Gravitational Condensation of Atmospheric Water Vapor

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Devices that collect water from the atmospheric air using condensation are well-known. They operate in a manner very similar to that of a *dehumidifier*: air is passed through a cooled coil, making water to condense. This is the most common technology in use. Here, we present a device that can collect a *large amount of water* (more than $1m^3/s$) from the atmospheric air using *gravitational condensation*. Another novelty of this device is that it consumes little electricity. In addition, the new technology of this device leads to a new concept of pump, the *Gravitational Pump*, which can be used to pump water at very low cost from aquifers, rivers, lakes, etc., and also to supply the high pressure (100atm or more) needed to push seawater through the semipermeable membrane, in the desalinization process known as *reverse osmosis*.

Key words: Gravitational Condensation, Atmospheric Water, Reverse Osmosis, Gravity, Water Crisis.

1. Introduction

The percentage of water vapor in the atmospheric air varies from 0.01% at -42 °C [1] to 4.24% at 30 °C [2]. Water vapor is only water in the form of invisible gas. The atmospheric air contains 0.001% of the planet's water, which has a total volume of $1.338\times10^{18}m^3$ [3]. Thus, the Earth's atmosphere contains a volume of about $10^{13}m^3$ of water, which is kept constant by cycle evaporation /condensation. On the other hand, the world's population consumes currently 9,087 billion cubic meters of water per year ($\sim10^{13}m^3$) [4], which is approximately, the same value maintained constant in the atmospheric air.

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A vapor is gas at a temperature lower than its critical point [5], which means that the vapor can be condensed to a liquid *by increasing its pressure* without reducing the temperature. The water, for example, has a critical temperature of 374 °C, which is the highest temperature at which liquid water can exist. Therefore, in the atmosphere at ordinary temperatures, water vapor *will condense to liquid if its pressure is sufficiently increased*.

Here we show how a large amount of atmospheric water vapor (more than $1m^3/s$) can be condensed to liquid *by means of gravitational compression* produced in a compression chamber, where gravity is strongly increased by using gravity control technology (BR Patent Number: PI0805046-5, July 31, 2008 [6]) based on the discovery of correlation between gravitational mass and inertial mass [7]. Also we present a *Gravitational Pump*, which works based on the same principles, and can be used to pump water at very low cost from aquifers, rivers, lakes, etc., and also to supply the high pressure (100atm or more) needed to push seawater through the semipermeable membrane, in the desalinization process known as reverse osmosis.

2. Theory

The *gravitational mass* m_g and *inertial mass* m_i are not equivalents, but correlated by means of a factor χ, i.e.,

$$m_g = \chi\ m_{i0} \tag{1}$$

where m_{i0} is the *rest* inertial mass of the particle.

The expression of χ can be put in the following form [7]:

$$\chi = \frac{m_g}{m_{i0}} = \left\{1-2\left[\sqrt{1+\left(\frac{B^2}{\mu\,\rho\,c^2}n_r\right)^2}-1\right]\right\} \tag{2}$$

where n_r is its index of refraction; B is the intensity of the magnetic field (T); ρ is the matter density of the particle; c is the speed of light; μ is the magnetic permeability of the mean.

It was shown that there is an additional effect - *Gravitational Shielding* effect - *produced by a substance whose gravitational mass was reduced or made negative* [8]. It was shown that, if the *weight* of a particle in a side of a lamina is $\vec{P} = m_g \vec{g}$ ($\vec{g}$ perpendicular to the lamina) then the weight of the same particle, in the other side of the lamina is $\vec{P}' = \chi m_g \vec{g}$, where $\chi = m_g / m_{i0}$ (m_g and m_{i0} are respectively, the gravitational mass and the inertial mass of the lamina). Only when $\chi = 1$, the weight is equal in both sides of the lamina. The lamina works as a Gravitational Shielding. This is the *Gravitational Shielding* effect. Since $P' = \chi P = (\chi m_g) g = m_g (\chi g)$, we can consider that $m'_g = \chi m_g$ or that $g' = \chi g$.

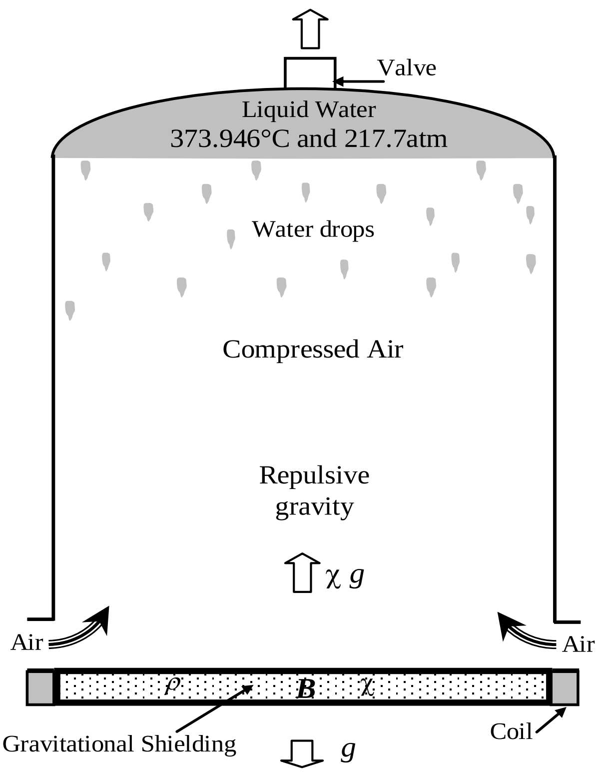

Fig. 1 – *Gravitational Condenser*. Condensation of the atmospheric water vapor *by means of gravitational compression.* (Developed starting from a process *patented* in July, 31 2008, PI0805046-5 [6]).

Now consider the system shown in Fig.1. At the base of the compression chamber there is a *gravitational shielding*. In this case, this device is basically a hollow cylinder, where a magnetic field B passes through its air core. The air density inside the cylinder was reduced down to $\rho = 8.017 \times 10^{-14}\, kg.m^{-3}$ *, in order to produce a strong value (negative) of χ, using a practicable value of B. Thus, according to Eq. (2), the value of χ inside the air core is given by

$$\chi = \left\{1 - 2\left[\sqrt{1 + 1217620 B^4} - 1\right]\right\} \tag{3}$$

Consequently, for $B = 1.0T$, we obtain

$$\chi \cong -217.7 \tag{4}$$

This means that the air inside the compression chamber can be subjected *up to* a pressure 217.7 times greater than the atmospheric pressure at the Earth's surface, i.e., 217.7atm.

The *pressure* required to liquefy (to condense) water vapor at its critical temperature (373.946°C, 647.096K) is 217.7atm [9]. When this occurs in the Gravitational Condenser, water drops are driven to the top of the chamber (See Fig.1), because they are subjected to *repulsive gravity*† χg. Thus, this "reverse rain" fills with water the top of the compression chamber. Then, the regulator valve (placed at the top of the chamber) opens, releasing the water to be stored and distributed. After the exit of the water, occurs the exit of the dehumidified air, which was inside the compression chamber. When the pressure inside the chamber becomes equal to the atmospheric pressure, the regulator valve is closed, and a new cycle of compression begins, in order to produce more water.

If the atmospheric air inside the Gravitational Condenser is at temperature of 30 °C, then the percentage of water vapor contained it is 4.24% [2]. Assuming that the Gravitational Condenser can withdraw of the air just 30% of this value, then the total *volume of water* withdrawal from the atmospheric air inside the chamber will be $1.27\% (\rho_{wvapor} / \rho_{water})$ *of the volume of atmospheric air compressed inside the compression chamber*. Since the *state equation*, gives $\rho_{wvapor} = 2.2 \times 10^{-3} (p_{wvapor}/T)$ [10], then for $p_{wvapor} \cong 217.7 atm = 2.2 \times 10^7 N/m^2$ and $T = 647.096K$, we get $\rho_{wvapor} \cong 74.8 kg.m^{-3}$. Thus, if the volume of the compression chamber of the Gravitational Condenser is 1,000 m^3, ($10m \times 10m \times 10m$) and the *volume of the compressed air* inside the chamber

* This density is equivalent to Earth's atmospheric density at about 600km height.

† In respect to Earth's gravity which is *attractive*.

is 217.7×(the volume of the chamber)=217,700 m^3, then the total volume of water withdrawal from the atmospheric air will be given by $(1.27\%/100)(\rho_{wvapor}/\rho_{water})\times 217{,}700 \cong 207 m^3$ of water. Assuming that the time interval required to condense this volume of water is approximately 60*s*, then just *one* Gravitational Condenser with the mentioned characteristics can supply about 3.5 m^3/s of water. This means that a set of 10 or 15 Gravitational Condenser of this type can supply sufficient water for the total consumption of a large city as New York or S. Paulo.

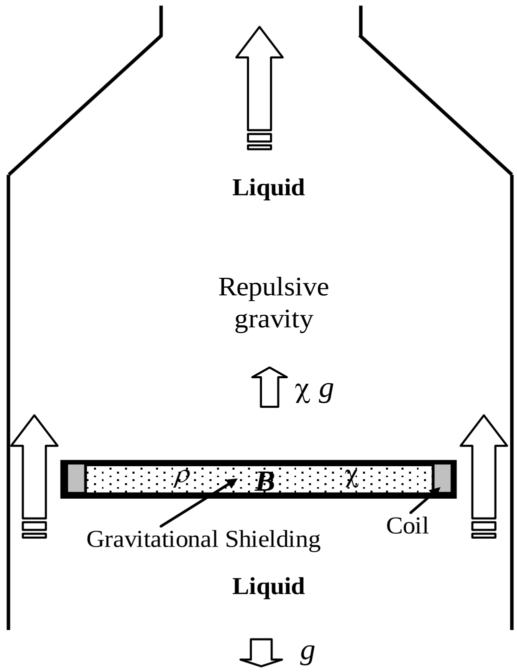

Fig. 2 – *Gravitational Pump* – Liquids (Water, Oil, etc) can be propelled by using the gravitational pump shown above (a process *patented* in July, 31 2008, PI0805046-5 [6]).

Figure 2 shows a *Gravitational Pump* based on the same principles described in Fig.1. A Gravitational Shielding placed at the bottom of the pump, *reverses* and *intensifies* the gravity in the region above the gravitational shielding (it becomes equal to χg). Thus, any liquid can be propelled through this type of pump (See Fig.2).

Obviously, the operational costs of the Gravitational Condenser and of the Gravitational Pump are very low. In addition, the Gravitational Condenser can be constructed at the own cities, where the water will be consumed.

The Gravitational Pump, in turn, can pump water at very low cost from aquifers, rivers, lakes, etc., and also to supply the *high pressure* (100 atm or more (See Eq. (4)) needed to push seawater through the semipermeable membrane, in the *desalinization* process known as *Reverse Osmosis*‡ (See Fig.3). Thus, these devices can strongly contribute to solve the current water crisis.

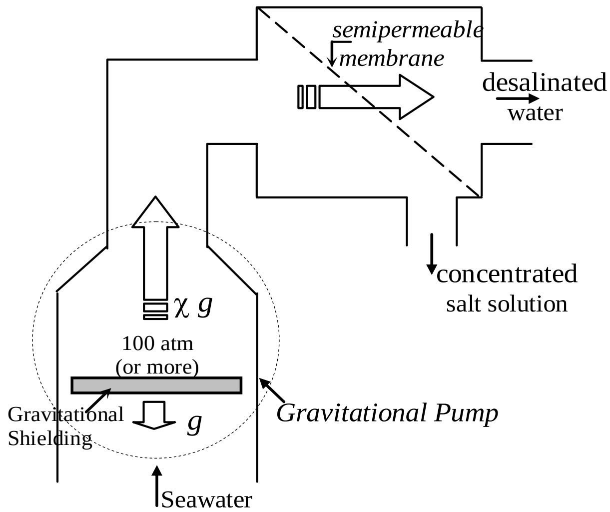

Fig. 3 – Reverse Osmosis using a *Gravitational Pump*.

‡ *Reverse Osmosis* is the process of forcing a solvent from a region of high solute concentration through a semipermeable membrane to a region of low solute concentration by applying a *pressure* in excess of the *osmotic pressure*. The most important application of reverse osmosis is the separation of pure water from seawater and brackish waters. However, the conventional process of reverse osmosis has a great obstacle: it requires high amount of electricity to produce the high pressure (60 to 80atm), needed to push seawater through the semipermeable membrane [11,12]. This process is best known for its use in desalination (removing the salt and other minerals from sea water to get fresh water), but since the early 1970s, it has also been used to purify fresh water for medical, industrial, and domestic applications.

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