NOTES TO OPTIMIZATION OF SOLAR ENGINE

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Solar engine is discussed as integration of solar collector and heat engine. Solar collector with linear heat loss and Curzon-Ahlborn engine is considered. This simple endoreversible model is used to discuss some applications of results of endoreversible heat engine in the field of solar engine. Optimum operating temperature of the solar collector and relevant maximum overall efficiency of solar engine are calculated, the results being compared with those by the models where Carnot and Curzon-Ahlborn efficiencies were used. Conclusions obtained for endoreversible model are used for simple optimal design of solar engine. The size of heat engine for a given solar collector is optimized. The investment costs of solar collector and heat engine per unit of output power are used as optimization criterion.

Key words : *endoreversible thermodynamics, heat engine, solar collector, solar energy, optimization*

1. Introduction

Solar (heat) engine (in Fig. 1) is discussed as integration of two devices that also can be used independently. The first device is solar collector, which receives radiation from the sun and converts it into useful heat Q_b at collector (absorber) temperature T_b. The second device is the heat engine, which works between high T_h and low (ambient) T_0 temperatures and produces power W from input heat Q_1. In conventional heat engines temperature T_h is usually a metallurgical upper limit for the used materials. This temperature is constant and is maintained by combustion (or other processes) regardless of amount of input heat Q_1. In solar engines (see Fig. 1), on the contrary, T_h is given by collector [1]

$$T_\mathrm{h} = T_\mathrm{b} \ , \qquad (1)$$

and varies according to amount of useful heat rate from collector to heat engine

$$Q_1 = Q_\mathrm{b} \ . \qquad (2)$$

The efficiency of solar engine is defined as the ratio of mechanical power output to received solar radiant heat rate, and can be naturally expressed as the product of efficiencies of its components [2, 3]

$$\eta_\mathrm{s} = \frac{W}{A_\mathrm{c}\,\varphi} = \eta_\mathrm{c}\,\eta_\mathrm{e} \qquad (3)$$

where $\eta_\mathrm{c} = Q_\mathrm{b}/(A_\mathrm{c}\,\varphi)$ is thermal efficiency of solar collector, φ and A_c are direct solar flux and the solar collector projected area, respectively, and $\eta_\mathrm{e} = W/Q_1$ is thermal efficiency of

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