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EFFECT OF SOME EXTERNAL PARAMETERS ON FRESH WATER QUALITY AND PRODUCTION BY SOLAR WATER DISTILLATION

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ABSTRACT

In Algeria, as in developing countries, the problem of drinking water is becoming increasingly important, due to the population growth and rising living standards. Desalination of seawater and brackish water is now possible to meet the demand for potable water. Among the various methods, solar distillation is an attractive solution for isolated and remote area.

The main objective of the present work is the study of a plan solar still with greenhouse effect. We have especially worked on the determination of operating characteristics, production and other parameters. The performed work is purely experimental and is part within the framework of improving the profitability of a solar still with greenhouse effect. During this period of experimentation, different parameters have been mainly a series of measurements: solar radiation, the temperatures of different parts of the setup (internal pane of glass, internal air, water in the tank...) and the daily production. The obtained results have allowed us to determine the external and internal parameters influence on the still yield.

Keywords: Solar energy, Desalination, Solar still, pure water.

INTRODUCTION

Water is the basic necessity for human along with food and air. There is almost no water left on Earth that is safe to drink without purification. Only 1% of Earth's water is in a fresh, liquid state, and nearly all of this is polluted by both diseases and toxic chemicals. For this reason, purification of water supplies is extremely important. Moreover, typical purification systems are easily damaged or compromised by disasters, natural or otherwise. This results in a very challenging situation for individuals trying to prepare for such situations, and keep themselves and their families safe from the myriad diseases and toxic chemicals present in untreated water. Everyone wants to find out the solution of above problem with the available sources of energy in order to achieve pure water. Fortunately there is a solution to these problems. It is a technology that is not only capable of removing a very wide variety of contaminants in just one step, but is simple, cost-effective, and environmentally friendly. That is use of solar energy.

ABOUT SOLAR ENERGY

The sun radiates the energy uniformly in all direction in the form of electromagnetic waves. When absorbed by body, it increases its temperature. It is a clean, inexhaustible, abundantly and universally available renewable energy (Malik et al., 1982).
Solar energy has the greatest potential of all the sources of renewable energy and if only a small amount of this form of energy could be used, it will be one of the most important supplies of energy, especially when other sources in the country have depleted. This solution is solar water distillation. It is not a new process, but it has not received the attention that it deserves. Perhaps this is because it is such a low-tech and flexible solution to water problems. Nearly anyone is capable of building a still and providing themselves with completely pure water from very questionable sources. The energy radiated by the sun on a bright sunny day is 4 to 7 KWh per m^2 (Alpesh et al., 2011).

ABOUT SOLAR STILL

The first "conventional" solar still plant was built in 1872 by the Swedish engineer Charles Wilson in the mining community of Las Salinas in what is now northern Chile (Region II). This still was a large basin-type still used for supplying fresh water using brackish feed water to a nitrate mining community. Solar water Distillation system also called “Solar Still”. Solar Still can effectively purify seawater & even raw sewage. Solar Stills can effectively removing Salts/minerals {Na, Ca, As, Fe, Mn}, Bacteria {E.coli, Cholera, Botulinus}, Parasites, Heavy Metals and TDS (Kumar et al., 1989).

Solar Still Operation

Water to be cleaned is poured into the still to partially fill the basin (fig1). The glass cover allows the solar radiation to pass into the still, which is mostly absorbed by the blackened base. This interior surface uses a blackened material to improve absorption of the sunrays. The water begins to heat up and the moisture content of the air trapped between the water surface and the glass cover increases. The heated water vapor evaporates from the basin and condenses on the inside of the glass cover. In this process, the salts and microbes that were in the original water are left behind. Condensed water trickles down the inclined glass cover to an interior collection trough and out to a storage bottle.

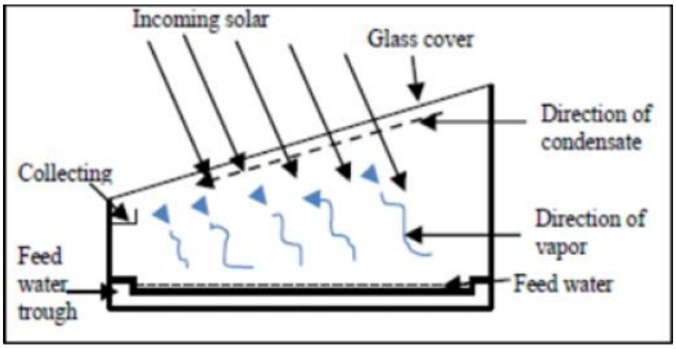

Figure 1: Basic operation of a conventional solar still.

In the present work, we have examined the temperatures effect of the various still components and the solar radiation on the distiller productivity, and on the other hand, the climatic conditions effect in the town of Bou Ismail-Algeria (located 36° 38’ N in latitude and 2° 41’ E longitude) on the pure water quality. The obtained results allow us to present the evolution of different temperatures, the quantity of distillate versus time and the physic-chemical analysis of the distillate.

EXPERIMENTAL

A basin type solar still is an box formed by an assembling of different materials having the property to produce the phenomenon of green house, thanks to various properties possessed by its constituent materials.
The study design is based on the choice of the materials and the variant of distiller.
The materials used have the same functions regardless of the variant of the distiller. We mainly have:

- an absorber (Mokhtari and Semmar, 2001),
- an transparent glass,
- an insulating material,
- an distilled water evacuation system,

• an brackish water admission system,
• an material for sealing the system,
• and eventually a box.

In this study, a conventional still was constructed. The parameters of the still are given in Table1.

Table 1: Technical specifications of solar still

Specifications	Dimensions	Construction materials nature
Basin Area,m2	1.20	
Glass Area, m2	1.20	
Glass Thickness, mm	4 mm	
Number of Glass	1	
Slope of Glass	13^0	
Width	1000 mm	
Length	1200 mm	
Basin		concrete
Walls		plexiglas
Absorber		bitumen
Distillate recovering system		PVC

The bottom of the tanc is covered by a bitumen layer in order to capture the maximum thermal solar energy.
Temperatures of different components of the still were measured by thermocouples connected to a data logger of fluke type for the acquisition of the data and recorded every one hour from 09:30 - 15:30 PM.
The experimentation began the day filling the basin (10/09/2012) with 26 l of seawater of Fouka which has a salinity of 32.7, an electrical conductivity of 49.9 and a pH =7.87 at a thickness which is not constant. The recovery of produced water is every hour, which is later analyzed qualitatively and quantitatively.

RESULTS AND DISCUSSION

Solar radiation

The variation of solar radiation received by an inclined glazing surface =13°C during 6 days is shown in figure 2. There is a classical bell-shaped variation of the solar radiation.
The results show that the solar radiation becomes preponderant and more

intensive in the middle of the days which provides maximum energy storage.

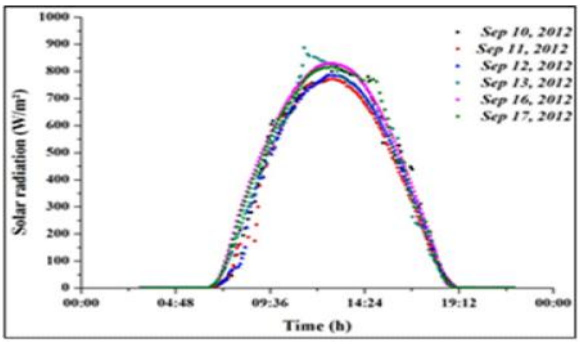

Figure 2 : Evolution of the solar radiation versus the time.

Temperature evolution

The following figures present the temperature variation of water, concrete, bitumen, inner glass, and outer glass versus time.

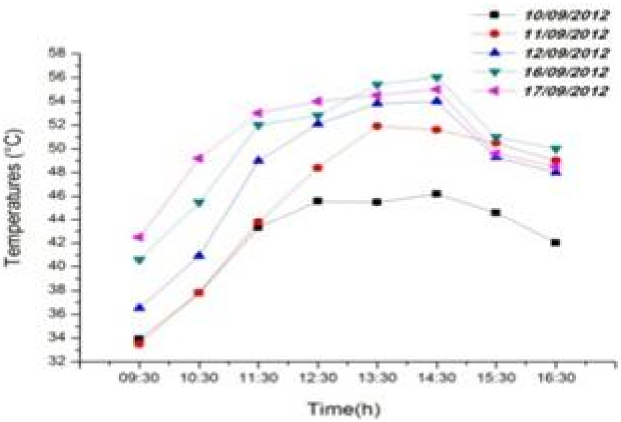

Figure 3: Evolution of the water temperatures as a function of time for different days

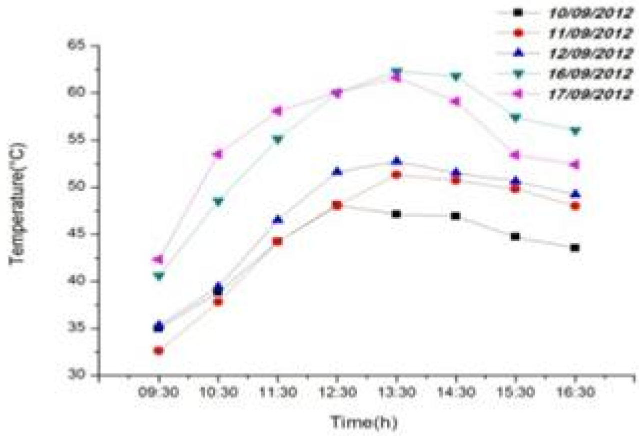

Figure 4: Evolution of the concrete temperatures as a function of time for different days

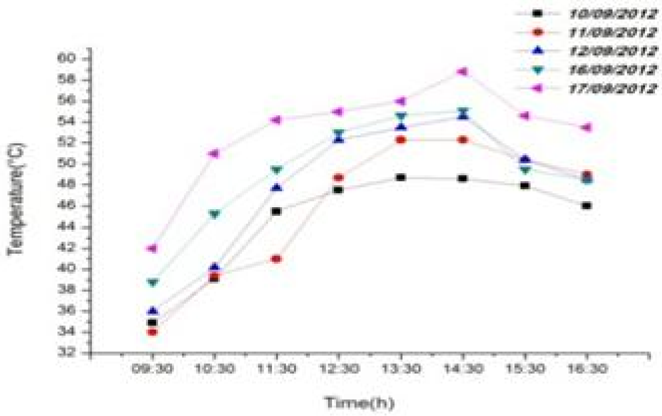

Figure 5: Evolution of the bitumen temperatures as a function of time for different days

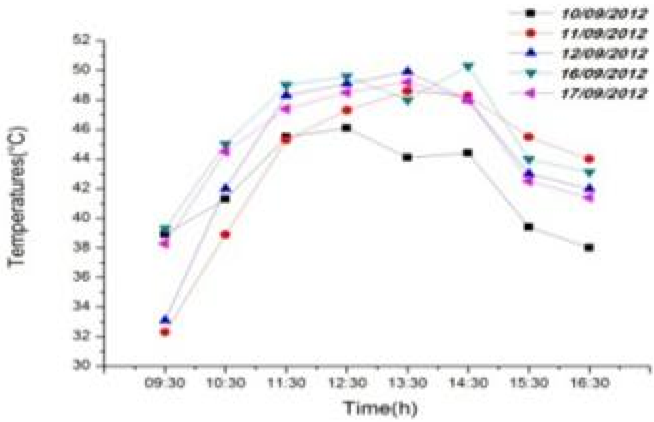

Figure 6: Evolution of the inner glass temperatures as a function of time for different days

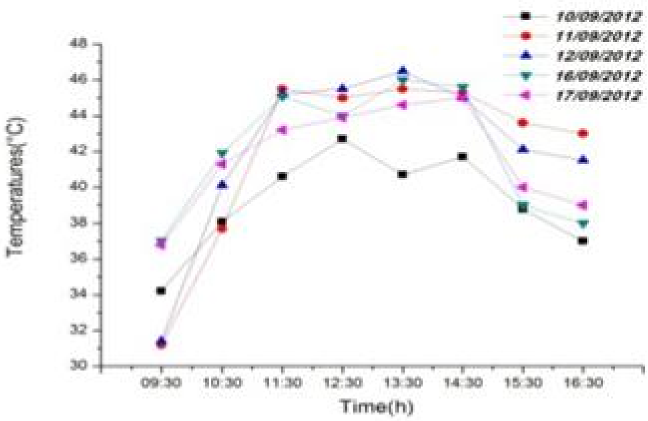

Figure 7: Evolution of the outer glass temperatures as a function of time for different days

We note that the temperatures of the various components of the distiller vary function of the incident solar flux. They are growing faster than the ambient temperature (greenhouse). The maximum temperature achieved is 60°C and it was recorded for the concrete and bitumen which represents the best medium for thermal energy storage.

Regarding the water, concrete and bitumen temperatures, we clearly see that for the different days its values are proportionally the same, it means that the water temperature depends on the other two temperatures, i.e. if the temperature of the concrete and bitumen increases, it can increase the temperature of the water and hence its evaporation.

The figures 6 and 7 show that the inner glass temperatures are higher than those of outer glass, producing a temperature gradient which allows the condensation water that has evaporated.

Distillate productivity

The Figure 8 shows the intensity of solar radiation decreases, so there is a simultaneous decrease in the output. Hence the fresh water production is decreased due to the decline in the intensity of solar radiation and the production reach the maximum between 12:30 and 14:30 for the different days. The maximum value of the produced water which is 270 ml is recorded for the day of 11/09/2012, which was characterized by good meteorological conditions. The overall amount of distilled water recovered from 26 l is 13.907 l.

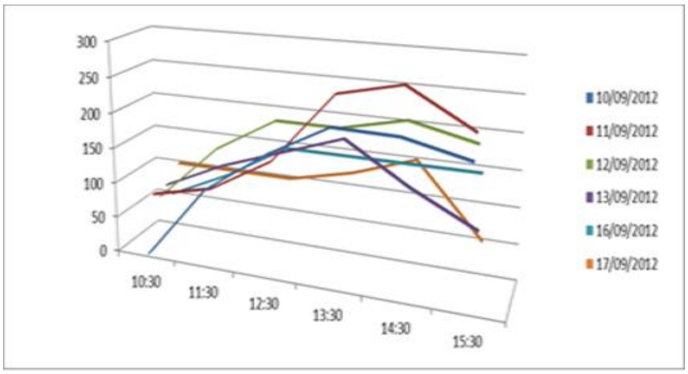

Figure 8: Hourly fresh water production

Distillate quality

The pure water recovered was analysed to determine the pH and electrical conductivity. The fig. 9 and 10 present the results of measurement of these two.

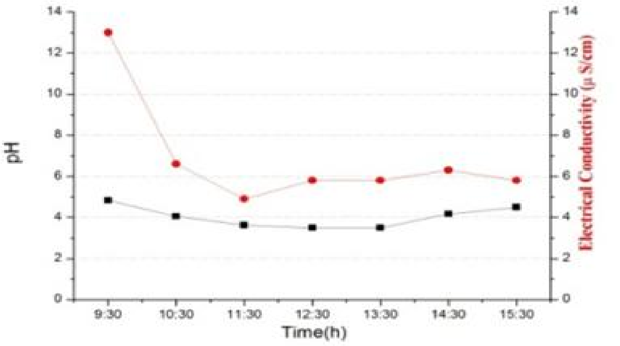

Figure 9: Variation of pH and conductivity versus the time. (11 sep 2012)

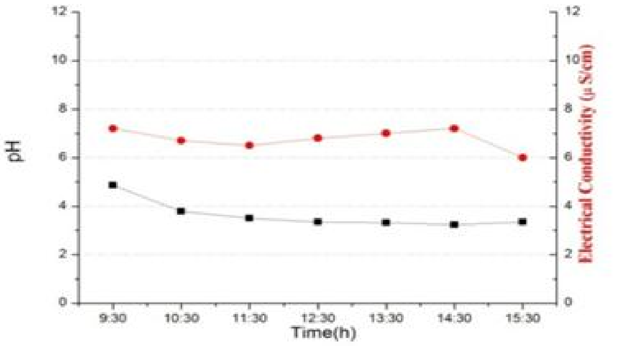

Figure 10 : Variation of pH and conductivity versus the time. (16 sep 2012)

From this figures, it can be seen that the pH present values which are close and they don't exceed a value of 6, this is due to carbon dioxide dissolves in water (GYSI and Stefa, 2008; Aburideh et al., 2012). On the other hand, the electrical conductivity keeps practically the same value except for the day of 11sep 2012 when it reaches 13µs/cm, this can be explained by external factors such as wind which may influence the quality of the distilled water at its collection.

CONCLUSION

The basin type solar still is a very simple in its execution; it can be made with local materials, which gives it the advantage of being easily used by rural people skilled technically.
Using materials that are very ordinary, we will reach temperatures higher than 60 ° C. With a temperature of this order, the system works until a certain time after sunset,
The temperature variation of different components of the still and the distilled

water production depends on the incident solar energy, meteorological conditions…etc.
About the quality of pure water produced, this distiller has allowed us to have water that has a very low electrical conductivity (in the order of µs/cm) in comparing with tap water (in the order of ms/cm) and a pH which is similar to its value in drinking water. Among other things a volume more than 1 liter of distillate could be recovered from 10:30 to 15:30.

REFERENCES

ABURIDEH H., DELIOU A., ABBAD B., ALLAOUI F., TASSALIT D., TIGRINE Z. (2012). An experimental study of a solar still: Application on the sea water desalination of Fouka, Procedia Engineering, 33, 475-484.

ALPESH M., ARJUN V., NITIN B., DHARMESH L. (2011). Design of Solar Distillation System, International Journal of Advanced Science and Technology, Vol. 29, 67-74.

GYSI A.P., STEFA A. (2008). Numerical modelling of CO_2-water-basalt interaction, Mineralogical Magazine, Vol. 72, N°1, 55-59.

KUMAR A., SOOTHA G.D., CHATURVADI P. (1989). Performance of a multi-stage distillation system using a flat-plate collector, Extended Abstract, ISES Solar World Congress, Kobe, Japan..

MALIK M.A.S., TIWARI G.N., KUMAR A., SODHA M.S. (1982). Solar Distillation, Pergamon Press, Oxford, UK..

MOKHTARI F., SEMMAR D. (2001). The Influence of the absorber Configuration on Thermal Performance of a Solar Air Sensor, Journal of Renewable Energies, thermal days, 159-162.