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Thermoelectric phenomena on thermoelectric generator surface under temperature oscillation.

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Thermoelectric generators (TEGs) are a device to convert heat into power. Because low-temperature waste heat can be harvested and turned into electricity by TEGs, they are a promising facility in the green energy development. However, the efficiency of TEGs is low. How to improve the efficiency of TEGs via materials, system design or operation has become an important task for TEG development. TEGs are operated by means of the thermoelectric effect[1], which pertains to a solid-state energy conversion route between heat and electricity where the interaction among the electric field, current and het is involved. Seebeck effect, Peltier effect and Thomson effect are three important thermoelectric effects[2].

To improve the performance of TEGs, we devote ourselves in the design and optimization of thermoelectric system over the last decade. One of the topics studied is the effect of oscillating temperature on the module's surfaces upon the performance of a TEG. As shown in Fig. 1, the temperature at the hot-side and cold-side surfaces are approximated by sinusoidal functions where the amplitudes at the two surfaces and the phase angle of the sinusoidal waves are controlled. The results suggest that the average output power and efficiency increase with increasing the amplitudes, but the absorbed heat is affected slightly. The figure-of-merit (ZT) of a material plays a key role on the performance of a TEG[3]. The study also indicates that the mean efficiency can be lifted by a factor of 1.71 once the ZT value goes up from 0.736 to 1.8 at the phase angle of 180 °, and the maximum efficiency is 8.45%. It is concluded that the performance of TEG can be intensified via appropriate controls of the oscillating temperatures on the surfaces and their phase angle. These findings are conducive to the utilization of low-temperature waste heat and development of green power.

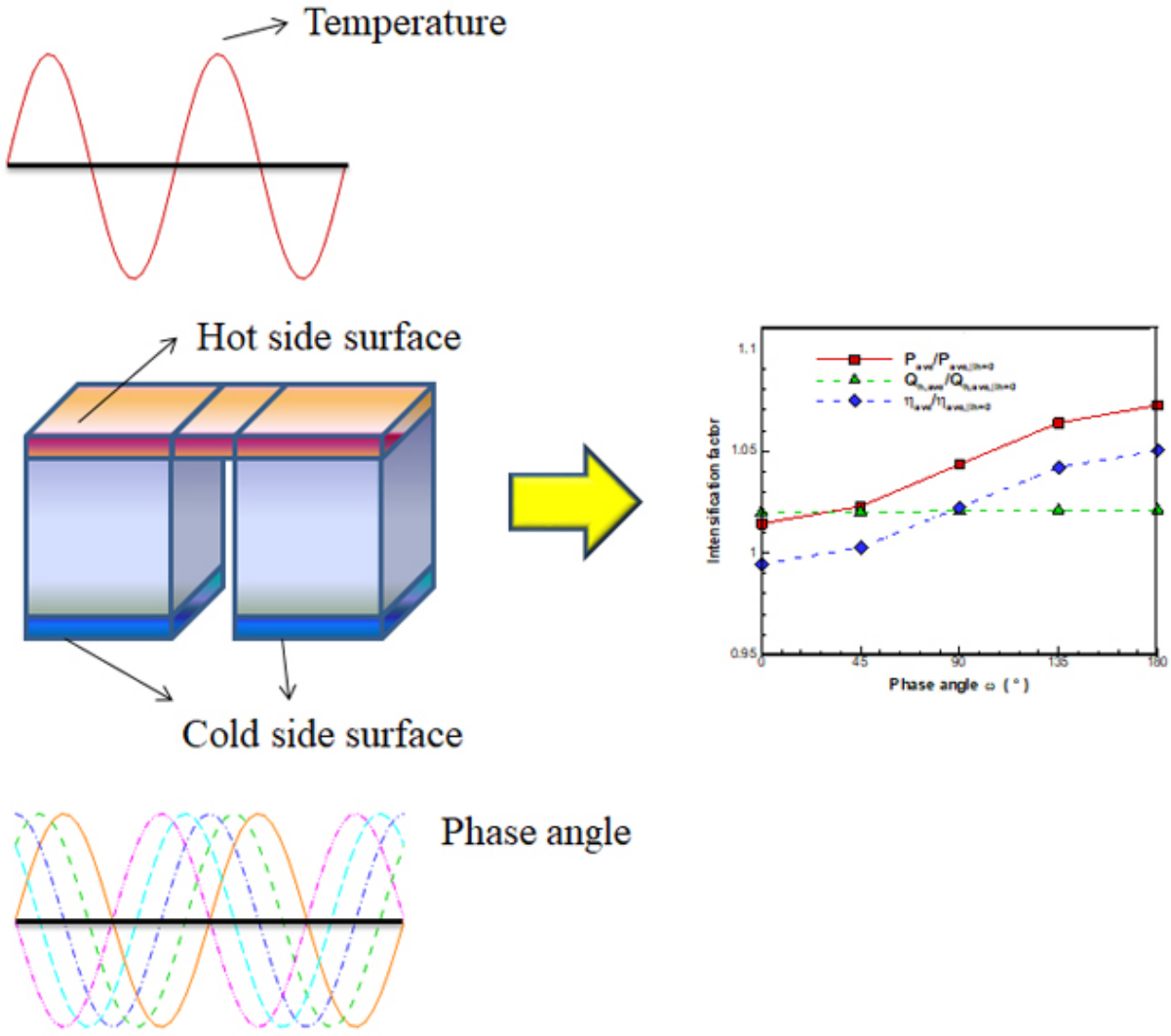

Figure 1. A schematic of temperature oscillation on the surfaces of a TEG and its performance.

Reference

1. Riffat SB, Ma X. Thermoelectrics: a review of present and potential applications. Applied Thermal Engineering. 2003;23:913-35/.
2. Chen WH, Liao CY, Hung CI. A numerical study on the performance of miniature thermoelectric cooler affected by Thomson effect. Applied Energy. 2012;89:464-73.
3. He W, Zhang G, Zhang X, Ji J, Li G, Zhao X. Recent development and application of thermoelectric generator and cooler. Applied Energy. 2015;143:1-25.