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Original Research Article

The basic evaluation of production process of potable water from waste water by solar energy

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Abstract: Sweet water scarcity is human future wonder since usual technologies used to produce water from salty water are expensive (Reverse osmosis, Electro dialysis) or depends on fossil energies (Multi stage flash, multi effect distillation). On the other hand, air pollution due to the use of fossil energy has led to the widespread use of renewable energy such as solar energy.
Keywords: solar; drinking water; plate; technology.

INTRODUCTION

Water scarcity

Water scarcity involves water stress, water shortage or deficits, and water crisis. While the concept of water stress is relatively new, it is the difficulty of obtaining sources of fresh water for use during a period of time and may result in further depletion and deterioration of available water resources [1]. Water shortages may be caused by climate change, such as altered weather patterns including droughts or floods, increased pollution, and increased human demand and overuse of water. A water crisis is a situation where the available potable, unpolluted water within a region is less than that region's demand. Water scarcity is being driven by two converging phenomena: growing freshwater use and depletion of usable freshwater resources [2]. Water scarcity can be a result of two mechanisms: physical (absolute) water scarcity and economic water scarcity, where physical water scarcity is a result of inadequate natural water resources to supply a region's demand, and economic water scarcity is a result of poor management of the sufficient available water resources. According to the United Nations Development Programme (UNDP), the latter is found more often to be the cause of countries or regions experiencing water scarcity, as most countries or regions have enough water to meet household, industrial, agricultural, and environmental needs, but lack the means to provide it in an accessible manner. The reduction of water scarcity is a goal of many countries and governments. The UN recognizes the importance of reducing the number of people without sustainable access to clean water and sanitation [3]. The Millennium Development Goals within the United Nations Millennium Declaration state that by 2015 they resolve to "halve the proportion of people who are unable to reach or to afford safe drinking water."

Zero Discharge Desalination (ZDD)

Zero discharge desalination (ZDD) process is the most promising technology which has been introduced to answer these problems. Generally, zero discharge desalination process is the best and logical solution to decrease or remove the biological problems which are resultant of concentrated brine wastewaters drainage into ecosystem [4]. The goal of process considers two critical environmental issues for desalting plants: reusing the effluent concentrated brine from desalination unit thereby negating the need for disposal (zero discharge); and producing the potable water and salt. Desalination process in zero discharge desalination plants can be performed in some methods.

Most of countries have unlimited seawater resources and also a good level of solar energy, which could be used to produce drinking water from seawater. Although everybody recognizes the strong potential of solar energy to seawater desalination, the process is not yet developed at the commercial level. The mentioned technique is an environmental friendly and cost saving process competitive with other desalination techniques [5].

Published researches from 1986 to 1995 focused on the technical feasibility of solar ponds. During 1995 to 2000 the papers have been focused on development of solar pond. Since 2000, the published research projects have been surveyed the operating conditions which improved the thermodynamic performance and economics in order to make it more cost effective and competitive with the other desalination techniques such as reverse osmosis, RO, multi stage flash, MSF, multi effect distillation, MED, electrodialysis, ED, concentrating photovoltaic/thermal systems, CPVTS, and etc [6].

This paper is focused on the solar pond which is situated a nano plate as the bottom of the pond. The authors are tried to evaluate the thermal performance of sola pond with nano plate as bottom layer to produce the potable water and concentrated brackish water.

The proposed solar pond is one of the basic stages in zero discharge desalination.

MATERIALS AND METHODS

Description of a solar pond

A solar pond is a pool of saltwater which acts as a large-scale solar thermal energy collector with integral heat storage for supplying thermal energy. A solar pond can be used for various applications, such as process heating, desalination, refrigeration, drying and solar power generation [7]. The saltwater naturally forms a vertical salinity gradient also known as a "halocline", in which low-salinity water floats on top of high-salinity water. The layers of salt solutions increase in concentration (and therefore density) with depth [8]. Below a certain depth, the solution has a uniformly high salt concentration. According to the researches, there are 3 distinct layers of water in the pond: a). the top layer, which has a low salt content, b). an intermediate insulating layer with a salt gradient, which establishes a density gradient that prevents heat exchange by natural convection and c). The bottom layer, which has a high salt content. If the water is relatively translucent, and the pond's bottom has high optical absorption, then nearly all of the incident solar radiation (sunlight) will go into heating the bottom layer. The heat trapped in the salty bottom layer can be used for many different purposes, such as the heating of buildings or industrial hot water or to drive an organic Rankine cycleturbine or Stirling engine for generating electricity [9].

Zinc oxide nano plate of proposed solar pond

The nano plate is situated under the proposed solar pond as floor. The used material for making this plate is zinc oxide nano particles.

Zinc oxide nano particles

Zinc oxide nano particle is a common ingredient and has a huge variety of applications. Zinc is an essential mineral and is non-toxic in low concentration.

Methods

This solar pond operates on the same principle as rainwater: evaporation rate and condensation. The water from the oceans evaporates, only to cool, condense, and return to earth as rain. When the water evaporates, it removes only pure water and leaves all contaminants behind.

RESULTS AND DISCUSSION

Figure 1 shows the average temperature of three zones of wastewater in studied solar pond in 30 June 2013.

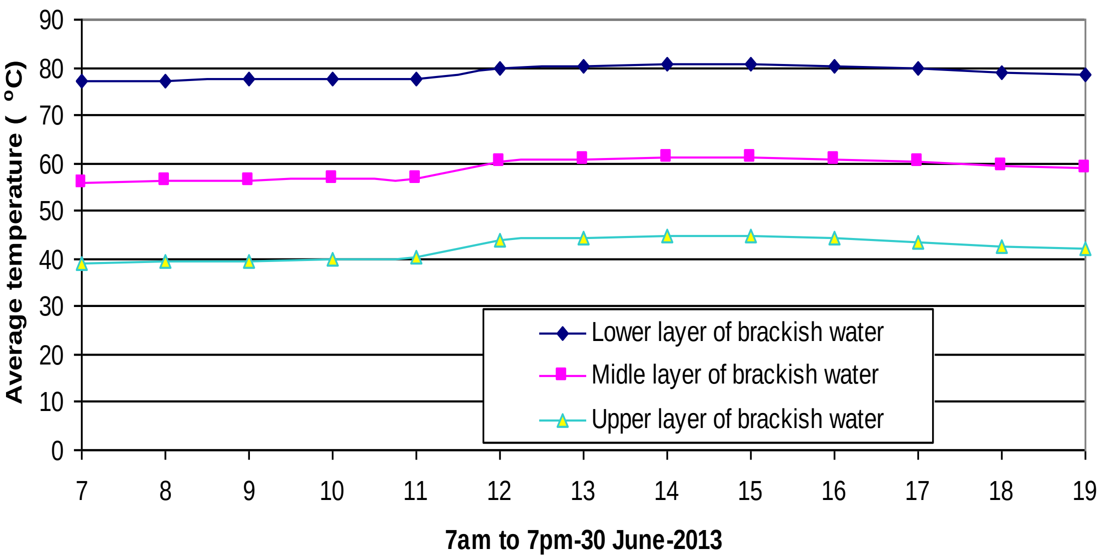

Fig-1: The average temperature of wasterwater in solar pond in 30June 2013.

Temperature values of lower layer of brackish water are obtained near 80°C. This may be described by applied conditions; color of surface is black, the floor which is made nano particles of zinc oxide, the space between the table and base of solar desalination pond is insulated with sawdust. Also, Figure 1 shows the average temperature of upper layer is 42.5°C, approximately.

CONCLUSION

In this work, application of nano science in one passive solar pond is investigated to produce clean water from the desalination effluent stream. This solar system reuses the waste brine to produce concentrated liquor and distilled water, as a basic unit in zero discharge desalination process. So, combination of renewable energy and nano science is considered to earn potable water which is vital for human future.

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