Comparative Study of Single Slope and Double Slope Solar Stills with Pin Fin Absorber

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Abstract— In this present research paper discusses to study the performance of two types of stills such as single slope and double slope with pin fin basin. Experiments were carried out with constant water depth in basin. Finally, we found that productivity attain maximum in double slope solar still compared with single slope solar still within pin fin absorber basin.

Key words: Single Slope Still, Double Slope Still, Pin Fin, Comparison

I. INTRODUCTION

Water is important one in everybody life. Today water crisis increases drastically due to rapid industrialization and also population growth etc. several technologies are developed to obtain pure water from impure water, but cheap and simple method is solar still. Nowadays lot of works are conducted in solar still with different parameters are used. So, we compare the performance of single and double slope solar still with pin fin absorber basin. R.R. Shah, A.B. Damor has studied the effect of using heat absorbing materials such as rubber, black dye. Finally, found that black dye gives solar still output is 26.7% higher than without absorbing materials [1]. Pankaj k. Srivastava, S.K. Agrawal, Abhay Agrawal used multiple floating porous absorbers such as jute fabric and cotton cloth. Hence, jute fabric yield better distillate output than cotton cloth [2]. Sathish Kumar T R, Raja Bharathi B has studied the effect of water depth in basin for productivity of distillate output. In addition black gravel powder as used as thermal energy storage materials. Hence, found that decreasing water depth increased the still distillate output productivity [3]. Amit Malik, Himanshu Manchanda, Mahesh Kumar, Rakesh Kumar had used energy storage material, additives, sponges and also taken parameters like climatic (solar radiation, wind speed, ambient temperature) also effect the solar still productivity. The temperature difference between glass cover and basin water temperature can be decreased by high wind speed [4]. Sushrut Shashidhar Halewadimath, C.N. Nataraj conducted experiments for different water samples harvesting rain water, lake water, bore well water. In above samples maintained in basin with different water depths such as 10mm, 20mm, 30mm, and 40mm. Finally, obtain good efficiency for rain water harvesting (36.1%), lake water (35.4%) and bore well water (34%). The productivity mainly depends on water depth in basin, solar radiation and ambient temperature [5]. Pamesh K. Lanjewar, Dr. S.V. Prayagi had investigated the performance of solar still with storage by mathematical model. The efficiency of still is around 60 % [6]. Deepak.S.A, Sagar Shetty, Soyal Kumar, Siddesha.K.M had made experiment on single slope single basin solar still. They have used aluminium foil laminated parabolic concentrator to increase the extra amount of heat in still for better productivity. The aluminium foil lamination gives better reflectivity of the surface. Finally, concluded that the parabolic concentrator still is more efficient than conventional still [7]. Sanjeev Kumar, G.N. Tiwari, H.N. Singh had analyzed the annual performance of active solar still system. They have found that for better annual yield to maintain collector inclination (20°) and then the solar still glass cover inclination (15°) [8]. V Ramanathan, B Kanimozhi, V K Bhojwani attempt has been made to increase the productivity of solar still output by flat plate absorber. Finally, distillate output of modified solar still (flat plate absorber) reached 25% compared to conventional solar still [9]. D.K. Dutt, Ashok Kumar, J.D. Anand, G.N. Tiwari have studied the effect of using dye in double basin solar still. They have studied the effect of parameters like upper and lower basin water mass and also absorptivity of lower basin water with dye. Hence, performance of solar still is better (dye is used) compared to without dye [10]. A. Tamini has analyzed the performance of solar still with and without reflectors and black dye. Hence, the Productivity of still is increased by addition of reflectors and dye [11]. A.E. Kabeel has made experiment on solar still with a concave wick evaporation surface [12]. S.N. Rai, G.N. Tiwari experimentally studied the performance of single basin solar still coupled with flat plate collector and concluded that daily Productivity attain maximum about 24% higher than simple single basin solar still [13]. Sangeeta Suneja, G.N. Tiwari has made experiment on inverted absorber double basin solar still. They have found that the distillate output attain maximum for least water depth in lower basin [14]. G.N. Tiwari, H.N. Singh, Rajesh Tripathi has discussed the present status of distillation units such as double slope FRP conventional solar still is suitable for remote region and also active solar still is suitable for commercial uses. Then, the value of C and N should be used to know internal heat transfer for the estimation of performance [15]. Hitesh N Panchal has experimentally analysis the performance of double slope solar still with three different absorber plates such as (mild steel sheet, galvanized iron sheet, copper sheet). Hence, found that the productivity is increased when copper sheet is used as an absorber plate in basin [16]. M. Koilraj Gnanadason, P. Senthil Kumar, Vincent H. Wilson, A. Kumaravel have conducted experiment on single basin solar still. They have also used black paint coating, use of pebbles, fins and then modified still made up of copper sheet ensure evaporation rate is higher and it increases the efficiency of modified still [17]. J. Prabahar, Varghese M John, T. Balusamy have done investigation on double slope solar still with different water depth in basin such as 0.5cm, 1cm, 1.5cm, 2cm. hence, observed that productivity increased 51% (0.5cm) compared to that 2cm water depth in basin [18]. Mehdi montazeri, Ahmad Banakar, Barat Ghobadian have investigated two cascades solar still namely, ordinary cascade solar still and cascade solar still with sloping absorber plate. They were

found that productivity attain maximum when sloping absorber plate used in cascade solar still [19]. Hitesh Panchal, Ravishankar Sathyamurthi has conducted experiment on single basin solar still. They were used porous fins on solar still absorber plate to reduce preheating time of water. Hence, they found that productivity of modified solar still (42.3%) when compared to that conventional solar still [20].

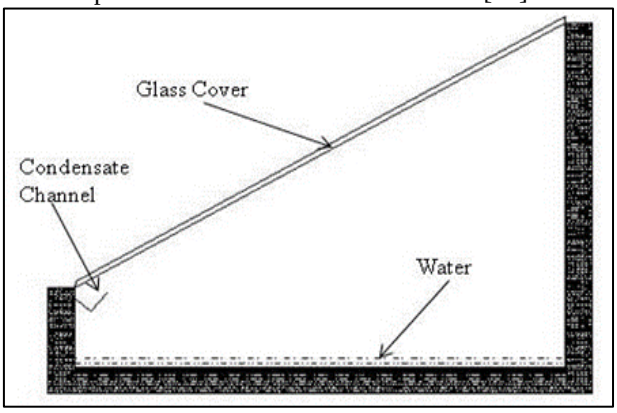

Fig. 1.1: Schematic Diagram of Single Slope Solar Still

In this present work, we aim to carry out an experimental comparative study between pin finned double slope solar still with single slope solar still (pin fin absorber basin). The experimental setup, Results and conclusions are detailed in section II, III, IV.

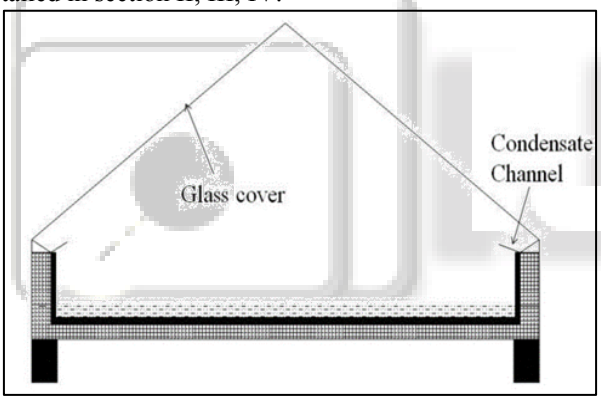

Fig. 1.2: Schematic Diagram of Double Slope Solar Still

II. Experimental Setup

The present work consists of two stills such as single slope and double slope solar still were fabricated with 1.4 mm thickness mild steel plate as shown in Fig. 1.1 and Fig. 1.2.The size of basin for double slope still (1m x 0.8 m x 0.15 m). The size of single slope still (1m x 0.8 m) and height of 0.2m at one side and 0.32m at another side. The glass of 4mm thickness is used in both stills for transparent purpose. For both stills, the glass covers are inclined at 30°. To reduce heat losses in both stills, 50 mm thermocol is used as a best insulator. V- shaped collection channel is provided below the lower edge of glass cover on both stills. The outlet were provided to collect the water through hose and then to store in bottles or jars.

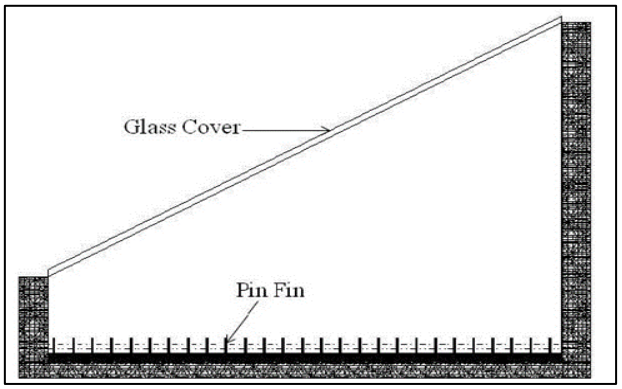

Fig. 2.1: Schematic Diagram of Pin Finned Single Slope Solar Still

The experiments were conducted on two stills for the constant basin condition at MRK institute of technology, Kattumannarkoil, Tamil Nadu, India during the month of March-April. Pin fins are used as absorber plate in both stills namely single slope and double slope solar still as shown in Fig.2.1 and Fig.2.2. The pin fin is made of mild steel with size of 0.01 m diameter and height of 0.10 m. The total number of fins in absorber plate is 140. The capacity of storage tank 50 l is used to supply saline water to both stills. In two stills, we have to maintain water level 3cm in basin. Schematic views of both stills are shown in Fig.2.3.

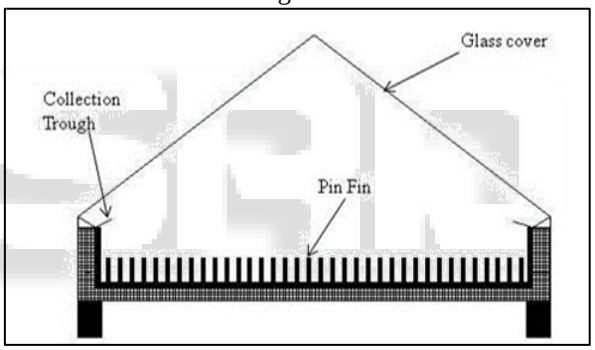

Fig. 2.2: Schematic Diagram of Pin Finned Double Slope Solar Still

In this experiment, every hour to measure the different temperatures like glass cover temperature, pin fin absorber temperature, water temperature and ambient temperature with the help of K-type thermocouples with temperature indicator . Wind velocity and solar radiation is measured by pyranometer and digital anemometer. Distillate output is measured by using measuring jar.

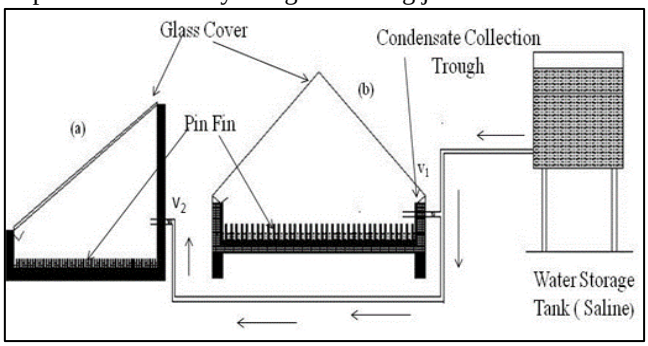

Fig. 2.3: schematic view of solar stills (a) single slope and (b) double slope solar still with pin finned absorber plate basin

III. RESULTS AND DISCUSSION

In this experiment were conducted for constant water depth (3 cm) in basin for both stills such as single slope and double slope solar still. To compare obtained result from single slope still with double slope solar still. In Fig. 3.1 shows the variation of solar intensity radiation with respect to time interval of every hour. Maximum solar radiation is obtained at noon.

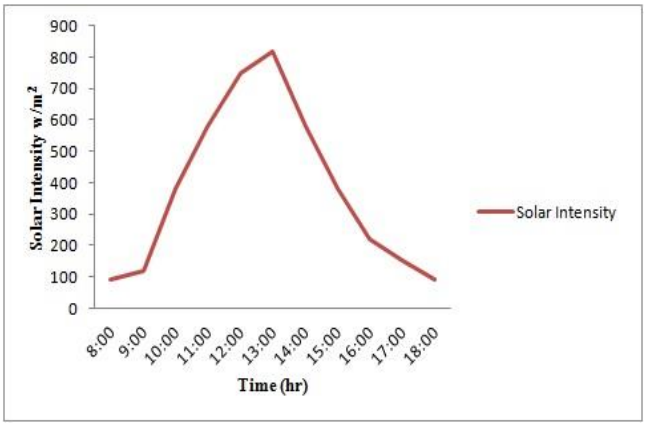

Fig. 3.1: Solar Intensity with Respect to Time

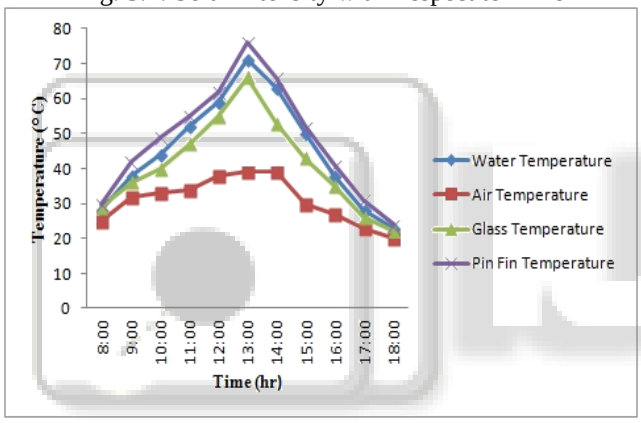

Fig. 3.2: Variation of Pin Finned Single Slope Solar Still Temperature with Respect to Time

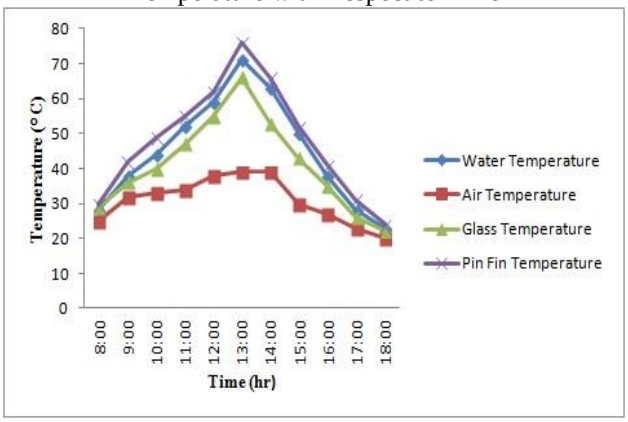

Fig. 3.3: Variation of Pin Finned Double Slope Solar Still Temperature with Respect to Time

In Fig. 3.2 and 3.3 shows the variation of different temperatures with respect to time. Finally, higher temperatures are obtained in double slope solar still (pin finned) with compare to pin finned basin single slope solar still.

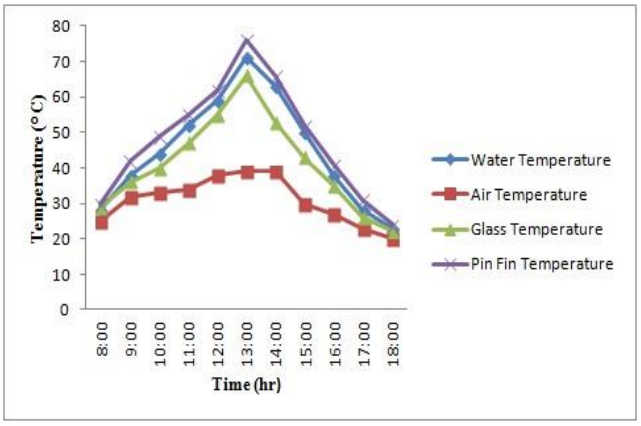

Fig. 3.4: Variation of Single Slope (Conventional) Solar Still Temperature with Time

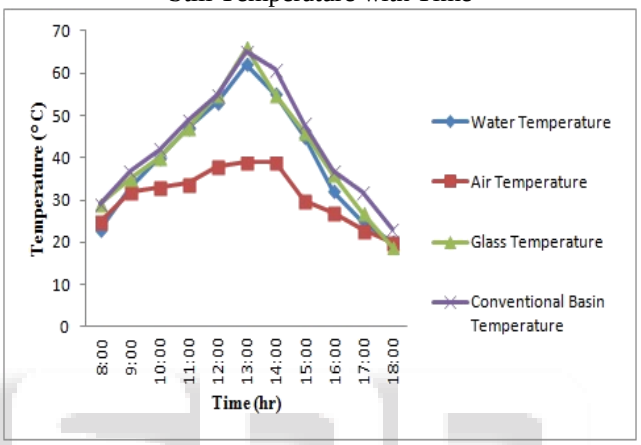

Fig. 3.5: Variation of Double Slope (Conventional) Solar Still Temperature with Time

The variation of different temperatures of conventional stills namely (single and double slope) solar stills shown in Fig. 3.4 and Fig. 3.5.

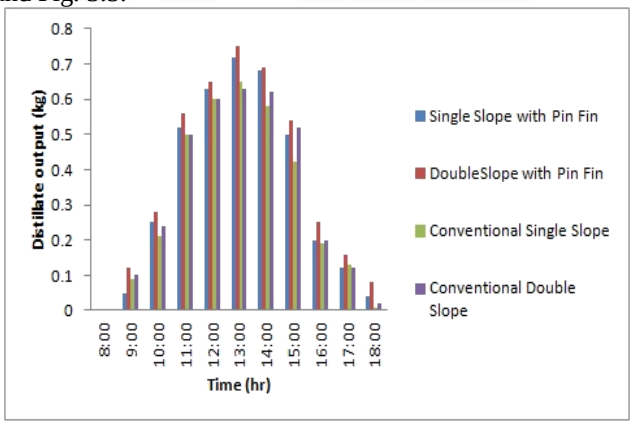

Fig. 3.6: Variation of Distillate Output with Respect to Time

The variation of distillate output of stills such as (single slope and double slope) with and without pin finned basin with time shown in Fig. 3.6. Finally, better productivity obtained in double slope solar still with pin fin compare to single slope solar still.

IV. CONCLUSION

In this present work, the performance of two stills such as single and double slope solar still were compared with constant water depth in basin. In both stills are integrated with pin finned absorber plate basin. Fins are used in still basin for

better heat transfer rate inside the still. Maximum distillate output of about 4.4 kg/m^2 .day is obtained in double slope solar still with pin fin basin were compared to pin finned single slope solar still (3.6 kg/m^2.day). Maintain constant water depth level (3 cm) in basin of both stills.

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