Wrocław, 31.01.2020

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Title of doctoral dissertation:

„MODELLING OF HEAT TRANSFER PROCESSES IN BIFACIAL FLAT-PARABOLIC SOLAR COLLECTOR"

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Abstract

As part of doctoral dissertation research, a new type of solar collector was invented – bifacial flat-parabolic solar collector (KDD) – the author's patent. The aforementioned solar collector is an innovative device that combines advantages of concentrating solar collectors (low heat losses from absorber to ambient) and flat-plate solar collectors (can work during cloudy weather).

Within the thesis, the following tasks were carried out: a comprehensive review of solar energy technologies was conducted; Hottel-Whillier-Bliss model was presented; four original, complex mathematical models of the considered solar collectors were developed: evacuated tube collector (ETC), evacuated tube collector with oil film (ETCO) and bifacial flat-plate collector (KDD) in two modes: KDD-PTC when direct solar radiation is available, and KDD-ETC when most of the incoming solar radiation is diffuse; the solution of radiation heat transfer between four surfaces with unknown temperatures associated with each other in the KDD collector thermal network was demonstrated; the method of determining complex expressions for the overall heat transfer coefficient was presented; an experimental set-up for testing three prototype solar collectors (ETC, ETCO and KDD) was designed and built; methods of testing to determine thermal performance of solar collectors were presented; uncertainty analyses were performed; the experimental results for three solar collectors: ETC, ETCO and KDD were demonstrated; mathematical models were validated; numerical analysis of solar collectors energy efficiency was conducted, the influence of emissivity, absorptivity,

thermal conductivity, solar irradiance and mass flow rate was assessed; analyses concerning optimal collector efficiency were presented.

It was proven that it is possible to design and build bifacial flat-parabolic solar collector capable of working in two modes. The conducted research allowed to determine, both qualitatively and quantitatively, heat transfer processes in the solar collectors. Numerical analyses carried out for selected physical parameters showed their significant impact on the performance of ETC, ETCO and KDD solar collectors. Utilisation of optimal parameters brought measurable benefits in the form of a significant increase in thermal performance and useful energy of the considered solar collectors.