US006182951B1

(12) **United States Patent**
Hallman, Jr. et al.

(10) **Patent No.: US 6,182,951 B1**
(45) **Date of Patent: Feb. 6, 2001**

(54) **METHOD AND APPARATUS FOR PROVIDING A PRECISE AMOUNT OF GAS AT A PRECISE HUMIDITY**

(75) Inventors: **Russell L. Hallman, Jr.**; **James C. Truett**, both of Knoxville, TN (US)

(73) Assignee: **Lockheed Martin Energy Systems, Inc.**, Oak Ridge, TN (US)

(*) Notice: Under 35 U.S.C. 154(b), the term of this patent shall be extended for 0 days.

(21) Appl. No.: **09/150,920**

(22) Filed: **Sep. 10, 1998**

(51) **Int. Cl.**[7] **B01F 3/04**

(52) **U.S. Cl.** **261/130**; 261/43; 261/64.3; 261/107

(58) **Field of Search** ..... 261/104, 107, 261/130, 42, 43, 64.3, DIG. 34; 239/44, 45

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,036,915 * 7/1977 Lucero et al. 261/104
4,474,051 * 10/1984 Fukuda et al. 73/19.01
5,996,976 * 12/1999 Murphy et al. 261/104

OTHER PUBLICATIONS

Kin–Tek, "Certified Cal–Gas Standards," Good Analysis Depends on Good Calibration, La Marque, Texas.
Kin–Tek, "Span Pac™ H_2O Standards Generator," Good Analysis Depends on Good Calibration, La Marque, Texas.
Sensors & Systems, Inc., "Air and Water Analyzers and Related Systems."
Mermoud et al., "Low–Level Moisture Generation," *Anal. Chem.,* vol. 63, No. 3, pp. 198–200 (Feb. 1, 1991).

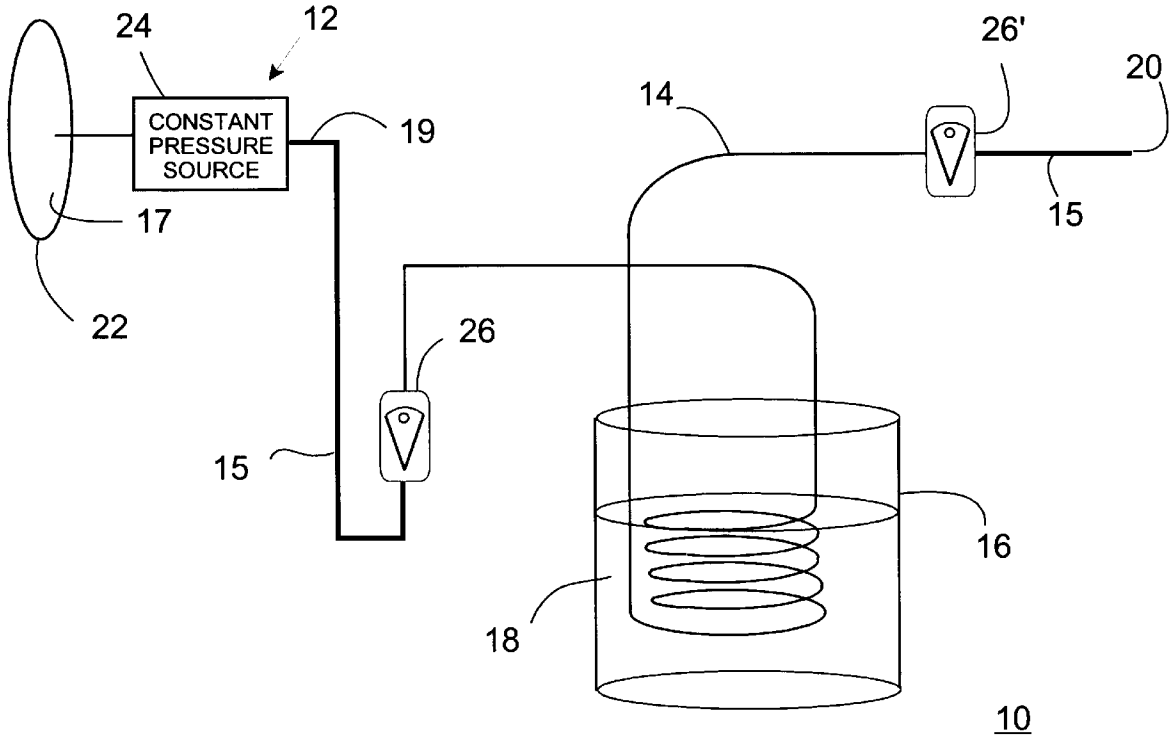
* cited by examiner

Primary Examiner—Duane Smith
Assistant Examiner—Robert A. Hopkins
(74) *Attorney, Agent, or Firm*—Ackerman, Senterfitt, & Eidson, P.A.

(57) **ABSTRACT**

A fluid transfer system includes a permeable fluid carrier, a constant temperature source of a first fluid, and a constant pressure source of a second fluid. The fluid carrier has a length, an inlet end, and an outlet end. The constant pressure source connects to the inlet end and communicates the second fluid into the fluid carrier, and the constant temperature source surrounds a least of portion of the length. A mixture of the first fluid and the second fluid exits via the outlet end A method of making a mixture of two fluids is also disclosed.

19 Claims, 2 Drawing Sheets



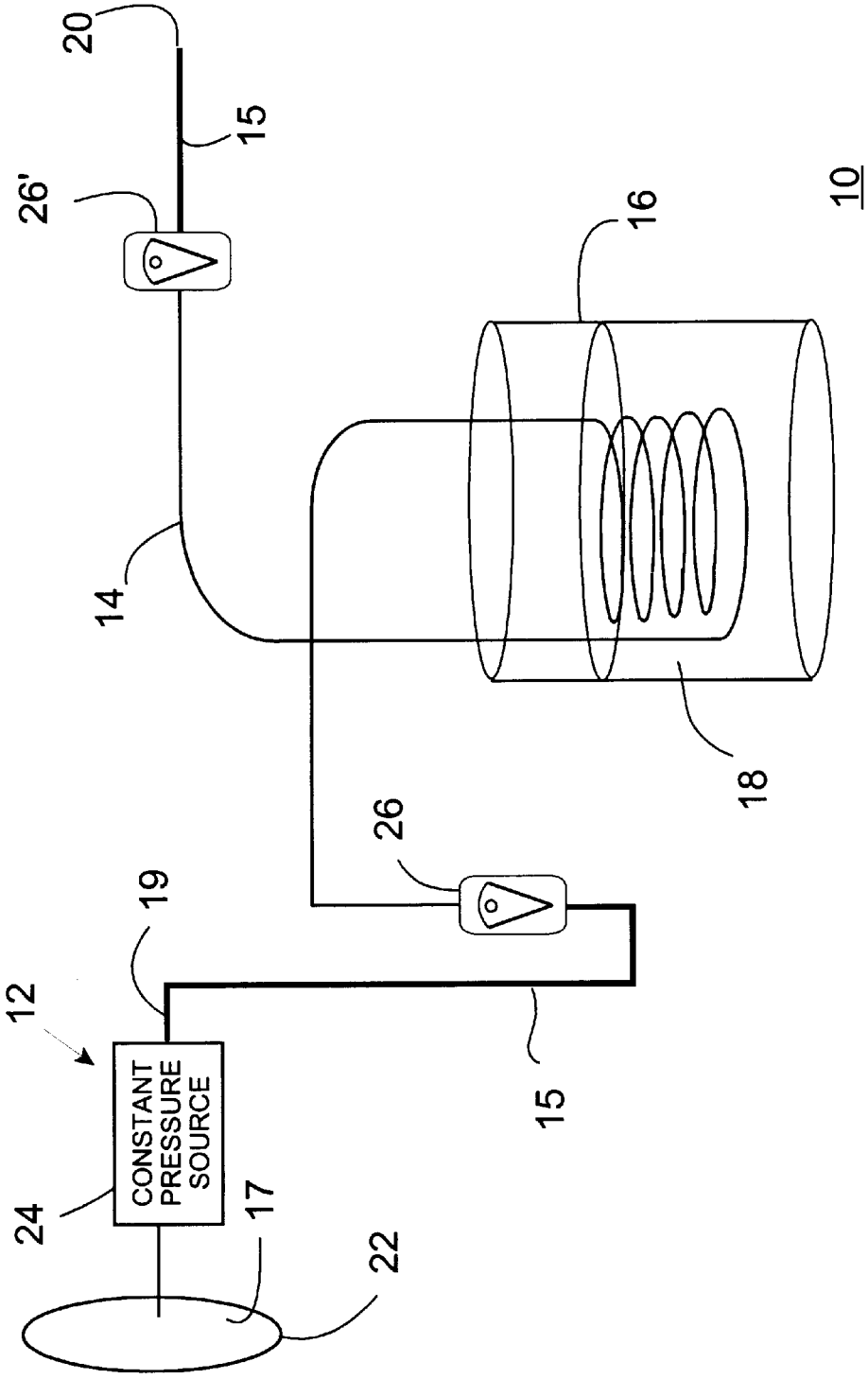

20
15
26'
14
16
10
18
26
19
12
CONSTANT PRESSURE SOURCE
24
17
22
15

FIG. 1

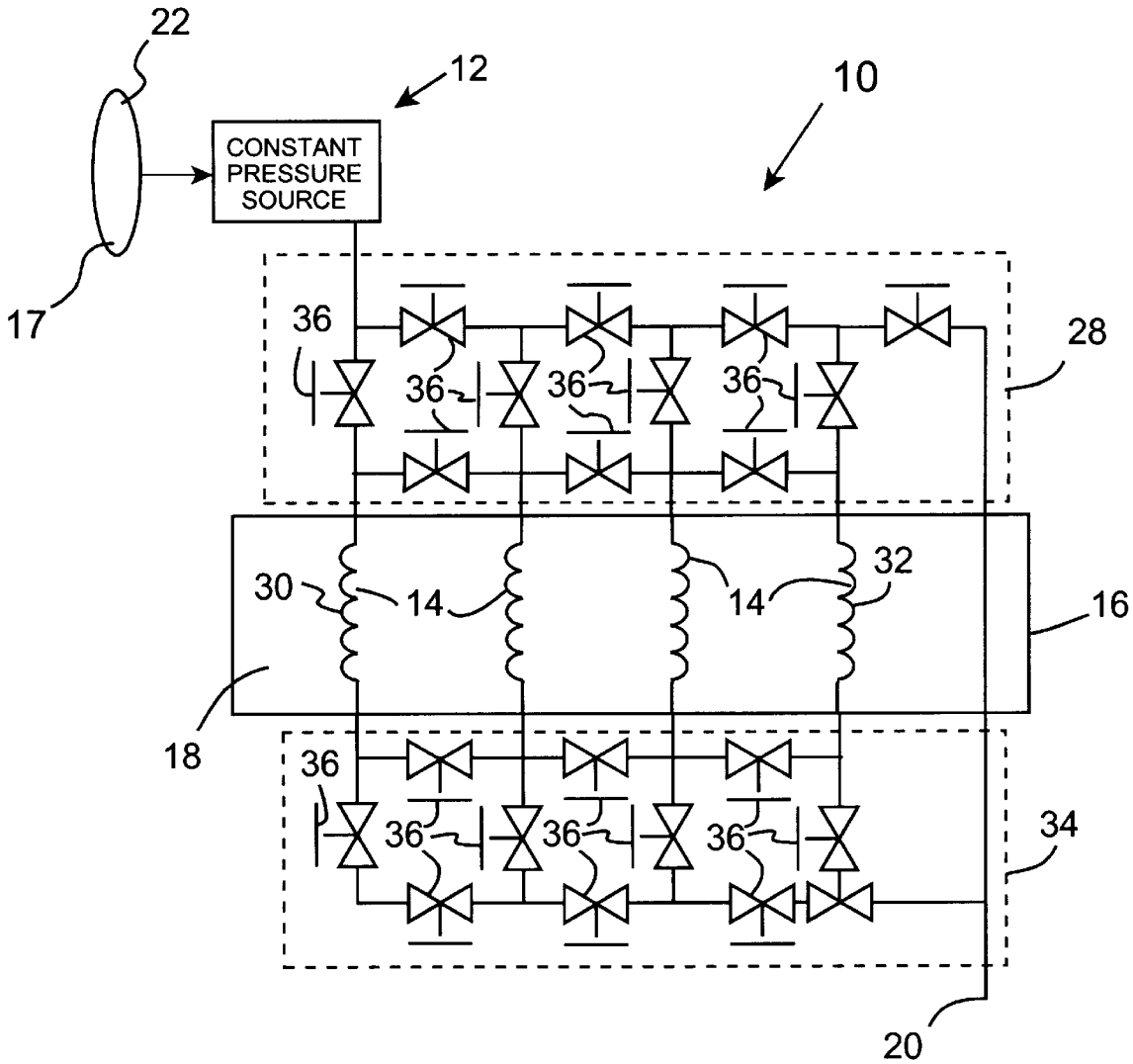


FIG. 2

METHOD AND APPARATUS FOR PROVIDING A PRECISE AMOUNT OF GAS AT A PRECISE HUMIDITY

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT

This invention was made with government support under contract DE-AC05-96OR22464, awarded by the United States Department of Energy to Lockheed Martin Energy Systems Corporation, and the United States Government has certain rights in this invention.

FIELD OF THE INVENTION

This invention relates to a method and apparatus for introducing a precise amount of a first fluid into a second flowing fluid. This invention particularly relates to a new and improved method and apparatus for providing a precise amount of gas having a precisely controlled humidity.

Many applications in science and industry require an apparatus that creates a controlled amount of a first fluid to be introduced into a second fluid, such as a gas having a precise flow rate and a precisely controlled humidity. For instance, some material corrosion testing applications require such an apparatus to determine the reaction of a material over time upon exposure to a controlled liquid-gas mixture. Tests are typically performed using a higher liquid concentration of the liquid-gas mixture, in an effort to decrease the duration of the test. Data is then extrapolated to model the material's reaction over time. However, because the results are extrapolated, any error caused by an imprecisely controlled liquid-gas mixture will be magnified. Thus, the need for an apparatus that creates a controlled testing environment with a gas having a precise flow rate and a precisely controlled humidity is critical to ensure the accuracy of these types of tests.

A wide variety of conventional devices and methods used to produce a precise gas flow having a precisely controlled humidity are known in the art. Various systems introduce a liquid, such as water, into a gas stream using a calibrated leak. Generally, water is stored in a small vial having a very small orifice through which water vapor is metered. The humidity of the gas stream is modified by either adjusting the gas flow over the device or by adjusting the temperature of the vial. The accuracy of this apparatus is limited because changes in the gas stream flow rate or the temperature of the vial of water result in substantial changes in the humidity of the gas. Furthermore, this known apparatus requires controllers for varying gas flow and vial temperature.

Flow regulators and pressure regulators are distinct devices having different functions and characteristics. A pressure regulator differs from a flow regulator in that pressure regulators are actuated into opening or closing by sensing pressure of a fluid at its outlet, which regulation can be independent of the fluid flow. A flow regulator is actuated into opening or closing by sensing the flow rate of a fluid, which regulation can be independent of pressure.

Another conventional apparatus, known as a permeation cell, employs a permeable vial containing the liquid to be introduced into the gas stream. The liquid permeates through the vial and into the gas stream to produce the desired humidity. However, the aforementioned problems also affect this apparatus. In particular, vial temperature changes result in significant gas stream humidity changes. This apparatus also requires additional components for controlling gas flow.

Successive dilution is another known method for producing a precise gas flow with a precise humidity. With this

method, dry gas is split into minor and major gas streams. After both gas streams are passed through separate flow controllers, the minor gas stream is passed through a liquid bubbler and reintroduced into the major gas stream. The reintroduction of the minor gas stream into the major gas stream produces the desired humidity. However, this method also has a number of inherent problems. First, the system requires that the major gas stream have a very large volumetric flow rate—on the order of liters per minute—to blend the gas streams to the required humidity. As a result, production of a product gas stream having a low flow rate cannot be practically accomplished. Also, costly detection equipment is required for measuring moisture vapor content. Further limitations of this method include the need for flow control valves in each gas stream, for controlling the process based on detection equipment data, and a proportional integral derivative controller for continuous adjustment of the flow control valves in order to maintain the desired humidity in the product gas stream.

SUMMARY OF THE INVENTION

It is an object of this invention to provide a fluid transfer system for introducing a first fluid into a second fluid flowing through a fluid carrier, wherein the system is designed for precisely controlling both the mixture rate of the fluids and the flow rate of the second fluid through the fluid carrier.

It is another object of this invention to provide a fluid transfer system capable of maintaining production of a precisely controlled fluid mixture under changing external conditions, such as fluctuations in ambient temperature and pressure.

It is another object of this invention to provide an instrument for independently verifying the calibration of dew point measurement devices.

It is another object of this invention to provide a fluid transfer apparatus that does not require costly components such as flow control valves, proportional integral derivative controllers, and humidity detection equipment.

In accordance with the present invention, these and other objects are accomplished by a fluid transfer system comprising a first fluid, a second fluid, a fluid carrier length having an inlet and an outlet, a constant temperature source for maintaining the first fluid at a constant temperature, and a constant pressure source connected to the fluid carrier inlet for introducing the second fluid into the fluid carrier at a constant pressure. The first fluid surrounds and permeates at least a portion of the fluid carrier length. A mixture of the first and second fluids is exhausted through the fluid carrier outlet.

In the preferred embodiment, a tubular fluid carrier is provided for directing the second fluid through the fluid carrier system. In this embodiment, the first fluid constant temperature source comprises a liquid bath, and the second fluid constant pressure source comprises a pressure regulator connected to the fluid carrier inlet.

A fluid transfer system in accordance with an alternate embodiment of the invention further comprises an inlet manifold, an outlet manifold, and at least one additional permeable fluid carrier length. In this embodiment, the constant pressure source is connected to the inlet manifold for regulating pressure which, in turn, regulates the flow of the second fluid into the inlet manifold. The first fluid surrounds and permeates at least a portion of each of the fluid carrier lengths, and a controlled mixture of the first and second fluids exits the fluid carrier lengths through the outlet manifold.

In yet a further embodiment of the invention, a fluid transfer system comprises a permeable fluid carrier tube having inlet and outlet ends, a water bath having a constant water temperature, and a gas source connected to the inlet end of the permeable fluid carrier tube via a pressure regulator. The gas source communicates a gas, through the pressure regulator, to the tube inlet. The pressure regulator fixes the pressure of the gas. The constant temperature bath surrounds and permeates at least a portion of the fluid carrier tube, allowing the water to mix with the flowing gas. A controlled mixture of dry gas and water vapor is expelled through the outlet end of the carrier tube. The flow rate of the gases through the tube is controlled, at least in part, by controlling the ratio of carrier tube inner diameter to carrier tube length.

A method of producing a mixture of a first and second fluids includes providing a first fluid at a constant temperature, communicating a second fluid at a constant pressure into an inlet end of a fluid carrier, submersing a length of the fluid carrier within the first fluid such that the first fluid permeates the fluid carrier to mix with the second fluid, and flowing the mixture toward an outlet end of the fluid carrier.

BRIEF DESCRIPTION OF THE DRAWINGS

There are shown in the drawings embodiments of the invention that are presently preferred, it being understood, however, that the invention is not limited to the precise arrangements and instrumentalities shown, wherein:

FIG. **1** is a schematic view of a fluid transfer system according to the invention.

FIG. **2** is a schematic view of an additional embodiment of a fluid transfer system according to the invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

FIG. **1** illustrates a fluid transfer system **10** according to the present invention. The fluid transfer system includes a fluid carrier for transporting a second fluid, contained in a second fluid source **22**, from a fluid carrier inlet end **19** to a fluid carrier outlet end **20**. In the best mode of the invention, the fluid carrier includes a permeable section **14** and impermeable sections **15**, with the permeable and impermeable sections attached at air tight connection points **26** and **26'**. In the preferred embodiment of the invention, the air tight connection points comprise flow measuring devices. A constant pressure source **12** is applied to second fluid **17**. The constant pressure source **12** connects to the fluid carrier at inlet end **19** and provides a means for introducing second fluid **17** into the fluid carrier.

The fluid transfer system further comprises a first fluid **18** contained in a constant temperature source **16**. The permeable section **14** of the fluid carrier is at least partially surrounded by first fluid **18**. First fluid **18** permeates into fluid carrier **14** where it mixes as a vapor with second fluid **17**. The fluid mixture is subsequently exhausted through outlet end **20**. Although various fluid mixtures are possible, it is preferred that first fluid **18** is liquid water and second fluid **17** is a gas requiring humidification. It will occur to one skilled in the art that the fluid transfer system could include only permeable fluid carrier sections. In that case, the portion of the total length of the fluid carrier not surrounded by first fluid **18** should be minimized.

Constant pressure source **12** must be capable of communicating second fluid **17** into the fluid carrier at a uniform pressure. It will occur to one skilled in the art that a variety of constant pressure source arrangements are possible. In the preferred embodiment of the invention, constant pressure source **12** comprises a high pressure tank **22** containing second fluid **17**, and connected to inlet end **19** of the fluid carrier by a pressure control device **24**. Where source **22** is a fixed volume container, it is preferred that the container have sufficient volume such that the desired second fluid pressure is maintained during removal of second fluid **17** from the container.

Preferably, the pressure level provided by constant pressure source **12** can be varied via pressure control device **24**. Numerous devices are available for controlling the pressure of constant pressure source **12**. However, the preferred device is a pressure regulator. The fluid carrier has a fixed flow resistance which is dependent upon the ratio of fluid carrier diameter to fluid carrier length. The flow rate of second fluid **17** through the fluid carrier is proportional to the pressure exerted by pressure regulator **24**. As a result, the flow rate of second fluid **17** through fluid carrier **14** can be controlled by manipulating pressure regulator **24**.

As a general criteria, permeable fluid carrier **14** must be permeable to first fluid **18** and capable of transporting second fluid **17** across its entire length. Experiments were successfully performed using a capillary tube having a length of 6.096 meters, an inner diameter of 0.5875 mm, and an outer diameter of 0.762 mm. However, countless fluid carrier configurations are possible without departing from the scope of the invention. The configuration and dimensions of the fluid carrier directly influence the characteristics of the fluid transfer system. For instance, decreasing the fluid carrier inner diameter while holding the length constant, or increasing the fluid carrier length while holding the inner diameter constant, will produce a greater pressure drop across the length of the fluid carrier. In turn, the increased pressure drop will cause an increased resistance to flow and a corresponding decrease in the flow rate of second fluid **17** through the fluid carrier. Varying the flow rate of the second fluid provides one means of controlling the final mixture of first and second fluids, **18** and **17**, with the rate of mixing inversely proportional to the flow rate of second fluid **17**. Numerous other system variables can be manipulated to regulate the final fluid mixture, including, but not limited to: carrier tube permeability; carrier tube thickness; the length of carrier tube surrounded by the first fluid; first fluid temperature; and first fluid pressure.

It will occur to one skilled in the art that numerous fluid carrier materials could be employed. For example, possible materials include glass, Teflon and high-density polyethylene, to name just a few. The type of fluid carrier material used will directly impact the characteristics of the fluid transfer system. In particular, materials having high permeability to liquids, such as Teflon@, will allow a higher rate of fluid mixing than materials having a low rate of permeability, such as glass.

Generally, a specified length of permeable fluid carrier **14** is submersed in first fluid **18**, such that first fluid **18** is able to permeate fluid carrier **14** and intermix with second fluid **17**. The length of fluid carrier **14** which is submersed in first liquid **18** may be controlled to vary the characteristics of the fluid transfer system. Generally, increasing the length of fluid carrier **14** submersed in first fluid **18** will increase the quantity of first fluid permeating the fluid carrier and mixing with second fluid **17**.

This invention is not limited as to the type of constant temperature source **16** that is used to keep first fluid **18** at a

constant temperature. The source should be of sufficient size to accommodate a desired length of fluid carrier **14** to be surrounded by the first fluid, and the source should maintain the first fluid at a desired constant temperature. For instance, one preferred constant temperature source comprises a bath having a continuously circulated first fluid **18**, wherein heating or refrigeration means are applied to maintain a desired constant temperature of first fluid **18** within approximately 0.1° C.

The temperature of constant temperature source **16** can be used to vary the permeation rate of first fluid **18** into second fluid **17**, since changes in the temperature of the first fluid alter its permeation rate into fluid carrier **14**. In particular, increasing the temperature of first fluid **18** will typically result in an increase in the permeation rate of first fluid **18** into fluid carrier **14**, increasing the proportion of first fluid **18** in the final fluid mixture exhausted from the fluid carrier.

It is preferable to maintain first fluid **18** at a different temperature than the ambient temperature, since it is more difficult to maintain a constant first fluid temperature equal to the ambient temperature. Where an attempt is made to maintain equal first fluid and ambient temperatures, slight changes in ambient temperature, barometric pressure, or first fluid vaporization rate will cause a slight drift in the temperature of first fluid **18**, actuating either heating or cooling of the first fluid. Because the temperature drift is minimal, refrigeration or heating tends to overcompensate for the drift, causing a greater temperature disparity.

Maintaining the first fluid temperature at a temperature other than ambient results in continuous application of either heating or refrigeration, thereby precluding the aforementioned undesirable effect of noncontinuous heating or cooling.

Referring now to FIG. **2**, in conjunction with FIG. **1**, an alternate embodiment of the invention is shown. Fluid transfer system **10** includes: a constant pressure source **12** of a second fluid **17**; an inlet manifold **28**; a first length **30** of fluid carrier; at least one additional length **32** of fluid carrier; a constant temperature source **16** containing first fluid **18**; and an outlet manifold **34**. Constant pressure source **12** is fluidly connected to inlet manifold **28** for transporting second fluid **17** into the fluid carrier lengths **30**, **32**. Carrier lengths **30** and **32** are at least partially submersed in first fluid **18**. First fluid **18** simultaneously permeates lengths **30** and **32**, mixing with second fluid **17**. Subsequently, the fluid mixture is transported to outlet manifold **34** and exhausted through outlet **20**.

Preferably, manifolds **28** and **34** allow interconnection of fluid carrier lengths **30** and **32** in both series and parallel. The composition of the fluid mixture exiting the fluid transfer system can be varied by selectively connecting some fluid carrier lengths in parallel and others in series. Manifolds capable of producing series and/or parallel connections are well known in the art of fluid transfer systems. It is preferable that the manifolds **28**, **34** include a number of interconnected valves **36** that can be opened or closed to produce either a series connection or a parallel connection between the carrier lengths **30**, **32**.

Each length comprises a permeable fluid carrier **14** that can either be immersed in a single constant temperature source or multiple constant temperature sources. Any quantity of additional lengths **32** is acceptable so long as each length **32** can fluidly communicate with the manifolds **28**, **34** and is surrounded by a constant temperature source **16**.

Connecting the carrier lengths **30**, **32** in series effectively increases the total length of fluid carrier **14** immersed in first fluid **18**. This increase in immersed carrier length results in a reduced flow rate of second fluid **17** through the fluid transfer system. Increasing the total length also increases the surface area through which the second fluid can intermix with the first fluid **18**. Therefore, connecting a plurality of carrier lengths in series produces a reduced flow rate of second fluid **17** through the fluid transfer system and a higher pickup, or mixing rate, of the first fluid into the second fluid.

Connecting the carrier lengths **30**, **32** in parallel has no effect on the total length of fluid carrier immersed in a first fluid **18** prior to exhaustion through outlet **20**. Consequently, the permeation rate of the first fluid into the second fluid, or the mixing rate, will remain unchanged. However, the flow rate of the second fluid through the total system will increase proportionally with the quantity of carrier lengths **30**, **32** in the system. For example, a total of two lengths will double the flow rate and a total of four lengths will quadruple the flow rate through the system. Thus, by varying the number of carrier lengths **30**, **32** and their manner of connection (i.e., series or parallel), the output of the intermixed fluids at outlet end **20** can be varied.

The first step in operating the fluid transfer system of the instant invention involves setting system characteristics. Characteristics inherent to the physical construction of the system include fluid carrier length, material composition; and inner and outer diameter. Readily changeable characteristics of the fluid transfer system **10** include the pressure of the second fluid **17** entering the fluid carrier **14**, the temperature of first fluid **18**, and the composition of the first and second fluids. Other changeable characteristics are the number of individual carrier lengths **30**, **32** employed and their relative arrangement in series and/or parallel.

In operation, a fluid transfer system **10** is provided and the first and second fluids are selected. The operator can vary the final fluid composition by varying the pressure of the second fluid entering the fluid carrier **14** (thereby changing the second fluid flow rate) and the temperature of the first fluid **18**. Pre-calibrated pressure-temperature charts can be derived experimentally for particular fluid transfer systems. In particular, the charts provide the operator with relevant pressure and temperature settings to achieve desired flow rates and fluid mixtures. Typically, it is desirable to first determine the pressure level required to achieve a specified flow rate. Subsequently, a chart relating first fluid temperature to final fluid composition can be developed at the desired second fluid flow rate.

For instance, the following chart was derived experimentally for a given system. Initially, it was determined that a second fluid pressure of 15 pounds per square inch (psi) was required to produce a desired flow rate of 1.5 standard cubic feet per hour (scfh). Subsequently, the following table was derived based on the particular second fluid pressure setting (or flow rate):

Temperature (° C.)	Content (PPM)
35	19
40	21
45	30
50	42
55	60
60	82

Similar charts can be derived empirically for different fluid transfer systems according to the invention.

Producing the chart requires the use of a device capable of measuring the relative quantities of first and second fluids **17**, **18** exiting the system. Specifically, the operator sets the pressure of the second fluid required to obtain the desired flow rate. Subsequently, the first fluid temperature is varied over a useful range. Upon stabilizing at each first fluid temperature set point, the relative composition of the exiting fluid is measured. A chart can be further developed by repeating the process for a desired range of flow rates.

Each chart is designed for use with a fluid transfer system **10** having particular system characteristics, such as fluid carrier materials and dimensions. Modifications to system characteristics which affect exhaust fluid composition warrant the production of additional charts. Although an operator can choose to vary either the temperature of the first fluid **18** or the pressure of the second fluid, it is preferred that the operator set the pressure of the second fluid at a described level to achieve a particular flow rate. Once the desired flow rate is achieved, the operator can vary the temperature of the first fluid **18** to obtain varying controlled compositions of the first and second fluids exiting the fluid transfer system **10**.

The first step in constructing the system of the present invention entails determining the first and second fluids to be combined, since fluid selection affects the type of fluid carrier **14**, constant temperature source **16**, and constant pressure source **12** to be used. For instance, fluid carrier and constant temperature source material should be chosen to minimize reactivity with respective second and first fluids.

Once the characteristics of particular elements of the invention are determined, the construction of the fluid transfer system **10** requires that the permeable fluid carrier **14** is at least partially immersed in a volume of first fluid **18**. As previously stated, the length of the fluid carrier **14** immersed in the first fluid is a characteristic affecting the mix rate of the first fluid into the second fluid.

The fluid carrier **14** must also be connected to a constant pressure source **12** of a second fluid. Any means of connecting the constant pressure source to the fluid carrier will suffice so long as the second fluid flows through the fluid carrier at a constant flow rate, when the second fluid is at a constant pressure.

The invention is capable of taking on alternative embodiments without departing from the spirit or essential attributes thereof. Accordingly, reference should be had to the following claims, rather than to the foregoing specification, as indicating the scope of the invention.

What is claimed is:

1. A fluid transfer system, comprising:

a fluid carrier having a length, an inlet end, and an outlet end, said outlet end having an outlet pressure, said fluid carrier having a resistance to the flow of a given fluid;

a constant pressure source of a second fluid attached directly to said inlet end for communicating said second fluid into said fluid carrier through said inlet end, whereby an amount of said second fluid flows through said fluid carrier in an amount equal to the pressure drop across said fluid carrier divided by said resistance; and

a constant temperature source of a first fluid surrounding at least a portion of a permeable section of said fluid carrier length,

whereby said first fluid permeates into said fluid carrier and intermixes with said amount of said second fluid, and a mixture of said first and second fluids exits said fluid carrier through said outlet end.

2. A fluid transfer system according to claim **1**, wherein said fluid carrier is tubular.

3. A fluid transfer system according to claim **1**, wherein said constant temperature source is a liquid bath.

4. A fluid transfer system according to claim **1**, wherein said constant pressure source is a pressure tank connected by a pressure regulator to said inlet end.

5. A fluid transfer system according to claim **1**, further comprising means for varying the temperature of said first fluid.

6. A fluid transfer system according to claim **1**, further comprising means for varying the pressure of said second fluid.

7. A fluid transfer system, comprising:

a constant pressure source of a second fluid connected to an inlet manifold, said constant pressure source attached directly to an inlet end of said inlet manifold for regulating the flow of a second fluid into the inlet manifold for communication of said second fluid through said system;

a first permeable fluid carrier length and at least one additional permeable fluid carrier length, a first end of each said length fluidly connected to an output of said inlet manifold;

a constant temperature source of a first fluid surrounding at least a portion of each said fluid carrier length; and

an outlet manifold fluidly connected to a second end of each said fluid carrier length, whereby an amount of said second fluid flows through said system in an amount equal to the pressure drop across said system divided by the combined flow resistance of said inlet manifold, said fluid carrier lengths and said output manifold, and said first fluid permeates into each said length and intermixes with said amount of said second fluid, and a mixture of said first and second fluid exits said lengths through said outlet manifold.

8. A fluid transfer system according to claim **7**, wherein said lengths are tubular.

9. A fluid transfer system according to claim **7**, wherein said constant temperature source is a fluid bath.

10. A fluid transfer system according to claim **7**, further comprising means for varying the temperature of said first fluid.

11. A fluid transfer system according to claim **7**, further comprising means for varying the pressure of said second fluid.

12. A fluid transfer system comprising:

a constant pressure source connected to an inlet manifold, said constant pressure source for regulating the flow of a second fluid into the inlet manifold;

a first permeable fluid carrier length and at least one additional permeable fluid carrier length, each said length fluidly connected to said inlet manifold;

a constant temperature source of a first fluid surrounding at least a portion of each said fluid carrier length; and

an outlet manifold fluidly connected to each said fluid carrier length, wherein said inlet and outlet manifolds include valving means for connecting said lengths in series;

whereby said first fluid permeates into each said length and intermixes with said second fluid, and a mixture of said first and second fluid exits said lengths through said outlet manifold.

13. A fluid transfer system comprising:

a constant pressure source connected to an inlet manifold, said constant pressure source for regulating the flow of a second fluid into the inlet manifold:

a first permeable fluid carrier length and at least one additional permeable fluid carrier length, each said length fluidly connected to said inlet manifold;

a constant temperature source of a first fluid surrounding at least a portion of each said fluid carrier length: and

an outlet manifold fluidly connected to each said fluid carrier length, wherein said inlet and outlet manifolds include valving means for connecting said lengths in a parallel;

whereby said first fluid permeates into each said length and intermixes with said second fluid, and a mixture of said first and second fluid exits said lengths through said outlet manifold.

14. A fluid transfer system comprising:

a constant pressure source connected to an inlet manifold, said constant pressure source for regulating the flow of a second fluid into the inlet manifold;

a first permeable fluid carrier length and at least one additional permeable fluid carrier length, each said length fluidly connected to said inlet manifold;

a constant temperature source of a first fluid surrounding at least a portion of each said fluid carrier length; and

an outlet manifold fluidly connected to each said fluid carrier length, wherein said inlet and outlet manifolds include valving means for connecting said lengths in series and in parallel;

whereby said first fluid permeates into each said length and intermixes with said second fluid, and a mixture of said first and second fluid exits said lengths through said outlet manifold.

15. A fluid transfer system, comprising:

at least one water-permeable tube having an Inlet end and an outlet end, said outlet end having an outlet pressure, whereby said at least one tube has a resistance to the flow of a given gas;

a constant temperature liquid bath of water surrounding at least a portion of said permeable tube; and

a constant pressure gas source directly connected to said inlet end for communicating a gas into said tube, whereby an amount of said gas flows through said system in an amount equal to the pressure drop across said system divided by the combined flow resistance of said at least one tube and said water permeates into said tube as a water vapor and intermixes with said gas and a mixture of said water vapor and said gas exits through said outlet end.

16. A fluid transfer system according to claim **15**, wherein said gas source is connected by a pressure regulator to said inlet end.

17. A fluid transfer system according to claim **15**, further comprising means for varying the pressure of said gas.

18. A fluid transfer system according to claim **15**, further comprising means for varying the temperature of said water.

19. A method for producing a mixture of a first fluid and a second fluid, said first fluid having a substantially constant temperature, the method comprising the steps of:

communicating said second fluid at a constant pressure directly into an inlet end of a fluid carrier having a resistance to a flow of a given fluid, whereby an amount of said second fluid flows through said fluid carrier in an amount equal to the pressure drop across said fluid carrier divided by said resistance;

surrounding at least a section of said fluid carrier length with said first fluid;

permeating said first fluid through said fluid carrier and into said amount of second fluid, such that a mixture of said first and second fluids is produced; and

exhausting said mixture through an outlet end of said fluid carrier.

* * * * *