Solar Energy Based Purification of Water

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Abstract- *The availability of drinking water is essential for the survival all of mankind. Adequate amount of water resources are available on our planet but very few of them can be used for the purpose of drinking. A number of water purification methods have been put forth by researchers to purify brackish water and sea water. As water purification processes require some sort of energy source, and with the advent of renewable sources of energy utilization in various fields, a thorough review of solar powered purification setups is essential. An effort has been made to fabricate system for water distillation using solar energy in this research paper. It is found from the literature survey that, a number of research setups and devices are available but are currently not being used due to high initial setup costs and limited technological awareness in the society.*

Keywords- Brakish water, Solar energy, Water purification, Distillation.

I. INTRODUCTION

About 70% of the planet is covered in water, yet of all of that, only around 2% is fresh water, and of that 2%, about 1.6% is locked up in polar ice caps and glaciers. So of all of the earth's water, 98% is saltwater, 1.6% is polar ice caps and glaciers, and 0.4% is drinkable water from underground wells or rivers and streams. And despite the amazing amount of technological progress and advancement that the current world we live in has undergone, roughly 1 billion people, or 14.7% of the earth's population, still do not have access to clean, safe drinkable water. A few of the negative results of this water crisis are:

1. Inadequate access to water for sanitation and waste disposal
2. Groundwater over drafting (excessive use) leading to diminished agricultural yields
3. Overuse and pollution of the available water resources harming biodiversity
4. Regional conflicts over scarce water resources

In addition to these problems, according to WaterPartners International, waterborne diseases and the absence of sanitary domestic water is one of the leading causes of death worldwide. For children less than 5 years old, waterborne disease is the leading cause of death, and at any given moment, roughly half of all hospital beds are filled with patients suffering from water-related diseases. Clearly, having affordable potable water readily available to everyone is an important and pressing issue facing the world today.

Solar water purification is a relatively simple treatment of brackish (i.e. contain dissolved salts) water or sea water in to fresh water. Distillation is one of many processes that can be used for water purification and can use any type of thermal energy. Concentrated solar energy can be used to provide this thermal energy. In this process, water is evaporated; using the energy of the sun then the vapor condenses as pure water leaving behind the dissolved salts and dirt sediments.

II. EXPERIMENTAL SETUP

The layout of experimental setup is shown in figure1.1 It consist of reflector, evaporator Condenser and storage tank for supply water.PVC pipe and copper tubes are used for supplying water to evaporator and condenser. Distilled water is obtained at the outlet of condenser. Solar parabolic type reflector is used for reflecting purpose.

Dimension of experimental setup:-
Storage capacity of supply tank = 10 litres. Water
Dimension of reflector
Aperture diameter = 1.4metre
Depth = .2 metre
Focal length = .61 metre

III. FABRICATION

Selection of material for the construction of water purifier system

Material for the Body of the Dish: Steel was selected because of its strength, lower cost, ease of fabrication in use of material. Its light weight reduces the overall weight of the system.

Material for the Reflecting Surface. To reduce the overall weight of the solar water purifier, a light glass mirror of 2mm thickness, of high surface quality and good specular reflectance was selected. A glass mirror was selected over polished aluminum surface because its reflectivity of 95% is better than that of aluminum (85%). Also, glass surface is easier to clean than aluminum surface.

Material for the Absorber Aluminum was selected over copper and steel because of its lower cost, light weight, ease of fabrication and energy effectiveness in use of material. Its light weight reduces the overall weight of the solar water purifier and also reduces the amount of work to be done in turning the dish about its horizontal axis.

Material for the Absorber Surface Coating Black paint was selected for the absorber coating. It is selected over other coatings because of its higher absorptivity at angles other than normal incidence, adherence and durability when exposed to weathering, sunlight and high temperatures, cost effectiveness and protection to the absorber material.

Material for the Vertical Support of the Dish A rectangular, hollow, steel bar was selected for the support of the dish .This is because of its strength, rigidity, resistance to deflection by commonly encountered winds, and its ability to withstand transverse and cross-sectional loads of the entire portion of the solar purifier

Material for the Base of the Solar water purifier A combination of angle and flat, steel bars were chosen for the base which supports the whole solar water purifier structure. Flat and angle bars were chosen to provide solid and rigid support for the rectangular, vertical axis steel bar which supports the parabolic dish.

IV. CALCULATION

The purifier is provided 40 litres of drinkable water a day for family of four, assuming that each member of family requires 10 litres of drinkable water per day. However in order to reduce space requirement, the purifier will be designed in such a way that it will purify about 10litres of water only at a time.

Heat required to convert 10kg water into vapour(Q)

Q = Sensible heat + Latent heat of water at 100 degree celsius

= mCpdt + (2264.74 kJ/Kg)m

m =10 kg

Cp = 4.18kJ/K.Kg

dt = (100-25)

= 75

Q = 10×4.187×75+ 2264.74×10

Q = 25782.4 KJ ---------(1)

Now

Heat generated by collector

$Q = n. I_d A$

Where

n = efficiency of collector

A = Area of collector

I_d = Average solar radiation

CASE 1:- In winter

I_d = 4.59kJ/h.m^2/day

n = 0.7 to 0.9 (for low reflectivity glass polished mirror)

Q = 0.8 ×4.59 ×3600 kJ/s.m^2 ×A

Q = 13219.2 × A ---------- (2)

Equate eq. (2) and (1) we get

$13219.2 \times A_a = 25782.4$

$$\mathbf{A_a = 1.95037\ m^2}$$

CASE 2:- In summer

I_d =7.48kJ/h.m^2/day

n = 0.7 to 0.9 (for low reflectivity glass polished mirror)

Q = 0.8 ×7.48 ×3600 kJ/s.m^2 ×A

Q = 21542.4 × A ---------- (3)

Equate eq. (1) and (3) we get

$13219.2 \times A_a = 25782.4$

$$\mathbf{A_a = 1.196821\ m^2}$$

CASE 3:- Average in whole year

I_d =5.63kJ/h.m^2/day

n = 0.7 to 0.9 (for low reflectivity glass polished mirror)

Q = 0.8 ×5.63 ×3600 kJ/s.m^2 ×A

Q = 16214.4 × A ---------- (4)

Equate eq. (1) and (4) we get

$16214.4 \times A = 25782.4$

$$\mathbf{A_a = 1.5900\ m^2}$$

V. CONCLUSION

Simple parabolic concentrator seems to be far better than flate plate collector. Following advantages are concluded for parabolic concentrator

1. It increases the intensity by concentrating the energy available over a large surface on to smaller surface (absorber).
2. There are many practical applications where moderate temperature (not very high or low) is required. Such applications are water heating, steam generation, industrial process heating, pumping of ground water, power generation and many more. The temperature needed for such application is about 100^{0} C.Parabolic concentrator is most suitable for this purpose
3. Flat plate collector may attain the temperature up to 90^{0} C. This puts the limitations on most of the moderate temperature applications.
4. Due to smaller size of absorber in parabolic concentrator, loss coefficient and hence losses are less as compared to that in flate plate collector.

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