The effects of operations parameters on the performance of a flat-plate solar collector in south Algeria (Ouargla)

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jith 2017
25 au 27 Octobre
Monastir, TUNISIE

Abstract

Flat-plate solar collector **(FPSC)** is a special kind of heat exchanger that transforms solar radiant energy into heat. **FPSC** can be designed for applications requiring energy delivery at moderate temperatures, up to perhaps 100 °C above ambient temperature. The major applications of these units are in solar water heating, building heating, air conditioning, and industrial process heat. **FPSC** need to be operated with the maximum possible performance, This paper reports on a simple test procedure where the performances of **FPSC**, this can be achieved by influences of volumetric flow rate, inclination angle, flow direction (Z or U) and on serial or parallel on the performance of a **FPSC** in south Algeria (Ouargla).

Keywords: Flat plate solar collector, inclination angle, solar water heater, solar intensity.

1. INTRODUCTION

Ouargla is located in the South East of Algeria, in a hot dry area at latitude 31.95° North and longitude 5.32° East and at 141 m above sea level (Table.1). Fortunately, Ouargla has an enormous potential of solar energy, **FPSC** application aims to produce hot water by directly utilizing sunshine solar energy with very simple equipment. Solar water heater systems, like any other systems, need to be operated with the maximum possible performance. This can be achieved by proper design, construction, installation and orientation. The orientation of the solar still is described by its azimuth and tilt angles. Generally, systems installed in the northern hemisphere are oriented to the south and tilted at a certain angle. The aim of the present paper is to report an experimental study on the performance of a simple solar water heater under the south Algeria climate in winter.

2. EXPERIMENTAL WORK

Solar water heater is a popular device used for converting available solar intensity into thermal energy (hot water). Different design configurations could be found in literatures. A photo of the used **FPSC** is shown in fig.1. Six identical **FPSCs** with different tilt angles were constructed, The rate of flow of hot water was measured at hourly intervals by VMI Electromagnetic flowmeter . The temperatures were measured using type K thermocouples. The wind speed was monitored using a NI CompactDAQ USB Chassis. The solar intensity was measured by a pyrometer with integrator (Kipp & zonen B.V., pyrometer model CMP 3). The experiments reported were for sunny to mostly sunny days.

In order to test the yield of the **FPSCs**, the experiments were repeated 4 to 5 times successively and the best result was choosen.

Table.1 Solar potential in Ouargla (Sahara)

Town	Ouargla (Sahara)
Surface (%)	8.9002
Area (km²)	211.980
Mean daily sunshine duration (h)	9.59
Average duration of sunshine (h.year^{-1})	3500
Received average energy (kWh.m^{-2}.year^{-1})	2650
Solar daily energy density (kWh.m^{-2})	7.26
Potential daily energy (TWh)	14,870.63

Fig.1. Photo of investigated stills

3. Results and discussion

The effect of solar intensity on ambient temperature is very apparent in fig.2 and the ambient temperature is in expressive concordance with the solar intensity,

The effect of the tilt angle, rate flow and setting operation parameters on yield of FPSCs has been investigated in many publications. It was found that the tilt angle is the most affecting parameter on the FPSC productivity. In general, the yield of the FPSCs increases as the incident solar radiation increases. Figs.2 make clear that yield is affected by the solar intensity, and 30° is the optimum tilt angle . 75 kg/h rate flow is the best, Z and in serial butter than U and in parallel respectively, this is due to residence time in them is more larger than U and parallel.

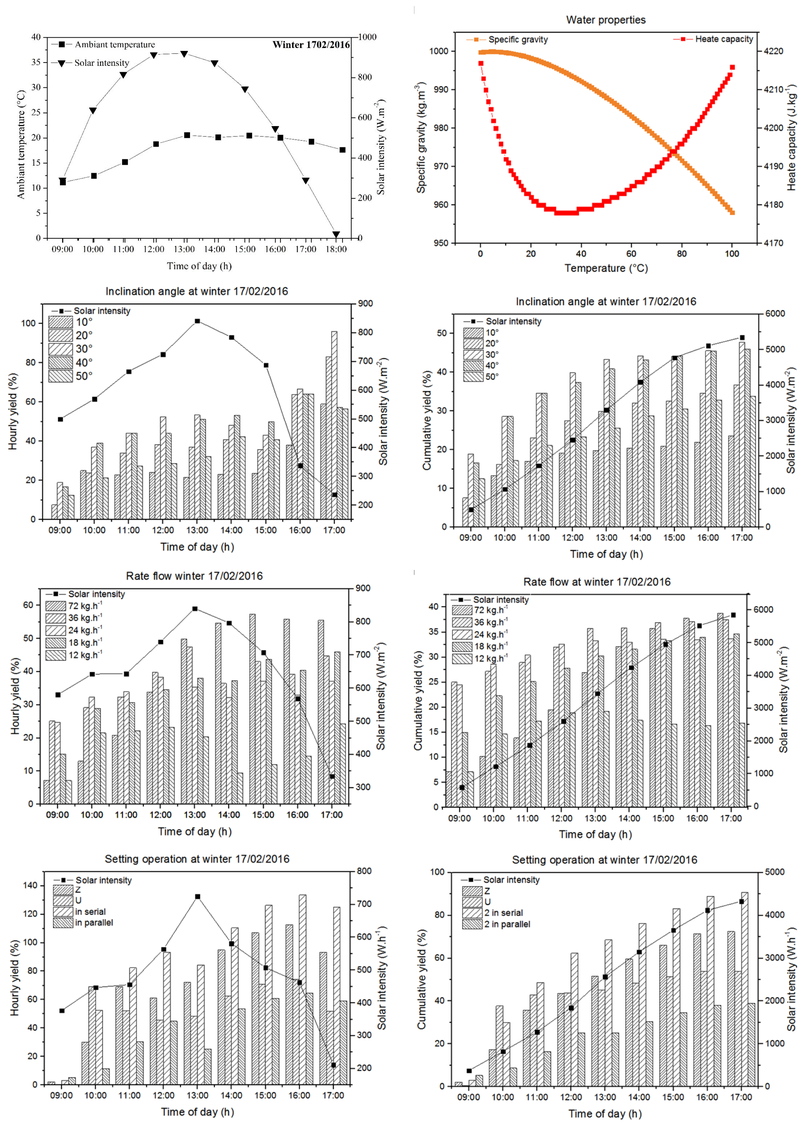

Fig.2. Experimental results

Conclusion

Solar thermal is one of the most cost effective renewable energy technologies and has enormous market potential globally.

The optimum values of tilt angle, rate flow and setting operation parameters for a **FPSCs** in Ouargla (south Algeria) were determined using an experiments data. The following conclusions have been drawn:

- Comparisons between the optimal tilt angles of a FPSCs based on experimental data in winter showed that the optimal tilt angle is 30° ;
- The best rate flow is the highest, Z and in serial the best position than others ;
- Solar water heater is a viable option for providing hot water to remote arid villages in Ouargla as well as isolated farms. Solar water heater will produce around 3000 W/day in winter.

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