



Evaluation of Atmospheric Water Generator on Motor Vehicle (AWGMV): A Review

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ABSTRACT: As an alternative water source, we present an Atmospheric Water Generator on Motor Vehicle (AWGMV) device which intends to develop and produce absolutely safe, almost costless, and drinkable water sources. Installed in a motor vehicle, the device constantly provides hot and cold drinkable water from atmospheric air. One of the most interesting methods to get clean water is harvesting humidity from thin air. Many new initiatives have been taken to develop this old way of getting water, and in so many ways it has the potential to solve the challenge of getting a new, sustainable and renewable source of freshwater during travel. There are mainly two methods of harvesting air humidity. In cooling condensation method air is lowered to dew point temperature. The mechanism of the device is based on the air condensation phenomenon. In the desiccant method, desiccants absorb the water molecules in the air. Variation in the atmospheric conditions will cause to change in the production of water. We can use any form of energy for this Technology. Technology includes no waste formation and chemical reactions so the proposed method is environmentally friendly. The device can be especially helpful for travelers and truck drivers who need water on long roads. Water issues have become a disturbing worldwide problem in the current era, but it is more complicated during traveling, most of the rural areas and there is no freshwater source. Hence, there is a serious need to find new, sustainable, alternative ways to get drinking water.

Index Terms: AWGMV, Condensation, Desiccant, Purification or Desalination Drinking Water

1. INTRODUCTION:

One of the great challenges of our time is the limited access to freshwater globally. Due to climate change and growing pollution, natural freshwater is not always available, leading to water shortages while traveling long distances for personal, business, or commercial distribution. To help address this crisis, we proposed atmospheric water generation (AWGMV) as a possible solution. In existing research focused on methods of atmospheric water generation, but little has been done to show its financial viability, said Dr. Bahram Asiaban pour, we studied the demonstration that is a cost-effective way to produce potable water and analyze AWGMV's production costs; we utilized a commercial system is shown in Fig.1. AWGMV Systems extract moisture from the air, filter it, and collect it for use. The system includes a fan, a condenser coil, a pump, and multiple states of filters. It also offered both hot and cold water options [2].

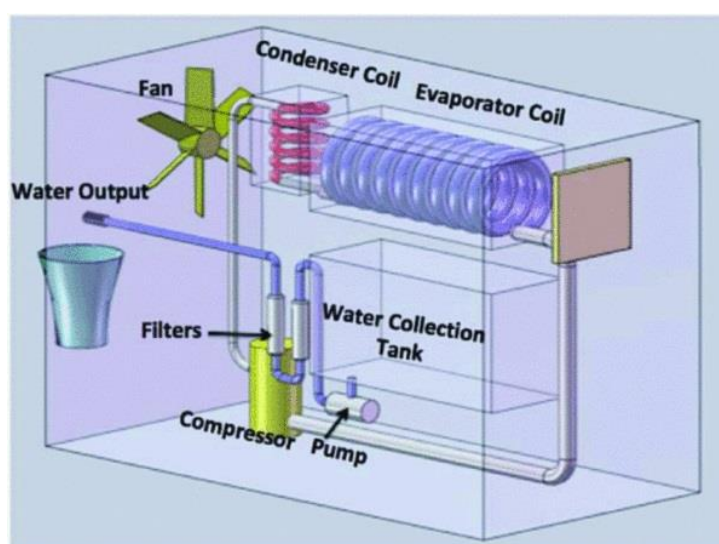


Fig.1 AWGMV Systems

The AWGMV's production costs were compared to the costs of existing water sources, such as vending machines and one-gallon containers. The net present value of costs compared with initial, consumables, and energy was also taken into account for financial assessments [3]. In Fig.2, the amount of water collected from the AWGMV System's measured, as well as the amount of power it used in different temperatures and humidity levels. Though the system generated about 20% less water than originally predicted, we include its cost-effectiveness.

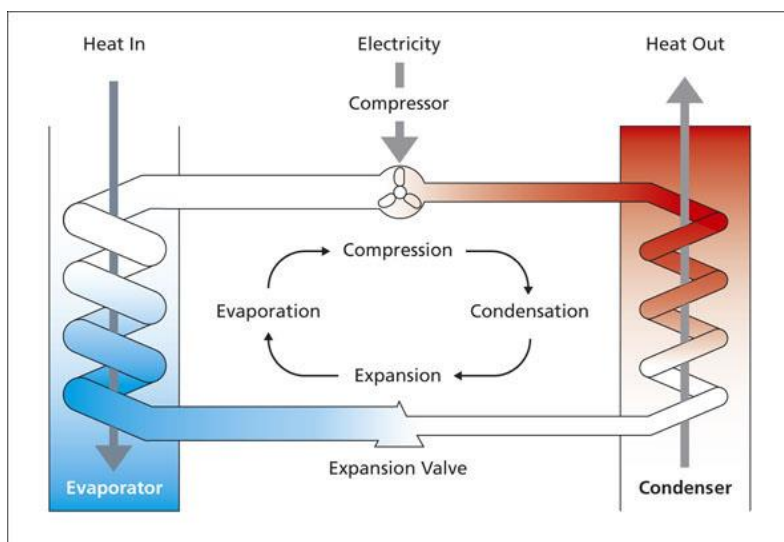


Fig.2 Modified AWGMV System

Although, Bharat Electronics has unveiled its new product, the Atmospheric Water Generator (AWG), an innovative solution to meet the ever-increasing need for drinking water worldwide, at Aero India 2019. BEL's Atmospheric Water Generator can be used to generate water straight from the humidity present in the atmosphere. BEL's Atmospheric Water Generator employs a novel Technology to extract water from the humidity present in the atmosphere and purify it. It uses heat exchange for condensing the atmospheric moisture to produce pure, safe, and clean potable water [6]. The AWG comes with a Mineralization Unit, which is used to add minerals that are required to make the water potable. The AWG is configurable in static and mobile (vehicular) versions and is available in 30 liters/day, 100 liters/day, and 500 liters/day and 1,000 liters/day capacities.

Water is the most vital source on the earth required all forms from microorganisms to humans. However, its availability is on the decline in all parts of the world due to reasons such as climate change, population growth, and change in lifestyle. Water is second to oxygen as being essential to life. People can survive days, weeks, or even longer without food but only about four days without water. The average adult consumes and excretes two or more liters of water each day. Water scarcity is the lack of sufficient available water resources to meet the demands of water usage within a region. As per the world health organization in 2025, affects around 2.8 billion people around the world [4]. In all continents, at least one month out of every year and more than 1.2 billion people lack access to clean drinking water. The sum of people without access to piped freshwater accounts for more than 25% of the global population, most of them located in Africa, Asia, and South America. Every 8 seconds a child in the developing countries dies from a disease caused by unsafe drinking water. The rapid growth of urban and rural populations, industry, and agriculture forces governments to enlarge the infrastructures to provide freshwater; however, the existing budgets are insufficient for both water treatment of purification or desalination and installation of pipe-net.

In India, more than 50% of the country's population lacks access to safe drinking water. Currently, the water scarcity problem is solved by exploiting groundwater resources, transportation of water from other locations, desalination of the saline water. Transportation of water from other locations or regions is very expensive and desalination depends on the presence of saline water resources which are usually rare in arid regions. The extraction of water from air is remedial for the above problems. The main features of Technology are no need for a long pipe network; the air is a renewable source so Technology is secured and it can be used anywhere in the world. Hence, there is a serious need to find new, sustainable, alternative ways to get drinking water [5].

2. ATMOSPHERIC WATER GENERATION FROM MOTOR VEHICLE (AWGMV):

The world's two-third portion is covered with the water. 97% of the total water is saltwater. The freshwater is 2.5%. In this accessible water is only 1.6% remaining is groundwater and water seen in the glaciers. 3% of this accessible water is contributed by the atmosphere [2]. At any given time each square kilometer of air, almost everywhere on the globe, contains 10-40 thousand metric tons of water, sufficient to supply at least 100,000 people with all their water consumption or at least 2 million people for drinking only.

The idea of collecting humidity from thin air is not new; several tries were done to get the water from the air humidity. Extracting water from air occurs naturally as well as by men made Technologies'. The importance of implementation of Technologies' for the extraction of water from air results from four main reasons:

- In many regions drinking water is not available or insufficient;
- In many regions where water is available the water is polluted;
- Tens of percentages of the global population have no access to piped freshwater;
- Infrastructures expansion cannot overtake the rapid growth of the population, industrial development, and developing agricultural needs.

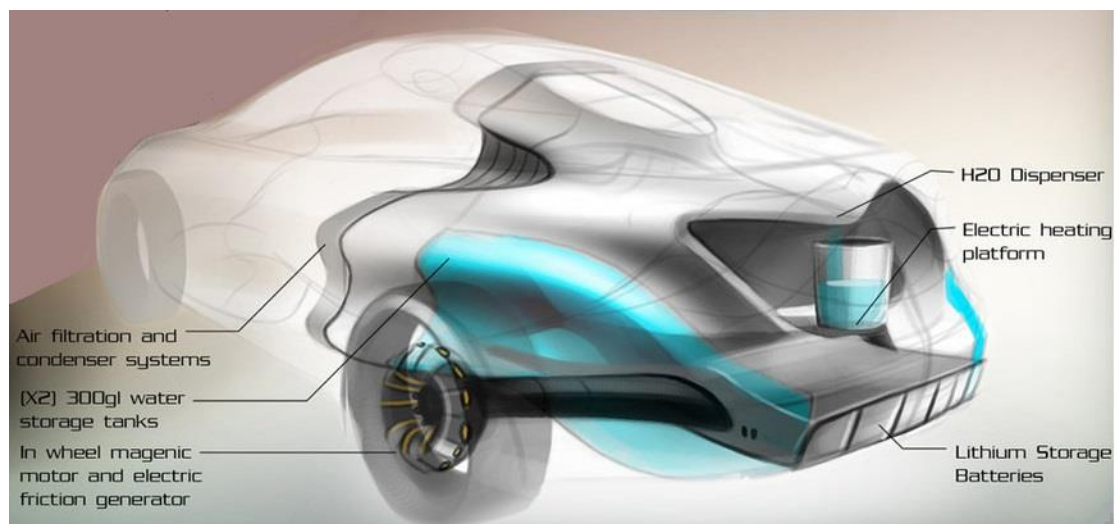


Fig.3 Proposed AWGMV System (Vehicle)

There are two methods for AWGMV Technology,

- ❖ Cooling condensation method
- ❖ Desiccant method

➤ **Cooling condensation method:**

In a cooling condensation method, a compressor circulates the refrigerant through a condenser and then an evaporator coil which cools the air surrounding it. This lowers the air temperature to its dew point, causing water to condense. A controlled-speed fan pushes filtered air over the coil. The resulting water is then passed into a holding tank with purification and filtration system to help keep the water pure and reduce the risk posed by viruses and bacteria which may be collected from the ambient air on the evaporator coil by the condensing water.

The rate at which water can be produced depends on relative humidity and ambient air temperature and size of the compressor. Atmospheric water generators become more effective as relative humidity and air temperature increase. As a rule of thumb, cooling condensation atmospheric water generators do not work efficiently when the temperature falls below 18.3°C (65°F) or the relative humidity drops below 30%. This means they are relatively inefficient when located inside air-conditioned offices. The cost-effectiveness of an atmospheric water generator depends on the capacity of the machine, local humidity and temperature conditions, and the cost to power the unit [7].

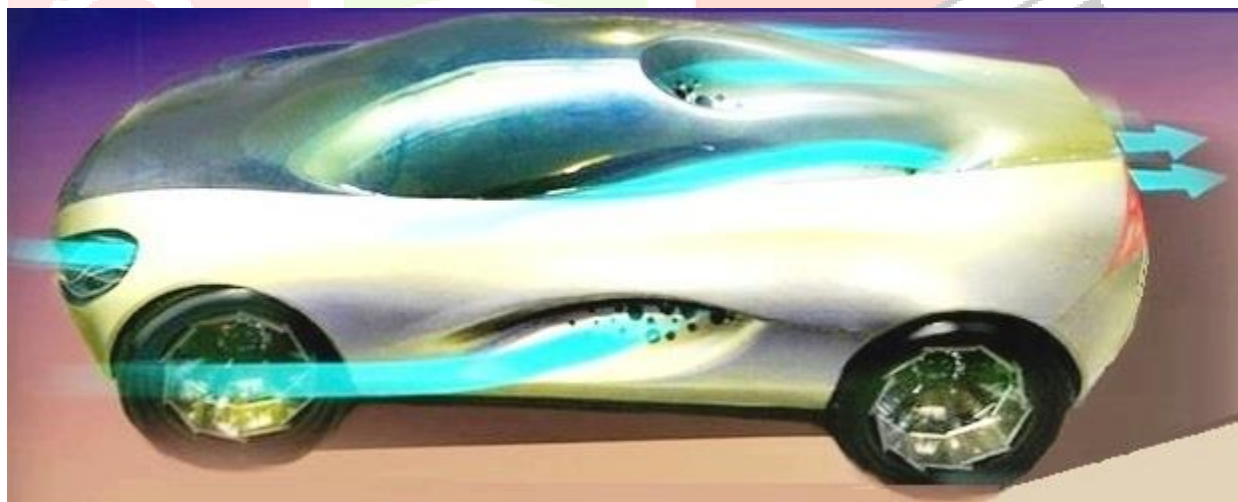


Fig.4 Air Flow in AWGMV System (Vehicle)

➤ **Desiccant method:**

Desiccants are chemical substances that have a unique property to absorb moisture from the atmosphere. Desiccants may absorb atmospheric moisture by several methods: by physical absorption, forming chemical bonds (chemisorptions) or adsorption (surface phenomenon). The water intake capacity of the desiccants depends on their physical composition, chemical properties, and atmospheric condition. Examples of desiccants are

- ❖ Calcium chloride
- ❖ Lithium chloride
- ❖ Water gel crystals



a) Clay desiccant



b) Lithium chloride desiccant



c) Calcium chloride desiccant



d) Calcium chloride salt

Fig.5 Various desiccants

Nevertheless, desiccation Technologies are superior over cooling condensation in the following,

- The water produced is clean of air contaminants and microorganisms;
- Desiccation occurs at lower relative humidity;
- Waste and residual heat can be used;
- Solar heat can be used;
- The heat from the adsorption process, as well as desorption, could be recovered to minimize energy consumption.

The advantages of extraction of air humidity over conventional water sources

- i. Supply of freshwater independently of existing water resources (sea, brackish water, etc.)
- ii. No need for long and expensive delivery (pipe) systems
- iii. Unlimited, free renewal of raw material (air) that contains tremendous amounts of water
- iv. Suitable for almost anywhere around the globe where water is needed
- v. A compact and portable machine that could easily be transported
- vi. The process does not harm the environment in any way; no chemicals are involved and no wastes are formed
- vii. Secured water source

3. Implementation of AWGMV System:

The AWGMV will operate in any environment, where the temperature ranges from 5° to 45° Celsius and with a minimum of 20% relative humidity. The daily water production capacity is varied as a change in environmental conditions. In the Sahara desert also we can exert water using this technology [8]. Only the cooling condensation method will be required the specific atmospheric conditions the desiccant method has no specific atmospheric conditions.

Any form of energy with residual heat can be used in this method. It includes solar energy, wind power, fossil fuel, electricity, etc. any form of renewable energy sources can be utilized in the proposed method so the cost and lack of energy can be reduced. The AWGMV uses only 10 kW-h of electricity to produce 1,000 liters of water. There is no utilization of any chemicals in the method and waste materials are formed [9]. The input of Technology is the atmospheric air it is a renewable energy source. Because of these reasons, the ISO 14040 Life Cycle Assessment (LCA) suggested AWGMV Technology is an environmental method.

3.1 Limitations of AWGMV System:

- The initial investment cost is high
- To work effectively, a few conditions must be met:
 - The temperature of the ambient air has to be at least a few degrees above freezing.
 - The humidity should be above a certain concentration

3.2 APPLICATION OF AWGMV: ATMOSPHERIC WATER GENERATOR:

An atmospheric water generator (AWG) is a device that extracts water from humid ambient air. Water vapor in the air is condensed by cooling the air below its dew point, exposing the air to desiccants, or pressurizing the air. Unlike a dehumidifier, an AWG is designed to render the water potable. AWGs are useful where pure drinking water is difficult or impossible to obtain because there is almost always a small amount of water in the air that can be extracted [10].

The leading manufacturers of AWG are,

- i. Water makers(India)
- ii. Konia(Australia)
- iii. Water micron

3.2.1 Water Makers:

The water generators can make from 25L – 50,000L per day depending on the device. The cost of producing 1L of water is Rs 3. The device has a very good filtration system so it can be used inside or outside the home, and it is very sustainable and environmentally friendly.

3.2.2 Konia Air Water Generators:

In this device, the water generator is separated from the purifier and they can be sold separately. The water generators can make from 30L – 74L per day. The cost of the production varies from Rs 7,500 – 25,000.

3.2.3 Water Micron:

This company produces also different types of devices that make water from thin air. The C-Series of this brand can make pure water from 250L – 5000L per day, but it can work only in the temperature between 15°C or 20°C to 38°C, and with RH between 40% and 95%. Although the amount of water we can get with this device is big, it needs electricity input power between 5Kw and 115Kw, and it weights from 320Kg to more than 4000Kg which means that it needs to be placed in a big place. The prices ranged between Rs25,000 – 10,00,000.

4. Peltier Couple used to over conventional device:

The atmosphere contains a large amount of water in the form of vapor, moisture, etc. Within those amounts, almost 30% of water is wasted. This amount of water can be used by implementing a device like an Atmospheric Water Generator (AWG). This device is capable of converting atmospheric moisture directly into usable and even drinking water. The device uses the principle of latent heat to convert water vapor molecules into water droplets. In many countries like India, there are many places which are situated in the temperate region; there are desert, rain forest areas, and even flooded areas where atmospheric humidity is eminent. But resources of water are limited. We know that the temperature require to condense water is known as dew point temperature. Here, the goal is to obtain that specific temperature practically or experimentally to condense water with the help of some electronic devices. This proposed system consists of a thermoelectric Peltier couple (TPC), which is used to create the environment of water condensing temperature or dew point, indeed conventional compressor and evaporator system could also be used to condense water by simply exchanging the latent heat of coolant inside the evaporator. The condensed water will be collected to use for drinking purposes and various other uses [1].

The Peltier thermoelectric device has two sides of a p-type and an n-type semiconductor, and when DC current flows through the device, it brings heat from one side to another, so that one side gets cooler while the opposite one gets hotter. This is called the Peltier effect and electron-hole theory. Peltier coolers consist of a Peltier element and a powerful heat sink/fan combination. Peltier elements come in various forms and shapes. Typically, they consist of a larger amount of thermocouples arranged in rectangular form and packaged between two thin ceramic plates. This type of device is so powerful that it can freeze a good amount of water within several minutes. A conventional cooling system contains three fundamental parts-the the evaporator, compressor, and condenser. A TPC also has some analogous parts. Energy (heat) is absorbed by electrons at the cold junction, as they pass from a low energy level in the p-type semiconductor element to a higher energy level in the n-type semiconductor element. It is the power supply that provides the energy to make those electrons to move through the system. At the hot junction, energy is expelled to a heat sink as electrons move from a high energy level element (n-type) to a lower energy level element (p-type) [6].

5. Conclusion:

New weather patterns appeared in our world in the past century, and that caused lots of confusion for humans who used to expect only one weather pattern per season in certain areas. However, this is not the case in the current days, which means that people have to change their behaviors in so many ways if they want to have a good life quality for future generations. However, finding sustainable alternatives to the traditional natural sources is one of the most important issues that should be studied and developed, whether for energy source, or water sources.

Finally, in this proposed method we reviewed about the way of harvesting water from thin air, and these ideas mentioned above can solve the poorer arid areas water problems with cheap prices inventions that they can buy or maybe produce their selves. Atmospheric Water Generator on Motor Vehicle (AWGMV) experiment which intends to develop and produce absolutely safe, almost costless and drinkable water source. Installed in a motor vehicle, the device constantly provides hot and cold drinkable water from atmospheric air. One of the most interesting methods to get clean water is harvesting humidity from thin air. We can produce an unlimited supply of water without environmental pollution for the current water scarcity problem. Air-water is a renewable source of water so Technology is a secured source for the future. In India, about 50% of the population is affected by water scarcity problems and Peltier Couple used to over conventional device, modified AWGMV device as proposed to generate water from air with cost-effective. The device can be especially helpful for travelers and truck drivers who need water on long roads. Water issues have become a disturbing worldwide problem in the

current era, but it is more complicated during traveling, most of the rural areas and there is no freshwater source. Hence, the proposed method provides an alternative way to get drinking water.

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