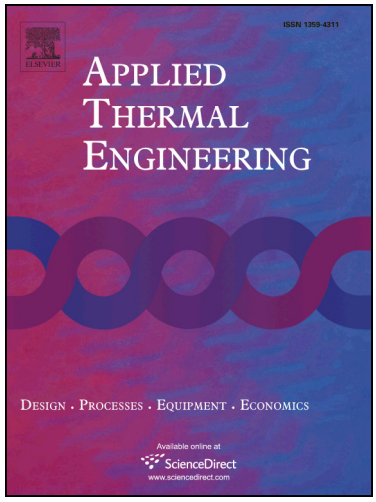

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A STUDY ON HEAT TRANSFER ENHANCEMENT IN THE RADIAL DIRECTION OF GAS FLOW FOR THERMOELECTRIC POWER GENERATION

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Abstract

The performance of thermoelectric generation (TEG) systems is significantly dependent on the hot side temperature of thermoelectric legs and the temperature difference between the hot side and cold side of the legs. To keep the TEG module working at an optimal condition, a high heat flux over 10 W/cm2 through the TEG needs to be maintained. Due to the low heat transfer coefficient of the gas flow to the exhaust pipe wall surface, typically at a high temperature ranging from 400 °C to 800 °C, the actual heat flux into the TEG heat exchanger is limited significantly, resulting in relatively low efficiency of the TEG conversion. In the present study, an effective solution for enhancing the heat transfer of gas flow in the radial direction to the TEG is proposed by means of immersing high temperature heat pipes perpendicularly into the exhaust flow. Similarly, conventional heat pipes are radially inserted into a concentric coolant jacket in order to enhance heat transfer performance at the cold side of TEG modules. Overall, the TEG assembly is configured as a compact and scalable heat pipe heat exchanger. The simulation results show that the hot side temperature of the TEG can reach and be maintained as high as 300 °C while the cold side temperature of the TEG can be maintained at approximately 85 °C for a normal engine coolant loop. The results also show that the closer to the heat source in the pipeline the TEG system is located, the better the power generation that is expected. Moreover, better thermoelectric generation can be expected at a higher engine speed. By installing the TEG heat exchanger between catalytic converter and muffler, the best power output in the thermoelectric heat exchanger can be achieved at 450 W and 5000 rpm. If the TEG heat exchanger is adjacent to the outlet of a catalytic converter, the best-simulated performance at 6000 rpm is 705 W for a single sub pipeline. Therefore, a total power generation of 1410 W is achievable since the existing exhaust pipe is a dual pipeline system.