Access to Drinking Water in Desert Regions: Solar-Obtained Water

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***Abstract*— We are all certain that water is a basic element for social and economic development. This means that water resources play a fundamental role in the well-being of the population, being essential for the reduction of poverty, causing a positive impact on food and energy security, and mainly, human health. However, access to drinking water is not equal to all. Therefore, the main objective of this paper is to discuss the access to drinking water in desert areas. The problem may be solved through an innovative solar device. This is a safe, economical option, easy to use and, in addition, friendly to the environment. This solution may radically change the quality of life of all people in the desert areas of our planet.**

***Resumen*— Todos tenemos la certeza de que el agua es un elemento básico para el desarrollo social y económico. Esto significa que los recursos hídricos juegan un papel fundamental para el bienestar de la población, siendo esenciales para la reducción de la pobreza, provocando un impacto positivo en la seguridad alimentaria y energética, y principalmente, la salud humana. Sin embargo, el acceso al agua potable no es igual para todos. Entonces, el objetivo principal de este trabajo es discutir el acceso al agua potable en las zonas desérticas. La problemática puede solucionarse a través de un innovador dispositivo solar. Ésta es una opción segura, económica, de fácil utilización y, además, amigable con el medio ambiente. Esta solución puede cambiar rotundamente la calidad de vida de todas las personas en las zonas desérticas de nuestro planeta.**

I. Introduction

Water is a basic element for social and economic development. This means that water resources play a fundamental role for the well-being of the population. These resources are essential for poverty reduction, generating a positive impact on food and energy security, human health and environmental protection.

There is an abundant supply of water in the world. However, the access to this resource is not equal for all. For example, in desert regions in the Middle East and North Africa, people suffer from continuous shortages [1]. Desert regions are those that are in intermediate or transition zones between deserts and regions with a more humid climate, presenting scarce or irregular rainfall.

Raising awareness of the difficulties of various communities in desert regions in accessing clean water sources is one of the great challenges that the National Academy of Engineering (NAE) poses, namely, the need to "provide access to clean water" [1, p.19]. In the same line, the United Nations' Sustaintable Development Goals (SDG) report states that one of the SDGs to be achieved by 2030 is to"[e]nsure availability and sustainable management of water and sanitation for all" [2, p. 38]. For these reasons, it is necessary to guarantee access to drinking water in desert areas. A possible way to achieve this aim is by obtaining water from a solar device.

The objective of this paper is to present a sustainable and environmentally friendly solution for obtaining clean water in desert areas. The solution presented is the Hydropanel, which is a solar device that is used to obtain and mineralize water in an innovative way.

The aim of this paper is to describe and analyze the characteristics of the Hydropanel. To do so, first, the description of this system will be made, addressing the function of each part of the system as well as its advantages and disadvantages. The second part of the paper will analyze the performance of the system, considering the quantity and frequency of the water captured.

II. Hydropanels

A. Description of the system

The Source company offers the Source Hydropanel device [3], which is capable of producing drinking water easily, safely and sustainably anywhere in the world. This device extracts water from the moisture in the air and converts it into pure drinking water [4]. It has the capacity to extract approximately eight liters of water per day, depending on the natural sunshine and humidity conditions [3].

B. System Components and Water Harvesting Process

Fig. 1 shows that the Hydropanel consists mainly of five components. The system consists in a standard photovoltaic module combined with two hydraulic panels. One of them is capable of generating energy and the other of absorbing the humidity present in the atmosphere. The process is quite simple: part of the solar energy is stored in an accumulator, and another part is used to trigger a cycle of condensation and evaporation of water, cleaning pollutants.

Fig. 1. Hybrid Solar Panel Rear View. [4]

The water harvesting process consists of different stages. The air is collected in the unit with the help of a fan. Then, the water content is absorbed by a hygroscopic material. The water vapor is collected and then natural air flows through a closed condenser, after which the air flows into a reservoir unit, which is mineralized with magnesium and calcium [5]. The water continues to circulate and is pumped through a polished type of cartridge before being delivered to the designated normal tap or to a cooling unit with an accumulated water dispenser.

Having described the way the device works, it is now necessary to analyze the dimensions and capacity of each unit. Each of the compact reservoir Hydropanel units has a capacity of almost 30 liters, making a total of 60 liters for a standard fixed installation design (2 Hydropanels) and weighs approximately 124 kilograms. Each panel measures 1.2 m x 2.4 m [6].

On cloudy days and at night, Hydropanels have a solution to water harvesting despite these conditions. Solar panels have a battery to collect water at night and continuously produce water during cloudy periods. In addition, for climates in which the percentage of humidity is too low, the Hydropanel collects water vapor from the air in the same way. The difference lies on the amount of water they will produce in such conditions.

The process of obtaining and purifying water takes place at two different times of the day. Absorption occurs during the night at higher humidity (20-40% RH) and solar-assisted desorption/water production occurs during the day at lower humidity (10-20% RH) [5]. Apart from the process of absorption, which involves the accumulation of the absorbed substance throughout the volume of the absorbent, this system carries out a second process called adsorption.

This process occurs using two elements: a Metal-Organic Structure (MOF) adsorbent layer with a black-coated face that serves as a solar adsorbent, and an air-cooled condenser in an enclosure. During the adsorption of a gas or a solute in solution, its particles accumulate on the surface of other stuff. The adsorbed substance is called adsorbate and the material on which it does so is the adsorbent. Adsorption is therefore distinguished from absorption since the latter involves the accumulation of the absorbed substance throughout the volume of the absorbent, not only on its surface [8].

The operation that is performed within the system through the MOF material takes place as follows. During overnight adsorption, the side walls of the recipient are opened, and the MOF layer is saturated with vapor from the ambient air. Here, the air is passively cooled. During the day, the enclosure is closed, and the side of the solar absorber is covered with a transparent thermal insulator. The MOF layer is heated by exposure to solar irradiation, causing the release of water, which is a process called desorption. The desorbed water vapor diffuses from the MOF layer to the condenser due to a concentration gradient. The accumulation of vapor in the enclosure leads to saturation conditions and, consequently, the condensation process occurs at room temperature. The condensation heat is dissipated to the surroundings by a heat sink [4].

C. Advantages and Disadvantages of Hydropanels

The adoption of innovative and decentralized drinking water solutions may be the answer to displacing other methods that are not friendly to the environment or people, such as bottled water. The use of the Hydropanel system offers benefits such as the following. It is a source of water that does not depend on rain. From the humidity of the air, the system returns sustainable and quality water. Also, it only requires one pipe running from the panel to the unit to the connected faucet. This system also has the versatility to be installed anywhere due to its small size and does not require electricity. Other advantages are that it reduces the ecological footprint, eliminates 54,000 plastic bottles, does not extract groundwater and is made with 91% recyclable materials [7].

On the other hand, the system has two main disadvantages related to its cost and its water production capacity. This system has the disadvantage of having a high cost ($5500 - $6500) [2]. In addition, it cannot be used as the only source of drinking water, since it would not cover the basic demands needed because it produces a small amount of water.

III. Conclusion

The situation of lack of drinking water in the desert regions of the world is a major problem that requires an efficient and ecological method of collecting and treating water. Because of this, finding a solution has to be one of the primary objectives of civil engineers, in line with the NAE and UN's aims of proving access to clean water for all.

In this respect, the Source Hydropanel is the only alternative to date that meets the above characteristics for installation in these regions. In addition, this system does not produce polluting residues and is carbon-free so it complies with the water access demands with little to no impact on the environment.

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