Multiphysics Modeling and Development of Thermoelectric Generator for Waste Heat Recovery

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Abstract

Waste heat is inevitable in any heat engine while producing useful mechanical work. A lots of heat energy is often dissipated to surrounding environment as waste, which limits the system efficiency. In almost all of the industrial processes, half of the heat energy is turned into waste heat. Many innovation and investment is been happening to convert waste heat into useful work. The waste heat is been used in various way to get useful work in various industries. Producing electricity in a convenient way from the waste heat is a challenge, that every industry face. There are many known technologies to produce electrical energy from waste heat. One of the approach is using Thermoelectric Devices, where a temperature gradient across the semiconductor modules produces voltage that causes electric current to flow. This phenomenon is referred as Seebeck effect. Developing a optimized TEG Device for maximum power output from waste heat is a challenging one, which need more attention in energy industry. In this work, the numerical modelling and simulation of a Thermoelectric Generator (TEG) is investigated. The studied model is consists of P-Type and N-Type Bi2Te3 semiconductor modules connected electrically in series and thermally in parallel. The produced electric voltage, current and power from temperature gradient is investigated. The design module, thermoelectric module, Heat Transfer Module and AC/DC Module of COMSOL Multiphysics® software is used to develop and simulate the TEG device for maximum power efficiency. In this paper the thermodynamics of TEG, analytical and numerical calculations are explained respectively. The numerical simulation and investigation of TEG device in COMSOL Multiphysics® shows more potentials for further research and various application of TEG in several industries.