inspection of which when considered in
30 connection with the following description, the invention, its construction and operation

and many of its advantages would be readily understood and appreciated.

FIG. 1a is a diagram illustrating a first embodiment of the system of the present invention that accommodates gaseous fluid.

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FIG. 1b is a diagram illustrating a second embodiment of the system of the present invention that accommodates liquid fluid.

FIG. 2 is a diagram illustrating a detailed block diagram of the computer of the
10 computerised duct.

FIG. 3a is a diagram illustrating a first example of the “Main Page” user interface that is displayed on the human-machine interface unit, which pertains to the first embodiment of the present invention.

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FIG. 3b is a diagram illustrating a second example of the “Main Page” user interface that is displayed on the human-machine interface unit, which pertains to the second embodiment of the present invention.

20 **FIG. 4** is a diagram illustrating an example of the “Settings” user interface that is displayed on the human-machine interface unit.

FIG. 5 is a diagram illustrating an example of the “Logger” user interface that is displayed on the human-machine interface unit.

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FIG. 6.1 is a flowchart illustrating an A-series operational flow pertaining to the first embodiment of the present invention. **FIG. 6.2** is a flowchart that continues from the flowchart of **FIG. 6.1**.

FIG. 7.1, FIG. 7.2, FIG. 7.3, FIG. 7.4, and FIG. 7.5 are a series of diagrams showing the flow of the fluid within the first embodiment as per the A-series operational flow described in **FIG. 6.1** and **6.2**.

- 5 **FIG. 8.1** is a flowchart illustrating a B-series operational flow pertaining to the second embodiment of the present invention. **FIG. 8.2** is a flowchart that continues from the flowchart of **FIG. 8.1**.

- FIG. 9.1, FIG. 9.2, FIG. 9.3, FIG. 9.4, and FIG. 9.5** are a series of diagrams showing
10 the flow of the fluid within the second embodiment as per the B-series operational flow described in **FIG. 8.1** and **8.2**.

FIG. 10 is a flowchart illustrating a series of steps done by a remote computer for providing predictive maintenance of the system of the present invention.

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DETAILED DESCRIPTION OF THE INVENTION

- The present invention relates to a system and a method for monitoring the purity of fluid through the creation of an environment that regulates the pressure of the fluid. The
20 invention may also be presented in a number of different embodiments with common elements. According to the concept of the invention, the system comprises a computerised duct connected to a fluid source. Fluid from the fluid source is sampled by having a fluid portion of the fluid source directed into the duct as a sample. The duct is of an environment in which the pressure of the fluidal sample is regulated, so that its
25 purity sensor measures a purity level of the sample, which corresponds to the purity level of fluid flowing within the fluid source.

- It should be noted that in the context of the present invention, the term “fluid” preferably refers to materials or substances that exist in a phase that exhibits the behaviour of
30 flowing from one point to another, either through natural means or man-made means.

Phases of matter in which the material or substance may exist thereby shall include liquid, gas, plasma, semisolid, or mixtures thereof. Moreover, the term “fluid” may further refer to substances that exhibit behaviours that include fluidity, viscosity, pseudo-plasticity, viscoelasticity, Bingham plasticity, rheopecticity, thixotropy, dilatantcity, or the like. In particular, throughout this description, the term “fluid” shall primarily refer to carbon dioxide being in the gaseous phase or liquid phase.

From hereon, it will be understood that, although the terms first, second, etc. are used herein to describe various elements, components, regions, layers or sections, these elements, components, regions, layers or sections should not be limited by these terms. These terms are only used to distinguish one element, component, region, layer or section from another region, layer or section. Thus, a first element, component, region, layer or section discussed below could be termed a second element, component, region, layer or section without departing from the teachings of the present invention.

The invention will now be described in greater detail, by way of example, with reference to the figures.

FIG. 1a and **FIG. 1b** are diagrams illustrating examples of the system of the present invention in different embodiments. In particular, **FIG. 1a** illustrates the system in its first embodiment **A**, which accommodates gaseous fluid coming from a fluid source **1**. Whereas, **FIG. 1b** illustrates the system in its second embodiment **B** which accommodates liquid fluid coming from the fluid source **1**. It is noted that both the embodiments **A** and **B** possess similarities and differences, which shall now be described below.

Referring to **FIG. 1a**, the system in its first embodiment **A** comprises a computerised duct **2** connected to a fluid source **1**. Here, the fluid source **1** has the gaseous fluid, preferably being gaseous carbon dioxide, flowing therein. The duct **2** further includes one or more valves, at least one purity sensor **22**, a pressure regulator **231a** and a

computer **25**. The one or more valves include a first valve **211** and a second valve **212**.

Referring to **FIG. 1b**, the system in its second embodiment **B** comprises a computerised duct **2** connected to a fluid source **1**. Here, the fluid source **1** has liquid fluid, preferably being liquid carbon dioxide, flowing therein. The duct **2** further includes one or more valves, at least one purity sensor **22**, one or more pressure regulators, a phase conversion unit **24** and a computer **25**. The one or more valves include a first valve **211** and a second valve **212**. The one or more pressure regulators include a first pressure regulator **231b** and a second pressure regulator **232b**.

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Referring to both **FIG. 1a** and **FIG. 1b**, both embodiments **A** and **B** also involve a human-machine interface (HMI) unit **3**, an alert unit **4**, and a fluid source control system **10**.

15 Referring to both **FIG. 1a** and **FIG. 1b**, in both embodiments **A** and **B**, the fluid source **1** is in the form of a pipeline that delivers fluid from an origin to an intended destination through natural or man-made means. Alternatively, the fluid source **1** may be a tank whereby fluid is stored therein, with the tank preferably being pressurized to have an internal pressure that is higher than the atmospheric pressure.

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Referring to both **FIG. 1** and **FIG. 1b**, in both embodiments **A** and **B**, the duct **2** itself comprises one or more interconnected hollow structures. Composition wise, they are preferably metallic material or any kind of rigid material. Moreover, it is much preferred that each of these structures are elongated and have an inner diameter that is between 6mm and 7mm. These structures define the passages of the duct **2** through which the sample travels.

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Within both embodiments **A** and **B**, the duct **2** further includes a first inlet point **P₁₁**, a first outlet point **P₀₁**, a convergence point **P_c**, and a second outlet point **P₀₂**.

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In particular, the first inlet point **P₁₁** and the first outlet point **P₀₁** are points of the duct **2** that are substantially attached to the body of the fluid source **1**. The means by which the first inlet point **P₁₁** and the first outlet point **P₀₁** are attached may be through welding. Alternatively, the body of the fluid source **1** has built-in sockets that would
 5 allow the first inlet point **P₁₁** and the first outlet point **P₀₁** to be attached thereto.

In particular, the convergence point **P_C** is a point along the duct **2** whereby a delivery structure extending from the first inlet point **P₁₁** and a return structure extending from the first outlet point **P₀₁** meet and converge. This defines a looped configuration that is
 10 present within both embodiments **A** and **B**.

In particular, the second outlet point **P₀₂** is a point along the duct **2** whereby the sample is purged therefrom.

15 Referring to both **FIG. 1a** and **FIG. 1b**, in both embodiments **A** and **B**, the first valve **211** and the second valve **212** are to be in an open state or a shut state. It is to be noted that the section between the first valve **211** and second valve **212** defines a monitoring section of the duct **2**.

20 Preferably, the valves **211** and **212** are to be in an open state or a shut state in a timed manner such that (i) a fluid portion from the fluid source **1** enters the monitoring section of the duct **2** as a sample, (ii) the sample is sufficiently pressure-regulated and for its purity level to be measured by the purity sensor **22**, and (iii) the sample is purged from the duct **2** to the external environment.

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The valves **211** and **212** may be, but shall not be limited to, mechanical valves, solenoid valves, diaphragm valves, or the like. Preferably, the valves **211** and **212** are at least automated and can be remotely controlled to be in an open state or a shut state.

30 Referring to both **FIG. 1a** and **FIG. 1b**, in both embodiments **A** and **B**, the purity sensor

22 is a kind of sensor that measures a purity level based on the concentration of one or more constituents present within the sample. Conversely, it is a kind of sensor that measures the purity level based on the concentration of one or more contaminants present within the sample. Preferably, the purity sensor **22** is capable of identifying and differentiating constituents within the fluid whether they be in a solid, liquid or gas phase. Preferably, the purity sensor **22** operates in an environment that has a pressure equivalent to the atmospheric pressure of 1 bar. The purity sensor **22** may be an optical gas sensor, electrochemical gas sensor, photoionization gas sensor, metal oxide gas sensor or the like.

Referring to both **FIG. 1a** and **FIG. 1b**, in both embodiments **A** and **B**, the pressure regulators **231a**, **231b** and **232b** regulate the pressure of the sample at points along the monitoring section to be between 0.9 bar to 5 bar, but preferably 1 bar or 14.5 PSI. Since the purity sensor **22** is to measure a purity level of a sample that may have higher pressure than the atmospheric pressure, it is desirable that the pressure regulators **231a**, **231b** and **232b** regulate the pressure within the monitoring section so that the purity sensor **22** may operate in an optimal manner. Moreover, it is preferred that the pressure regulators are capable of regulating up to a pressure of 5 bar so as to cause the sample to be purged out from the monitoring section when required. Even so, the sample may still be purged out at the preferable pressure of 1 bar. The kind of pressure regulator employed in both embodiments **A** and **B** may be pressure reducing regulators, back-pressure regulators, or the like. Preferably, the pressure regulators **231a**, **231b**, and **232b** are at least automated and can be controlled to vary the pressure to be regulated within the duct **2**.

Referring to **FIG. 1b**, in the second embodiment **B**, the phase conversion unit **24** is to convert, or vaporise, a sample from a liquid phase into a gaseous phase. This is so that purity of the fluid may be measured by the purity sensor **22** later on. The kind of phase conversion unit employed in the second embodiment **B** may be a heater, evaporator device, two-phase heat exchanger, or the like. Preferably, the phase conversion unit **24**

is at least automated and can be remotely monitored and regulated.

Referring to both **FIG. 1a** and **FIG. 1b**, in both embodiments **A, B**, the computer **25** is to (i) manage the operations of the valves **211, 212**, pressure regulators **231a, 231b,**
 5 **232b**, and the phase conversion unit **24**, (ii) interpret the sensor data signals generated by the purity sensor **22**, and (iii) generate outputs based on the interpreted sensor data. To this end, it is preferably interfaced with the valves **211, 212**, the purity sensor **22**, the pressure regulators **231a, 231b, 232b**, and the phase conversion unit **24**. It is preferably further interfaced with the human-machine interface **3**, the alert unit **4** and the fluid
 10 source control system **10**. Embodiments of the computer **25** may be, but shall not be limited to a motherboard, a single-board computer, a single-board microcontroller, or the like.

The human-machine (HMI) interface **3** is a platform that allows an operator to interact
 15 with computerised duct **2** so that the operator may (i) be informed on the current processes that are occurring within the duct **2**, (ii) be informed on historical purity levels of the fluid, and (iii) change configurative settings of its computer **25**. Preferably, it is in the form of a desktop, laptop, smartphone, or the like. Connections between the computerised duct **2** and the human-machine interface **3** is wired or wireless.

20 The alert unit **4** is a device or a system that serves to alert an operator when the measured purity level fails to meet a threshold. Means by which the alert unit **4** may alert the operator by producing audio or visual stimuli such as the sounding of an alarm or warning lights. Connections between the duct **2** and the alert unit **4** may be wired or
 25 wireless.

The fluid source control system **10** is a system that controls the fluid source **1**. In particular, it controls the fluid source in a way that it allows fluid therewithin to flow from one point to another, or prevent the flow of fluid entirely. Connections between
 30 the duct **2** and the fluid source control system **10** may be wired or wireless.

Referring to **FIG. 1a**, the positional arrangement within the first embodiment **A** is such that (i) the first valve **211** is positioned downstream of the convergence point **P_c**, (ii) the pressure regulator **231** is positioned downstream of the first valve **211**, (iii) the purity sensor **22** is positioned downstream of the pressure regulator **231**, and (iv) the second valve **212** is positioned downstream of the purity sensor **22** and upstream of the second outlet point **P_{o2}**.

Referring to **FIG. 1b**, the positional arrangement within the first embodiment **B** is such that (i) the first valve **211** is positioned downstream of the convergence point **P_c**, (ii) the phase conversion unit **24** is positioned downstream of the first valve **211**, (iii) the first pressure regulator **231b** and the second pressure regulator **232b** are positioned downstream of the phase conversion unit **24** in succession, (iv) the purity sensor **22** is positioned downstream of the second pressure regulator **232b**, and (v) the second valve **212** is positioned downstream of the purity sensor **22** and upstream of the second outlet point **P_{o2}**.

It is to be noted that the positional arrangements being defined to be “upstream of” or “downstream of” are meant to be interpreted as relative terms.

As for the computer **25**, it is at the very least integrated to the duct **2**. For example, it is substantially attached or coupled to the body of the hollow structures.

Referring to **FIG. 1b**, in the second embodiment **B**, it is seen that the phase conversion unit **24** and the first pressure regulator **231b** may be part of a first accessory **2a**. More specifically, the second embodiment **B** may arise from the first embodiment **A** by having this modular first accessory **2a** fitted onto the computerized duct **2** of the first embodiment **A** in a customizable matter, preferably between the first valve **211** and the pressure regulator **231a**.

FIG. 2 illustrates a detailed block diagram of the computer **25**. In particular, it is noted that the computer **25** has a set of input/output (I/O) ports **251**, at least one processor **252** running an application software **2520**, and a memory unit **253**. In particular, the
 5 computer **25** is able to be configured to accommodate the first embodiment **A** and the second embodiment **B**.

Regarding the input/output (I/O) ports **251**, it is a collective set of terminals that allow the computer **25** to interact with (i) the valves **211** and **212**, pressure regulators **231a**,
 10 **231b** and **232b**, and phase conversion unit **24** by sending out control signals, (ii) the purity sensor **22** for receiving sensor data signals, (iii) the human-machine interface **3** for a user interface to be displayed thereon, and (iv) the alert unit **4** and the fluid source control system **10** when the measured purity level fails to meet a threshold. These I/O
 15 ports **251** may be conventional communication protocols such as Universal asynchronous receiver-transmitter (UART), Serial Peripheral Interface (SPI), Inter-Integrated Circuit (I2C), or the like.

Regarding the processor **252**, it performs the scheduling and the execution of software instructions or computer logic instructions based on the application software **2520**
 20 pertaining to (i) the control of the valves **211** and **212**, pressure regulators **231a**, **231b**, and **232b**, and phase conversion unit **24**, and (ii) and measurement of the purity level. Preferably, it is a conventional processor, application-specific integrated circuit (ASIC), a field-programmable gate array (FPGA), or a combination thereof.

25 Regarding the memory unit **253**, it further comprises one or more non-volatile memory units **2531**, one or more volatile memory units **2532**, or a combination thereof. The non-volatile memory unit **2531** would store program files related to the application software **2520**, while volatile memory unit **2532** would temporarily store processing data during runtime of the application software **2520**. The non-volatile memory unit **2531** may be,
 30 but will not be limited to, data storage devices such as hard disk drives (HDD), solid-state drives (SSD), hybrid drives, secure digital (SD) cards, TransFlash (TF) cards or

their likes. The volatile memory unit **2532** may be, but will not be limited to, dynamic random access memory (DRAM), static dynamic random access memory (SRAM), and their synchronous variants.

5 It is further shown in **FIG. 2** that processor **252** operates one or more modules. More particularly, these modules are software modules of the application software **2520** that operates, or runs, on the processor **252** for computing algorithms and generating control instructions. These modules include a master control sub-module **2521**, a sensor interpreter module **2522**, a recorder module **2523**, a comparison module **2524**, a timing
10 module **2525**, a contingency module **2526**, a security module **2527**, and a user interface module **2528**. It should be noted that the presented modules need not be in a software embodiment, and may be a hardware embodiment where they are connected to the processor **252** or they are their own independent computer system. Ancillary modules may be included to provide support for the aforementioned modules.

15 In particular, the master control module **2521** serves to generate control signals for controlling the operations of any one or a combination of the valves **211**, **212**, the pressure regulators **231a**, **231b**, **232b**, or the phase conversion unit **24**. Preferably, it further comprises one or more sub-modules which include a valve control sub-module
20 **2521.1**, a pressure regulator sub-module **2521.2**, and a phase conversion unit control sub-module **2521.3**.

The valve control sub-module **2521.1** generates control signals for controlling the valves **211** and **212** to be either in an open state or shut state. The pressure regulator
25 sub-module **2521.2** shall generate control signals for controlling the pressure regulators **231a**, **231b**, **232b** for them to exert a specified pressure. The phase conversion unit control sub-module **2521.3** generates control signals for controlling the phase conversion unit **24** for them to provide a specified temperature that (i) brings the fluid to its vaporisation point so that liquid fluid may be converted into a gaseous phase, and
30 (ii) maintains the fluid to be above its dew point.

In particular, the sensor interpreter module **2522** serves to convert the sensor data signals received from the sensor module, through the I/O Ports **251** into an interpreted sensor data that represents the measured purity level in a numerically comprehensible manner. To do so, it runs one or more proprietary codes for generating the interpreted sensor data.

In particular, the recorder module **2523** serves to record the measured purity level and store it in the memory unit **253**. Besides the interpreted sensor data, the recorder module **2523** may also record (i) a timestamp indicating when the sensor measurement was taken, (ii) the current status of the system, and (iii) users who have logged into the system.

In particular, the comparison module **2524** serves to compare the measured purity level with a threshold. For the case of the invention, there may be a default threshold as defined by the program files, or it may be re-configured by the operator. Preferably, the threshold is adjusted based on the intended use case of the fluid as the required purity of the fluid may vary for different use cases. Depending on the outcome of the comparison, the comparison module **2524** shall inform the contingency module **2526** on the results of the comparison.

In particular, the timing module **2525** serves to dictate operational frequencies of the valves **211** and **212**, in conjunction with the master control module **2521**. It shall dictate (i) the frequency in which the first valve **211** switches between an open state and a shut state, and/or (ii) the frequency in which the second valve **212** switches between an open state and a shut state.

Moreover, the timing module **2525** manages these operation periods such that (i) the sample entering the monitoring section is of a small volume relative to said section, (ii) the purity sensor **22** has ample time to measure the purity level of the sample, and (iii) equilibrium vapour pressure is prevented from being achieved within the space of the

monitoring section. Should it be required that the second valve **212a** assume a shut state, it is preferred that ample time is provided for the space within the monitoring section to return to being a partial vacuum after the sample is purged into the environment.

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In particular, the contingency module **2526** serves to generate control signals relevant to the alert unit **4** and the fluid source control system **10** when it is informed by the comparison module **2524** on the results of the comparison. These control signals are instructions for (i) the alert unit **4** to begin alerting the operator through both one or
10 both audio or visual stimuli, and (ii) the fluid source control system **10** to shut off the fluid source **1** to prevent fluid flowing therein from reaching its intended destination.

In particular, the security module **2527** serves to provide a layer of security to the system. It shall enforce authentication measures by requesting a username and
15 password when the operator attempts to make changes to system configuration. Encrypted usernames and passwords may be stored within the memory unit **253**, and the security module **2527** shall run cryptographic hash functions to verify that the username and password keyed into the system match.

20 In particular, the user interface module **2528** serves to compile either one or both real-time data and historical data that has been stored in the memory unit **253** into a format that may be displayed on the HMI unit **3** as a Graphical User Interface (GUI). Also, the user interface module **2528** shall compile the data in such a way that it is displayed on the HMI unit **3** as three or more distinct interfaces. These interfaces include a Main
25 Page interface, a Settings interface and a Logger interface. Furthermore, the user interface module **2528** further includes a user configuration sub-module **2528.1**.

A first Main Page interface corresponding to the first embodiment **A** is as shown in **FIG. 3a**. A second Main Page interface corresponding to the second embodiment **B** is
30 as shown in **FIG. 3b**. Both Main Page interfaces are to display an interactive schematic

diagram of the system. Included are (i) symbolic indicators of the valves **211** and **212**, the purity sensor **22**, the pressure regulators **231a**, **231b**, and **232b**, and the phase conversion unit **24**, (ii) the positional relation between the aforementioned items, (iii) indicative depictions of the sample travelling down the duct **2**, and (iv) current sensor
 5 data of the system, which includes the measured purity level of the sample. In a first usage example, when the sample is purged from the duct **2**, the “Fluid (Gas) Purge” indicator will light up. In a second usage example, the operator directly selects any one of the symbolic depictions to override system control.

10 A Settings interface is as shown in **FIG. 4**. It displays one or more settings in which the operator can interact therewith for configuring the system. In particular, the user configuration sub-module **256.1** facilitates the input of information from the operator through an input device of the HMI unit **3**. The parameters available for the operator to configure preferably include (i) data logging frequency, (ii) period in which the first
 15 valve **211** switches between an open state and a shut state, (iii) period in which the second valve **212** switches between an open state and a shut state, (iv) fluid purity threshold in a 2 decimal point percentage, (v) enablement of interface with the alert unit **4**. It is inferable that further advanced embodiments would have more parameters for the operator to configure.

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A Logger interface is as shown in **FIG. 5**. It displays a table that lists out data pertaining to the status of the system at various periods of time. In particular, the Logger interface updates the table (i) at specified time intervals, (ii) in the event where the measured purity level fails to meet the threshold, or (iii) in the event where configurations have
 25 been made to the system. The table shall present the data in a reverse chronological order.

FIGS. 6.1 and **6.2** illustrate an A-series operational flow pertaining to the system of the present invention in its first embodiment **A**. The system, in its first embodiment **A**, is
 30 to perform a series of steps in which gaseous fluid from the fluid source **1** is directed

into the computerised duct **2** to have its purity level measured by the purity sensor **22**.

FIGS. 7.1 to 7.5 are a series of figures depicting the flow of fluids within this first embodiment **A** as per the A-series operational flow, and it is to be understood that the
5 valves **211**, **212**, sensor unit **22**, and pressure regulators **231a** are interfaced with the computer **25**.

Preferably, it is assumed that the initial conditions of the computerised duct **2** are such that (i) the valves **211** and **212** are in a shut state, and (ii) the monitoring section, defined
10 to be the section between the valves **211** and **212**, is at least a partial vacuum, and (iii) the computer **25** has been set up with the sensor **22** being in a ready mode.

The steps illustrated in **FIGS. 6.1** and **6.2** shall now be described with reference to **FIGS. 7.1 to 7.5**.

15

First, in step **SA1**, fluid, in a gaseous phase, is allowed to flow within a fluid source **1** to travel from an origin to an intended destination by the fluid source control module **10**.

20 During this step **SA1**, fluid from the fluid source **1** may enter the duct **2** through the first inlet point **P₁₁** and exit through the first outlet point **P₀₁** as (i) the first valve **211** in a shut state, and (ii) due to the looped configuration. The fluid returns to the fluid source **1**. This is illustrated in **FIG. 7.1**.

25 Next, in step **SA2**, under the control of the valve control module **2521.1** and timing module **2525**, the first valve **211** is actuated to be in an open state for a fluid portion from the fluid source **1** to flow into a monitoring section of the computerised duct **2** as a sample. This is illustrated in **FIG. 7.2**.

Next, in step **SA3**, under the control of the valve control module, the first valve **211** is actuated to be in a shut state after a predetermined amount of time.

During this step **SA3**, it should be noted that fluid shall still continuously enter the first inlet point **P₁₁**. As the first valve **211**, being positioned after the convergence point **P_c**, is in a shut state, there will be a pressure build-up occurring at the first valve **211**. However, due to the looped configuration, a fresh flow of fluid shall continuously be situated adjacent to the first valve **211**. Moreover, pressure build-up at the first valve is relieved as the fluid is redirected to return to the fluid source **1** through the first outlet point **P₀₁**. As such, the first valve **211** is relieved from experiencing significant pressure build-up when it is actuated from being in an open state to a shut state, thereby improving its operational lifespan and integrity.

Next, in step **SA4**, the sample flows within the duct **2** in a downstream direction. Preferably, the entry of the sample into this section creates a pressure differential that causes the sample to flow like so. An illustration of the flow of fluids in steps **SA3** and **SA4** is shown in **FIG. 7.3**.

Next, in step **SA5**, the sample passes through a pressure regulator **213a**, thereby having its pressure reduced to be between 0.9 bar to 5 bar, but preferably 1 bar or 14.5 PSI. The sample, now having a reduced pressure, continues to flow in the downstream direction due to the pressure differential still present.

Next, in step **SA6**, the sample, now having reduced to a desired pressure of preferably 1 bar or 14.5 PSI, passes through purity sensor **22**, or at least the detectors of the purity sensor **22**. With this, the purity sensor **22** measures the purity of the sample and generates sensor data signals therefrom. This is illustrated in **FIG. 7.4**.

Next, in step **SA7**, the sensor data signals are then sent to the computer **25** and its sensor

interpreter module **25** shall convert it to a numerical value representative of the purity level of the sample.

Next, in step **SA8**, the computer **25**, more particularly its recorder module **2523**, shall
 5 record the purity level and stores it within the memory unit **253** of the computer **25**.

Next, in step **SA9**, the computer **25**, more particularly its comparison module **2524**, shall obtain the purity level either from the recorder module **2523** or the memory unit **253** of the computer. It shall then compare the measured purity level with a threshold,
 10 this threshold being a default threshold or a configured threshold.

The next step, step **SA10** is a decision step. Here, it shall be determined whether or not the measured purity level is higher than the threshold. Should this not be the case, step **SA10** proceeds to step **SA11**. Should this be the case, step **SA10** proceeds to step **SA13**.
 15

In step **SA11**, the computer **25**, more particularly the contingency module **2526** is informed that the measured purity level of the sample fails to be higher than the threshold. The contingency module **2526** shall interpret that the purity level of the fluid in the fluid source **1** fails to meet specified purity requirements for its use case. As such,
 20 it shall generate signals that are to be sent to the alert unit **4** to inform operators that the fluid within the fluid source **1** fails to meet specified purity requirements.

Following step **SA11** is step **SA12**, whereby the computer **25**, more particularly the contingency module **2526**, shall also generate signals that are sent to the fluid source control module **10** to inform it to prevent further fluid from flowing within the fluid source **1** so that the impure fluid does not reach its intended destination.
 25

Step **SA13** is a shared step that follows from either one of step **SA10** or step **SA12**. Here, under the control of the valve control module **2521.1** and timing module **2525**,

the second valve **212** is actuated to be in an open state for the sample to be purged out from the duct **2** into the environment. This is illustrated in **FIG. 7.5**.

Following step **SA13** is step **SA14**, which is a decision step. Here, it shall be determined
 5 by the computer **25** whether or not the fluid source control module **10** still allows fluid to flow within the fluid source **1**.

Should this be the case, it means that fluid is still flowing within the fluid source **1**. As such, step **SA14** shall return to step **SA2** in which operations pertaining to the
 10 measurement of the purity level of the fluid continues. It is to be noted that in succeeding step cycles, the second valve **212** remains in an open state so that the sample is instantaneously purged from the monitoring section after its purity level is measured. More specifically, in succeeding step cycles, **FIGS. 7.1 to 7.5** still apply, but with the second valve **212** remaining in an open state for an entered sample to continuously flow
 15 out into the environment after having its purity level measured.

Should this not be the case, it means that the fluid source control module **10** has prevented fluid from flowing within the fluid source **1**, which may be caused by (i) the computer **25** previously informing it that the sample had a purity level that failed to
 20 meet the threshold, or (ii) direct intervention by the operator through the HMI unit **3**.

With this, step **SA14** proceeds to step **SA15**, whereby under the control of the valve control module **2521.1** and timing module **2525**, the second valve **212** is actuated to be in a shut state. Preferably, at this point, the monitoring section returns to being at least
 25 a partial vacuum once more, and operations pertaining to the measurement of the purity level of the fluid comes to an end.

With this, the A-series operational flow pertaining to the system of the present invention in its first embodiment **A** has been sufficiently elucidated.

FIGS. 8.1 and **8.2** illustrate a B-series operational flow pertaining to the system of the present invention in its second embodiment **B**. The system, in its first embodiment **B**, is to perform a series of steps in which liquid fluid from the fluid source **1** is directed
 5 into the computerised duct to have its purity level measured by the purity sensor **22**.

FIGS. 9.1 to **9.7** are a series of figures depicting the flow of fluids within this first embodiment **B** as per the B-series operational flow, and it is to be understood that the valves **211** and **212**, the sensor unit **22**, the pressure regulators **231b** and **232b**, and the
 10 phase conversion unit **24**, are interfaced with the computer **25**.

Preferably, it is assumed that the initial conditions of the computerised duct **2** are such that (i) the valves **211**, **212** are in a shut state, (ii) the monitoring section, defined to be the section between the valves **211** and **212**, is at least a partial vacuum, and (iii) the
 15 phase conversion unit **24** is ready for phase conversion of the fluid.

The steps illustrated in **FIGS. 8.1** and **8.2** shall now be described with reference to **FIGS. 9.1** to **9.7**.

20 First, in step **SB1**, fluid, in a gaseous phase, is allowed to flow within a fluid source **1** to travel from an origin to an intended destination by the fluid source control module **10**.

During this step **SB1**, similar to step **SA1** as before, fluid from the fluid source **1** may
 25 enter the duct **2** through the first inlet point **P₁₁** and exit through the first outlet point **P₀₁** due to (i) the first valve **211** assuming a shut state, and (ii) due to the looped configuration. The fluid returns to the fluid source **1**. This is illustrated in **FIG. 9.1**.

Next, in step **SB2**, under the control of the valve control module **2521.1** and timing
 30 module **2525**, the first valve **211** is actuated to be in an open state for a fluid portion

from the fluid source **1** to flow into a monitoring section of the computerised duct **2** as a sample. This is illustrated in **FIG. 9.2**.

Next, in step **SB3**, under the control of the valve control module, the first valve **211** is
 5 actuated to be in a shut state after a predetermined amount of time.

During this step **SB3**, similar to step **SA3** before, fluid shall still continuously enter the first inlet point **P₁₁**. As the first valve **211**, being positioned after the convergence point **P_c**, is in a shut state, there will be a pressure build-up occurring at the first valve **211**.
 10 However, due to the looped configuration, this pressure build-up is relieved as the fluid is redirected to return to the fluid source **1** through the first outlet point **P₀₁**. As such, the first valve **211** is relieved from experiencing significant pressure build-up when it is actuated from being in an open state to a shut state, thereby improving its operational lifespan and integrity.

15 Next, in step **SB4**, the sample flows within the duct **2** in a downstream direction. Preferably, the entry of the sample into this section creates a pressure differential that causes the sample to flow like so. An illustration of the flow of fluids in steps **SB3** and **SB4** are shown in **FIG. 9.3**.

20 Next, in step **SB5**, the sample passes through the phase conversion unit **24**. Here, the phase conversion unit **24** shall convert the sample from being in a liquid phase into a gaseous phase. The sample, now in a gaseous phase, has an increase in kinetic energy and hence continues flowing in a downstream direction due to an increase in the
 25 pressure differential. This is illustrated in **FIG. 9.4**.

Next, in step **SB6**, the sample, now in a gaseous phase, passes through a first pressure regulator **231b**, thereby having its pressure reduced to be between 0.9 bar to 5 bar, but preferably 1 bar or 14.5 PSI. This is illustrated in **FIG. 9.5**. The sample, now having a

reduced pressure, continues to flow in the downstream direction due to the pressure differential.

Next, in step **SB7**, the sample, now in a gaseous phase and having reduced pressure,
5 passes through a second pressure regulator **231b**, thereby having its pressure reduced
once again to be between 0.9 bar to 5 bar, but preferably 1 bar or 14.5 PSI. The reason
for going through the second pressure regulator **232b** which provides the same pressure
regulation is to prevent either one of the pressure regulators from freezing out due to
10 the temperature of the liquid fluid. Moreover, such a configuration shall ensure that the
entire gaseous sample has a pressure of preferably 1 bar. The sample, now having a
reduced pressure, continues to flow in the downstream direction due to the pressure
differential.

Next, in step **SB8**, the sample, now in a gaseous phase and preferably having a desired
15 pressure of 1 bar or 14.5 PSI, passes through purity sensor **22**, or at least the detectors
of the purity sensor **22**. With this, the purity sensor **22** measures the purity of the sample
and generates sensor data signals therefrom. This is illustrated in **FIG. 9.6**.

Next, in step **SB9**, the sensor data signals are then sent to the computer **25** and its sensor
20 interpreter module **25** shall convert it to a numerical value representative of the purity
level of the sample.

Next, in step **SB10**, the computer **25**, more particularly its recorder module **2523**, shall
record the purity level and stores it within the memory unit **253** of the computer **25**.

25

Next, in step **SB11**, the computer **25**, more particularly its comparison module **2524**,
shall obtain the measured purity level either from the recorder module **2523** or the
memory unit **253** of the computer. It shall then compare the measured purity level with
a threshold, this threshold being a default threshold or a configured threshold.

The next step, step **SB12** is a decision step. Here, it shall be determined whether or not the measured purity level is higher than the threshold. Should this not be the case, step **SB12** proceeds to step **SB13**. Should this be the case, step **SB12** proceeds to step **SB15**.

5

In step **SB13**, the computer **25**, more particularly the contingency module **2526** is informed that the measured purity level of the sample fails to be higher than the threshold. The contingency module **2526** shall interpret that the purity level of the fluid in the fluid source **1** fails to meet specified purity requirements for its use case. As such,
 10 it shall generate signals that are to be sent to the alert unit **4** to inform operators that the fluid within the fluid source **1** fails to meet specified purity requirements.

Following step **SB13** is step **SB14**, whereby the computer **25**, more particularly the contingency module **2526**, shall also generate signals that are sent to the fluid source
 15 control module **10** to inform it to prevent further fluid from flowing within the fluid source **1** so that the impure fluid does not reach its intended destination.

Step **SB15** is a shared step that follows from either one of step **SB12** or step **SB14**. Here, under the control of the valve control module **2521.1** and timing module **2525**,
 20 the second valve **212** is actuated to be in an open state for the sample to be purged out from the duct **2** into the environment. This is illustrated in **FIG. 9.7**.

Following step **SB15** is step **SB16**, which is a decision step. Here, it shall be determined by the computer **25** whether or not the fluid source control module **10** still allows fluid
 25 to flow within the fluid source **1**.

Should this be the case, it means that fluid is still flowing within the fluid source **1**. As such, step **SB16** shall return to step **SB2** in which operations pertaining to the measurement of the purity level of the fluid continues. It is to be noted that in

succeeding step cycles, the second valve **212** remains in an open state so that the sample is instantaneously purged from the monitoring section after its purity level is measured. More specifically, in succeeding step cycles, **FIGS. 9.1 to 9.7** still apply, but with the second valve **212** remaining in an open state for an entered sample to continuously flow
5 out into the environment after having its purity level measured.

Should this not be the case, it means that the fluid source control module **10** has prevented fluid from flowing within the fluid source **1**, which may be caused by (i) the computer **25** previously informing it that the sample had a purity level that failed to
10 meet the threshold, or (ii) direct intervention by the operator through the HMI unit **3**.

With this, step **SB16** proceeds to step **SB17**, whereby under the control of the valve control module **2521.1** and timing module **2525**, the second valve **212** is actuated to be in a shut state. Preferably, at this point, the monitoring section returns to being at least
15 a partial vacuum once more, and operations pertaining to the measurement of the purity level of the fluid comes to an end.

With this, the B-series operational flow pertaining to the system of the present invention in its second embodiment **B** has been sufficiently elucidated.
20

While it is illustrated and elucidated that, in the A-series operational flow and the B-series operational flow, the second valve **212** remains in an open state in succeeding step cycles and only assumes a shut state during the end of the operation, it may not necessarily be the case. Alternatively, the second valve **212** may periodically alternate
25 between an open state and a shut state in each step cycle. More specifically, the second valve may assume an open state for the sample to be purged into the environment, and may assume a shut state after the sample is purged into the environment.

In a first example of an advanced embodiment of the present invention, pump units may
30 be included in the vicinity of the first inlet point **P₁₁**, the first outlet point **P₀₁**, and the

second outlet point **P₀₂**. These pump units are devices that direct the flow of fluid through man-made means, such as impellers, fans, of the like. To further clarify this, there may be a first pump unit at the first inlet point **P₁₁** that draws fluid from the fluid source **1** into the duct **2**, a second pump unit at the first outlet point **P₀₁** that draws the fluid from the duct **2** back into the fluid source **1**, and a third pump unit at the second outlet point **P₀₂** that draws the sample from the duct **2** for purging it into the environment.

In a second example of an advanced embodiment of the present invention, extra sensors may be present for further monitoring. To further clarify this, the system of the present invention may further include sensors such as a temperature sensor, a pressure sensor and a relative humidity sensor. The temperature sensor measures the temperature within the monitoring section for ensuring the vaporisation point and dew point of the fluid are reached. The pressure sensor for monitoring the pressure within the monitoring section. The relative humidity sensor for measuring the relative humidity of the sample. The sensor data measured by these sensors may similarly be interpreted by the sensor interpreted module **2522** and their measured values may be shown on the user interface as shown in the Logger interface of **FIGS. 3a, 3b** and **5**.

In a third example of an advanced embodiment, it is understood that based on the description of the first embodiment **A** and the second embodiment **B**, a third embodiment that possesses the features and characteristics may be construed. Moreover, this third embodiment may have additions that include the means to determine whether the fluid flowing in the fluid source **1** is of a gaseous phase or liquid phase, and additional valves to direct fluid to immediately enter the first valve **221** or direct fluid to at least pass through the phase conversion unit **24** before entering the first valve **221**. The computer **25** may be programmed accordingly to facilitate the control of these additions.

In a fourth example of an advanced embodiment, the computer **25** may be further

interfaced with one or more remote computers that serve to provide predictive maintenance of the system. A flowchart illustrating a series of steps done by a remote computer for providing predictive maintenance of the system is shown in **FIG. 10**. Here, in a first step, a set of recently generated sensor data that is stored in the computer
5 **25** is retrieved. Then, in a second step, a data trend is generated from this set of sensor data. The third step is a decision step whereby it shall be determined whether or not the current data trend is consistent with previous data trends. Should this not be the case, the third step proceeds to a fourth step whereby the operator is informed that maintenance of the system may be required, such as changing of filters of the fluid
10 source **1**. Should this be the case, the third step proceeds to a fifth step whereby the system is assumed to be able to operate without any maintenance required.

With this, the details pertaining to the system and the method of the present invention have been sufficiently elucidated.

15

The present disclosure includes as contained in the appended claims, as well as that of the foregoing description. Although this invention has been described in its preferred form with a degree of particularity, it is understood that the present disclosure of the preferred form has been made only by way of example and that numerous changes in
20 the details of construction and the combination and arrangements of parts may be resorted to without departing from the scope of the invention.

25

30

CLAIMS

1. A system for monitoring purity of fluid, comprising
a duct (2) connecting to a fluid source (1), which includes
5 a first valve (211) for directing the fluid flowing from the fluid source (1) into the duct (2), or portions thereof, as a sample;
a purity sensor (22) disposed downstream of the first valve (211); and
one or more pressure regulators for controlling pressure within the duct (2), or portions thereof;
10 wherein the duct (2), or portions thereof, is of an environment with a desired pressure for measuring a purity level of the sample by the purity sensor (212),
wherein the duct (2) further comprises a phase conversion unit (24) located upstream of the purity sensor (22) for converting the sample from a liquid phase into a gaseous phase, and
15 wherein the or each pressure regulator includes either one, or a combination of a first pressure regulator (231b) disposed downstream of the phase conversion unit (24), for regulating the pressure of the sample after it passes through the phase conversion unit (24), and
a second pressure regulator (232b) disposed upstream of the purity sensor (22),
20 for regulating the pressure of the sample before it passes through the purity sensor (22), and
wherein the duct (2) further comprises a return structure provided upstream of the first valve (211) and connected upstream of the fluid source (1) that allows fluid that entered the duct (2) to return to the fluid source (1).
25
2. The system according to claim 1, wherein the desired pressure ranges from 0.9 bar to 5 bar.
3. The system according to claim 1 or claim 2, wherein the duct (2) further
30 comprises a second valve (212) located downstream of the purity sensor (22) for

purging the sample therefrom.

4. The system according to claim 3, further comprising at least one processor (252) that operates a combination of modules that include
 - 5 a master control module (2521) for at least controlling either one or a combination of the first valve (211), the second valve (212);
 - a recorder module (2523) for recording the purity level of the sample and storing it in a memory unit (253); and
 - a comparison module (2524) for comparing the purity level of the sample with
 - 10 a threshold.
5. The system according to claim 4, wherein the processor (252) further operates one or a combination of modules that include
 - a timing module (2525), for controlling the frequency of monitoring;
 - 15 a security module (2527), for protecting the system from unauthorized use; and
 - a user interface module (2528), for compiling purity levels that were recorded through the recorder module (2523) for them to be displayed on a human-machine interface unit (3).
- 20 6. The system according to claim 4 or claim 5, further comprising an alert unit (4) that produces either one or both audio and visual stimuli when the purity level of the sample is below the threshold.
7. The system according to any one of the preceding claims, wherein the fluid is
- 25 either one of liquid carbon dioxide or gaseous carbon dioxide.
8. A method for monitoring purity of fluid, comprising the steps of
 - directing the fluid from a fluid source (1) into a duct (2) of a system for monitoring the purity of fluid, as a sample; and

measuring a purity level of the sample within the duct (2) by a purity sensor (22);

wherein the duct (2), or portions thereof, is of an environment with a desired pressure for measuring the purity level of the sample by the purity sensor (22), and

5 whereby the duct (2), includes

a first valve (211) for directing the fluid flowing from the fluid source (1) into the duct (2), or portions thereof, to form the sample, the purity sensor (22) being disposed downstream of the first valve (211);

a return structure provided upstream of the first valve (211) and connected
10 upstream of the fluid source (1) that allows fluid that entered the duct (2) to return to the fluid source (1);

one or more pressure regulators for controlling pressure within the duct (2), or portions thereof; and

a phase conversion unit (24) located upstream of the purity sensor (22) for
15 converting the sample from a liquid phase into a gaseous phase, whereby the or each pressure regulator includes either one, or a combination of

a first pressure regulator (231b) disposed downstream of the phase conversion unit (24), for regulating the pressure of the sample after it passes through the phase conversion unit (24), and

20 a second pressure regulator (232b) disposed upstream of the purity sensor (22), for regulating the pressure of the sample before it passes through the purity sensor (22).

9. The method according to claim 8, further comprising the step of converting the sample within the duct (2) from a liquid phase into a gaseous phase by the phase
25 conversion unit (24) prior to measuring the purity level of the fluid by the purity sensor (22).

10. The method according to claim 9, further comprising either one or both the steps of

regulating the pressure of the sample after it passes through the phase conversion unit (24), by the first pressure regulator (231b); and

regulating the pressure of the sample before it passes through the purity sensor (22) by the second pressure regulator (232b).

5

11. The method according to any one of claims 8 to 10, wherein the desired pressure ranges from 0.9 bar to 5 bar.

12. The method according to any one of claims 8 to 11, further comprising the step
10 of purging the sample from the duct (2) through a second valve (212) upon measuring the purity level of the fluid.

13. The method according to claim 12, further comprising the steps of
controlling either one or both the first valve (211) and the second valve (212) to
15 open or shut, through a master control module (2521);
recording the purity level of the sample, through a recorder module (2523); and
comparing the purity level of the sample with a threshold, through a comparison
module (2524).

20 14. The method according to claim 13, wherein the step of comparing the purity level of the sample with a threshold further comprises the steps of
determining that the purity level of the sample is below the threshold;
producing either one or both audio and visual stimuli using an alert unit (4); and
preventing further flow of the fluid into the fluid source (1).

25

15. The method according to claim 13 or claim 14, further comprising the step of compiling the purity levels that were recorded by the recorder module (2523) to be displayed on a human-machine interface unit (3), through a user interface module (2528).