Answer on Question #70455, Physics / Molecular Physics | Thermodynamics

An ideal heat engine operating at 15 % efficiency exhausts heat into a cold reservoir at 280 K. By how much would the temperature of the hot reservoir need to be raised (in K) in order to increase the efficiency of the heat engine to 35.6 %?

Solution:

Let T_h be the temperature of the "hot" reservoir, and T_c the temperature of the "cold" reservoir

$$\varepsilon = \frac{T_h - T_c}{T_h}$$
$$\varepsilon \times T_h = T_h - T_c$$
$$\varepsilon \times T_h - T_h = -T_c$$
$$T_h(\varepsilon - 1) = -T_c$$
$$T_h = -\frac{T_c}{(\varepsilon - 1)}$$
$$T_h = \frac{T_c}{(1 - \varepsilon)}$$

For 15% efficiency:

$$T_h = \frac{280\ K}{(1 - 0.15)} = 329\ K$$

For 35.6% efficiency:

$$T_h = \frac{280\ K}{(1 - 0.356)} = 435\ K$$

Finally,

$$\Delta T_h = 435\ K - 329\ K = 106\ K$$

Answer: 106 K in order to increase the efficiency to 35.6%