Sea-Water Desalination Based on Greenhouse Effects Using Heatpipe

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Abstract

To abate scarcity of water in the world, desalination process has been touted for nearly 50 years. During these periods, public and private investment in developing and improving desalination technology has aggregated more than a billion dollars. Although there have been successful attempts in developing water supplies in very dry regions, the espousal remains largely inadequate. The annotation can be given by the fact that, although the process costs have been decreased, the total costs of desalination, including the costs of planning, permitting, and concentrate management, remain relatively high, both in absolute terms and in analogizing, with the costs of other alternatives. In evaluating the future contemplation and assurance of desalination technology, it is important to analyse the current and impending financial and economic circumstances that are likely to surround the technology as it develops. However, there has been an increase in Reverse Osmosis seawater desalination especially due to its lower cost and primitiveness..

Keywords: Sea-water desalination, RO desalination, Saline water green house, Design and model of Sea water desalination

1. Introduction

1.1 Necessity for Water Desalination

The supply of fresh water is becoming an increasingly paramount issue in many areas of the world. In arid areas the scarcity of potable water and the establishment of a human habitat strongly depends on how much water is available. Water is essential to life. The importance of provision of potable water can hardly be exaggerated. Water is one of the most abundant resources on earth, covering three fourth of the planet's surface. About 97% of the earth's water is salt water in the oceans and 3% (about 36 million km3) is fresh water contained in the poles (in the form of ice), ground water, lakes and rivers, which supply most of human and animal needs. Nearly, 70%from this tiny 3% of the world's fresh water is frozen in glaciers, permanent snow cover, ice and permafrost. Thirty percent of all fresh water is underground, most of it in deep, hard-to-reach aquifers. Lakes and rivers together contain just a little more than 0.25% of all fresh water; lakes contain most of it.

1.2 Objectives

1. To study and understand the commercially used processes used for Water desalination
2. To understand the role played by Seawater for agriculture
3. To study the working of a full scale commercial Desalination plant.

2. TYPES OF DESALINATION

2.1 MULTI STAGE FLASH (MSF) DISTILLATION

There are two different consonance of the multistage flash process (MSF): the brine recirculation and the once-through versions. In this process, seawater is supplied to the plant and fed through the heat rejection section. This water passes through a series of heat exchangers, raising its temperature. The water then enters the first recovery stage through an orifice and in doing so undergoes decompression to a pressure below its saturation pressure. As the water was already at the saturation temperature for a higher pressure, it becomes superheated and has to give off vapor to become saturated again at the lower pressure. This is known as 'flashing'.

2.2 REVERSE OSMOSIS

In the reverse osmosis (RO) process, the osmotic pressure is overcome by applying external pressure higher than the osmotic pressure on the seawater. Thus, water flows in the reverse direction to the natural flow across the membrane, leaving the dissolved salts behind with an increase in salt concentration. No heating or phase separation change is necessary. The major energy required for desalting is

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for pressurizing the seawater feed. Raw seawater flows into the intake structure through trash racks and traveling screens to remove waste from the seawater. The seawater is cleaned further in a multimedia gravity filter which removes suspended solids.

2.3 SALT WATER GREENHOUSES

The purpose of a greenhouse is to provide a controlled environment that promotes the optimal growth of high-value crops such as salad tomatoes, cucumbers, peppersor flowers. With optimal conditions the output per unit area can be increased by a factor of10 to 20 times that of growing plants outside. Saltwater-cooled greenhouses provide suitable growing conditions that enable year-round cultivation of high-value vegetable crops even in desert conditions that can be very hot but also cool and humid, particularly at night and in the winter. They provide the climate and crop control typically for very high productivity commercial greenhouses, while avoiding the high environmental and economic costs of traditional cooling methods.

3. DESIGN OF SEA-WATER DESALINATION MODEL

3.1 DESIGN DATA

Considering 5.33 kw/m^2/day an average the energy delivered by the Fresnel lens over its area in one minute is given by

Area of lens = $\pi \times d^2 / 4 = \pi \times (0.09)^2 / 4 = 6.36 \times 10^{-3}$

Thus energy delivered by lens per day = 5.33 x 6.36 x10^{-3} = 0.0339 kW. = 33.9 watt. Therefore the heat pipe selected should have a capacity above 33.9 watt.

Selection of the Heat-pipe:

A heat pipe is a simple device that can quickly transfer heat from one point to another. They are often referred to as the "superconductors" of heat as they possess an extra ordinary heat transfer capacity & rate with almost no heat loss. It consists of a sealed aluminum or copper container whose inner surfaces have a capillary wicking .The wick provides the capillary driving force to return the condensate to the evaporator. The quality and type of wick usually determines the performance of the heat pipe. Different types of wicks are used depending on the application for which the heat pipe is being used.

The three basic components of a heat pipe are:

1. The container
2. The working fluid
3. The wick or capillary structure

Container:

The function of the container is to isolate the working fluid from the outside environment. It has to therefore be leak-proof, maintain the pressure differential across its walls, and enable transfer of heat to take place from and into the working fluid. Selection of the container material depends on many factors. These are as follows:

- Compatibility (both with working fluid and external environment)
- Strength to weight ratio
- Thermal conductivity
- Ease of fabrication, including welding, machinability and ductility
- Porosity
- Wettability.

Working fluid:

A first consideration in the identification of a suitable working fluid is the operating vapour temperature range. Within the approximate temperature band, several possible working fluids may exist, and a variety of characteristics must be examined in order to determine the most acceptable of these fluids for the application considered. The prime requirements are:

- Compatibility with wick and wall materials
- Good thermal stability
- Wettability of wick and wall materials
- Vapour pressure not too high or low over the operating temperature range
- High latent heat
- High thermal conductivity
- Low liquid and vapour viscosities
- High surface tension
- Acceptable freezing or pour point

Wick or Capillary Structure:

It is a porous structure made of materials like steel, aluminum, nickel or copper in various ranges of pore sizes. They are fabricated using metal foams, and more particularly felts, the latter being more frequently used. By varying the pressure on the felt during assembly, various pore sizes can be produced. By incorporating removable metal mandrels, an arterial structure can also be molded in the felt.

Working:

Inside the container there is a liquid under its own pressure, that enters the pores of the capillary material, wetting all internal surfaces. Applying heat at any point along the surface of the heat pipe causes the liquid at that point to boil and enter a vapor state. When that happens, the liquid picks up the latent heat of vaporization. The gas, which then has a higher pressure, moves inside the sealed container to a colder location where it condenses. Thus, the gas gives up the latent heat of vaporization and moves heat from the input to the output end of the heat pipe.

3.2 DESIGN DETAILS

The various parts designed for a solar desalination are as follows: -

- Insulated box- To insulate the container

- Container- The part where the desalination takes place
- Nozzle- Water from the tank is injected on the heat pipe through this
- Heat pipe- It plays a vital role in desalination
- Tank- Seawater is stored in this
- Pump- To pump the water from the tank and send it to the nozzle
- Lens- To increase the intensity of sun light
- Frame- The base for the setup
- Lid- To cover the container for condensation process

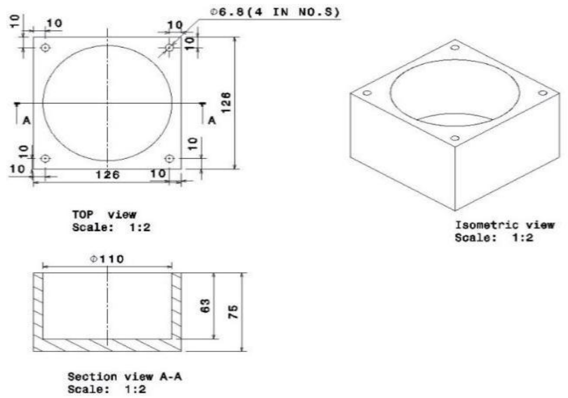

Fig. 1 CAD Design of Insulated Box

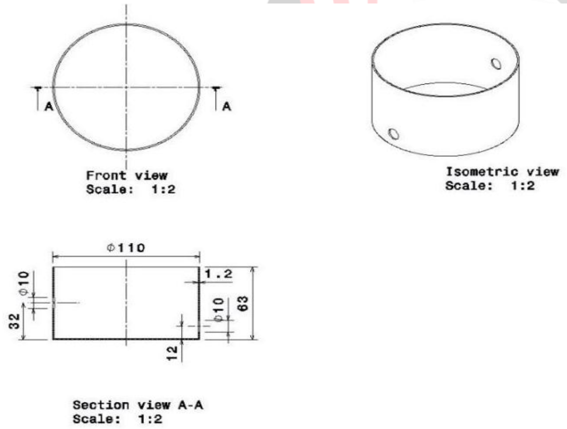

Fig. 2 CAD Design of Container

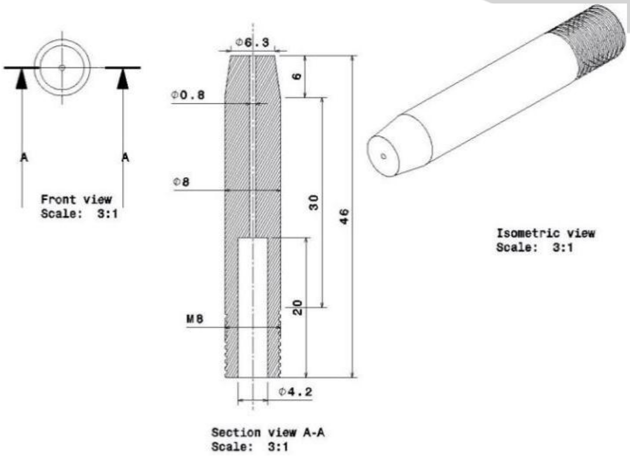

Fig. 3 CAD Design of Nozzle

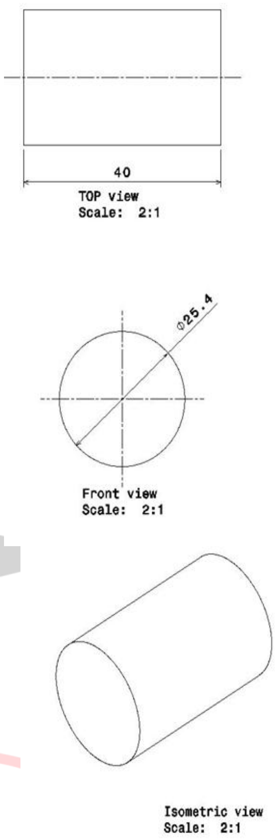

Fig. 4 CAD Design of Heat-Pipe

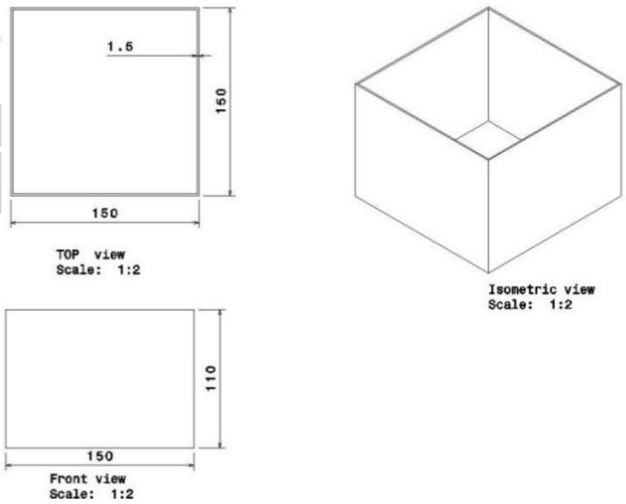

Fig. 5 CAD Design of Tank

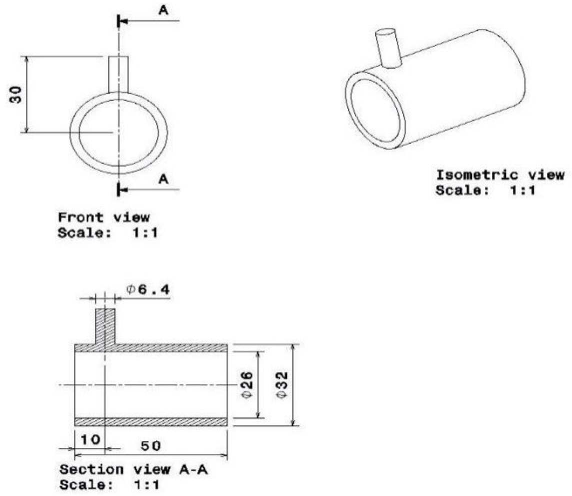

Fig. 6 CAD Design of Pump

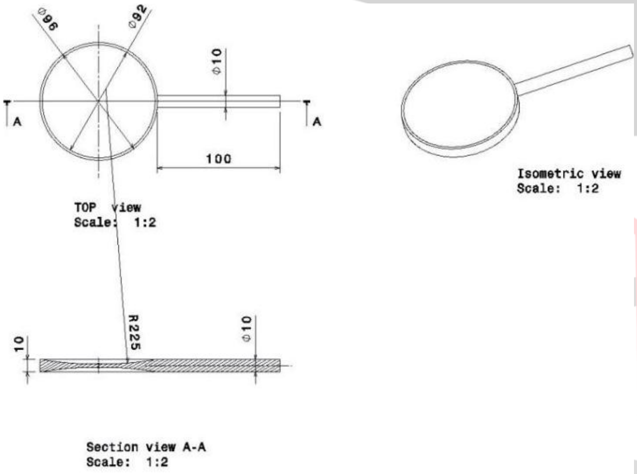

Fig. 7CAD Design of Lens

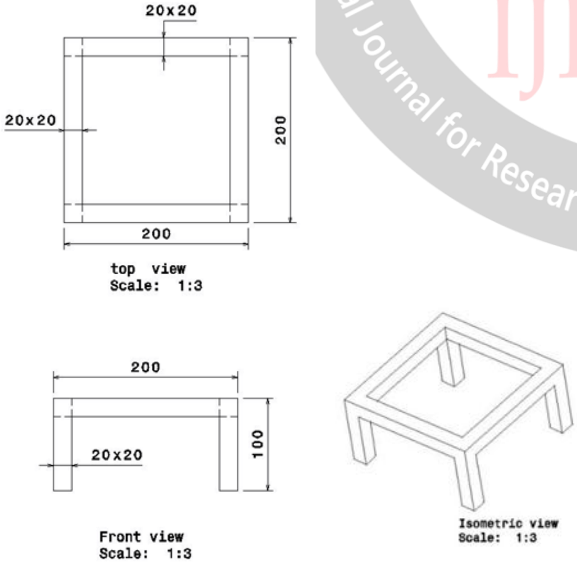

Fig. 8 CAD Design of Frame

Fig. 9 Working Model of Sea-Water Desalination

4. Observation

1. Total Dissolved Salt for sea-water is 36850mg/L
2. Total Dissolved Salt for fresh water is 0-1000mg/L
3. 12V batteries are used for the pump
4. Capacity of tank is 500ml

Sr. No	Amount of Water before Desalination (mL)	Total Dissolved Salt before Desalination (mg/L)	Ambient Temp. (degree C)	Time taken for Desalination (sec)	Water Temp. (degree C)	Amount of Water after Desalination (mL)	Total Dissolved Salt after Desalination (mg/L)
1	100	3685	26	48	27.4	98.5	78.8
2	200	7370	28.5	90	29	197	157.6
3	300	11055	29.2	133	32.6	298.8	239.04
4	400	14740	31	184	33.1	399	319.2
5	500	18425	32.8	236	35	498.6	398.88

5.Conclusion

$$Productivity = \frac{TDS(Input) - TDS(Output)}{TDS(Input)} \times 100 = 97.85\%$$

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