IOSR Journal of Computer Engineering (IOSR-JCE)
e-ISSN: 2278-0661,p-ISSN: 2278-8727, Volume 21, Issue 2, Ser. IV (Mar - Apr 2019), PP 90-94
www.iosrjournals.org

Review Performance of a Double Condensing Chamber Solar Still with a Conventional Solar Still

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Abstract: *Accessibility of drinking water on the earth is less. Sun powered stills are utilized to change over saline water into new water. Various models and plans of sun based stills have been made to build the day by day profitability of the still. In such manner a sun oriented still with discrete consolidating chamber is created to upgrade the pace of buildup and subsequently the efficiency. Their exhibitions as far as vitality and exergy efficiencies were contrasted and the traditional still. The trial was directed in the premises of SHUATS Allahabad, U.P., INDIA. It was seen that the exergy effectiveness of still with isolated consolidating chamber is 60.8% more than the customary sun powered still.*

Key words: *Solar still, separate condensing chamber solar still, exergy efficiency.*

I. Introduction

About 97% water available on the earth is salty. 2% of water available on the earth is in the form of glaciers and polar ice. 1% of water if fresh water and can be made into use. Because of the population growth and industrial activities, the different sources of portable water including rivers, lakes, and underground aquifers have been contaminated [1, 2]. Hence, in this case solar still have been developed which can be used to convert saline water to fresh water. Solar still is a very simple and easy to construct and low cost device [3]. They work on the principle of evaporation and condensation. Solar energy is abundantly available on earth as it is a renewable source of energy and can be used again and again. Solar distillation is majorly one of the processes which can be used for water purification.

Different designs of solar still have been constructed by different researchers and performance has been compared. Many researchers have studied the performance evaluation of solar stills by using energy or exergy analysis. Energy and Exergy analysis has also been done to see the efficiency of the still. Torchia et al [4] have carried out the exergy analysis of a single basin passive solar still their result shows the collector component has the higher irreversibility rates of solar still and also, this rate increases with the increase of solar radiation intensity due to the increase of temperature of various component of solar still. Zoori et al [5] have investigated the effect of mass flow rate on energy and exergy of a weir type cascade solar still the results obtained showed that the maximum energy and exergy efficiencies are obtained at the minimum inlet brine flow. Ragh Vendra Singh et al [6] In this research paper, a comparative energy and exergy analysis of various conventional solar distillation systems has been presented. The study includes passive solar distillation systems such as single and double slope solar stills. It has been found that the energy, exergy and embodied energy of single slope solar still are found higher than that of double slope solar still. K.R. Ranjan et al [7] In this communication, a comprehensive thermodynamic model for exergy analysis of a passive solar distillation system is presented. Energy and exergy analysis of a single-effect, single-slope horizontal passive solar still has been carried out under climatic conditions of India. Ankur Kumar Singh et al [9] performed energetic and exergetic analysis of a double-slope solar still. It was observed that the daily energy efficiency of the system was 29%. The exergy efficiency of the system with north cover was higher than that of the system exergy efficiency with south side glass cover. Narayan pandey et al [12] in this research paper performance study of solar still with separate condenser was done and the energy efficiency was 19% more than the conventional solar still. Ajeet Kumar Rai et al [13] in this an experimental investigation of a double slope solar still with a latent heat storage medium using Zinc Nitrate Hexahydrate was conducted. It was observed that increment of 33.5% in the collection of distillate when still is used with Zinc Nitrate Hexahydrate.

II. Experimental Setup

In the present study a conventional single basin solar still has been designed of galvanized iron having basin area as $1m^2$. A separate compartment is attached to the back side of the still working as the separate condenser and is also made up of galvanized iron. Small ports are made on the inner side to enhance the condensation rate. Glass cover 4 mm thick is used as the top cover of the still at an angle of 26^o to the horizontal. The inner side of the galvanized basin are painted black so that there can be maximum absorption of solar radiation. The water level was checked throughout. A duct was attached at the lower side of the still used to collect the condensate. This distillate is then measured with the help of a graduated measuring cylinder. Thermocouples were attached at different location so as to measure the different temperatures i.e. glass temp., water temp. Solar radiation incident on the glass cover is measured with the help of solarimeter.

Figure 1 Experimental setup of still with separate condenser.

III. Energy And Exergy Efficiency Of Solar Still

The daily η i.e. η_d was obtained by summing up the hourly condensate production m, multiplied by latent heat of evaporation (h_{fg}) and divided by average solar radiation I_g over the whole area.

$$\eta_d = \frac{\sum m h_{fg}}{\sum A I_g} \quad (1)$$

The exergy efficiency is defined as the ratio of exergy output of solar still to the exergy input to the solar still [8,11]

$$\eta_{EX} = \frac{Ex_{evap}}{Ex_{input}} \quad (2)$$

The exergy of solar radiation, as the exergy input Ex_{input} to the solar still can be calculated using available solar energy flux and is expressed through equation which is widely accepted.
[14]

$$Ex_{input} = A_b \times I(t)_s \times \left[1 - \frac{4}{3}\left(\frac{T_a}{T_s}\right) + \frac{1}{3}\left(\frac{T_a}{T_s}\right)^4\right] \quad (3)$$

Where, A_b area of basin in solar still (m^2), $I(t)_s$ is the solar radiation on the inclined glass surface of solar still (W/m^2) and T_s is the sun temperature, 6000 K.
The hourly exergy output of a solar still can be defined as [8,11, 14]:

$$Ex_{output} = Ex_{evap} = \frac{m_{ew} L}{3600\ s.h} \times \left(1 - \frac{T_a}{T_w}\right) \qquad (4)$$

Where, m_{ew} is the hourly yield of solar still, L is the latent heat of vaporization (j/kg), T_a is the ambient temperature (K) and T_w is the water temperature (K).

IV. Result And Disscussion

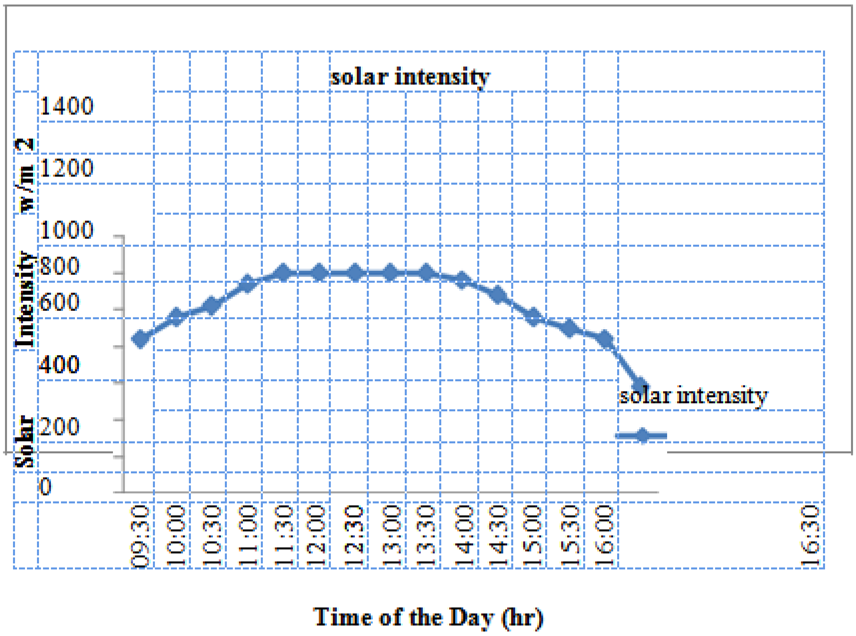

Figure 2 Variation of solar intensity with time

Fig: 2 Shows the variation of solar intensity with respect to the time it can be seen that the solar intensity is maximum i.e. 1200 W/m^2 at around 11:30 am to 1:30 pm.

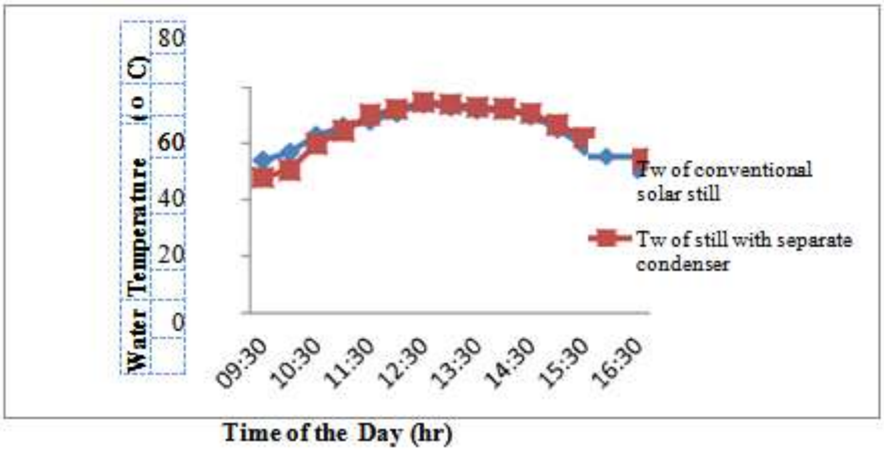

Figure 3 Variation of water temperature with and without separate condenser

Fig 3 shows the variation of water temperature with respect to time for the still without and with separate condenser. It can be seen that the water temperature is maximum at around 12:30 pm.

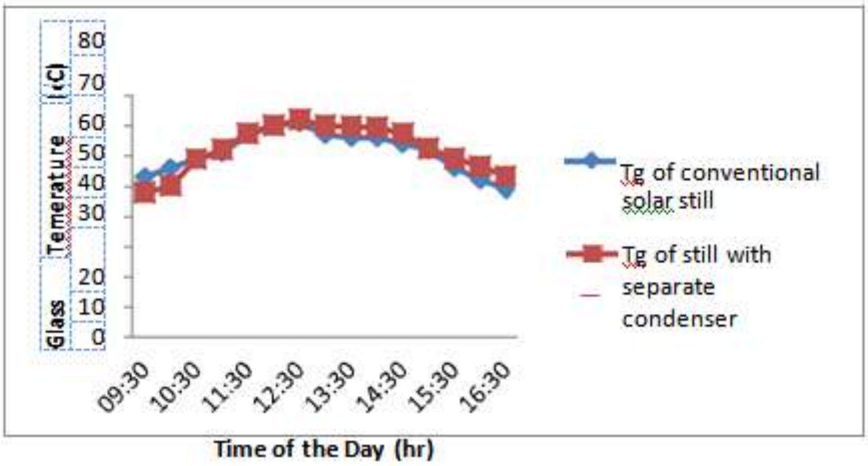

Figure 4 Variation of glass temperature with and without separate condenser

Fig 4 shows the variation of glass temperature with respect to time for the still without and with separate condenser. It can be seen that the water temperature is maximum at around 12:30 pm.

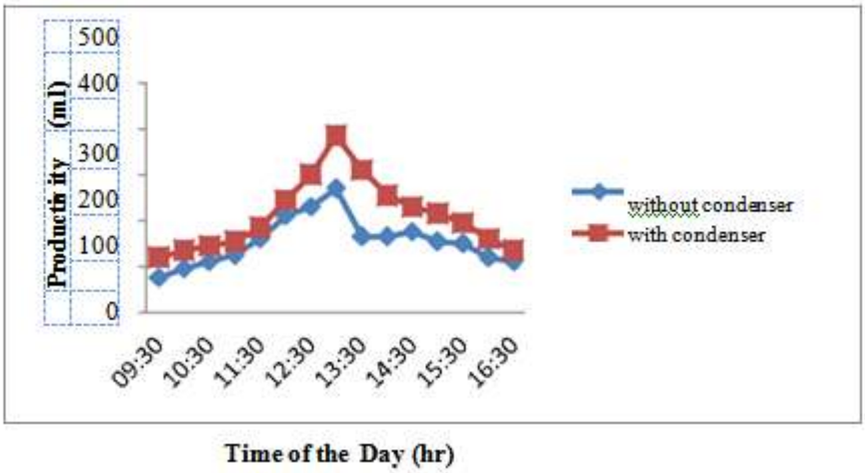

Figure 5 Variation of productivity with time with and without condenser

Fig 5 shows the variation of productivity with respect to the time for the still without and with separate condenser. It can be seen that the productivity of still with separate condenser is much higher than the still without condenser. The productivity gradually increases and reaches maximum value then decreases.

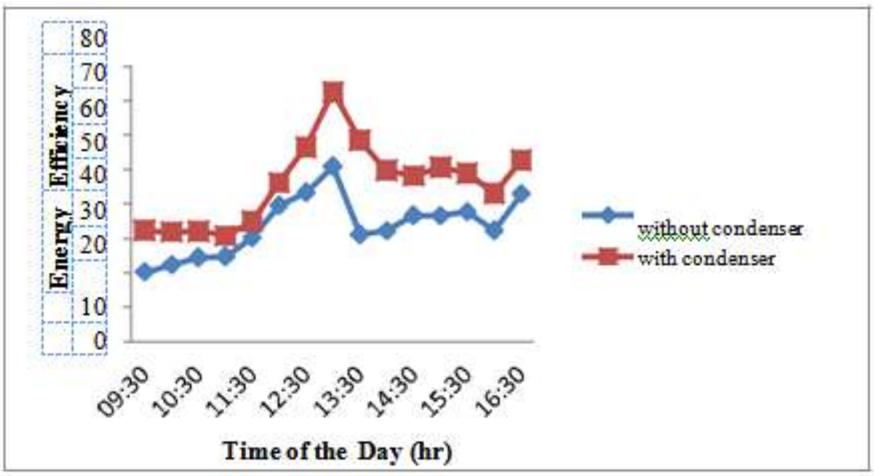

Figure 6 Variation of Energy efficiency with time with and without condenser

Fig 6 shows the variation of Energy with respect to time for the still without and with separate condenser. It can be seen that the energy efficiency of still with separate condenser is much higher than the conventional solar still.

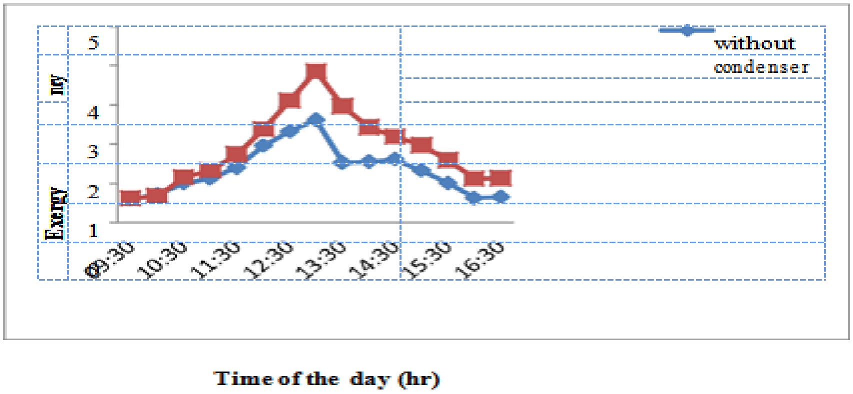

Figure 7 Variation of Exergy efficiency with time with and without condenser

Fig 7 shows the variation of Exergy with respect to time for the still without and with separate condenser. It can be seen that the exergy efficiency of still with separate condenser is 60.48% more than the conventional solar still.

V. Conclusions

In the present work an experimental study is carried out to compare the performance of a double condensing chamber solar still with respect to that of a conventional solar still. Performance is compared on the basis of three different parameters namely daily distillate output, energy efficiency and exergy efficiency. It is observed that the productivity of still with separate condenser is 36.9% higher than the conventional still. Still with separate condenser is 37% more efficient than the conventional solar still. The daily exergy efficiency of the still with separate condenser is 60.8% higher than the conventional solar still.

References

[1]. Kumar S., Tiwari A. An experimental study of hybrid photovoltic thermal (PV/T) active solar still. Int. J Energy Res 2008; 32: 847-858.
[2]. Kaushal Varun A Solar stills: a review. Renew sustain Energy Rev; 14; 446-453.
[3]. Bahadur B., Dubey Richa, Rai A.K. Performance study of a solar still with salt hydrate as energy storage medium. International journal of Mechanical Engineering and Technology (IJMET) 2017, Volume 8, Issue 2, pp. 289–294.
[4]. Torchia-Nùṅez JC, Porta-Gàndara MA, Cervantes-de Gortari JG. Exergy analysis of s passive solar still. Renew Energy 2008; 33: 608-616.
[5]. Zoori H Aghaei, Tabrizi F Farshchi, Sarhaddi F, Hashmatnezhad F. Comparision between energy and exergy efficiencies in a weir type cascade solar still. Desalination 2013; 325: 113-121.
[6]. Ranjan K.R., Kaushik S.C. and Panwar N.L. Energy and exergy analysis of passive solar distillation systems International Journal of Low-Carbon Technologies 2013, 11, 211–221.
[7]. Singh Ragh Vendra, Dev Rahul, Hasan M. M., Tiwari G. N. Comparative Energy and Exergy Analysis of Various Passive Solar Distillation Systems. World renewable energy congress 2011- Sweden Solar Thermal applications (STH) 2011 pp. 3929-3926.
[8]. Kianifar Ali, Heris Saeed Zeinali, Mahian Omid Exergy and economic analysis of a pyramid-shaped solar water purification system: Active and passive cases. Energy (2012) 38 pp. 31-36.
[9]. Singh Ankur K., Dr. Rai A. K., Sachan Vivek Energy and Exergy analysis of a Double Slope Solar Still International Journal of Mechanical Engineering and Technology (IJMET), 2014 Volume 5, Issue 6, pp. 47-54.
[10]. Rabadia Chirag Factors Influencing the Productivity of Solar Still International Journal for Research in Applied Science & Engineering Technology (IJRASET) (2016) Volume 3 Issue X pp. 313-322.
[11]. Hepbalsi A. A key review on exergetic analysis and assessment of renewable energy sources for a sustainable future. Renewable and sustainable energy Reviews 2008; 12 (3): 593-661.
[12]. Pandey Narayan and Rai A.K. performance study of solar still with separate condenser. International journal of Mechanical Engineering and Technology (IJMET) 2016, Volume 7, Issue 4, pp. 125-130.
[13]. Rai A.K., Sachan V., and Kumar Maheep Experimental investigation Of a Double slope solar still with latent heat Storage medium. International journal of Mechanical Engineering and Technology (IJMET) 2013 Volume 4, Issue 1, pp. 22-29.
[14]. Khare Neha, Rai A.K. and Sachan Vivek Experimental study on a stepped basin solar still, International journal of Advanced Research in Engineering and technology (IJARET) July 2015, Volume 6, issue 7, pp. 25-31.
[15]. Archana Dubey and Ajeet Kumar Rai. Performance Study of Solar Still Integrated with Solar Pond. International Journal of Mechanical Engineering and technology. 8(6), 2017, pp. 248 –254.