Theoretical investigation on the influence of Seebeck and Thomson effects in a thermoelectric generator

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Abstract

Four possible cases of modelling a thermoelectric generator (TEG) are presented in this paper. Case 1 models equal hot and cold junction Seebeck coefficient (SC) ignoring Thomson effect (TE), case 2 adopts equal hot and cold junction SC including TE, case 3 defines unequal hot and cold junction SC neglecting TE while case 4 represents unequal hot and cold junction SC with TE. The modified expressions for these cases are derived and employed in a comparative electric and geometric optimization of the TEG. The impact of the harmonious relationship between TE and SC on the optimum and maximum system performance parameters is studied and discussed. The results show that the systems performance can be enhanced or reduced depending on the operating temperature gradient and prevalent relationship between SC and TE. The results obtained from this work should be able to accurately predict the suitable TE and SC configuration for optimum and maximum system performance.

Full Text

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Figures

Fig. 1. Variation of the power output and efficiency for $\Delta T = 50$ K with (a) load resistance ratio (b) current (c) voltage

Figure 1

Due to technical limitations, the caption is only available in the manuscript file.

Fig. 2. Variation of the power output and efficiency for $\Delta T = 100$ K with (a) load resistance ratio (b) current (c) voltage

Figure 2

Due to technical limitations, the caption is only available in the manuscript file.

Fig. 3. Variation of the power output and efficiency for $\Delta T = 200$ K with (a) load resistance ratio (b) current (c) voltage

Figure 3

Due to technical limitations, the caption is only available in the manuscript file.

Fig. 4. Variation of the power output and efficiency for $\Delta T = 300$ K with (a) load resistance ratio (b) current (c) voltage

Figure 4

Due to technical limitations, the caption is only available in the manuscript file.

Fig. 5. Variation of the power output and efficiency for $\Delta T = 400$ K with (a) load resistance ratio (b) current (c) voltage

Figure 5

Due to technical limitations, the caption is only available in the manuscript file.

Fig. 6. Variation of the power output and efficiency for $\Delta T = 500$ K with (a) load resistance ratio (b) current (c) voltage

Figure 6

Due to technical limitations, the caption is only available in the manuscript file.

(a)

(b)

Fig. 7. Impact of dimensionless resistance and temperature on (a) power output
(b) efficiency

Figure 7

Impact of dimensionless resistance and temperature on (a) power output (b) efficiency

(a)

(b)

Fig. 8. Effect of temperature gradient and current generated on (a) power output (b) efficiency.

Figure 8

Effect of temperature gradient and current generated on (a) power output (b) efficiency.

Fig. 9. Variation of maximum power output and efficiency with load resistance ratio for (a) $\Delta T = 50$ K (b) $\Delta T = 100$ K (c) $\Delta T = 200$ K

Figure 9

Due to technical limitations, the caption is only available in the manuscript file.

Fig. 10. Variation of maximum power output and efficiency with load resistance ratio for (a) $\Delta T = 300$ K (b) $\Delta T = 400$ K (c) $\Delta T = 500$ K

Figure 10

Due to technical limitations, the caption is only available in the manuscript file.