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Solar Purifier of the Seawater, to Ensure Food Security in Social Aspects of Low Income, who sit in Coastal Area and Islands of Ecuador

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Abstract - In our country, lack of water for human consumption in arid coastal areas and especially on the islands, this is critical problem, therefore, the implementation of a system that allows desalinate seawater, improve considerably the quality of life of our citizens. Water is essential for ensure food and improving the quality of life, life without water is impossible, so it is necessary to generate, adapt and disseminate scientific and technological knowledge to allow safe access drinkable water. To contribute to provide solutions to this serious problem, in this project the analysis and synthesis of the current problem of the lack of potable water in coastal and islands areas of our country and we are proposed system model to purify seawater using radiant energy from the sun in a process of evaporation, distillation and condensation. We build a prototype to find respective test for validating research. The analysis was also performed, showing that the project is viable, sustainable and energy efficient. The project is aimed at low-income social sectors of coastal and islands areas of Ecuador, so materials, components and low-cost equipment, used some recycled. A methodology and procedures that enable the application and commercialization of these systems in Ecuador, by enterprises, mainly young engineers also developed.

***Keywords*:** *Solar purifier, desalination, food security, water treatment.*

1. Introduction

The agricultural sector stands as the largest consumer of water in the world, given its productive function, whose growth is constant and even more irrigation systems, which demand today about 70% of freshwater suitable for human consumption. In 1948, the Universal Declaration of Human Rights declared the right of all to adequate nutrition. On July 28, 2010, the United Nations General Assembly declared safe access drinkable water and sanitation as a human right. But water rights within the context of the right to food is a complex issue, especially in countries via development, where this right becomes a privilege, given the lack of resources by the government to carry potable water places of difficult access and arid areas where conditions are compelling and unfavorable, so it is necessary to establish management changes to ensure the best use of water resources and thus response the growing demand of food and other from agricultural products.

The total volume of water in a earth is 1.400 millions of km2, the major part are in liquid state; in solid state only are 29 millions of km2. This volume of water are spread in 97.5% its a seawater and 2.5% its a freshwater that provide from the lakes, ices and rivers, the 68.7% these are the polars and glacials, 30.1% are subterraneans water and the 1.1% less to the lakes freshwater. In Ecuador, the source of water are a problem worrying, although our country have average of annual rainfall of 1.200 millimeters, but this is unequal therefore that is a principals reasons provision of water. Some areas recibe only 250 millimeters of annual rainfall, while others 6.000 millimeters per year, even areas don't have rainfall in various months. In our country, only 10% of the total available water is used, and of this amount, 97% is used for irrigation and 3% for domestic and industrial purposes. Most of the water used for domestic purposes comes from surface sources. In rural areas there is a great need for systems of domestic water supply, especially along the coast and in the drought-stricken areas such as the provinces of Manabi and El Oro.

It is already semi-arid region and is accentuated even more by what is said are undergoing desertification. Many no longer provide water wells and drilling at great depths in small communities is very expensive. In the province of Manabi,

water must be hauled in trucks at a very high cost; and besides water shortages due to drought, poor groundwater quality due to excess iron naturally present in the groundwater, which cover grilles wells and seriously reduces the exploitation of these are presented.

In the case of Galapagos, rainfall in the lower part of the islands is only about 60-100 millimeters per year, this is due to the influence of the Humboldt Current that produces thermal inversions that prevent rainfall and generate areas very dry in nearby land parts to power. Except for San Cristobal, the availability of water from natural sources for agricultural and domestic use is almost nil. And in a country in rapid human development, the dilemma of ensuring the supply of this appeal arises, preserve the integrity of natural ecosystems and ensure the health of the population. In Santa Cruz, brackish water (a mixture of rain water and seawater) found in cracks near the coast, is the main source of water for the town of Puerto Ayora. However, the growing demand for a rapidly growing population is putting increasing pressure on this resource. For all the above, it is considered that make of a solar seawater purifier, sustainable and inexpensive, which significantly help the populations of these provinces that lack this vital resource.

1.2. Objects

To design a prototype for purifier seawater at low cost to ensure food security in the coastal zone of Ecuador.

1.3. Specific objectives

- To purify sea water through evaporation principle of using solar energy.
- To design a system (prototype vaporizer) for separate seawater.

1.3. Research Question

This method intended to identify new ways to purify seawater using solar energy, to ensure food safety in the coastal Ecuador areas.

2. Methodology and tools

There are previous experiences of applied scientific research, innovations and prototypes developed at university, in line with the use of solar energy to desalinate seawater and thus contribute to the sustainable development of regions suffer droughts in the country, would support the hypothesis that solar systems can be developed to purify seawater, that are sustainable and inexpensive.

The method applied is called desalination by distillation, which is accomplished by several steps in the salt water evaporates and is condensed into freshwater.

"Desalination (or desalting) is obtained by distillation is overheated evaporate water vapor containing no salts (the salts are not volatile from 300 ° C), the steam is then condensed in the interior or exterior of the tubes in installation.

The distillation process involves three discrete steps to achieve the goal:

a) Formation of steam due to the addition of heat to a body of salt water.
b) Separation of this vapor liquid contact it came from.
c) Condensation of steam by heat removal, typically by contact with a cold surface.

The goal of this process is to obtain freshwater with low cost and the use of renewable energies such as solar energy. This methodology has been used for several years under different processes; the creative in this project is the use of concentrated solar radiation, the same that through energy-efficient processes, evaporation of seawater and steam condensation results in the vital liquid fit for human consumption.

The methodology and tools that arise to fulfill the objectives and the solution of the problem is the following:

1. The project presents a design research model and prototype, which will explain and illustrate the fundamental technological characterization of solar water purification systems (components, performance, etc.) and technical, financial and environmental feasibility.
2. After a final design, which can be implemented simply, whether in the development of components, assembly of components into the system and, above all, easy operation is performed, so that the inhabitants of the communities with water shortages can handle it with ease.
3. A system with suitable characteristics will be built to facilitate transport, handling, environmental conditions and other needs that meets the beneficiary. If the project proves winner, will be implemented in the most

critical area of the Galapagos Islands and later in some of the Ecuadorian coast, so that the residents of the communities become familiar with the desalination system, and thus there is water sweet at low cost and without transportation problems.

4. The implementation of desalination equipment then performs the appropriate studies where they can demonstrate financial viability, with the support of governmental and / or private; and to commercialize the system of purification of seawater.
5. Optimized prototype is patent pending and research results in scientific and technological national and international journals will be disseminated.
6. In parallel, a Draft Feasibility and Business Plan for the phased implementation of an Enterprise Production and Marketing of these water purifying seawater will take place, this process can be carried out in six months.
7. In case of demonstrated financial viability will proceed to entrepreneurship, whose implementation is assumed in six additional months, ie a minimum of two years could mass produce and market these systems.

2. 1. System components

The system purify seawater using solar energy has the following components:

- Parabolic solar collector (made with recycled mirrors)
- Storage Tank Saltwater
- Conduit (pipe)
- Pressure container (for evaporation of salt water)
- Intercooler
- Purifier (final process) Filter

2. 2. Solar Collector parabolic

This device collects the energy radiated by the sun and then converted into thermal energy. There are two types of collectors, flat and parabolic. The type used is the parabolic collector (Fig.1), the collector has a concave parabolic reflective surface which focuses incident radiation to a small area of about one square centimeter, where the temperature can exceed receiver 600 ° C, facilitating the process of water evaporation.

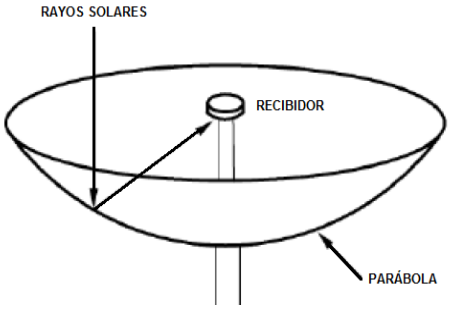

Fig. 1: Parabolic solar collector (reflective mirror).

2. 3. Storage Tank seawater

This component serves primarily for storage in seawater sealing glass (for action research); for the present study made by pipes or ducts, where seawater flow to the intercooler while the pressure container, in which the evaporation process is carried out by means of concentrated solar radiation. Seawater flows throughout the system, operating as the working fluid and consequently as refrigerant in the intercooler to the condensation process freshwater suitable for human consumption.

Table 1: Chemical Composition average seawater[1]

Seawater	**Amount of salt in 1 liter of water**	
	Grams(g)	**Total (%)**
Sodium chloride	27,213	77,758
Magnesium chloride	3,807	10,878
Sulfato de magnesio	1,658	4,737
Magnesium sulfate	1,26	3,6
Potassium sulphate	0,863	2,465
Calcium carbonate and traces of other salts	0,126	0,345
Lithium bromide	0,076	0,217

2. 4. Intercooler

Is a device used to transfer energy from one medium to another; in general, can be classified in intercoolers crossflow when fluid flows cross one another in space and intercooler of parallel flow (Fig.2), when the two streams move in parallel directions . Choose for this study using the intercooler of parallel flow, since their geometric arrangement facilitates the movement of fluids, because this whole process is a result of gravity. Thus the addition of pumps for movement thereof is prevented.

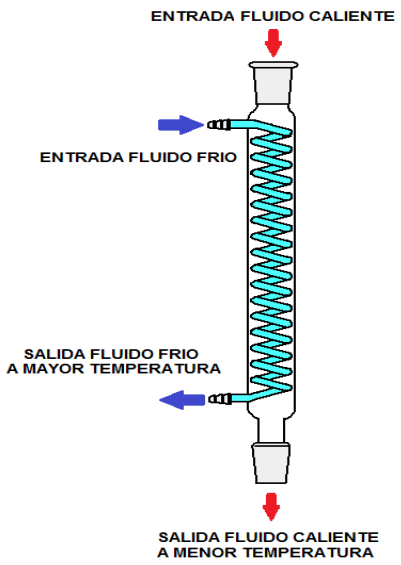

Fig. 2. Heat exchanger of parallel flow.

[1] Photochemincal processes involving nitrite in surface water samples, C. Minero, S. Chiron, G. Falletti, V. Maurino; Aquatic Sciences (2007).

Seawater transported from the storage tank, acts as a coolant (cooling fluid) within the intercooler; at the start, the fluid temperature increases which means an increase team efficiency, as it will use shorter warm seawater until it reaches evaporate; while the steam (hot fluid) exiting the pressure container is the Condensing for obtaining freshwater, which is the final product. Pressure container: This appliance is to concentrate the heat provided by the solar collector, within that saltwater that previously ran the intercooler is located, which increased the temperature contributing to decrease the time of evaporation of seawater.

3. Description of the purification process by solar energy

Once designed and built the "solar Purifier seawater" according to the guidelines of energy efficiency and sustainability, the purification process is summarized below. Firstly, seawater stored in the tank flows through ducts conduction to the intercooler as shown in Figure 3, the fluid water becomes more temperature then enters the high pressure container (about 12 psi) where the saltwater is heated to above its boiling point passing through concentrated solar radiation by the parabolic collector.

Immediately when the process of evaporation, the seawater passes to decompose into water vapor, salt and suspended solids, water vapor then passes into the intercooler coil where it is condensed and finally freshwater is obtained. Condensed freshwater finally enters purifier in which unpleasant tastes and odors caused by organic compounds such as iodine, chlorine, among others, being the fit for human consumption water are removed.

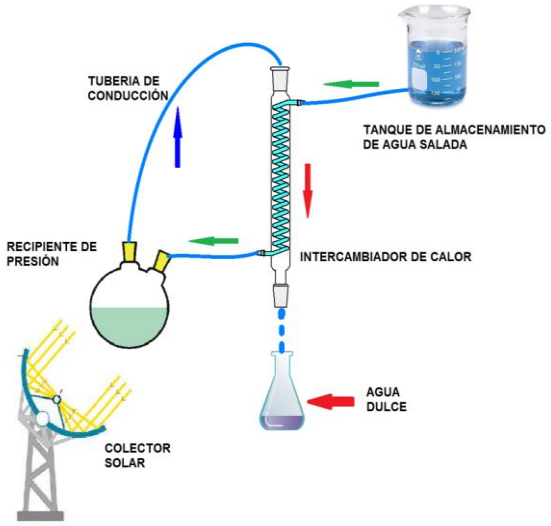

Fig. 3. Functional diagram of solar water purification system.

Because the biggest problem that involves solar desalination are the costs, especially in manufacturing solar parabolic collector, opt for the use of mirrors recycled to form the reflecting surface needed to reach the ideal temperature for the process of evaporation of water seawater. Testing and validation of the proposed research project is conducted and the feasibility of desalinate and purify seawater, obtaining freshwater fit for human consumption is tested.

As shown in Figure 4, the prototype 180.00 USD in total cost (one hundred eighty) and wherein the testing and validation were performed investigation was constructed. As shown in the photograph (Fig. 4) which was taken in the tests that were conducted in the field of Pomasqui, near the city of Quito, water of the Pacific Ocean is brought, the city of Atacames and the built the prototype Solar purifier.

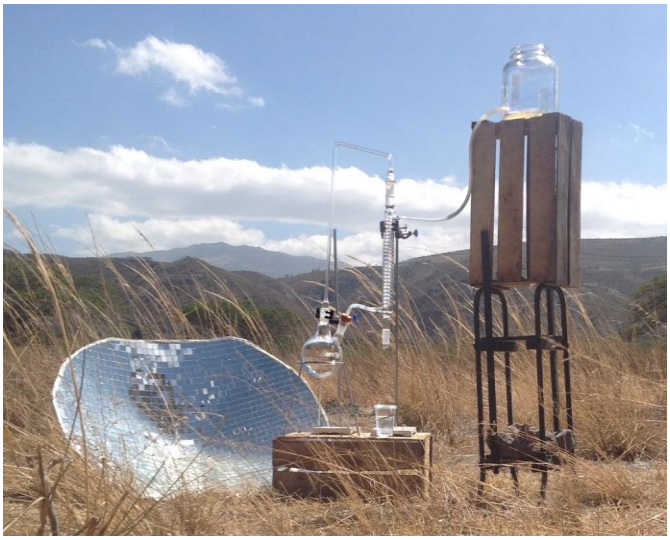

Fig. 4. Prototype solar purification (field test).

In four hours of the test, 200 ml of condensate were obtained meaning that the prototype constructed water purifier has a capacity of approximately 50 ml / hour. The condensed water after desalination process obtained, a microbiological, physical and chemical sampling in the laboratories of the university where the respective assays were performed Kurdish standardized for drinking water fit for human consumption methods is performed, determining that meets Ecuadorian Technical Standard NTE-INEN 1 108-2011, Fourth revision; and therefore it is potable water for human consumption.

To repeatability tests performed two additional proof, similar to those described, in which the results were very close to those obtained in the first test was performed, which validates the results of this research. The proposed project is a creative and innovative way to use solar energy to desalinate seawater, along with engineering it is possible to obtain a simple model, easy to use, and most accessible in the community.

3.1 Feasibility

The seawater desalination using solar energy is a project that meets the objective of obtaining freshwater fit for human consumption and thus contribute to food security in the sectors affected by this problem, taking into account environmental parameters since the energy source used is the sun. Suitable materials for making the system should be highly resistant to corrosion, so plastic is used for the main storage tank, namely recycled plastic is used.

The connection between the tank and the exchanger is a hose having low cost and is easy to handle; the intercooler has a copper coil and a plastic housing to avoid problems of corrosion and wear, these materials make this team has a very low cost. The steam generated in the tank pressure will be conducted by a hose back into the intercooler where it is cooled with salt water, which system efficiency is increased considerably. In mass production equipment, the unit cost of each part of the system decreases considerably; it is also accurate research into new materials that meet the requirements for the prototype.

The cost per cubic meter of freshwater in the Galapagos Islands will decrease considerably because in these islands the water is very hard to find and existing desalination plants do not supply the current demand for freshwater and sold at very high prices. The viability of the project is directly on the low cost of freshwater and the ease with which people can access this resource. The project supplies the inhabitants of the coastal and island areas of freshwater and this is a key indicator of the quality of life that people have, and from the environmental point of view, the use of renewable energy for its operation is extremely economical because electricity does not need.

4. Conclusions

- The use of solar energy generates an advantage over other types of energy because it is clean, sustainable, sustainable, unlimited and renewable. Also not generate harmful pollutants for the health of the population, let

alone the native flora and fauna of each region. At the same time it is contributing to the change in the energy matrix raised in Ecuador, which promotes the use of renewable energy.

- Desalination of seawater is a simple process, in which simple physical phenomena are used. Therefore the presented project can be implemented quickly in communities where drinking water is scarce, so the quality of life for residents will be improved, fulfilling an important objective within the National Plan for Good Living 2013-2017.
- Through research has succeeded in developing a prototype according to the needs of human beings, which is taken into account its easy handling and operation.
- To implement the prototype is necessary to have the support of companies both public and private, make appropriate inquiries and then project into mass production to achieve spread the idea seawater desalination using solar energy.
- The investigation phase yielded positive results in terms of water quality obtained after desalination process, which can be considered a viable, sustainable and viable solution to the problems posed for the current shortage of freshwater.
- This solution will bring fresh water to the headwaters, to reservoirs, to populations, agricultural and industrial establishments. This project is a schematic, but valid idea that need improvement for scientific and technological development, and it will force a profound socio-economic and financial feasibility for implementation, study ending in detecting the origin of money resources suitable. Would establish a national network of aqueducts that worked completely independently of the weather.

Acknowledgements

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