SELF-ASSESSMENT OF SCIENTIFIC CONTRIBUTIONS
by Rumen Kostadinov Popov, Associate Professor, PhD, Eng.
of publications presented for the G group of indicators

Scientific contributions

1. The thermal characteristics (unperturbed temperature value, thermal resistance of the borehole heat exchanger (BHE) and thermal conductivity of the earth layers around BHE) for three drilling heat exchangers in the region of Plovdiv have been studied. Such a study was conducted for the first time in Bulgaria. Several different methods were used to obtain estimates of the studied characteristics, based on the line source model, numerical models and methods of artificial intelligence (particle swarm optimization and genetic algorithms) [Г7.1, Г7.10].

2. Methods and algorithms for research and modeling of hybrid systems with ground-sours heat pump and solar collectors have been developed. The purpose of the methods and algorithms is to determine the thermal characteristics of the system in different operating modes depending on the season and the heating loads (with the possibility to validate the mathematical models). The determination of the efficiency of the solar collector, the efficiency coefficient COP of the heat pump, the efficiency of the borehole heat exchangers and the efficiency of the hybrid thermal system (HTS) at different operating modes is presented. The conditions of the research, the processing of the test data and the accuracy of the measured parameters are discussed. Methods and tools for mathematical modeling and simulations of the main components of HTS and their operation in general are presented. By using of the specialized software environment TRNSYS Simulation studio Simulation studio a numerical simulations of HTS were performed, taking into account the climatic conditions in Plovdiv. This makes it possible to specify the design parameters of such installations at the stage of preliminary design [Г7.2, Г8.7, Г8.14].

3. Algorithms for system identification using artificial intelligence methods (real and integer coded genetic algorithm and particle swarm optimization algorithm) have been developed and studied. They have been tested in assessing the parameters of chaotic systems and in performing structural identification of high-order systems. The results can be used in estimating the parameters of complex systems [Г8.4, Г8.5].

Scientifically applied contributions

1. Experimental and numerical study of storages based on PCM for solar thermal energy storage applications have been performed. By charging a latent heat storage (LHS) based on PCM, its energy storage capacity is determined. It is compared to that of a storage tank without PCM, filled only with water - sensitive heat storage (SHS). The result shows that LHS manages to store 40% more heat energy than an SHS storage (in the same temperature range and volume). In addition, the LHS charging process was studied numerically to visualize the thermal field in the PCM -based storage. The numerical results fully confirm the experimental ones, which demonstrates the adequacy of the mathematical model [Г8.11].

2. An experimental study (a series of 9 tests) was conducted to compare the efficiency of photovoltaic and photovoltaic-thermal solar panels. The limits of effective operation of the PV/T panel are set. The results show that the PV panel (made of polycrystalline silicon) has a

higher efficiency than at average inflowing fluid temperatures above 43 °C. At temperatures below 43 °C the PV/T panel gives a higher electrical output (at 35 °C to 1.5%) due to the improved cooling of the back wall of the panel. The simultaneous production of heat from it is also relatively high (up to 3.38 times more than electricity). Compared to the previously studied thin-film silicon panels, we have about 2 times lower efficiency increase in polycrystalline PV cells produced by CRANE using combined PV/T technology. The results of this study allow for the correct choice of the thermal mode of operation of PV/T panels [Γ8.12].

3. The effect of the design parameters on the energy characteristics of the Darrieus turbine was studied. The dependence of the maximum utilization factor of vertical axis wind turbines on the number of blades with constant filling factor a, on the number of blades with their constant width, on the elongation of blades A, identified on the basis of these results, is shown. A diagram of a wind turbine is also shown, which can provide thermal protection through natural ventilation with warm air in the rotating elements of the wind turbine, which occurs due to centrifugal forces [Γ8.9].

Applied contributions

1. A specialized measuring system for analysis of thermal fields in hybrid systems has been developed and studied [Γ7.3].

2. A study that examines how the term "renewable energy" is perceived by students in primary schools in Bulgaria was conducted. To this end, a face-to-face survey was conducted to clarify students' preferences for the name and color that best represents renewable energy sources [Γ7.4].

3. A cost-effective, precise, multi-channel RTD signal conditioner has been developed and tested [Γ7.5].

4. An analysis of the causes of computer system failures was conducted, focused on engineering training [Γ7.6].

5. An APRS based tracker has been developed and tested to determine the location of an object in real time [Γ7.7].

6. A virtual system for generating and measuring real time signals used in e-learning has been developed and tested [Γ7.8].

7. A set of virtual statistical measuring instruments designed for use in engineering education for the conditions of COVID-19 has been developed and tested [Γ7.9].

8. A conceptual design of a "Photovoltaic Power Plant" with a design capacity of 1MW has been developed, located in the land of the village of Resen, Veliko Tarnovo municipality and connected to the electricity system of the country. The stages, methods, means and results of the design are described. The potential of the solar radiation and the main technical parameters of the photovoltaic installation are determined. A variant of the furniture has been chosen. An economic analysis has been made, and the technical requirements for the site have been formed. An analysis and assessment of the environmental compatibility of the plant was performed [Γ8.1].

9. An experimental installation for testing a latent heat storage as part of a hybrid air conditioning system has been developed and tested [Γ8.2].

10. A measuring system of a hybrid installation with a ground-based heat pump and solar collectors has been developed and tested [Г8.3].

11. An overview of the laboratory SCADA systems, their current state and the challenges facing them has been made. Trends in the use of wireless communication applications are analyzed in particular detail [Г8.6].

12. A sensor has been developed and tested to determine the optimal orientation of photovoltaic parks [Г8.8].

13. An installation for performing tests to determine the thermal response has been developed and tested. Special attention is paid to the compact size, performance and appropriate order of the series-connected parts of the installation, as the carefully constructed system provides precise measurements of the thermal resistance of the borehole and the effective thermal conductivity of the ground around the borehole [Г8.10].

14. An assessment of the possibilities for transformation of marine energy in the Balkan region has been made. The emphasis is on energy from the sea, including energy from waves, currents, salinity, temperature differences and more. Based on the assessment of the power potential, determined by the geographical characteristics of the seas in the region and the scientific, technological and economic level, some conclusions have been drawn about the prospects in this area [Г8.13].

Submitted by:

Rumen Popov, Associate Professor, PhD, Eng.

7th August 2021
Plovdiv