Enhancing the performance of a thermo-electric generator through multiobjective optimisation of heat pipes-heat sink under natural convection

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ABSTRACT

Heat sink lack of design is one reason that negatively affects the performance of Thermo-Electric Generator (TEG). As compared to conventional cooling systems used with TEG, Heat Pipe Heat Sink (HP-HS) has various points of interest. It is the most appropriate heat exchanger for medium temperature range under 300 °C. However, the performance of TEG with HP-HS could be affected by the fin space, fin length, fin height, fin materials and optimum geometry of HPHS of the TEG cold side, which is still unknown. Thus, the aim of this study is to conduct an analytical and statistical study on the effects of fins space, fins length, fins height and fin materials parameters on the performance of TEG. In addition, the optimum geometry of HP-HS was investigated. The experimental study has been carried out with different dimensions of fin space, fin length and fin height, depending on the range determined based on previous studies. Besides, two materials were used namely aluminum (AL) and copper (CO). The multi-objective optimization using response surface methodology (RSM) is applied to determine the optimum geometry of HP-HS to maximise the TEG power output (P), TEG efficiency (η), and to minimise HP-HS cost ($\$$). The responses developed models were determined to be significant at 95% confidence level. It was found that an improvement in TEG performance as compared to literature was achieved. The maximum P and η after optimisation were 8.2 W and 3%, respectively. The percentage difference of TEG η as compared with the best previous results were, 36.7%. In addition, the CO HP-HS was found to be preferred over AL because of its lower costs per power output. CO was 8.75 USD/W, whilst, AL was 10.13 USD. Finally, this study shows an improvement in HP-HS cost, a reduction by 17.9% was achieved when compared with the estimated HP-HS cost in literature.

KEYWORDS: Thermo-Electric Generator**;** Heat Pipe Heat Sink**;** Multi-objective optimization

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