7th International Conference on Thermal Equipment, Renewable Energy and Rural Development

TE-RE-RD 2018

Drobeta Turnu Severin
31 May - 2 June 2018

7th International Conference on Thermal Equipment, Renewable Energy and Rural Development

TE-RE-RD 2018

ORGANIZERS:

University "POLITEHNICA" of Bucharest
Faculty of Mechanical Engineering and Mechatronics -
Faculty of Biotechnical Systems Engineering -

National Institute Of Research – Development For Machines And Installations Designed To Agriculture And Food Industry – INMA

Romanian Agricultural Mechanical Engineers Society – SIMAR

PROCEEDINGS

Editors:

Prof.dr.ing. Gabriel-Paul NEGREANU
Senior Lecturer dr.ing. Iulian-Claudiu DUȚU

Drobeta Turnu Severin – Romania
31 May - 02 June 2018

ISSN 2359 – 7941
ISSN-L 2359 – 7941

Editura POLITEHNICA PRESS

COVER: Gabriel-Paul Negreanu

SCIENTIFIC COMMITTEE

Dr. Atanas ATANASOV	BULGARIA
Prof. Viorel BĂDESCU	ROMANIA
Prof. Hristo BELOEV	BULGARIA
Prof. Alexandru DOBROVICESCU	ROMANIA
Dr. Cătălin DUMITRESCU	ROMANIA
Prof. Iliya ILIEV	BULGARIA
Prof. Ion V. ION	ROMANIA
Prof. Krzysztof JESIONEK	POLAND
Prof. Önder KABAŞ	TURKEY
Dr. Mihai MATACHE	ROMANIA
Dr. Igor KOVACEV	CROATIA
Prof. Edmond MAICAN	ROMANIA
Dr. Lucian MÂNDREA	ROMANIA
Prof. Jaroslaw MILESKI	POLAND
Prof. Prof. Mirjana LAKOTIC-PAUNOVIC	SERBIA
Prof. Constantin PANA	ROMANIA
Prof. Gigel PARASCHIV	ROMANIA
Prof. Ionel PÎŞĂ	ROMANIA
Dr. Ion PIRNĂ	ROMANIA
Prof. Tudor PRISECARU	ROMANIA
Prof. Violeta RASHEVA	BULGARIA
Prof. Kemal Çağatay SELVİ	TURKEY
Prof. Mariana Florentina ŞTEFĂNESCU	ROMANIA
Prof. Marija TODOROVIC	SERBIA
Prof. Rosen VASILEV	BULGARIA
Prof. Gheorghe VOICU	ROMANIA

ORGANIZING COMMITTEE

Chairman	Prof. Lucian MIHĂESCU	ROMANIA
Co-chairmen	Prof. Sorin-Ştefan BIRIŞ	ROMANIA
	Prof. Gabriel-Paul NEGREANU	ROMANIA
	Dr. Valentin VLĂDUŢ	ROMANIA
	Dr. Iulian-Claudiu DUȚU	ROMANIA

Members	Dr. Cristian-Gabriel ALIONTE	ROMANIA
	Prof. Valentin APOSTOL	ROMANIA
	Prof. Mircea BĂDESCU	ROMANIA
	Dipl.Eng. Viorel BERBECE	ROMANIA
	Dr. Cristina COVALIU	ROMANIA
	PhD student ing. Iuliana GĂGEANU	ROMANIA
	Dr. Mihaela-Florentina DUȚU	ROMANIA
	Dr. Irina-Aura ISTRATE	ROMANIA
	Dr. Elena POP	ROMANIA
	Dr. Iulian VOICEA	ROMANIA

Secretary

PhD student ing. Mariana MUNTEANU	ROMANIA
PhD student ing. Cristina Mihaela CIOBANU	ROMANIA
Dipl. ing. Gabriel GHEORGHE	ROMANIA
M.B.A. Andreea CRISTESCU	ROMANIA

CONFERENCE SPONSORS

SARTOROM
Garantează. Inovează. Excelează

Sos. Bucuresti - Magurele nr. 232
051434 Bucuresti 5, Romania
Tel: +40 21 255 31 32
Fax: +40 21 255 30 66

ENACHE-MORĂRIT
MORĂRIT ȘI PANIFICAȚIE din 1990

Calea Basarabiei nr. 96B
Loc. Huşi, jud. Vaslui, Romania
Tel. / Fax. +40 335 426 839

CONFERENCE PROGRAMME

Thursday, May 31	Friday, June 01	Saturday, June 02
	Breakfast	Breakfast
15.00-16.00 Registration of participants	08.30-09.30 Registration of participants	09.00-12.00 Networking
16.00-16.30 Opening ceremony	09.30-11.00 Oral presentations "Sections 1, 2"	12.00 Participants departure
16.30-18.30 Plenary session	11.00-11.30 Coffee break	
19.00-21.00 Welcome Cocktail	11.30-13.00 Oral presentations "Section 1, 2"	
	13.00-14.30 Lunch	
	14.30-16.30 Oral presentations "Section 1, 2"	
	16.30-17.00 Coffee break	
	17.00-18.30 "Workshop”	
	19.30-22.00 Conference dinner	

CONTENTS

SECTION 1: THERMAL EQUIPMENT AND RENEWABLE ENERGY

EXPERIMENTAL INVESTIGATION OF PARABOLIC TROUGH SOLAR COLLECTOR (PTC) PERFORMANCE FOR WATER DESALINATION

Dhafer Manea H. Al-Shamkhee [1], Essam. Oun Ali. Al-Zaini[2], Qahtan A Abed[3]

[1,2,3] *Dr. Eng. Al-Furat Al-Awsat Technical University, Engineering Technical College- Najaf, Iraq.*

ABSTRACT

Due to depleting traditional energy resources, solar energy appears a promising alternative renewable preference for many demonstrational applications including solar desalination plants. In this respect, an experimental study on the performance of pre-designed and manufactured Lab-scaled water desalination used parabolic trough solar collector PTC was carried out for the first time in Al-Najaf City-Iraq (32° 1' N / 44° 19' E). The proposed designed is to enhance the production of the water still by integrated with a parabolic trough solar. The used PTC with 90°-rim angle mirrored reflector that focused the sun on its focal line of a copper tube with black chrome coating receiver. Primary results reveal 11% improvement in system efficiency is obtained over the used vacuumed copper tube with black chrome coating receiver. Results also confirm PTC facing North or South positions is best for maintaining better system efficiency.

Keywords: Solar distillation, parabolic trough solar collector, condensation, Solar radiation.

1- INTRODUCTION

It is well known that worldwide regions with scarce sources of pure consumable water are having abundant solar energy. Conventional technology of desalinating saline water in such dry regions such as thermal processes is well discovered, implemented and developed. These including multiple effects, multi-stage flash and more recently humidification dehumidification process. Such practices are yet claiming high energy input rates due to the vaporization phase change of saline water [1].

In this respect, utilizing solar energy technology for desalination appears as superior choice of being renewable energy that promotes higher environmental and living standards within such regions. In this respect, trough solar concentrator technology for desalination applications is attractively growing research topic [2-5]. Parabolic trough solar collectors are a type of concentrating collectors used in thermal power plants. They consist of a reflective mirror in the shape of a parabola, a tubular receiver, and support structures. The collector uses the solar incident rays from the sun, reflecting them onto a tubular receiver. The tubular receiver is placed at the focal point of the parabola for effective reflection of the sun's rays onto the fluid inside the receiver [6].

Riffat and Mayere [2] investigated the performance of v-trough solar concentrator for desalination applications. They reported that the v-trough solar concentrator is a superior technique for small and medium water desalination, since the efficiency reaches 38% at 100°C temperature of transfer fluid at the concentrator outlet. Joo and Kwak [3] conducted an optimization study of solar thermal desalination over a small-scale multi effect distiller. Their results revealed an optimal ratio of 2.0.

The performance evaluation of combining desalination systems with concentrated solar power plants was conducted by Palenzuela et al. [4]. They concluded that a low temperature

[3] Corresponding author, email qahtan77@yahoo.com

multiple-effect distillation is more efficient than a low temperature multiple effect distillation integrated with a thermal vapour compression. A multiple-effect distillation system was investigated through a dynamic model generated by Calle et al. [5]. They reported that their generated model could be used to optimize the operating control of such systems. Yanjuan Wang et al. [7]. Carried out numerical simulation combining solar ray trace (SRT) method and finite element method (FEM) to solve problem coupled with fluid flow, heat transfer and thermal stress in a PTC system. Their results revealed that the circumferential temperature difference (CTD) of the absorber decreases with the increases of inlet temperature and velocity of the heat transfer fluid (HTF) and increases with the increment of the direct normal irradiance (DNI). They also reported that the thermal stress and the deformations of the absorber are higher than that of the glass cover. They concluded that their findings could provide a fundamental reference for the development of the parabolic trough solar thermal power plant in China.

The present study is focused on the amount of freshwater productivity of a solar still integrated with the parabolic trough collector in natural mode. The system has been optimized to increase the heat transfer coefficients by adding a heat exchanger coil.

2- EXPERIMENTAL SETUP

The experimental work involved experiments conducted on the solar parabolic trough (PTC) with distillation system. The performance of a locally designed and build PTC for water desalination application was investigated. Collected weather data including air temperature, solar radiation and wind speed was well considered in the experimental work. Where the work divided into two parts; the first part discusses efficiency of the parabolic trough collector and the second part discusses water desalination by use of parabolic trough collector. The PTC was made of a stainless-steel sheet in order to facilitate reflection and concentration of sun radiations towards an absorber tube located at the focus line of the parabolic. The receiver in turn is an absorber tube is made of copper at which point it absorbs the incoming radiations and transforms them into thermal energy, the last being transported and collected by a fluid medium circulating within a tank filled with saline water at which point it evaporates. Pure water then collected as a result of water condensation. The Specification of the used PTC are detailed in table1 below.

Table1. Specification for solar parabolic solar collector

Trough length(L)	1.99m
Aperture (a)	0.85m
Aperture area = L*a	1.99*0.85=1.6915m^2
Height trough	1.74 m
Absorber material	Black steel
Rim angle	90^o

To achieve cost-effectiveness in mass production, the collector structure must feature not only a high stiffness-to-weight ratio, to keep the material content to a minimum, but also to consider low-labor manufacturing processes. A steel parabola framework was designed and manufactured where it has been covered with a highly reflective Stainless-steel sheet as shown in Figure 1. The PTC was positioned facing the south direction in order to ensure a maximum amount of solar radiation to be received. Reflected solar radiation then directed to the receiver tube in its focal line.

Figure 1. Experiment parabolic trough solar with the receiver

The second part of this work is the distillation collector (See figure 2). The temperatures of the distilled water downstream of the pre-heating section, at the inlet and at the outlet of the receiver and downstream of the heat exchanger are measured by thermocouples as well.

Figure 2. Photographic side view of the distillation water

3- RESULTS & DISCUSSION

Solar radiation affects the performance of the PTC due to the fact that its intense varied along day cycle which in turn reflects its amount absorbed by the receiver. Figure 3, highlights the solar radiation-temperature relationship over two days running. Obviously, maximum radiation was recorded at 12:30 pm scoring as high as 962 where the highest temperature of 40.5 ^{o}C was obtained at 3:30 pm on 15/5/2018. On another day, an optimal radiation was reported at 12:10pm of 940 where highest temperature of 44.3^{o}C obtained at 2:30pm.

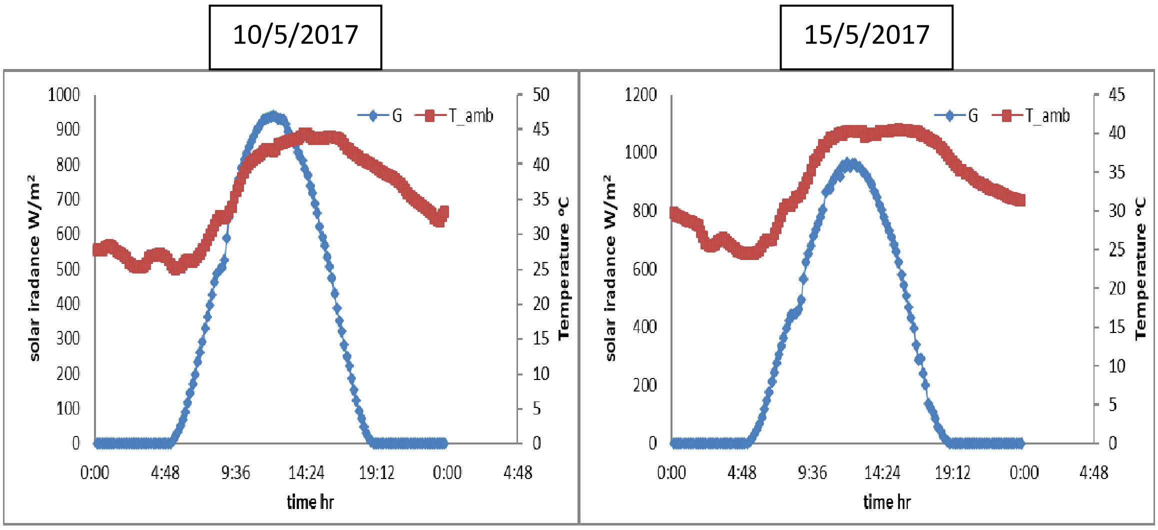


Figure 3. Solar radiation and ambient temperature variation with time at 10 and 15/5/2017

The experimental results of PTC with solar still for fresh water are reported and discussed first. The daily thermal efficiency, for the PTC with solar still was acquired by the summation of the total hourly condensate production for fresh water, multiplied by the latent heat of water vaporization and divided by the product of daily solar radiation and the whole area of the collector.

$$\eta_d = \frac{\sum M.h_{fg}}{\sum I.A}$$

In the experimental results, Figure 4 shows the relationship between time and temperature inlet, outlet and surface temperature of absorber pipe recorded on 10 and 15/5/2017 respectively. Generally, on 10/5/207, it should be mentioned that all temperatures were increased with time. However, a 10ºC decline in surface tube temperature at 12:10pm. This is mainly due to poor contact between the temperature sensor and the tube surface. The error was less pronounced on the results obtained on 15/5/2017 as can be shown in Figure 4.

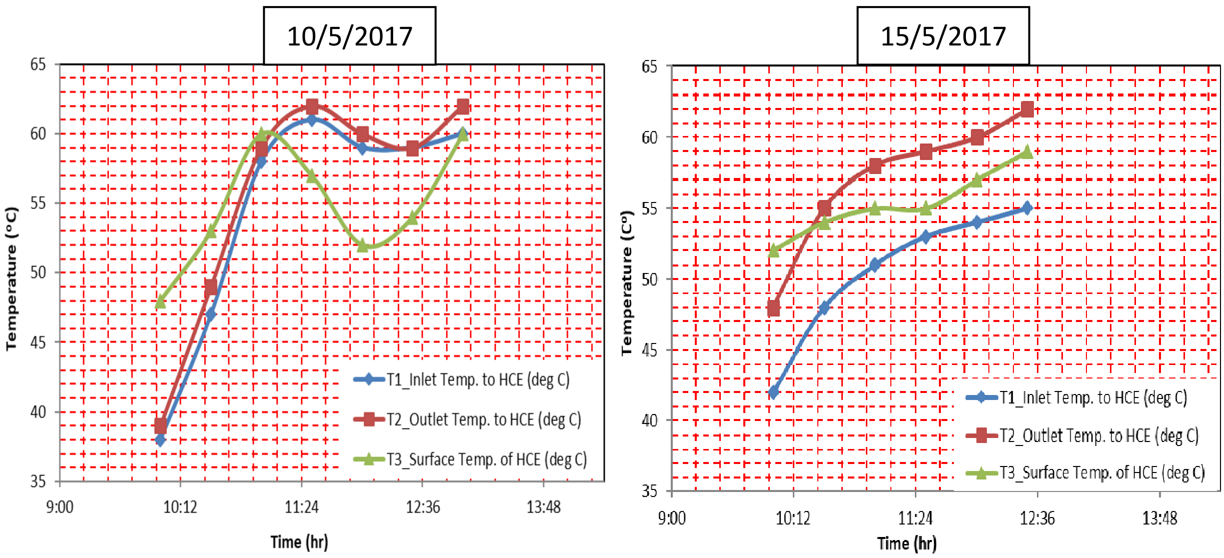
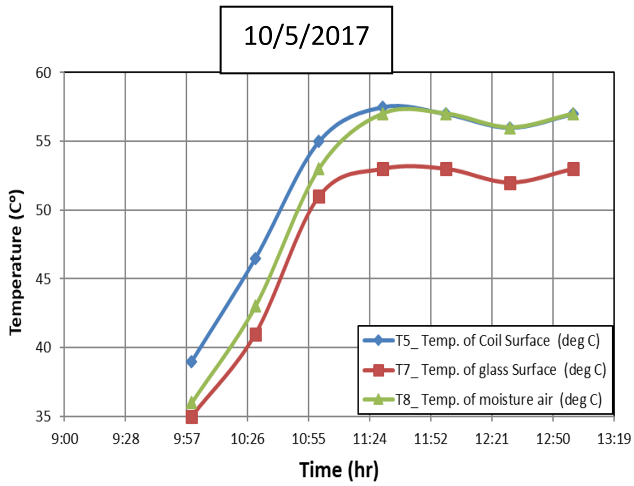


Figure 4. Variation of the inlet, outlet and surface temperature of the PTC with Time for two days

The Figure 5 displays the time-coil surface temperature relationship (T5- water in basin), the temperature of the glass surface (T7- condensation surface) and temperature of moisture air (T8) during the two experimental days 10/5/2018 and 15/5/2018. It can be noticed that the glass surface temperature was the lowest compared to those for the coil surface and moisture air. The difference in temperature also increased with time due to evaporation process takes place in the basin as result of increased solar radiation.



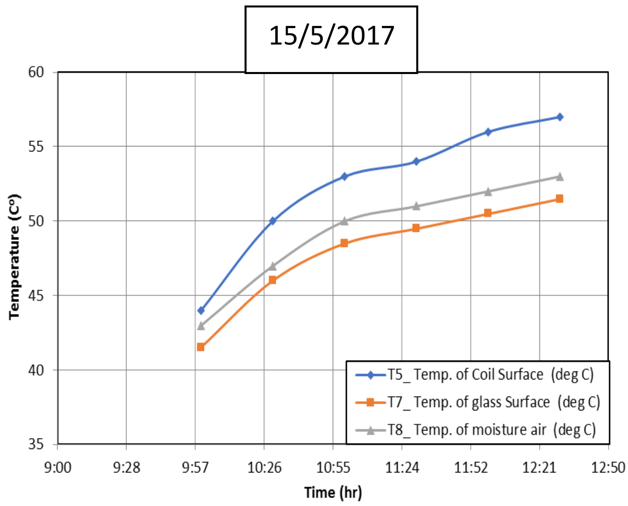


Figure 5. The Relationship between Time and Temperature of Coil Surface (T_5- Water in Basin), The Glass Surface (T_7- Condensation Surface) and Moisture Air (T_8) of two days

The Figure 6 shows the relationship between time and productivity for two days (10/5/2018 & 15/10/2018). It can be noticed that highest productivity was calculated at 12:00pm and lower of productivity at 10:30am on 10/5/2018. Similarly, highest productivity was obtained at 12:00pm on 15/10/2018. Beyond 12:00pm, a noticeable reduction in system productivity was recorded mainly due to reduced water evaporation effect as a result of declined solar radiation.

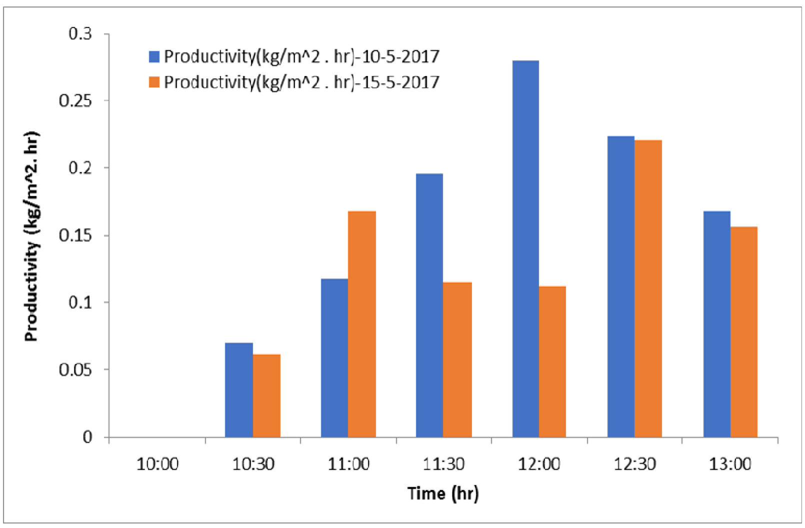


Figure 6. Productivity of fresh water for two days (10/5/2018 and 15/10/2018)

4- CONCLUSIONS

This paper reports the performance of pre-designed and manufactured Lab-scaled parabolic trough solar collector PTC for water desalination application for the first time in Al-Najaf City- Iraq (32° 1' N / 44° 19' E). Experimental outcomes indicate that PTC with single slope solar still system yields a relatively higher productivity of fresh water over traditional solar still systems approaching 5%. It also reported a significant growth in system production could be achieved with expanding the solar collecting space. In this respect, it can be concluded that PTC desalination systems appears to be superior approach in country like Iraq.

References

[1] Fahad A. Al-Sulaiman, M.I.Z., Maimoon Atif, Palanichamy Gandhidasan, Salem A. Al-Dini, Mohamed A. Antar, Humidification dehumidification desalination system using parabolic trough solar air collector. Applied Thermal Engineering 2015. 75: p. 809-816.

[2] Riffat, S. and A. Mayere, Performance evaluation of v-trough solar concentrator for water desalination applications. Applied Thermal Engineering, 2013. 50(1): p. 234-244.

[3] Joo, H.-J. and H.-Y. Kwak, Performance evaluation of multi-effect distiller for optimized solar thermal desalination. Applied Thermal Engineering, 2013. 61(2): p. 491-499.

[4] Palenzuela, P., et al., Evaluation of cooling technologies of concentrated solar power plants and their combination with desalination in the mediterranean area. Applied Thermal Engineering, 2013. 50(2): p. 1514-1521.

[6] De la Calle, A., et al., Dynamic modeling and performance of the first cell of a multi-effect distillation plant. Applied Thermal Engineering, 2014. 70(1): p. 410-420.

[7] Mohamed S. Shahin, M.F.O., Faruk Uygul, Thermodynamic analysis of parabolic trough and heliostat field solar collectors integrated with a Rankine cycle for cogeneration of electricity and heat. Solar Energy, 2016. 136: p. 183-196.

[8]Yanjuan Wang, Q.L., Jing Lei, Hongguang Jin, Performance analysis of a parabolic trough solar collector with non-uniform solar flux conditions. International Journal of Heat and Mass Transfer, 2015. 82: p. 236-249.