2022 8th International Conference
on Energy Efficiency and Agricultural Engineering
EE&AE 2022

30th June - 2nd July 2022, Ruse, Bulgaria

Simulation of Initial Characteristics of Thermoelectric Modules in Generation Mode Realized in MATLAB Environment

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GOAL OF THE STUDY

For the needs of the engineering practice concerning the development of thermoelectric generator systems, it is necessary to model and simulate the operation of the thermoelectric modules in generation mode. Thermoelectric modules generate electrical power directly proportional to the applied temperature difference (ΔT) between their two sides. The present work presents a simulator that calculates all main output characteristics of a thermoelectric module with its parameters set as input data in the system.

METHODOLOGY OF THE INVESTIGATION

With the help of the user application (TeGDS software), it is possible to simulate the operation of any randomly selected thermoelectric module, in the mode of generation of electromotive voltage, if the necessary input data for the simulation are available for it.

MAIN RESULTS FROM THE STUDY

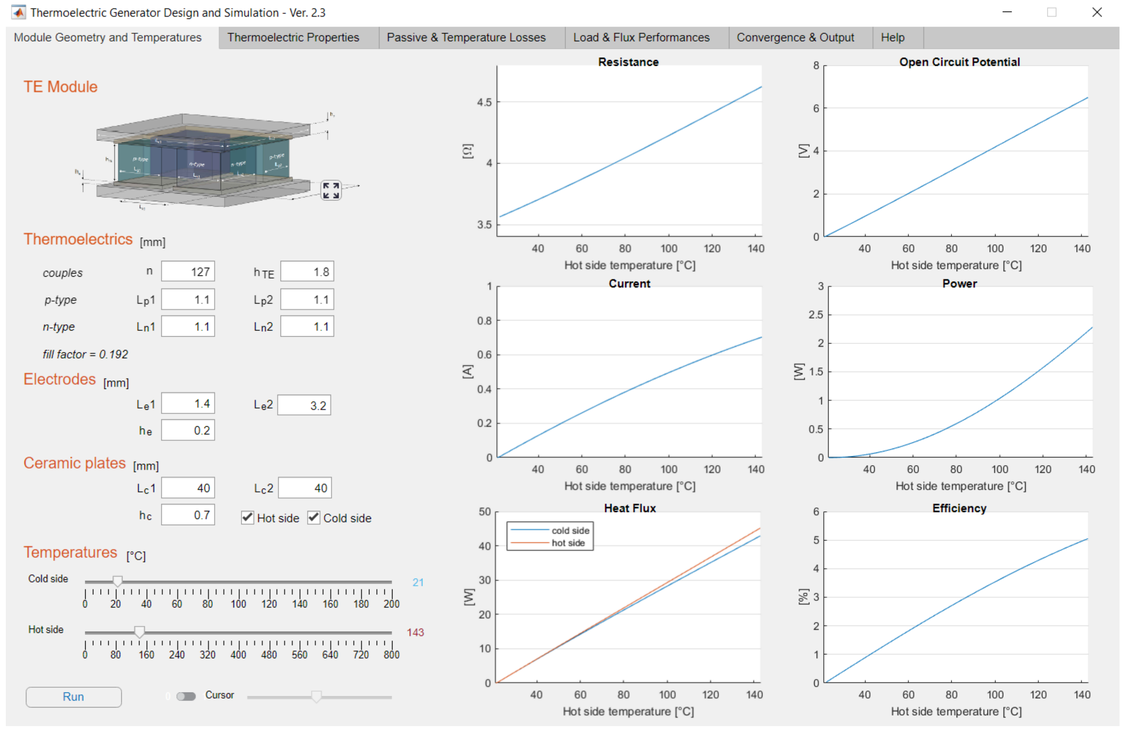

Fig. 1. Module geometry and temperatures – input/output of the software interface.

COMPARISON OF THE SIMULATION RESULTS WITH THE EXPERIMENTALLY OBTAINED DATA

To verify the simulation model, made is a comparison of the results for the generated e.m.f. at idle from the actual experiment and the output data obtained after the simulation. Fig. 2 presents the results.

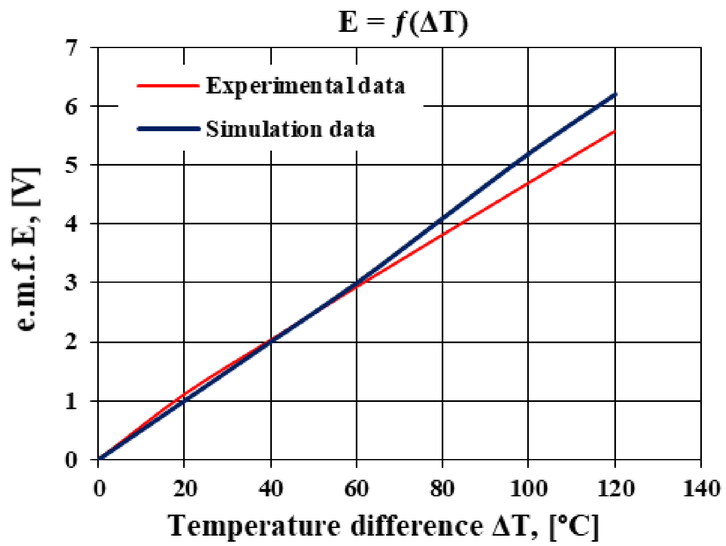

Fig. 2. Graphical comparative characteristic between experimental and simulation results for the generated voltage at open circuit.

Equations calculate the absolute *(ΔX)* and relative *(δX)* error at the highest temperature difference of *120 °C*, where *X exp* – experimental values, and *X sim* – values obtained from the simulation.

$$\Delta X = X_{sim} - X_{\exp} = 6.2 - 5.58 = 0.62$$

$$\delta X = \frac{\Delta X}{X_{\exp}}.100\% = \frac{0.62}{5.58} = 11.1\%$$

CONCLUSIONS

The comparison of the results of the experimentally obtained data and those of the simulation shows a great concurrence of the data. Differences of the order of 10% are due to inaccuracies in the entered input data, errors in the experimental measurements and the inertia of the heat transfer.

A disadvantage of the simulation can be the unsatisfactory accuracy of the calculation of the results when the set temperature difference is lower.

The simulation model of a thermoelectric generator module is a means by which the user can easily calculate many basic parameters of TEM and of the semiconductor thermocouples. The results of the simulation are given in the form of conversion characteristics. Based on the obtained results, a suitable TEG module can be selected in the design of a thermoelectric generator system.

ACKNOWLEDGMENT

The studies were carried out with the financial support of the CoC “QUASAR” – project № BG05M2OP001-1.002-0006.