THERMAL EFFICIENCY INVESTIGATION OF FLAT-PLATE SOLAR COLLECTORS WITH DIFFERENT TYPE OF GEOMETRY

***K. Kamiński*[1], *T. Krzyżyński*[1]**
[1] *Koszalin University of Technology, Department of Mechatronics and Applied Mechanics, Koszalin, Poland*

1. Introduction

The aim of this paper is to present the procedure and the results of experimental investigation of flat-plate solar collectors. The main purpose of research is to determine the influence of solar absorber and flow channels geometry on the solar collector thermal efficiency characteristics. In order to quantify the changes in efficiency characteristics caused by geometry modifications the experimental investigations were carried out using specially prepared group of flat-plate solar collectors, with varied geometrical structure of interior solar heat exchanger. The measurements of thermal efficiency of those prototypes were carried out according to EN-ISO 9806:2014, using natural and artificial solar radiation.

2. Test stand

In order to meet the requirements of EN-ISO 9806:2014 standard, the hydraulic system of working fluid witch auxiliary heating and cooling loop was used. Working fluid water was used. The inlet and outlet water temperature and ambient temperature were measured with RTD platinum sensors (PT-100). The circulation of working fluid was forced by pump and the mass flow rate was measured using ENCO MPP-6 flow meter. Solar irradiance at the collector front plane was measured with LP-PYRA 02 pyrometer.

Figure 1. Solar collectors experimental setup.

The data collection from RTD sensors, pyrometer, flow-meter, ambient temperature sensor and surface temperature sensor was executed by NI CompactDAQ data acquisition system and LabView-2012 software. The absorber surface temperature, during an indoor test, was measured using artificial solar radiation. To simulate the solar radiation a system of 28 metal-halide radiation sources was used.

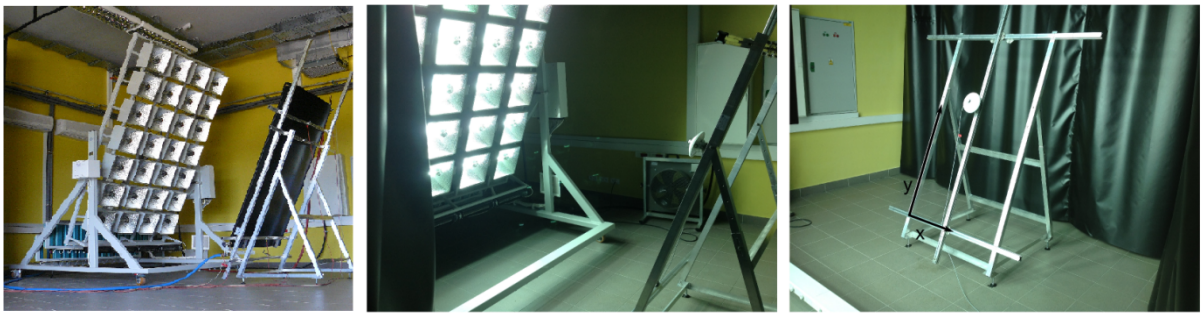

Figure 2. Simulator of solar radiation.

3. Test samples of solar collectors witch various geometrical parameters.

Thermal efficiency examinations were performed using six different flat-plate solar collectors. Each one was developed based on commercially available solar collector from a 2 m^2 parallel tube flat-plate solar from KOSPEL Inc., Poland. The geometrical parameters taken into consideration were: the absorber thickness, number of flow channels, flow channels distribution and diameter of flow channels.

Figure 3. Test samples of a solar collector with various geometrical parameters.

4. Results

The experimental analysis has proved a strong dependency between the geometrical details of solar collector and heat exchanging process. Based on the collected results, the effect of solar exchanger structure modifications were determined and the design defects were found. The high efficient geometrical configuration, in wide range of efficiency characteristic, was proposed. Additionally, the low cost design configuration, with satisfying thermal efficiency, was found.

6. References

[1] J. A. Duffie and W. A. Backmann (2006). *Solar Engineering of Thermal Processes*, 3rd ed. Wiley Interscience, New York.

[2] A. Alvarez, O. Cabeza, M.C. Muñiz and L.M. Varela (2010). *Experimental and numerical investigation of a flat-plate solar collector.* Energy 3, 3707-3716.

[3] D. Rojas, J. Beermann, S.A. Klein, D.T. Reindl (2008). *Thermal performance testing of flat-plate collector.* Solar Energy 82, 746-757.

[4] EN-ISO 9806:2014-2. Solar energy - Solar thermal collectors: Test methods.