Mathematical Modeling and Performance Analysis of the Parabolic Solar Collector

Mokhless Boukhriss, Mohamed Ali Maatoug, Mahdi Timoumi, Nizar Ounib and Nidhal Naat

April 6, 2021

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Mokhless Boukhriss [a,b,*] Mohamed Ali Maatoug[b], Mahdi Timoumi[b],Nizar Ounib,Nidhal Naat[b]

[a]Laboratory of Electromechanical Systems (LASEM); National School of Engineers of Sfax, Soukra road Km 3,5 B.P 1173- 3038 Sfax, Tunisia
[b] Higher institute of technological studies of kairouan quotes campus, Kairouan Tunisia

Email:mokhlessiset@yahoo.fr;maatoug@yahoo.fr;mahdi.timoumi@yahoo.fr;nizarouni@yahoo.fr,nidhalnaat@yahoo.fr

Abstract: In nowadays there are several types of solar collectors have already been developed. The parabolic cylindrical solar collector is used to increase the temperature of the fluid (air / water). In the present of our work, a parabolic cylindrical solar collector has been fabricated using the standard methodology proposed for the construction of conventional solar heaters. The variation in solar radiation, the air outlet temperature and the variation in the temperature of the absorbent plate throughout the day were recorded. The efficiency, effective optical efficiency and effective heat loss coefficient of the single cover flat plate solar collector were calculated. The effect of wind speed on the performance of the sensor was also studied.

Key words: Absorber, Parabolic trough, solar receiver

1. Introduction

In the work present, a cylindrical parabolic solar collector is fabricated using the methodology used in the construction of conventional solar fan heaters [1-2-3]. The variation in solar radiation, the air outlet temperature and the variation in the absorbent temperature throughout the day were checked in. The efficiency, effective optical efficiency and effective heat loss coefficient of the parabolic cylinder solar collector are calculated and the effect of wind speed on collector performance is also studied [4-5-6].

2. Modeling of the cylindro-parabolic sensor:

The most important element in concentrator systems is the absorber tube in which the coolant circulates inside. The absorber tube is often made of copper covered with an appropriate selective layer and surrounded by a glass tube, as shown in Figure 1 by the differential equations of the three temperatures: T_F (Fluid), T_A (absorber) and T_V (glass), these equations vary during the time t (the time illumination) for a length z of the absorber.

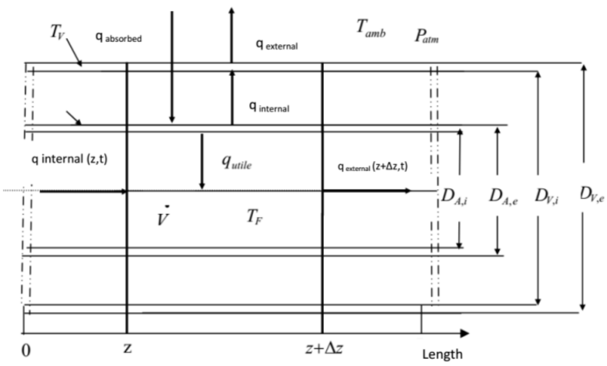

Figure.1: Thermal balance of a surface element of the cylinro manifold parabolic

2.1. Choice of a mathematical method of resolution:

There are several ways to discretely

We have chosen the finite difference method. The quantities y_q in our case are the temperature of the heat transfer fluid, and the temperature of the absorber as well as the temperature of the glazing, they are all a function of time and position. In general, we express the first partial derivative with respect to time as following:

$$\frac{dy_q}{dt} = \frac{y_q(z,t) - y_q(z,t-\Delta t)}{\Delta t} \qquad (1)$$

The partial derivative with respect to the abscissa z.

3. Results and discussions

The numerical calculation method used constitutes a means for the determination of the outlet temperature of the fluid (water) in the absorber of a collector with a concentration effect of the parabolic cylindrical type.

3.1 Solar radiation:

We represent the curves of figures (2, 3, 4, and 5) which reflect the variation of the global radiation, direct and diffuse during four typical days of the year 2020, by adopting the correlation between the localization in Tunisia.

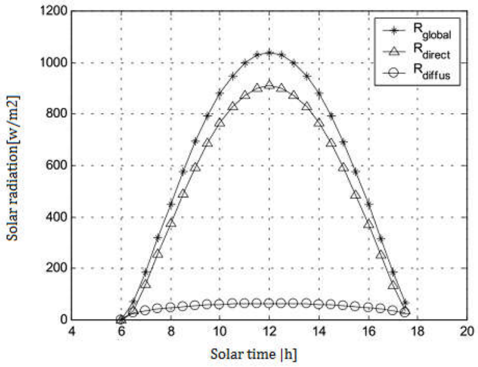

Figure.2: Evolution of global, diffuse and direct radiation as a function of time for the day March 21

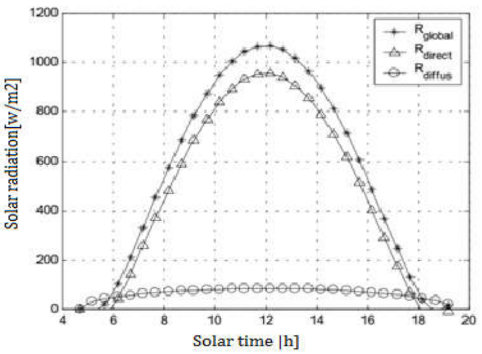

Figure .3 : Evolution of global, diffuse and direct radiation as a function of time for June 21.

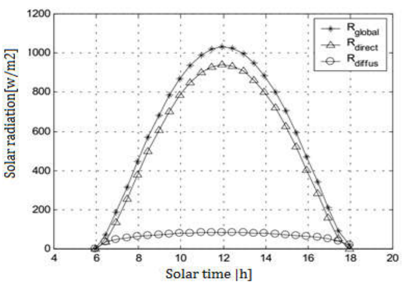

Figure.4 : Evolution of global, diffuse and direct radiation as a function of time for the day September 21.

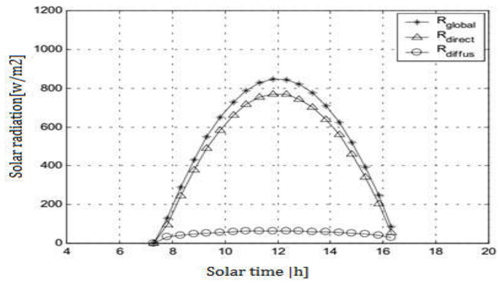

Figure .5: Evolution of global, diffuse and direct radiation as a function of time for December 21.

We note that for the day of June 21, the global radiation is maximum at true solar noon which can reach 1100 W / m^2. For the modeling of the outlet temperature, only direct radiation will be taken into account.

Conclusion

In the present work, a parabolic cylindrical solar collector has been studied by a mathematical study of the optical efficiency and the effective heat loss coefficient of the parabolic cylinder solar collector are calculated and the effect of wind speed on sensor performance is also investigated.

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