



Dehumidifier And Sterilised Water Generating Apparatus

Field of Invention

The invention relates generally to extraction of moisture from ambient air for processing
5 into sterilised water. In particular, it relates to a process and an apparatus for preparing
sterilised water by condensing moisture from ambient air.

Background

Water is an essential factor for human health since approximately 70% of the human
10 body is water. However, sterilised water is scarce or non-existent in many areas around
the world. This has therefore led to many attempts by inventors to produce sterilised
water from various sources. However, the inventions that were conceived are either too
expensive or inefficient.

15 In developing and third world countries, many people are living with scarce water
supplies for bathing and drinking. Clinics and hospitals in these countries also require
doctors and nurses to compromise with the lack of sterilised water for cleaning wounds
and medicine preparation. This has led to the deaths of many patients in these rural areas.

20 In developed and industrialised countries, there is an increase in both public health
consciousness and awareness of water-borne diseases. It is common sentiment and
knowledge that "bottled" drinks may not be any cleaner than municipally treated water.
A portion of the general public has already installed household type water filters with the
perception that such filters are sufficient. However, few of the household type water
25 filters in the market can significantly remove parasites, viruses, bacteria and heavy
metals. Therefore there is still risk of contaminated water consumption. Children and the
elderly are particularly susceptible to this risk.

Therefore, there is a need for an apparatus that is able to generate sterilised water. The
30 apparatus should be relatively inexpensive to manufacture while being able to operate



with a variety of different types of electrical power supply and requiring minimal maintenance over extended periods in unforgiving environments.

During summer or hot weather, the public usually retreats to cooler places or consumes cold drinks to help cool themselves down. While most water dispensers can provide cold water for consumption to effectively cool the human body internally, they are however unable to condition the temperature of or dehumidify a place in order for the human body to be cooled externally as well. This is especially essential in countries where the weather is warm and humid throughout the year.

United States Patent No. 5,669,221 (LeBleu) describes a water generating apparatus in which moisture from ambient air condenses to form sterilised water. However, such an apparatus uses a dedicated heating strip to heat up the ambient air, a secondary heat absorber to produce cold sterilised water and an electric heater to heat up hot sterilised water.

United States Patent No. 6,755,037 (Engel) also describes a water generating apparatus using moisture from ambient air as a source for providing air conditioning and dehumidification. However this apparatus requires use of physically and functionally separate and independent components to produce hot/cold sterilised water. In addition, the air conditioning function and the apparatus operate spatially away from one another.

Hence, this clearly affirms a need for an integrated water generating apparatus which also provides air conditioning and dehumidifying operations.

Summary

An apparatus disclosed herein is able to generate and dispense sterilised water while advantageously being able to provide air conditioning and dehumidifying functions. Additionally, the apparatus utilises excess heat and cooling from a refrigeration system to maintain the temperature of the sterilised water and is buildable as a single integral

apparatus, therefore maximising the utility of the components within the apparatus and making the apparatus affordable.

Therefore in accordance with one aspect of the invention, a process for preparing
5 sterilised water by condensation of moisture from ambient air is disclosed. This process
comprises the steps of introducing ambient air to a condenser for heating the ambient air
into heated air and forming condensate when the heated air is cooled while being
introduced to a heat exchanger. The condenser and the heat exchanger co-operatively
form a refrigeration system in the apparatus.

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In accordance with a second aspect of the invention, an apparatus for preparing sterilised
water by condensation of moisture from ambient air comprising a condenser for heating
ambient air into heated air and a heat exchanger for reducing the temperature of the
heated air. The condenser and the heat exchanger form a refrigeration cycle wherein
15 ambient air is guided through the condenser and is heated by heat generated from the
condenser. The heated air is directed to the heat exchanger whereby condensate is
substantially formed when the heated ambient air interacts with the heat exchanger. The
condenser and the heat exchanger co-operatively form a refrigeration system in the
apparatus.

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In accordance with a third aspect of the invention, an apparatus for preparing sterilised
water by condensation of moisture from ambient air comprising a condenser for heating
ambient air into heated air and a heat exchanger for reducing the temperature of the
heated air. The condenser and the heat exchanger co-operatively form a refrigeration
25 system in the apparatus wherein ambient air is guided through the condenser and is
heated by heat generated from the condenser. The heated air is directed to the heat
exchanger whereby condensate is substantially formed when the heated ambient air
interacts with the heat exchanger. After the heated air is cooled, cooled dehumidified air
is formed and exhausted out of the apparatus for cooling and dehumidification.

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Brief Description of the Drawings

Embodiments of the invention are described hereinafter with reference to the drawings, in which:

5 Fig. 1a is a front perspective view of a water generating apparatus according to a preferred embodiment of the invention;

Fig. 1b is a back perspective view of the water generating apparatus of Fig. 1a;

10 Fig. 2 illustrates a basic system flow diagram of the water generating apparatus of Fig. 1a; and

Fig. 3 is a cross-sectional side elevation of the water generating apparatus of Fig 1a, illustrating air flow within the water generating apparatus.

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Detailed Description

With reference to the drawing, a process and an apparatus according to embodiments of the invention for generating and dispensing sterilised water are described hereinafter for extracting moisture from ambient air to produce sterilised water while providing air
20 conditioning and dehumidifying functions.

Water is scarce in many developing or third world countries. The lack of sterilised water has been the cause of many epidemics around the world. Doctors and nurses in these countries have to make do with unsterilised water to clean wounds and for medicine
25 preparation. This has drastically reduced the health and hygiene level of people in such countries. Ironically, water can be found in and extracted from the air that everyone breathes.

The process and apparatus provided herein according to the embodiments of the
30 invention facilitate extraction of moisture from ambient air for producing sterilised water while providing air conditioning and dehumidifying functions. The process and

apparatus are additionally capable of keeping the sterilised water in both warm and cold states.

For purposes of brevity and clarity, the description of the embodiments of the invention is limited hereinafter to applications related to moisture from ambient air being extracted and processed into sterilised water. This however does not preclude the invention from other areas of application that requires similar operating functions and performance for generating and dispensing water.

The embodiments of the invention are described in greater detail hereinafter for the process and the apparatus therefor for converting moisture in ambient air into sterilised water. In the detailed description provided hereinafter and illustrations provided in Figs. 1a to 3 of the drawings, like elements are identified with like reference numerals.

Figs.1a and 1b are front and back perspective views of a water generating apparatus 100 respectively. The water generating apparatus 100 is primarily for extracting the moisture from the ambient air for processing into sterilised water 101 (as shown in Fig. 2). The water generating apparatus 100 includes an enclosure 102, which is shown in exploded view in Fig.1a, and a refrigeration system, which in turn includes a condenser 106, a heat exchanger 108 and a compressor 110. The water generating apparatus 100 further includes a fan assembly 112 for drawing the ambient air into the water generating apparatus 100, a hot water container 114, a cold water container 116 and a filtration system 137 (as shown in Fig. 2) for removing impurities in order to produce sterilised water 101.

The enclosure 102 comprises a front panel 117, a top panel 118 and three side panels 119 for enclosing the components of the water generating apparatus 100 and providing an air flow path beginning with the drawing in of ambient air into the water generating apparatus 100 and ending with the blowing of cooled and dehumidified air out of the water generating apparatus 100. The enclosure 102 is fitted with a washable air filter 120 covering an inlet opening on the front panel 117 for allowing the ambient air to enter the

enclosure 102 as well as includes an outlet opening 121 for exhausting cooled and dehumidified air. The washable air filter 120 filters dust and particles from the ambient air drawn into the water generating apparatus 100.

5 In a typical refrigeration system, the condenser 106 is formed in a block shape, comprising a convoluted piping (not shown) being conveyance mean for the refrigerant. The convoluted piping has straight portions and bends in which the straight portions are substantially parallel. In addition, plate-like fins (not shown) are assembled transversely across the straight portion of the convoluted piping. Similarly, the heat exchanger 108
10 also comprises a convoluted piping (not shown) and plate-like fins (not shown).

A refrigerant (not shown) flows in a refrigeration cycle within the refrigeration system whereby the refrigerant is compressed in the compressor 110 and then fed to the condenser 106. The condenser 106 in turn liquefies the refrigerant to dissipate heat into
15 the air around the condenser 106. Thereafter, the liquefied refrigerant flows into the heat exchanger 108 and receives heat from the air around the heat exchanger 108 which in turn converts the refrigerant into a gaseous state. Subsequently, the gaseous refrigerant is flowed back into the compressor 110 whereby the refrigerating cycle restarts again.

20 With reference to Fig. 2, which illustrates a basic system flow diagram of the water generating apparatus 100, filtered air 122 being ambient air drawn into the water generating apparatus 100 and filtered by the washable air filter 120 is flowed through the condenser 106 wherein heat from the condenser 106 is advantageously used to heat the filtered air 122 instead of being a useless by-product. The heating of the filtered air 122
25 provides two advantages. Firstly, increasing the temperature difference between the heated air 123 and the cooled dehumidified air that eventually leaves the water generating apparatus 100. This increased temperature difference substantially increases the moisture content that can be extracted from the ambient air. Secondly, the heated air 123 substantially prevents freezing of the heat exchanger 108.

After the formation of the heated air 123, the fan assembly 112 draws the heated air 123 along an air flow channel 124 as shown in Fig. 3, which is a side elevation view of the water generating apparatus 100, illustrating the air flow of the ambient air within the water generating apparatus 100. The air flow channel 124 is located adjacent to the condenser 106, hot water container 114 and the fan assembly 112, wherein the condenser 106, the hot water container 114 and the fan assembly 112 are stacked upwardly from the base of the water generating apparatus 100, and distally away from the washable air filter 120.

Subsequently, the heated air 123 is drawn upwards in the air flow channel 124 and through the fan assembly 112 located above the hot water container 114. The fan assembly 112 is disposed adjacent to the heat exchanger 108. The fan assembly 112 then blows the heated air 123 towards and through the adjacent heat exchanger 108 which is placed oblique in respect of the direction of the air flow of the heated air 123. The heat exchanger 108 is supported by two flat panels on the side of the heat exchanger 108 which also helps to enclose the air flow path and direct the heated air 123 towards the heat exchanger 108. The heat exchanger 108 is placed in an oblique position to allow the heated air 123 to come in contact with a larger surface area. Therefore, when the heated air 123 comes in contact with the heat exchanger 108, the liquefied refrigerant in the convoluted piping of the heat exchanger 108 cools the heated air 123. Hot liquid condensate 125 starts to form when the temperature of the heated air 123 approaches dew point. Thereafter the hot liquid condensate 125 is then formed on chemically inert dew collector surfaces 126 of the heat exchanger 108.

The oblique position of the heat exchanger 108 also advantageously allows the formed hot liquid condensate 125 to gravitate and flow down substantially easier into the hot water container 114. A water filter (not shown) first filters the hot liquid condensate 125 before it flows into the hot water container 114. Furthermore, heat from the condenser 106 located below the hot water container 114 is utilised to heat the hot liquid condensate 125 within the hot water container 114 for substantially maintaining the heat therein. The heat substantially prevents bacterial growth within the hot water container 114.

The water generating apparatus 100 also includes the cold water container 116 for storing cold water. Heated condensate 128 from the hot water container 114 is flowed through a section of tubing (not shown) into the cold water container 116. Thereafter the cold water container 116 is kept cold for forming cold condensate 130 wherein the refrigerant (not shown) from the heat exchanger 108 to the compressor 110 is used to cool the cold water container 116. In addition, the low temperature substantially prevents bacteria from growing in the cold condensate 130. Additionally, a water filter (not shown) can be disposed between the hot water container 114 and cold water container 116 for further filtering the heated condensate 128 before being conveyed into the cold container 116.

The hot and cold water containers 114/116 form a container assembly. Within the hot and cold water containers 114/116, sensors (not shown) are installed. These sensors detect the level of condensate within the hot and cold containers 114/116 and thus prevent overflowing by stopping heated or cold condensates 128/130 from further flowing into the respective water containers. Prior to overflowing of the hot container 114, the sensor of the hot container 114 switches the compressor 110 off to stop condensate production. A valve (not shown) connecting the cold water container 116 to the hot water container 114 shuts prior to overflowing of the cold water container 116. Even though the compressor 110 is switched off, the refrigerant within the condenser 106 and the heat exchanger 108 allows the temperature of respectively the hot and cold water containers 114/116 to be maintained. The sensor of the cold water container 116 also controls the operation of an ultraviolet (UV) lamp 132. The UV lamp 132 is applied to the cold water container 116 to substantially eradicate any remaining bacteria therewithin. Alternatively, the UV lamp 132 can be further applied to the hot water container 114 to substantially eradicate any remaining bacteria therewithin.

Both the heated condensate 128 and the cold condensate 130 contained respectively within the cold and hot water containers 114/116 are delivered to an external water dispensing unit 136 for dispensing as drinking water. Additionally, the collected condensates 128/130 can be stored in external storage containers or bottles 136 for later usage. However, before the collected condensates 128/130 are dispensed for storage, the

collected condensates 128/130 are further filtered through the filtration system 137 for sterilizing the collected condensates 128/130 prior to being dispensed as the sterilised water 101.

- 5 Preferably, the filtration system 137 comprises four stages, namely, a pre-carbon filter, a sediment filter, an ultra-fine membrane filter and a ultra-violet light filter (all not shown). These filters are designed to substantially withstand a water flow rate of 60 litres/hr. After the collected condensate 128/130 is filtered through the filtration system, impurities and particles of up to 0.01 micron, odorous constituents and harmful chemicals are
10 substantially removed. Essentially, sterilised water 101 is eventually produced from the water generating apparatus 100 and introduced as drinking water for the public.

Besides being able to generate water, the water generating apparatus 100 also operates as an air conditioner and a dehumidifier. When the ambient air is introduced to the heat
15 exchanger 108, moisture is extracted from the ambient air to leave cooled dehumidified air 138 therefrom. The cooled dehumidified air 138 is subsequently exhausted through the outlet opening 121. This invention therefore not only generates sterilised water 101 but also functions as an air conditioner and a dehumidifier.

- 20 In the foregoing manner, a process and an apparatus for facilitating extraction of moisture from ambient air for processing into sterilised water 101 while providing air conditioning and dehumidifying functions are disclosed. While a particular embodiment of the invention has been herein described, it becomes apparent to one skilled in the art in view of this disclosure that numerous changes and/or modifications can be made without
25 departing from the scope and spirit of the invention.

Claims

1. A process for preparing sterilised water in an apparatus by condensation of moisture from ambient air comprising the steps of:

5 a) introducing ambient air to a condenser for heating the ambient air into heated air; and

b) forming condensate by cooling the heated air, the heated air being cooled when being introduced to a heat exchanger,

wherein the condenser and the heat exchanger co-operatively form a refrigeration system in the apparatus.

2. The process as in claim 1, the step of introducing the ambient air to the condenser comprising the step of:

filtering the ambient air using an air filter for removal of particles therefrom.

3. The process as in claim 1, the step of forming condensate comprising the step of: cooling the heated air on a surface of the heat exchanger to form the condensate thereon.

4. The process as in claim 3, the step of cooling the heated air comprising the step of:

exhausting cooled dehumidified air out of the water generating apparatus for dehumidification.

5. The process as in claim 3, the step of cooling the heated air comprising the step of:

providing a fan assembly for displacing the heated air through an air flow channel in the apparatus and towards the heat exchanger.

6. The process as in claim 1, further comprising the step of:

collecting the condensate in a hot water container for heating into heated condensate, the hot water container being heated by the condenser for achieving a substantially high temperature to thereby substantially reduce bacteria growth in the heated condensate.

7. The process as in claim 1, further comprising the step of:

cooling the condensate by directing the condensate into a cold water container to thereby obtain cold condensate therefrom, the cold water container being chilled by refrigerant from the heat exchanger for achieving a substantially low temperature to thereby substantially reducing bacteria growth.

8. The process as in claim 1, further comprising the step of:

filtering the condensate through a filtration system for obtaining sterilised water therefrom, the filtration system for substantially removing impurities from the condensate.

9. An apparatus for preparing sterilised water by condensation of moisture from ambient air comprising:

a condenser for heating ambient air into heated air; and

a heat exchanger for reducing the temperature of the heated air,

wherein the condenser and the heat exchanger co-operatively form a refrigeration system in the apparatus.

10. The apparatus as in claim 9, further comprising:

an enclosure for housing the condenser and the heat exchanger, the enclosure having air inlet opening and air outlet opening.

11. The apparatus as in claim 10, the enclosure further comprising:

a filter for removing particles from the ambient air being drawn into the enclosure.

12. The apparatus as in claim 9, further comprising:
a fan assembly for displacing the heated air through an air flow channel in the apparatus and towards the heat exchanger.

5 13. The apparatus as in claim 9, the heat exchanger comprising surfaces being coated with a chemically inert surface coating, wherein the heated air is cooled against the surfaces for forming the condensate therefrom.

10 14. The apparatus as in claim 9, wherein after the heated air is cooled by the heat exchanger, cooled dehumidified air is exhausted out from the apparatus for dehumidification.

15 15. The apparatus as in claim 9, further comprising:
at least one filter for filtering particles from the condensate; and
a container assembly for receiving and containing condensate filtered by the at least one filter.

16. The apparatus as in claim 15, the container assembly further comprising:
at least one of a hot container and a cold container, wherein the hot container is
20 for at least substantially heating the condensate therein, the hot container being heated by heat generated from the condenser, and the cold container is for at least substantially reducing the temperature of the condensate collected therein, the cold container being conductively cooled by return refrigerant from the heat exchanger;
wherein the at least one filter is for filtering condensate contained in at least one
25 of the hot container and the cold container.

17. The apparatus as in claims 16, at least one of the hot and cold container further comprising:
a sensor for detecting the amount of condensate contained within the container.

18. The apparatus as in claim 9, further comprising:
a filtration system for sterilizing the condensate before being dispensed as
sterilised water.
- 5 19. The apparatus as in claim 18, the filtration system comprising at least one of:
a pre-carbon filter;
a sediment filter;
an ultra-fine membrane filter; and
an ultra-violet light filter,
10 wherein the filtration system is adapted for substantially withstanding a water
flow rate of 60L/hr and for removing and trapping at least one of impurities and particles
of up to 0.01micron, odorous constituents and harmful chemicals.
20. The apparatus as in claim 19, further comprising:
15 a dispenser for dispensing the sterilised water filtered by the filtration system.
21. The apparatus as in claim 19, further comprising:
an external storage container for storing the sterilised water filtered by the
filtration system.
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22. An apparatus for preparing sterilised water by condensation of moisture from
ambient air comprising:
a condenser for heating ambient air into heated air; and
a heat exchanger for reducing the temperature of the heated air to eventually
25 obtain cooled dehumidified air therefrom;
wherein the cooled dehumidified air is exhausted from the apparatus for cooling
and dehumidification, and the condenser and the heat exchanger co-operatively form a
refrigeration system in the apparatus.