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A REVIEW ON SOLAR DISTILLATION AND ITS WORKING

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ABSTRACT: This paper aims to present the study on solar distillation and its use. Fresh water is a necessity for the sustenance of life and also the key to man's prosperity. It generally observed that in some arid, semiarid and coastal areas which are thinly populated and scattered, one or two family member are always busy in bringing fresh water from a long distance. In this area solar energy is used for converting saline water into distilled water. Water scarcity and strict environmental regulations has seen the rapid development of membrane technologies in water and wastewater treatment. This technology aims to remove particles and dissolved impurities by evaporation and condensation technique that mimics what occurs in nature within a water cycle. This technology aims to remove particles and dissolved impurities by evaporation and condensation technique that mimics what occurs in nature within a water cycle.

Keyword: Water, solar distillation, suns ray, purification, saline water.

I. INTRODUCTION

Water is an essential element for all life forms. Water is the basic necessity for human along with food and air. In order to be consumed by people, however, it must be treated to eliminate substances and organisms that could be harmful to human health. There is almost no water left on earth that is safe to drink without purification after 20-25 years from today. This is a seemingly bold statement, but it is unfortunately true. 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. Distillation is a highly effective method for purification; given that when water changes from liquid to gaseous state it leaves all impurities in the liquid phase [1]. Distillation is a highly effective method for purification; given that when water changes from liquid to gaseous state it leaves all impurities in the liquid phase. Solar distillation is a relatively simple treatment of brackish (i.e. contain dissolved salts) water supplies. Distillation is one of many processes that can be used for water purification and can use any heating source. Solar energy is a low tech option. In this process, water is evaporated; using the energy of the sun then the vapour condenses as pure water. This process removes salts and other impurities. Solar water distillation is a very old technology. An early large-scale solar still was built in 1872 to supply mining community in Chile with drinking water. It has been used for emergency situations including navy introduction of inflatable stills for life boats [2]. Distilling and reverse-osmosis filtering are the two best methods for purifying water. Both approaches remove more contaminants than activated carbon filters do. The U.S. Environmental Protection Agency says only reverse-osmosis systems and distillers may be called water "purifiers. For every gallon of purified drinking water produced, the process consumes 2 to 4 gallons of water. Distillation takes advantage of the principal that chemicals vaporize at different temperatures. Most potential chemical contaminants in drinking water have vaporization points higher than water. When untreated water is heated in a solar distiller, pure water vaporizes first, leaving contaminants behind. A simple solar distiller removes salts, heavy metals and bacteria, as well as arsenic and many other contaminants.

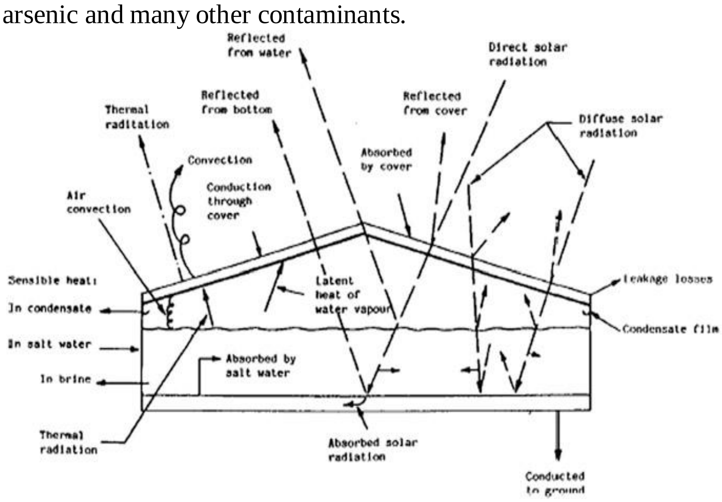

Fig 1- Energy flow diagram [13].

II. HIOSTIRY

Solar distillation is an ancient way of purifying water and making saltwater potable; Aristotle described the process as early as the 4th century BC. The first modern, large-scale solar still, built in Chile in 1872, consisted of 64 basins that supplied up to 20,000 liters of water per day to a mining community in the area. The first mass-production of solar stills, by the U.S. Navy during World War II, created 200,000 inflatable stills for placement aboard the Navy's lifeboats. The earliest onset of solar energy use to desalinate water is widely accredited to Aristotle during the fourth century B.C.E. Earlier attributions reference the Bible & Moses' use of a piece of wood to remove the "bitterness" from water (Exodus 15:25, English Standard Version). The first documented account of solar distillation use for desalination was by Giovani Batista Della Porta in 1958[3].However, no solar distillation publication of any repute leaves out the Father of solar distillation, Carlos Wilson, the creator of the first modern sun-powered desalination plant, built in Las Salinas (The Salts), Chile in 1872[3][4] [5] [6] [7][8][9]. This desalination plant, “can be considered to be the first industrial installation for exploitation of solar energy. "The plant was constructed of wood and timber framework covered with one sheet of glass. It consisted of 64 bays having a total surface area of 4450 m^2 and a total land surface area of 7896 m^2. It produced 22.70 m^3 of fresh water per day. The plant was in operation for about 40 years until the mines were exhausted [3]". "The plant was constructed of wood and timber framework covered with one sheet of glass. It consisted of 64 bays having a total surface area of 4450 m2 and a total land surface area of 7896 m2. It produced 22.70 m3 of fresh water per day. The plant was in operation for about 40 years until the mines were exhausted [10]."

III. TYPES OF SOLAR WATER DISTILLER

There are two types of solar water distiller are present.

- Singlebasin distiller
- Multibasin distiller

A. Singlebasin distiller:

A singlebasin distiller—a rectangular, black box fitted with a piece of angled glass sealed to the top. The basin is filled with untreated water; as the sunlight penetrates the glass, the water warms and evaporates, leaving most contaminants behind. The temperature difference between the cover, which does not absorb much heat and the water surface, causes the water vapor to condense, forming a thin film on the underside of the cover. When enough water condenses, it runs down the cover to a collection trough.

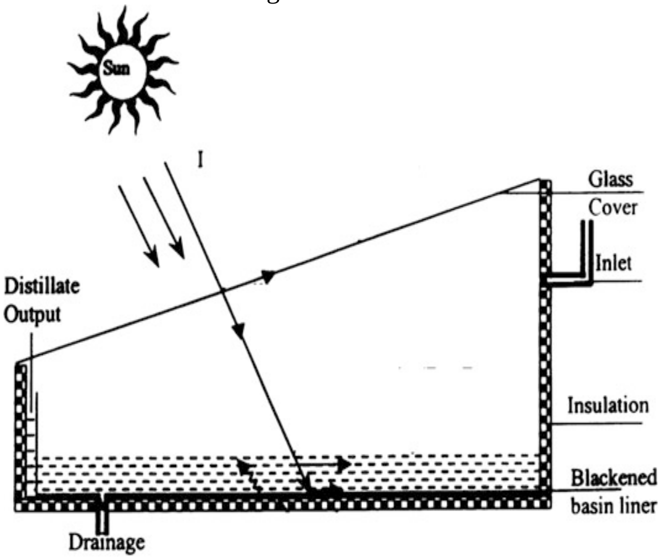

Fig 2- Single basin solar still [13].

B. Multibasin distiller

The other common type of solar distiller is the multibasin distiller. Also known as inclined solar distillers. These distillers generally can be transported easily and may be more suitable for temporary dwellings. Due to the amount of latent heat stored in one large basin of water, singlebasin distillers continue producing distilled water at night, and thus are as efficient as multibasin distillers.

IV. CONSTRUCTION AND WORKING

In figure shows the schematic diagram of solar distiller. Such solar distillers have been operated for farm community use in several countries. It consist of a blackened basin containing saline water at a shallow depth, over which is a transparent air tight cover that encloses completely the space above the basin. It has a roof-like shape. The cover which is usually glass, may be of plastic, is sloped towards a collection through. Solar radiation passes through the cover and is absorbed and converted into heat in the basin or tray is heated and the vapour produced is condensed to purified water on the cooler interior of the roof. The transparent roof material,(mainly glass) transmit nearly all radiation falling on it and absorbs very little; hence it remains cool enough to condense the water vapour. The condense water flows down the sloping roof and is collected in through at the bottom. Saline water can be replaced in the operation by either continuous operation or by batches. Although there are numerous configurations of basin type units, their basic theory is identical. The basin type solar still has produced distilled water at a cost per unit of product lower than other type of solar equipment and is the only type in operation. Operating efficiencies of 35 to 50% for basin type still have been achieved in practical units, as compared with a theoretical maximum of slightly more than 60%.[11].

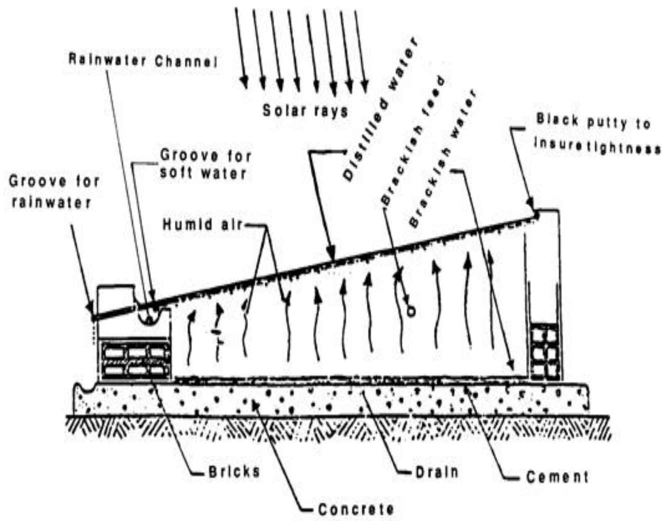

Fig 3: Solar still design.

Efficiency of the solar still is defined as $\eta = \frac{\omega \Delta h}{\mathrm{H}}$

Where $\omega =$ weight of distillate per square meter per day.
$\Delta h =$ Enthalpy change from cold water to vapour.
H = Solar radiation intensity per square meter per day.

Here area of the water surface is to be considered. Δh Includes the latent heat of vaporization, which is being taken as average value 594.5kcal/kg(2489kj/kg).

V. USE OF SOLAR CONCENTRATORS TO ENHANCE SOLAR DISTILLATION

Solar concentrators have a wide variety of applications. They are used to improve the overall collector efficiency, to enhance the aperture-to-cost ratio for a flat collector Broman (1984). They increase the incident solar energy on smaller absorber surfaces where a relatively high temperature is reouired. A V-trough reflector (flat booster mirrors) has been used with different designs of solar collectors such as vacuum tube collector Selcuk (1979) and In improving solar cell performance by an east-west groove alignment which has been proposed by Holland's (1971). The optical and thermal analysis of this type of concentrator has been studied by Meyer et al (1982) and Dang et al (1983). Mousa et al (1978) described a double exposure solar still. The water basin evaporator was exposed to the solar radiation at both its upper and lower surfaces using inner reflectors on the left and right side walls of the still as well as underneath the tray. Experimentally they obtained a yield improvement of 26 percent due to the presence of the reflectors with a solar intensity difference of 7 percent. Their main Introduction page 19 conclusions were that the effect of double exposure is more effective in the first half of the day and the idea of double exposure is a successful technique. Its disadvantage Is the rapid spoiling (degradation) of the mirrors. Tamimi (1987) confirmed that the Installation of reflectors on the Inside walls of a basin-type solar still enhances the still production of distilled water. A comparison of results using the reflectors and black dye has been shown, from which it is indicated the yield increase due to the reflectors is more than that due to the black dye. In this work, the effect of intensification of the solar radiation incident on the wick-type solar still is investigated. A V-trough concentrator-solar still combination was used. The concentrator has an apex angle of 300 with flat mirrors and fixed on the glass cover of a flat wick solar still.[12]

REFERENCE

[1] Gopal Nath Tiwari and Hriday Narayan Singh, Solar energy conversion and photoenergy system.

[2] Practical Action is a registered charity and company limited by guarantee. Company Reg. No. 871954, England | Reg. Charity No.247257 | VAT No. 880 9924 76 | Patron HRH the Prince of Wales, KG, KT, GCB.

[3] 4.0 4.1 4.2 4.3 4.4 4.5 4.6 4.7 4.8 Delyannis, E. (2003). Historic background of desalination and renewable energies. Solar Energy, 75(5), 357-366.

[4] Tiwari, G. N., Singh, H. N., & Tripathi, R. (2003). Present status of solar distillation. Solar Energy, 75(5), 367-373.

[5] 6.0 6.1 Velmurugan, V., & Srithar, K. (2011). Performance analysis of solar stills based on various factors affecting the productivity—A review. Renewable and Sustainable Energy Reviews, 15(2), 1294-1304.

[6] 7.0 7.1 7.2 7.3 7.4 7.5 Gordes, J., & McCracken, H. (1985). Understanding Solar Stills. Volunteers in Technical Assistance (VITA).

[7] Al-Hayeka, I., & Badran, O. O. (2004). The effect of using different designs of solar stills on water distillation. Desalination, 169(2), 121-127.

[8] Goosen, M. F., Sablani, S. S., Shayya, W. H., Paton, C., & Al-Hinai, H. (2000). Thermodynamic and economic considerations in solar desalination. Desalination, 129(1), 63-89.

[9] Bouchekima, B. (2003). A small solar desalination plant for the production of drinking water in remote arid areas of southern Algeria. Desalination, 159(2), 197-204.

[10] 14.0 14.1 Eibling, J. A., Talbert, S. G., & Löf, G. O. G. (1971). Solar stills for community use—digest of technology. Solar energy, 13(2), 263-276.

[11] Book "on-conventional sources of energy" G.D. RAI Khanna Publishers.

[12] Jassim Talib Mahdi, BSc, MSc AN Experimental and theoretical investigation of a wick-type solar still for water desalination. December 1992.

[13] S. K. Shukla "Application of Solar Distillation Systems with Phase Change Material Storage" Department of Mechanical Engineering, I.I.T (B.H.U.), Varanasi, U.P. 221005, India e-mail: skshukla.mech@itbhu.ac.in

