

NON-STATIONARY MATHEMATICAL MODEL OF THE TEMPERATURE DISTRIBUTION IN SOLAR PANEL LAYERS

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This paper presents the results of mathematical modeling of non-stationary temperature fields in a typical solar panel under real environmental conditions. The mathematical model is based on a system of nonlinear ordinary differential equations with corresponding initial and boundary conditions. The model takes into account radiation losses from the surface of the panel, which are determined by the Stefan–Boltzmann law, and convective losses due to free and forced convection. The solar flux density was considered constant, but its value depended on the solar panel setting angle. The temperature dependence of the solar cell efficiency was calculated using a standard method. A computational algorithm was developed in C++ using standard mathematical libraries with a linearization of the system of ordinary differential equations. The results were visualized using the gnuplot graphing utility. The temperature distribution in each of the solar panel layers was obtained as a function of the ambient temperature. It was found that an increase in the ambient temperature leads to a significant decrease, up to 40%, in the solar panel efficiency. With increasing ambient temperature, the time of transition to steady operation increases. The solar panel temperature was related to the blackness degree of the protective glass. It was shown that in the Kirchhoff approximation it is necessary that the blackness degree of the selective coating of the protective glass be a maximum, which reduces the temperature of the system and increases its efficiency. The solar panel temperature was related to the wind speed. It was shown that the convective losses increase with the wind speed, which has a favorable effect on the solar panel temperature regime. The results of the study showed the effect of various external environmental factors on the temperature regime of a solar panel and a way to maximize its efficiency by optimizing its parameters. The results may be used in the development and production of improved solar panels with minimum temperature effects on their efficiency.

Keywords: *non-stationary mathematical model, system of nonlinear differential equations, numerical experiments, silicon solar panel, solar panel efficiency.*

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Received on June 13, 2023,
in final form on September 13, 2023