Solar desalination by using hexagonal pyramid along with metallic cone

ABSTRACT

In the world, there are regions of vast extent that have many favorable features, but whose development is principally limited by the lack of fresh water. In arid areas where large-scale development has already occurred, the extraction of fresh water via desalination plants requires very large energy consumption. This motivates the development of solar-desalination systems, which are desalination systems that are powered by solar energy. With the of identifying key technical challenges and potential opportunities solar-desalination, we review a variety of solar energy technologies used for capturing and concentrating heat energy, and also review various technologies for desalination systems including advanced techniques for energy-recovery. Existing solar-powered desalination plants have generally been indirect solar-desalination systems that first(i) transform solar energy into electrical energy and then (ii) employ the resulting electrical energy to drive desalination systems. Other, potentially more efficient direct solar-desalination systems directly convert the solar energy to pressure and/or heat, and use these to directly power the desalination process.

INTRODUCTION

Water is the main source of the life. Water is essential for all life forms on earth-plants, animals and human being, etc. For fresh water requirements humanity is dependent on rivers, ponds, lakes and underground water reservoirs. The available fresh water on earth is fixed, but the demand of fresh water is increased due to population growth and rapid industrialization. Industrial wastes and sewage discharges are mostly mixed in the rivers, so the available Nature is carrying out the process of water desalination since ages. Oceanic water due to solar heating converts into vapours and pours down as precipitation on earth in the form of fresh water. Water is the most needed substance on the earth for sustenance of life. Due to rapid expansion of population, accelerated industrial growth and enhanced agricultural production, there is ever increasing demand for fresh water. Demand of fresh water (potable water) has increased from 15-20 litres/person/day to 75-100 litres/person/day, The ocean covers 71 recent of the earth's surface-140 million square miles with a volume of 330 million cubic miles and has an average salt content of 35,000 ppm. Brackish/saline water is strictly defined as the water with less dissolved salts than sea water but more than 500 ppm.

Desalination has been undertaken using various techniques. The choice of technique would depend on a number of factors including:-Salinity or brackishness of the water

Scale of water requirementLevel of availability of skills to operate and maintain the plant Energy use and power sources availableCapital costs Operating costs. Water scarcity is a growing problem for large regions of the world. Scarcity results when

the local fresh water demand is similar in size to the local fresh water supply.

shows regions of the world in which water withdrawal approaches the difference between evaporation and precipitation, resulting in scarcity.1¡3 The primary drivers of increasing water scarcity are population growth and the higher consumption associated with rising standards of living. A lack of infrastructure for water storage and distribution is also a factor in the developing world. Over time, global climate change is expected to affect existing water resources as well.

OBJECTIVE

1. To determine heat of absorption and condensation in particular instant by using (a) Only Glass (b) Glass And Metallic Cone.
2. To determine water discharge in each phase.

LITERATURE REVIEW

1. Different types of desalination technologies for drinking water

Authors: Shrivastava, Brajesh k

Abstract:

The research paper reviews different types of desalination technologies for drinking water and the innovation in conventional drinking water purification systems for inland and sea water salinity. It also provides the updated status of salinity problem in India and attempts to document field experiences in tackling desalination problem for the benefit of the people with scientific approach.

Keywords: Salin ity, reverse osmosis, habitations, LTTD plants

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2. **Exergy analysis of desalination by solar-powered membrane distillation unit**

Authors- Fawzi Banat and Nesreen Jwaied

Desalination 230 (2008) 27-40

Abstract

There has been an increasing interest in using exergy as a potential tool for analysis and performance evaluation of desalination processes where the optimal use of energy is considered an important issue. Unlike energy, exergy is consumed or destroyed due to irreversibilies in any real process and thus provides deeper insight into process analysis. Exergy analysis method was employed to evaluate the exergy efficiency of the “compact” and “large” solardriven MD desalination units. The exergy efficiency of the compact and large units with reference to the exergy collected by the solar collector was about 0.3% and 0.5% but was 0.01% and 0.05%, respectively, when referenced to the exergy of solar irradiance. The exergy efficiency of the flat plate solar collectors in both units varied diurnally and the maxima was 6.5% ad 3% for the compact and large units, respectively.

The highest exergy destruction was found to occur within the membrane distillation module.

3. Thermal and economic performance

Xiaohua Liu, Wenbo Chen, Ming Gu, Shengqiang Shen, Guojian Cao (2013), represented, thermal and economic performance on solar desalination system with evacuated tube collectors and low temperature multi-effect distillationUnder the calculation conditions of this paper, the following conclusions can be drawn: With the increasing of the number of effects, the volume of storage tank changes slightly, but the area of evaporator and fresh water production increase, fresh water cost reduces greatly. Among the cost constitution of ETC solar desalination system, the proportion of the cost of evacuated tube collector is the largest (31%), then the cost of civil installation and auxiliary equipment and the cost of manpower is second (15%).

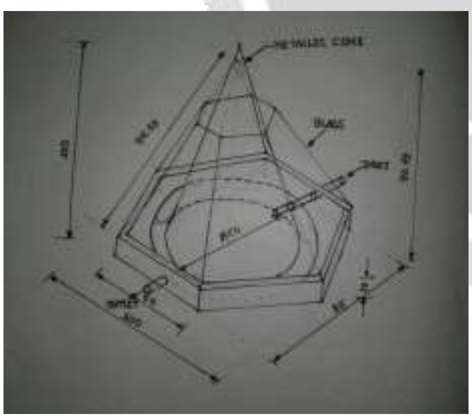

Figure 1- Design in 3D – Hexagonal Pyramid

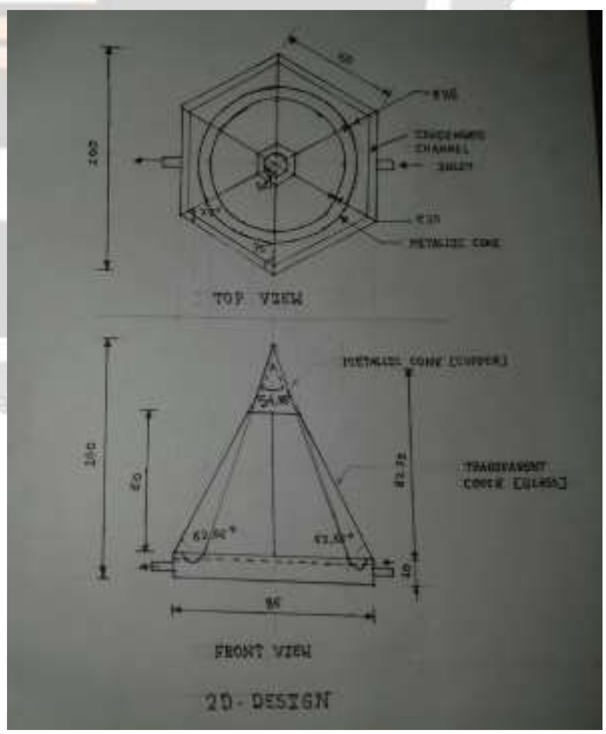

Figure 2- Design in 2D - Hexagonal pyramid

PROJECT SETUP

- The effect of design variables was studied on six single sloped permanent type solar stills with dimensions of 100 x100 x 10 cm i.e. with a basin area of 3.0 m^2.
- Still No. 1 does not contain any bottom insulation while still nos. 2,3 and 4 each contained 2.5 cm thick sawdust insulation.
- The glass angles for stills 1,2,3,4,5 and 6 are 62.56 degrees from horizontal respectively.
- Each of the still was filled daily with about 5 cm of water in the morning and hourly values of distillate was collected and measured.
- Both the channels of each of the still collect almost equal amount of distillate.

COMPONENTS

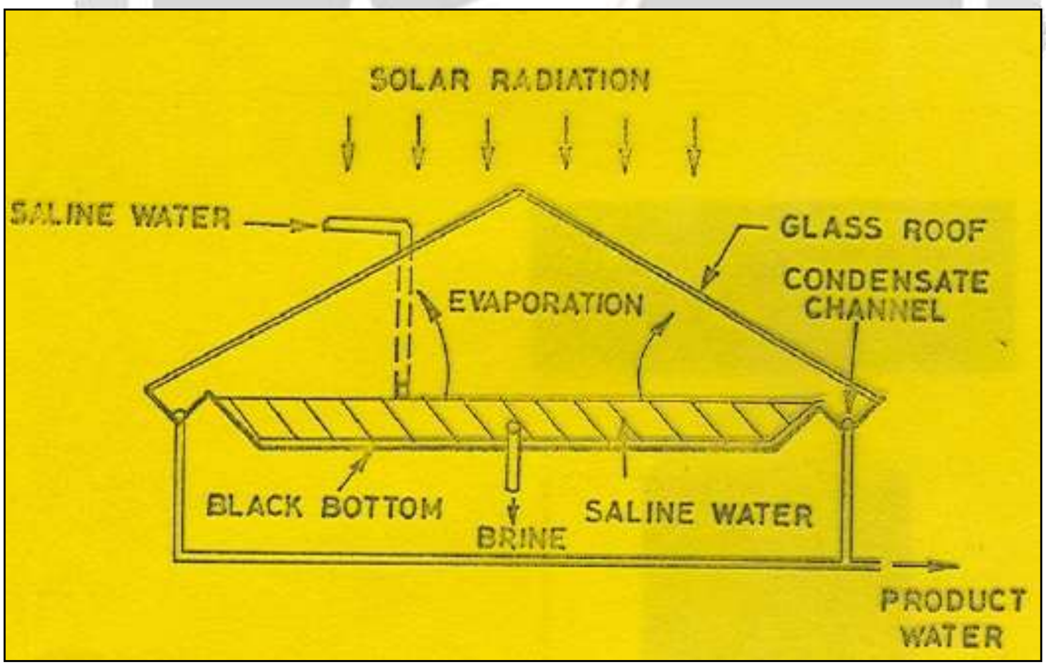

Figure 3:- Schematic of shallow basin type solar still

1. Basin
2. Black Liner
3. Transparent Cover
4. Condensate Channel
5. Sealant
6. Insulation
7. Supply and Delivery System

MATERIALS FOR SOLAR STILLS

- **Glazing:** Should have high transmittance for solar radiation, opaque to thermal radiation, resistance to abrasion, longlife, low cost, high wettability for water, lightweight, easy to handle and apply, and universal availability. Materials used are: glass or treated plastic.
- **Liner:** Should absorb more solar radiation, should be durable, should be water tight, easily cleanable, low cost, and should be able to withstand temperature around 100 Deg C. Materials used are: asphalt matt, black butyl rubber, black polyethylene etc.
- **Sealant:** Should remain resilient at very low temperatures, low cost, durable and easily applicable. Materials used are: putty, tars, tapes silicon, sealant.
- **Basin tray:** Should have long life, high resistance to corrosion and low cost. Materials used are: wood, galvanized iron, steel, aluminium, asbestos cement, masonary bricks, concrete, etc.
- **Condensate channel:** Materials used are: aluminium, galvanized iron, concrete, plastic material, etc.

OBSERVATION TABLE

a. By using only glass (without cone)

Sr.no.	Surface Temp. In degrees	Water discharge In cubic milimetre per min	Time in min
1	35	20	5
2	37	21	5
3	37	23	5

Table 1- Observation table (without cone)

b. By using metallic cne along with glass

Sr.no.	Surface Temp. In degrees	Cone Temperature In degree	Water discharge In cubic milimetre per min	Time in min
1	38	45	52	5
2	38	45	45	5
3	39	45	50	5

Table 2 Observation table (with cone)

CALCULATIONS

The performance of solar still can be predicted by writing energy balance equations on various components of the still. A steady state analysis of solar still is described here.

Referring to the figure the instantaneous heat balance equation on basin water can be written as :

$$I\alpha_w\tau = q_e + q_r + q_c + q_b + C_w \frac{dT_w}{dt}$$

Where I is the solar radiation on horizontal surface; a_w is absorptivity of water and basin liner, t is transmittance of glass cover; q_e, q_r, q_c are the evaporative, radiative and convective heat losses from water to the transparent cover respectively; q_b is the conductive heat loss from water basin; C_w is heat capacity of water and basin; T_w is water temperature; and t is the time. Similarly the instantaneous heat balance equation on glass cover will be :

$$q_{ga} + c_g \frac{dT_g}{dt} = I\alpha_g + q_e + q_r + q_c$$

The heat transfer by radiation q_r from water surface to glass cover can be calculated from the equation

$$q_r = F\sigma(T_w^4 - T_g^4)$$

Where F is the shape factor which depends on the geometry and the emissivities of water and glass cover, and s is the Stefan Boltzmann constant. For the basin type solar still and for low tilt angles of glass cover, the basin and glass cover can be assumed as two parallel infinite plates. The shape factor can be assumed to be equal to the emissivity of the water surface which is 0.9. Hence Eq. 4 will be:

$$q_r = 0.9\sigma(T_w^4 - T_g^4)$$

CONCLUSION

1. Hexagonal pyramid absorbs more enengy in any time of day due to their six faces. If one face is contact with sun another face is used for condensation. Metallic cone (Copper) has good heat transfer coefficient.

2. The solar still output (distillate) is a strong function of solar radiation on a horizontal surface. The distillate output increases linearly with the solar insolation for a given ambient temperature. If the ambient temperature increases or the wind velocity decreases, the heat loss from solar still decreases resulting in higher distillation rate. It is observed for each 10°C rise in ambient temperature the output increases by 10 percent.

3. The depth of water in the basin also effects the performance considerably. At lower basin depths, the thermal capacity will be lower and hence the increase in water temperature will be large resulting in higher output. However, it all depends on the insulation of the still. If there is no lnsulatlon, increase in water temperature will also increase the bottom heat loss. It has been observed that if the water depth increases from 1.2 cm to 30 cm the output of still decreases by 30 percent.

4. Number of transparent covers in a solar still do not increase the output since it increases the temperature of the inner cover resulting in lower condensation of water vapour.

5. Lower cover slope increases the output. From practical considerations a minimum cover slope of 10 deg. is suggested.

6. The maximum possible efficiency of a single basin solar still is about 60 percent.

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