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Performance Evaluation and Comparison of Electricity Generation Systems Based on Single- and Two-Stage Thermoelectric Generator for Hypersonic Vehicles

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Abstract:

Thermoelectric generator (TEG) is a promising electricity generation technology distinguished by a direct thermoelectric conversion. The single- and two-stage TEG model, the heat source of which was the combustion heat dissipation, were developed to predict and compare the power generation performance on hypersonic vehicles at different inlet temperatures of heating channel, T_{ho} . The distributions of the temperature and thermoelectric figure of merit (ZT value) were described by diagrams. Besides, some methods for performance enhancement were discussed. The results indicate that the single-stage TEG has an advantage of the maximum power density, and the two-stage TEG shows a higher conversion efficiency at the same T_{ho} . The maximum power density of 16.53 kW/m² is achieved by the single-stage thermoelectric generator. The optimal conversion efficiency is 10.78 %, obtained by the two-stage TEG. Both the maximum power density and corresponding conversion efficiency increase with the inlet temperature of heating channel. In addition, the two-stage TEG has a greater potential for improving performance, by means of multiple thermoelectric materials in their optimal temperature ranges.

Key words: Thermoelectric generator; electricity generation; hypersonic vehicle; single-stage; two-stage; silicon germanium.

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Nomenclature

A	Area, m ²
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