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Developing Low Power Consumption Solar Atmospheric Water Generator for Dealing with Water Crisis

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Abstract

Nowadays in India as well as in some places in the world there is a shortage of water. In the world, 46% population which is nearly 2 billion people are unable to have a clean water source for a drink. This became a threat. On Earth, water is present in different forms. One of them is water vapor. The relative humidity on earth varies by season and place. Due to the presence of water in the air, this problem has been solved by using artificial condensation of water. Atmospheric water generators (AWGs) have already been made to deal with this. But in some places due to the lack of electricity and the inflation rate of electricity, AWG is hindering its work. For that we have solved this problem by using two things, the first is a solar panel AWG, and the second solar concentrator boiler AWG. Through this process, people can easily be able to have a clean water source at a low cost. This process doesn't cause any pollution. This device is not only able to be used in the home but is also useful for offices, schools, and colleges. The small AWG can generate 1 to 20 liters of water in a day. The solar AWG is always kept on the upper side of the building and homes. It leads to covering a low area and space.

Keywords: Humidity, solar atmospheric water generator, artificial condensation, water crises, renewable energy, drinkable water

INTRODUCTION

In recent years, water crises have become the most common problem worldwide. This is a threat at the global level. Economic decline may occur due to the water crisis. Only fresh water was used for 3% water. However, only 1.2% can be used as drinkable water; the remainder is hidden in ice caps, glaciers, and permafrost, or remains deep in the ground. Most of the drinkable water is transported by rivers and streams. This has become a significant problem in desert areas. Atmospheric humidity can be used to address this issue. This problem can be solved by extracting water from atmospheric air. The troposphere of the atmosphere contains most water vapor. This water vapor can be used as drinkable water. For the utilization of atmospheric air, water condensation is required. This condensation process was performed using an atmospheric water generator (AWG). In the market, the availability of water generators is low. However, the price of electricity is also high. To overcome this problem, a water generator that uses a solar concentrator boiler and solar panels is the most efficient technique. An air–water generator requires a refrigeration system for condensation. In refrigeration systems, heat and pressure are required. Solar concentrator boilers and solar panels have the capabilities and features that drive renewable energy. Solar concentrator boilers with single-axis tracking controllers (SATC) are required for this technique. In a cooling system, the compressor is the driving part and the heart of the system. Driving the compressor requires electricity, but it is driven with another technology that will efficiently work and provide good results.

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Compressors based on a steam engine model were used. By using this cooling system and passing through the coolant gas using a high-area occupied radiator, it is possible to change the form of water vapor into its liquid form. In this paper, the solution to this problem is presented, and we present our virtual block design of a solar air–water generator with a solar concentrator boiler and solar panels.

LITERATURE REVIEW

The paper authored by Cerro addresses a critical global issue: the increasing urbanization of the world's population and the challenges of providing essential resources in rapidly growing urban areas. Focusing on the use of AWGs, the author suggests an innovative solution to the water scarcity problem in slums, particularly in the case of Mumbai.

The potential of this technology to produce significant quantities of clean water was highlighted. Furthermore, this paper goes beyond water supply and proposes a holistic approach to address nutrition problems by integrating urban farming within the same structure. This approach reduces transportation and packaging costs while ensuring access to fresh produce in slums [1].

The paper authored by Xiaohong Yin addresses the issue of maximizing energy efficiency in vapor compression refrigeration cycles (VCC) within Heating, Ventilation, and Air Conditioning (HVAC) systems. This study recognizes that the coefficient of performance (COP), a key efficiency metric, is influenced by various nonlinear thermodynamic factors. To address this, the author employed a model predictive control (MPC) strategy that leverages experimental data to track the optimal evaporator superheat and pressure difference settings, aiming to simultaneously enhance the COP and meet the cooling demand. This approach demonstrated promising results in the experimental validation. Yin's research contributes to the field of HVAC systems by offering a novel control strategy to improve the energy efficiency of VCC systems [2].

The paper authored by Xiaohong Yin focuses on the utilization of VCC systems in air-conditioning systems. It specifically delves into the development of a temperature controller for VCC systems using the MPC method. To achieve this, the study begins with a model identification approach for the simplified temperature control system of a VCC and subsequently outlines an MPC control strategy for regulating the superheat degree and room temperature [3].

The paper authored by Amul Kumbhare addresses the pressing global energy problem, which is characterized by increasing energy consumption due to population growth and the finite nature of non-renewable energy sources. To address this issue, this paper proposes the utilization of solar energy for electricity generation through a steam turbine, with a focus on providing energy to small villages and towns and the potential for integration to supply energy to larger cities.

The proposed system employs convex lenses and a concave mirror to concentrate sunlight on a specific point, raising the temperature sufficiently to heat the boiler and generate steam, which in turn rotates an alternator via a turbine. While the abstract introduces the concept, it leaves room for further in-depth exploration and study of the proposed method [4].

The paper authored by Arnab Dey presented an innovative design approach for a solar steam generator/boiler, departing from traditional designs by utilizing mirrors to concentrate solar radiation externally as opposed to internal tube grids heated by fuel flames [5].

This novel approach yielded promising results in terms of system efficiency and electricity production, with an overall efficiency exceeding 20%. Notably, the study suggests that this new design is competitive with established solar concepts, such as parabolic trough and central tower technologies, making it a valuable contribution to the field. As per the available information, this work appears to be a unique and unreported innovation in the realm of solar thermal power systems [6].

OVERVIEW

What is Atmospheric Air and Water?

Water that is found in the form of air is called atmospheric air water. The water is in the form of steam. The main reason for this water formation is evaporation. When a body of water, such as an ocean, river, or stream, is exposed to heat, it changes from its liquid form to gas. Many elements in the air help hold water in the air. The density of water depends on the temperature of the location. The water density in the air is higher in coastal or humid climates. This water was found at 0–4%. As water enters a gaseous state after increasing the temperature and absorbing heat, it reverts to its original form when its heat is removed [7].

When water is condensed, it is found in the following element. Dew, fog, clouds, and frost. This difference was determined based on level and temperature.

The water distinguished after condensation as following:

- Dew
- Fog and clouds
- Frost

What is a Solar Atmospheric Water Generator?

AWGs are devices that artificially convert gaseous water molecules into liquid form using solar energy. AWGs are devices that artificially convert gaseous water molecules into liquid form using solar energy. This device mainly operates based on the principles of refrigeration and condensation. The air–water generator was first developed by Moses West [8].

Why is a Solar Air–Water Generator Needed Over the Simple Atmospheric Water Generator?

Solar water generators operate using renewable energy sources. It operates using freely available energy. It has two types to carry out work such as solar concentrator boiler system and solar panel system for refrigeration. In contrast, simple air–water generators use electrical energy, which is costly.

Features of Solar Atmospheric Water Generator

1. Water generation
2. Availability of air everywhere
3. Clean source of water
4. Low power consumption
5. Free of cost energy
6. Low occupied area

The flow diagram of water mixing and extraction in the air is shown in Figure 1.

METHODOLOGY

Basic Working of Air–Water Generator

The closed-loop refrigeration cycle block diagram is shown in Figure 2.

The generator was started with compression. When the piston in the compressor moves, the refrigerant liquid in the compressor reaches a high temperature and pressure according to the gas law. Thus, the refrigerant liquid transformed into its gaseous form. The refrigerant gas from the discharge line of the compressor goes further into the condenser [9]. The temperature of the refrigerant gas is reduced in the condenser. The gas was then converted into its liquid form. To reduce the temperature, the effective area of the condenser was expanded using rods. These rods release heat from the gas in the air. However, when the temperature was reduced, the pressure did not decrease. With the help of the liquid line and the pressure remaining high, this refrigerant liquid is sent from the drier to the capillary tube.

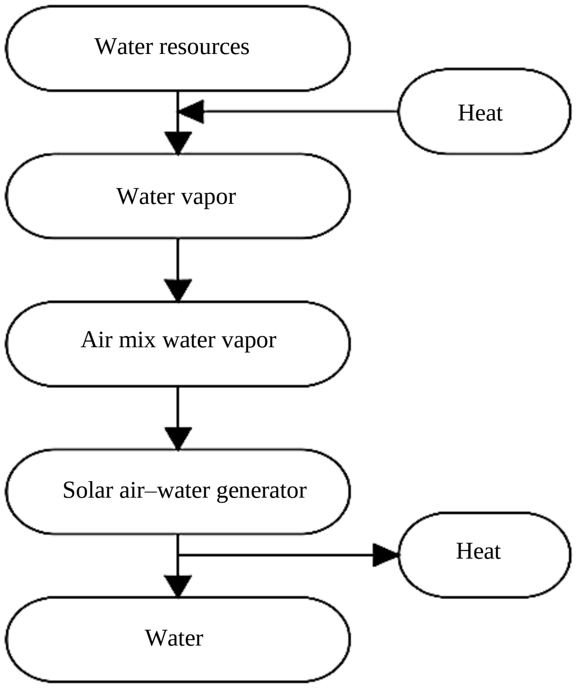

Figure 1. Flow diagram of water mixing and extraction in air.

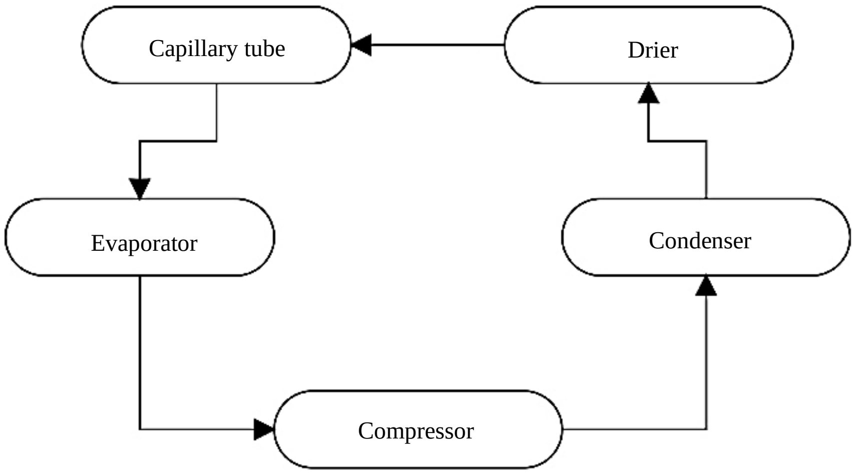

Figure 2. Block diagram of close loop refrigeration cycle.

The drier stops unwanted particles and sends the rest of the refrigerant liquid forward. The pressure in the refrigerant liquid suddenly decreased with the help of a capillary tube. Owing to the sudden low pressure, the temperature suddenly decreased. The diameter of the capillary tube is typically 0.5 to 2.28 mm [10]. The temperature of the refrigerant liquid was reached as per the capillary tube design. This temperature was sufficient to convert water into ice. The refrigerant liquid then entered the evaporator. The radiator and evaporation coil were attached. The evaporator coil absorbs the heat from the cooling liquid obtained from the radiator. The effective surface area was increased by changing the radiator design. A change in normalization involves the use of thinner layers of metal, increasing the number of layers, and a zigzag design. When air is sent from the radiator, water vapor in the air accumulates on the metal strip in the form of water droplets. If the temperature is too low, there is a high probability of ice formation on the metal strip. Thus, the efficiency of producing water declines [11]. Thus, after some time, the system shuts down. Thus, the snow accumulated on the metal strip was naturally converted into liquid form. This method is known as artificial water condensation. The liquefied water fell into a vessel placed under a radiator. Water was filtered and used for drinking. When the liquid leaves the evaporator coil, the vapor form of the liquid returns to the compressor. A microcontroller was used to operate all devices. This microcontroller operates according to different programs in two ways. However, the fan speed controller will do the same and increase air density on both sides [12].

A solar AWG is a device that generates water from air. The condensation of air was used to bring water from the air into a liquid form. The condensation was performed artificially. One part of the refrigeration process is the operation of the compressor. We divided solar AWG into two parts.

1. Solar panel AWG
2. Solar concentrator boiler AWG

Solar Panel Atmospheric Water Generator

In this method, a solar panel is used to obtain electrical energy..

The electrical energy generated from the solar energy is supplied to the motor, and this energy is converted into mechanical energy. Mechanical energy is applied to the piston using a motor shaft. The solar panel technique requires a voltage regulator and speed controller. The solar panel is shown in Figure 3. The temperature of the compressor was controlled using a microcontroller and speed control. A solar-tracking system is used to increase the efficiency of the solar panel [13–15].

Solar Concentrator Boiler Atmospheric Water Generator

A solar concentrator was used to concentrate the rays coming from the sun. When the rays converge, the temperature above the convergence point exceeds the normal temperature. A solar concentrator is used to heat the boiler in this device. Water vapor produced by the heat in the boiler was used to run the steam engine. The solar concentrator boiler AWG is shown in Figure 4. The speed of a steam engine depends on the productivity and temperature of the steam. The boiler temperature was controlled by a solar concentrator tracking controller. This controller was used to control not only the speed of the piston but also the temperature of the radiator [16]. In this method, the microcontroller used to control the system requires electrical energy. For this purpose, useful electrical energy is generated by attaching a small generator to the engine shaft.

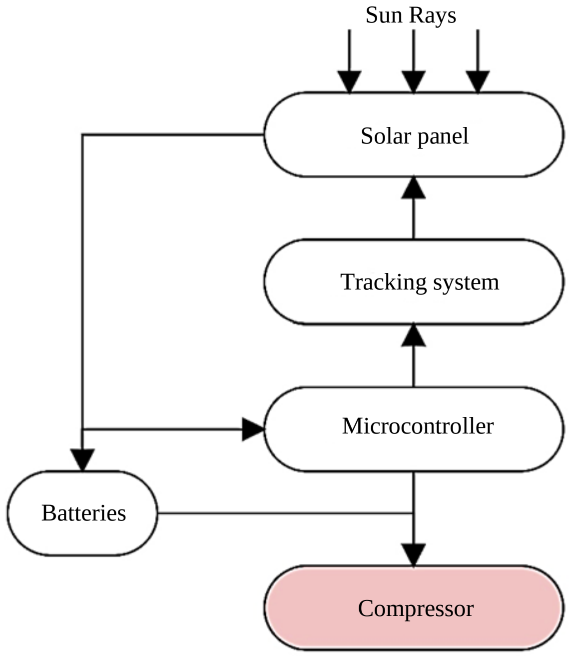

Figure 3. Solar panel AWG.

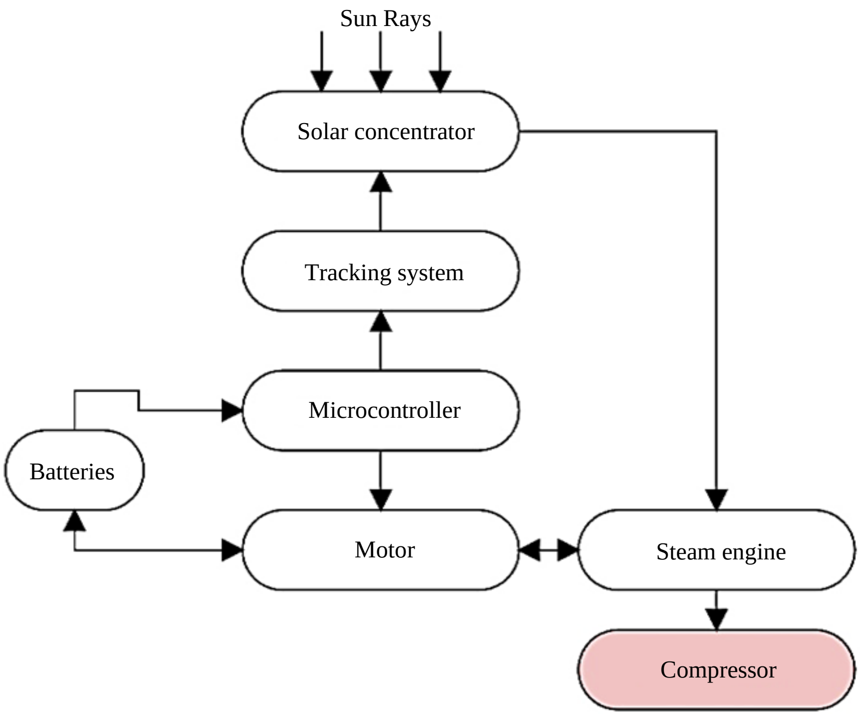

Figure 4. Solar concentrator boiler AWG.

The energy from the generator can also be used separately. By using the battery system and generator as starting motors, the steam engine becomes self-starting [17, 18]. The water vapor released from the steam engine is converted into liquid at a faster rate than the air in the radiator. Therefore, water is not wasted.

RESULT

Because solar AWGs emit no pollution and are cheaper to operate than other types of AWGs, we transformed our design Solar AWGs into them. We increased the generator efficiency by utilizing a battery system. Batteries are used to drive the system at night.

The production of water can be significantly intensified by the tracking system and by adding an effective surface area to the radiator. A basic microcontroller that controls system performance is the production of water, regulation, and temperature is the solar AWG. They also drive solar-tracking systems. The problems that arise from a water crisis can be addressed by this device. The solar system provides a lower efficiency on cloudy and rainy days. Production may vary according to the relative humidity. This system is more useful in desert areas, where electricity cannot be accessed. Furthermore, the use of solar AWGs can meaningfully help reduce pollution at low-cost production levels.

CONCLUSION

Recycling, reusing, and reducing are not just catchphrases for addressing environmental issues; they are essential actions for ensuring a sustainable future. By following these principles, we can mitigate the adverse effects of waste and overconsumption while safeguarding Earth's resources for future generations. The vision of a cleaner, greener world becomes achievable as individuals, communities, and nations collaborate in this endeavor.

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