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ALTERNATIVE ENERGY SOURCES, MATERIALS AND TECHNOLOGIES

AESMT ’23

Proceedings of short papers
Volume 5

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MAIN TOPICS

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- Solar and Hybrid Thermal Systems
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F O R E W O R D

The Sixth International Scientific Conference “Alternative Energy Sources, Materials & Technologies AESMT’23” was held between 16th and 17th May 2023 in Sofia, Bulgaria. Representatives of 24 countries (Bulgaria, Canada, China, Cuba, Germany, Greece, India, Iraq, Israel, Italy, Kazakhstan, Kosovo, Latvia, Macedonia, Poland, Portugal, Romania, Russia, Serbia, Singapore, Spain, Turkey, Ukraine, United Kingdom) sent their works to the conference. Selected reports (63 works) have been published as short papers in the proceeding of the conference.

It is my pleasure to be an editor of the presented short papers, which focus on new international scientific results in the field of Alternative Energy Sources, Materials and Technologies (Solar and Hybrid Thermal Systems, Solar Photovoltaic Systems, Solar Radiation Measurement and Sun-tracking, Geothermal Energy Applications, Wind Energy, Biotechnologies, Hydrogen Energy, Ocean/ Tidal Energy, Energy Materials, Building Materials, Phase Change Materials (PCM) Applications, Mechanical Engineering and Technologies, Electrical Engineering, Low-Carbon Technologies, Building Energy Performance, Energy Efficiency).

Prof. Aleksandar Georgiev, DSc (University of Telecommunications and Post, Sofia, Bulgaria)

Chair of the AESMT’23 conference

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Alternative Energy Sources, Materials & Technologies (AESMT'23), Volume 5, (pp. 23-24) 2023
ALTERNATIVE ENERGY SOURCES, Solar and Hybrid Thermal Systems

Maximizing performances of a solar domestic hot water system through optimum position of the solar collector in Serbian households

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In Serbia, it is customary to use electrical energy for heating of domestic hot water (DHW). As around 70% of electrical energy is produced by using coal with high greenhouse emission, it is beneficial for the environment to use solar energy for heating DHW in solar DHW system (SDHWS). The paper deals with the design optimization, practical implementation and operation of the solar collectors in space and time, as elements of solar installations which are explored. The main advantages of the installation investigated, are that by optimizing the position of solar collectors in houses we obtain the maximum value of the solar fraction. Solar energy systems have been improved, whereby the maximum value of energy and exergy, reduction of the use of energy resources, maximizing energy security, along with minimum impact on the environment are gained.

Keywords: Optimization, solar system for heating of DHW, simulation, solar collector, solar fraction

INTRODUCTION

During the first years of the twenty-first century, extensive efforts have been undertaken to alleviate global warming of the earth. The emissions may be mitigated when a part of energy needs is satisfied by using non-polluting energy sources.

In renewable energy field, SDHWS have arisen a great research interest [1, 2]. This paper analyses energy and exergy optimization of the solar system for DHW heating with solar collector, which works by using the angle slope of 37.5° and different azimuth angle values. On this occasion, a solar fraction for each SDHWS has been calculated as a function of number of optimum positions of the solar collector in SDHWS during year and represented by the corresponding curves. The monthly deficit of solar fraction is also shown for deviations of the azimuth angle, when it is not optimal. The solar collectors of the SDHWSs are placed in north-south direction on the roofs of houses. The used weather data was collected from the meteorological stations and software Meteonorm. The research applied the computer codes: EnergyPlus and GenOpt as well as HJ search algorithm. The Hooke-Jevees method was used to optimize energy flows in SDHWS [3-4].

MODELLING AND SIMULATION

Mathematical model used to simulate the energy behaviour of SDHWS and different parts of its installation consists of a solar collector, thermal tanks (storage & heaters), tempering valve, and SDHWS-control devices. These elements are located in two inner loops of the SDHWS: the solar loop and consumption loop. The solar loop is a loop through the solar collector. The consumption loop is a loop for DHW consumption. Calculations require that the solar collector surface is described geometrically.

RESULTS AND DISCUSIONS

To use SDHWS adequately, it must be designed, installed, and operated in a satisfactory way. In this paper, we report how the optimal installation of the SDHWS can be achieved, use software tools, for Belgrade, Serbia, obtained by optimization *(fi (βh = βa, opt, Ɣi),* for SDHWS with SC # 1 and SC # 2.

Fig.1. shows the curves representing the solar fractions which are obtained if SC # 2 has a different azimuth to its application. Fig.2. the deficit avoided exergy for SDHWS.

Their equations are shown in Tab.1 as the third-order polynomials. If the solar collector does not have the maximum value of azimuth angles during its operation, there will be loss in generating heat energy.

Table 1. The equations of the solar fraction in the function of the azimuth angle

Number of slopes	*Period of time*	*Day*	**Solar fraction** (%)	**Regression coefficient** *(R^2)*
1	*Year*	365	$f = -3\cdot10^{-5}\,Ɣ^3 - 2\cdot10^{-3}\,Ɣ^2 + 0.2\cdot10^{-2}\,Ɣ + 18.9$	0.998
2	*October-April*	182	$f = 3\cdot10^{-6}\,Ɣ^3 - 0.004\cdot10^{-3}\,Ɣ^2 + 0.177\cdot Ɣ + 19.75$	0.999
2	*April - October*	183	$f = -7\cdot10^{-3}\,Ɣ^2 + 0.023\cdot Ɣ + 51.02$	0.999

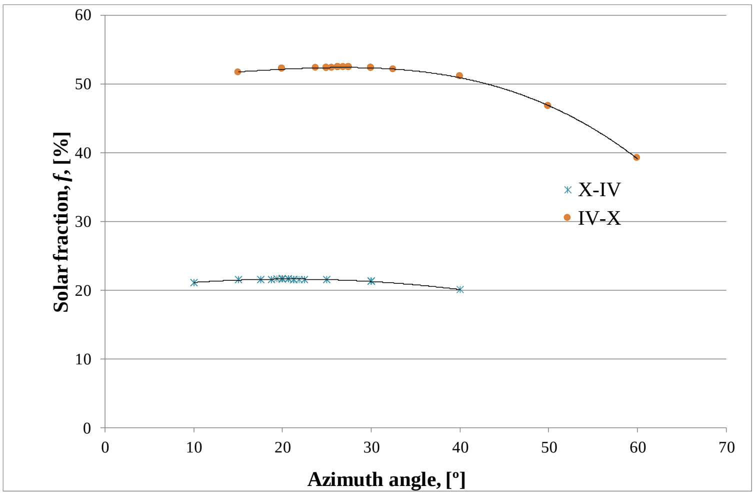

Fig.1. Solar fraction as a function of slope angle βq,opt =βa,opt = 37.5° and azimuth for SDHWS with SC # 1 and SC # 2

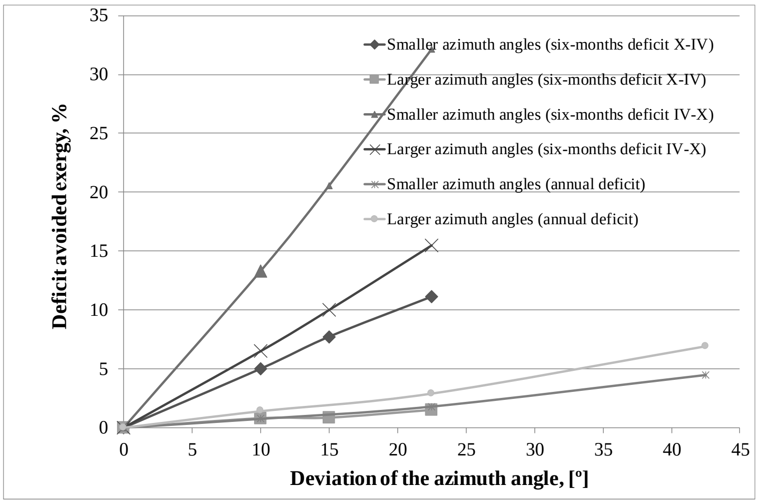

Fig.2. Deficit avoided exergy deviation of the azimuth angle | Ɣ - Ɣopt | = 22.5 °

CONCLUSIONS

In this paper, it is analysed how the SDHWS can be optimally installed by using EnergyPlus software with the modified Hooke Jeeves direct search methodology. As an example, algorithm is used to obtain the maximum amounts of performances for different SDHWS as a function of number of optimum positions of the solar collector in SDHWS during a year for the city of Belgrade, Serbia. By the exergy optimization the maximum exergy exploitation degree, analogus with the maximum value of the solar share in the function of the slope angle and azimuth, is achieved by positioning the solar colector to its optimum position.

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