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(54) **A method and apparatus for producing oxygen enriched water**

(57) The method for dissolving oxygen into water comprises of diffusing oxygen in small fine bubbles at the bottom of the water column in a closed vessel (101), building headspace pressure above the water column in the vessel, and circulating the oxygen from the headspace continuously till the desired oxygen dissolved concentrate of water is obtained. The apparatus for dissolving oxygen into water, comprises of an enclosed vessel (101), porous metallic diffusers (102), an agitator, a rotating hollow-shaft (103) extending till the bottom end of the water column, ventury slot (105) on the hollow-shaft configured to stay above the water level, and a disc (106) at the bottom end of the rotary hollow-shaft (103).

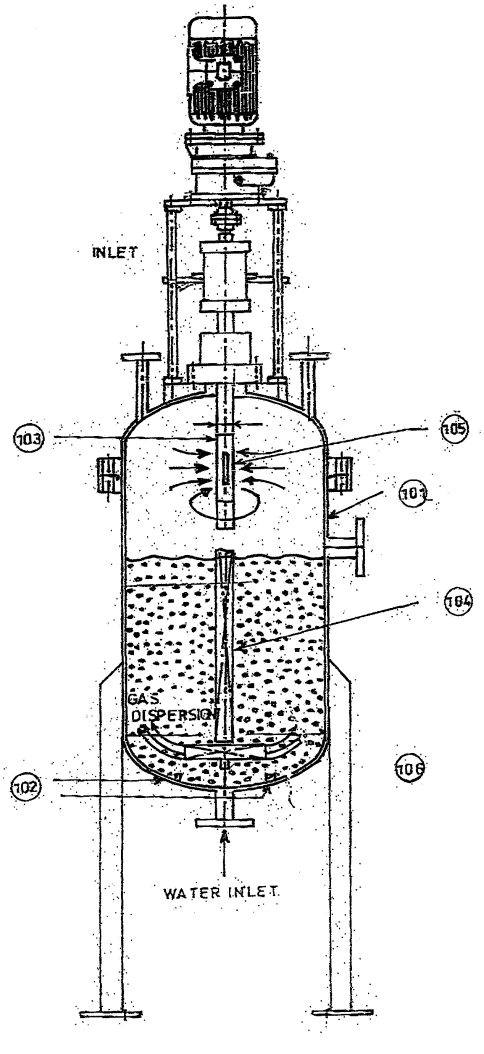

FIG. 3

EP 1 767 261 A1

Description

[0001] This invention relates to a method and an apparatus for dissolving a gas into water. In particular, the invention relates to a method and an apparatus for dissolving oxygen into water to increase it's proportion.

[0002] It is no secret that oxygen and water are the two most basic essentials of life and energy. Oxygen is a natural energizer and body purifier. Water contains oxygen, but in a very low proportion, like 5 - 6 ppm. or the like. The invention provides a method and an apparatus for dissolving a greater proportion of oxygen than found in normal potable water.

[0003] Since, all of the bodies activities are regulated by oxygen, the making of sufficient levels of oxygen available to every part of the body promotes optimum health and a person's ability to think and act effectively. Just as the body's need for sufficient healthy foods, pure healthy water and exercise have been firmly established; the body's need for sufficient levels of oxygen has also been firmly established.

[0004] It is established that the human body is approximately 70% water. Medical Associations have recommended eight glasses of water as an average daily requirement in order to have optimum health. Water contains no calories and serve as an appetite suppressant and helps to metabolize stored fats in the body. Water regulates body's temperature and dissolves the body's waste products and flushes out the body's toxins. Water is also necessary to maintain proper muscle tone and proper digestion.

[0005] There is no substitute for inadequate oxygen. When the body is oxygen deficient, it is not equipped to have proper chemical reactions occur throughout the body. Without oxygen, the blood and cells are weakened and impaired of waste efficiently. All body cells are weakened and impaired of their functioning, if deprived of oxygen. In fact, some cells if deprived of oxygen may mutate into colonies of disease in their attempt to survive. Brain cells die in just 15 seconds if deprived entirely of oxygen. It was suggested that the lack of a need for oxygen is the property of cancel cells that uniquely distinguishes them from normal cells.

[0006] Oxygen is also critical to the healing process. It is believed that increase in oxygen level helps red blood cells to pick up the extra oxygen and become energized. Thus, the body retains the capability to remove waste gases and toxins efficiently and the cells begin to function normally. Anaerobic viruses, bacteria and fungi are neutralized, and body chemical reactions are charged up. When oxygen level in the blood is up, it is felt better, energetic, healthier and brain gets purified.

[0007] Since, the body cannot store oxygen, it is depended on a life-long steady supply to sustain life. One of the ways body gets oxygen is by breathing air. The atmospheric air is known to contain about 21% oxygen, which is absorbed into our lungs. The lungs attach oxygen to read blood cells (hemoglobin) and the blood stream transports it to the cells of various organs and muscles in the body. In the cells, the energy is set free and used.

[0008] As the life gets aged, the body develops various degrees of oxygen shortages in the blood stream, due to the fact that respiratory and circulatory systems do not work at full capacity. Those who smoke have had prolonged exposures to polluted air, or have other respiratory illnesses suffer from even greater diminished lung capacity. Therefore, it is not unusual for the air volume in our lungs to drop from the average 5 to 7 liters down to 3 to 4 liters as the body ages and gets exposed to harmful environment conditions. This represents a 40% loss in lung capacity, and a resulting loss in blood oxygen saturation. Stress, malnutrition, illness and lack of physical activities can also contribute to reductions in oxygen levels.

[0009] To summarize, when there is inadequate oxygen in the body, physical energy is drained, it is unable to function properly and just do not feel right. Oxygen is critical to good health and general well being.

[0010] Increasing oxygen level in drinking water can enhance availability of oxygen to the body through breathing atmospheric air. Since, the ambient conditions of pressure and temperature, the oxygen solubility in water varies from 6.5 mg/lit. to 13 mg/lit., on naturally occurring water, surface or underground, the dissolved oxygen concentration is from 5 mg/lit. to 11 mg/lit. In view of development of industries and increase in pollutant discharges, in most of the naturally available sources of water there is a depletion of oxygen and there is growing awareness among the common people to opt for bottled water, whenever there is uncertainty of naturally available water.

[0011] Invention therefore, provides a method and an apparatus for enriching water with dissolved oxygen, which is absorbed into the body when consumed. The method envisaged according to the present invention will operate at conditions of high oxygen solubility. Solubility of oxygen in water depends upon critical parameters, i.e. to say -

Water temperature
Water salinity
Oxygen partial pressure

Oxygen solubility is -

Inversely proportional to water temperature,
Inversely proportional to water salinity, and
Is directly proportional to oxygen's partial pressure.

[0012] By operating at suitable values of these among other parameters, in accordance with the present invention, high oxygen solubility in water is achieved.

[0013] Oxygen being a sparingly soluble gas, it's percentage (mole fraction) in gas phase is directly proportional to it's percentage (mole fraction) in water. The proportionality constant varies with temperature. In mathematical form, this statement is presented as -

$$Y = H(T)X$$

Where,

Y - mole fraction of oxygen in the gas phase.

H(T) - temperature dependent proportionality constant.

X - oxygen's mole fraction in water.

[0014] By using the above said formula, oxygen solubility in water under ambient conditions is plotted below as a function of temperature. It may be noted that the air contains 21% oxygen; therefore, mole fraction of oxygen in the gas phase is 0.21.

[0015] The invention will now be described with reference to illustrative figures in the accompanying drawings, in which

Fig.1 is a graph showing the oxygen solubility in water versus the temperature.

Fig. 2 represents a graph of the desired oxygen partial pressure as a function of the temperature.

Fig. 3 is an illustrative plan of the apparatus of the present invention for dissolving oxygen into water.

[0016] The graph of fig. 1 shows that under the ambient conditions, the oxygen solubility in water varies from 6.5 - 13 ppm. This is why in naturally occurring waters, the DO levels of 5-11 mg/lit are observed.

[0017] Again, by using the above formula, the plot fig. 2 shows the desired oxygen partial pressure as a function of temperature for oxygen solubility from 15 - 75 mg/ lit.

[0018] From the figures 1 and 2, it can be seen that to achieve a dissolved oxygen concentration of 45 mg/lit. at normal water temperature of 25C, the required oxygen partial pressure is about 1.1 atm.

[0019] The desired oxygen partial pressures may be achieved either by compressing air to a 5 times higher pressure, or by having pure oxygen at the desired pressure.

[0020] Under the circumstances discussed hereinabove, the process for increasing the dissolved oxygen level in water in accordance with the present invention revolves around tasks -

Reducing the water salinity;

Reducing water temperature;

Increasing the oxygen partial pressure; and

[0021] Improving the contact between oxygen and water - i.e. providing high interfacial area.

[0022] Low salinity is achieved by passing natural waters through membrane filters. Salinity of less than 100 mg/lit. is easily achieved by passing water through Reverse Osmosis membranes.

[0023] Water temperature is reduced through heat exchangers, such as shell and tube devices or jacketed vessels.

[0024] Increased oxygen partial pressure is achieved by either compressing air, or by feeding compressed oxygen in a pressure vessel.

[0025] Contact area between oxygen and water is improved by employing packed beds, or by diffusing the gas (air/oxygen) from the bottom of the pressure vessel, or by splashing water in pressurized gas (air/oxygen), or by employing a special agitator device. Gas diffusers made from various materials such as membranes, ceramics, sintered metals and the like are employed.

[0026] The apparatus envisaged according to the present invention for increasing dissolved oxygen in the water is a pressure vessel in which air or pure oxygen is injected into the vessel from bottom through porous metal diffusers suitable for drinking water applications, which are capable of diffusing the gas into very fine bubbles.

[0027] The oxygen injected at the bottom of the reactor, after attaining saturation in the water column, raises through the water column in the form of very fine bubbles. The un-dissolved oxygen bubbles burst at the water surface, and this fills up the vessel headspace and pressure develops.

[0028] An agitator rotating at the center of the vessel has a hollow shaft, which extends up to the bottom end of the vessel. A ventury slot is provided at the top of the hollow shaft. A disc like device, or an impeller or the like device is provided at the bottom end of the hollow shaft. The water level in the vessel is maintained below the ventury slot in the hollow shaft. Suction is created in the ventury slots on rotation of the agitator. Due to the suction, oxygen in the headspace gets sucked into the hollow shaft, which gets discharged from the bottom end outlet. The disc like device or an impeller or the like device at the bottom end of the hollow shaft continuously re-injects the oxygen into the water in the form of small bubbles. The continuous recycling of the unutilized oxygen in the headspace helps to attain super saturation of oxygen in water and thus improves efficiency of the process.

[0029] In accordance with a preferred embodiment of the invention, the water in the pressure vessel is cooled with heat exchanger devices located either inside or outside the vessel. The equipment is operated in a batch mode or in continuous mode.

[0030] According to the invention a method for dissolving oxygen into water to increase the proportion, comprises the steps of diffusing oxygen in small fine bubbles at the bottom of the water column in a closed vessel; building headspace pressure above the water column in the vessel; and circulating the oxygen from the headspace continuously till the desired oxygen dissolved concentrate of water is obtained.

[0031] According to the invention an apparatus for dissolving oxygen into water, comprises of an enclosed vessel; built-in porous metallic diffusers at the bottom of the said vessel; an agitator at the top of the said vessel; the said agitator having a rotating hollow-shaft extending till the bottom end of the water column in the said vessel; at least one ventury slot on the said hollow-shaft configured to stay above the water level; and a disc at the bottom end of the said rotary hollow-shaft.

[0032] Referring to the figure 3, numeral 101 is an en-

closed vessel. 102 are built-in porous metallic diffusers at the bottom of the vessel 101, 103 is an agitator at the top of the vessel 101, 104 is a rotating hollow-shaft of the agitator 103 that extends till the bottom end of the water column in the vessel 101. 105 is ventury slot on the hollow-shaft that is configured to stay above the water level in the vessel 101.106 is a disc at the bottom end of the said rotary hollow-shaft, which may be an impeller.

Table hereunder is Trial Conditions:

Process parameter	Trial range
Water temperature	10 - 30°C
Water salinity	50 -1000 mg/lit.
Oxygen partial pressure	0.3 - 2.0 kg/cm^2
Mode of operation	Continuous flow
Hydraulic retention time	Up to 1 hour
Agitator rpm	60-150

[0033] At the above operating conditions, in the water, dissolved oxygen concentrations of 20 mg/lit. to 60 mg/lit. was obtained.

Claims

1. A method for dissolving oxygen into water to increase the proportion, comprises the steps of diffusing oxygen in small fine bubbles at the bottom of the water column in a closed vessel; building headspace pressure above the water column in the vessel; and circulating the oxygen from the headspace continuously till the desired oxygen dissolved concentrate of water is obtained.

2. A method as claimed in claim 1, wherein the said oxygen is pure oxygen.

3. An apparatus for dissolving oxygen into water, comprises of an enclosed vessel; built-in porous metallic diffusers at the bottom of the said vessel; an agitator at the top of the said vessel; the said agitator having a rotating hollow-shaft extending till the bottom end of the water column in the said vessel; at least one ventury slot on the said hollow-shaft configured to stay above the water level; and a disc at the bottom end of the said rotary hollow-shaft.

4. An apparatus for dissolving oxygen into water as claimed in claim 3, wherein there is provided multiple ventury slots in the rotating hollow-shaft.

5. An apparatus for dissolving oxygen into water as claimed in claims 3, or 4, wherein the said disc is an impeller.

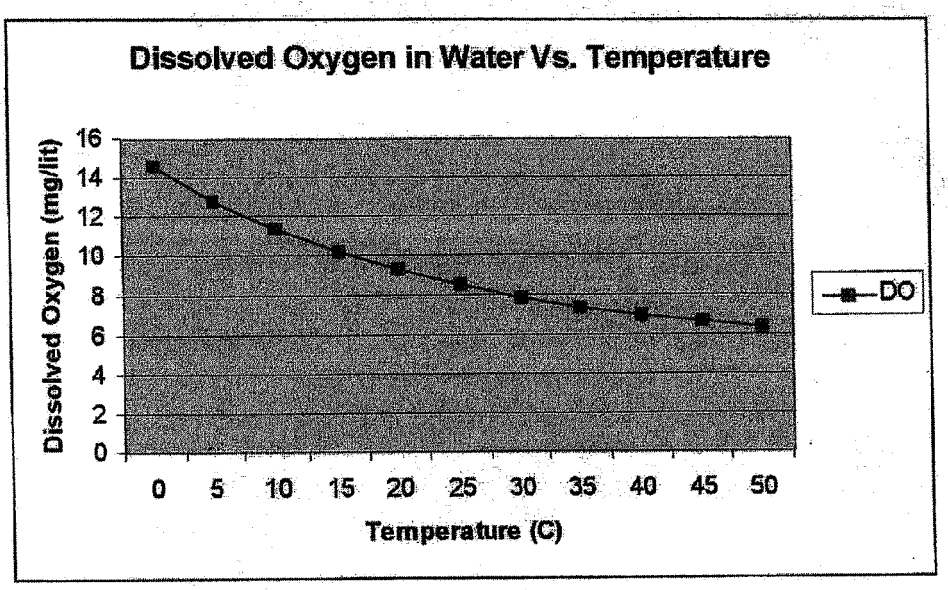
Dissolved Oxygen in Water Vs. Temperature
Dissolved Oxygen (mg/lit)
16
14
12
10
8
6
4
2
0
0 5 10 15 20 25 30 35 40 45 50
Temperature (C)
DO

Fig 1.

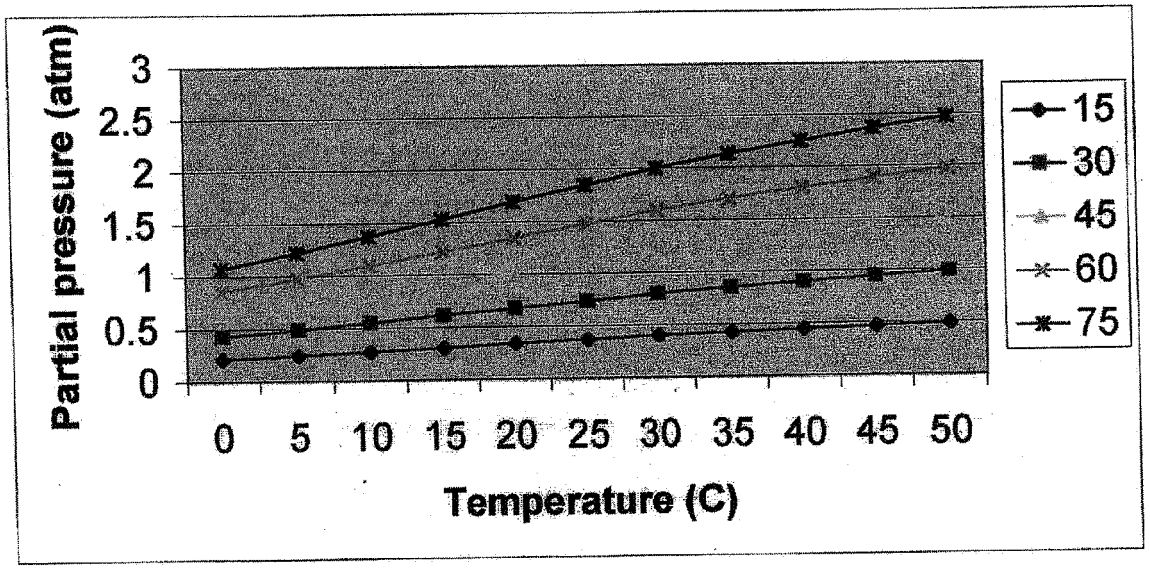
Partial pressure (atm)
3
2.5
2
1.5
1
0.5
0
0 5 10 15 20 25 30 35 40 45 50
Temperature (C)
15
30
45
60
75

Fig 2.

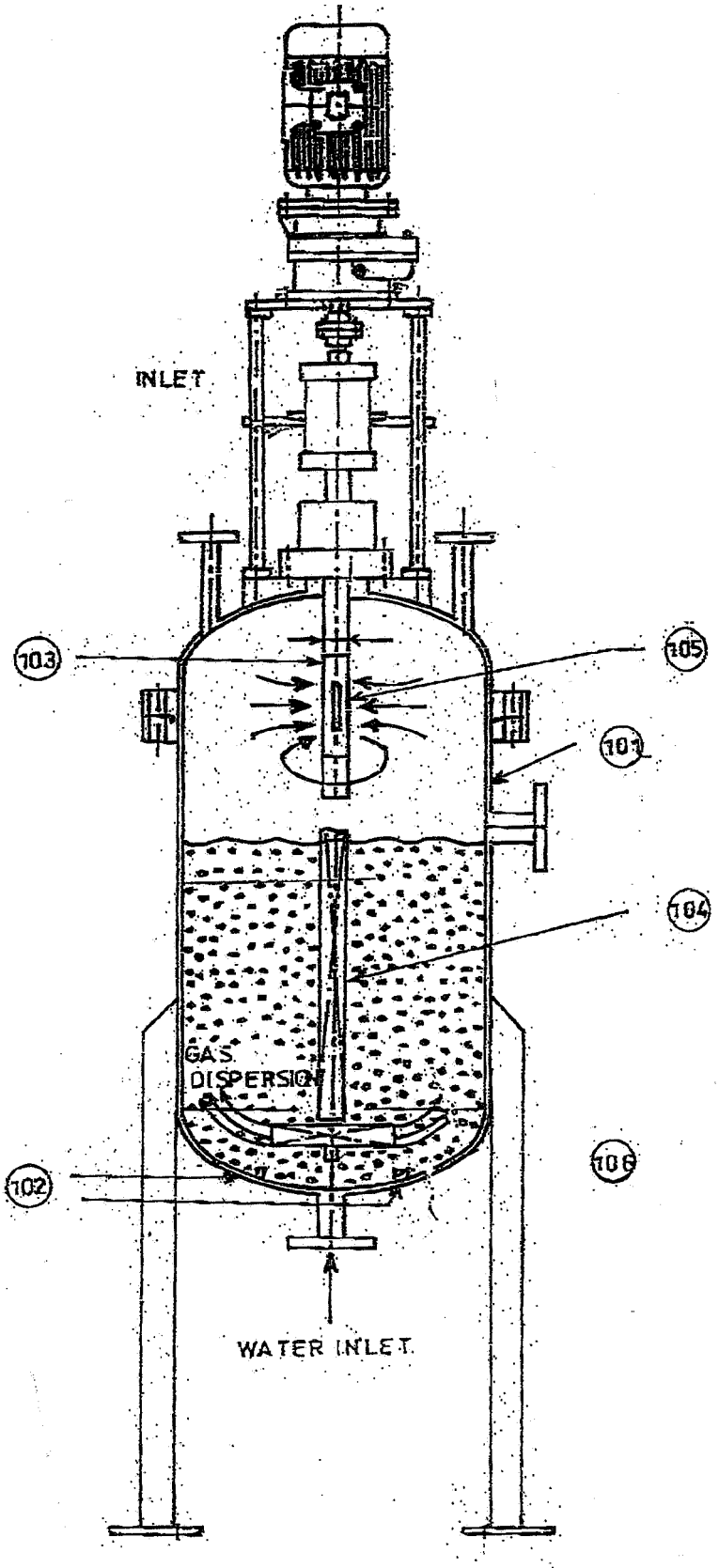

FIG. 3

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EUROPEAN SEARCH REPORT

Application Number
EP 05 10 8857

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	1 March 2006	Muller, G

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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EPO FORM 1503 03.82 (P04C01)

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