Varmafræði – Skiladæmi 5

Andri [illegible]

Q2 $\eta = 0{,}35$, $\dot{W}_{net} = 70\,kW = 70\,kJ/s$

We have $\dot{Q}_H = \frac{\dot{W}_{net}}{\eta} = \frac{70\,\frac{kJ}{s}}{0{,}35} = \underline{\underline{200\,kJ/s}}$

Q3 $\dot{W}_{net} = 73{,}2\,kW$, $HV = 46540\,\frac{kJ}{kg}$, $\dot{V} = 22{,}3\,\frac{L}{H}$

$\rho = 0{,}8\,g/cm^3 = 0{,}8\,kg/L$ $\qquad = 6.19 \cdot 10^{-3}\,\frac{L}{s}$

First we find the mass flow:

$$\dot{m} = \dot{V} \cdot \rho = 6.19 \cdot 10^{-3}\,\frac{L}{s} \cdot 0{,}8\,\frac{kg}{L}$$

$$= \underline{\underline{4.952 \cdot 10^{-3}\,kg/s}}$$

The rate of heat is

$$\dot{Q}_{in} = \dot{m} \cdot HV$$

$$= 4.952 \cdot 10^{-3}\,\frac{kg}{s} \cdot 46540\,\frac{kJ}{kg}$$

$$= 230{,}47\,kW$$

And the efficiency is

$$\eta = \frac{\dot{W}_{net}}{\dot{Q}_{in}} = \frac{73{,}2\,kW}{230{,}47\,kW} = \underline{\underline{0{,}318}}$$

*Q6

We have $$Q_H = 1.5\,kWh > 1\,kWh = W_{in}$$

The first law of thermodynamics states that energy can't be created or destroyed

Here we have a system that turns 1 kWh to 1.5 kWh and thus we have a perpetual-motion machine.

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*Q8

The thermal efficiency of a power plant is defined as

$$\eta = 1 - \frac{T_L}{T_H}$$

The efficiency will be higher, for a plant with higher value for T_H.

Because of that, the plant with $T_H = 700°C$, will have better efficiency.

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*Q9

$T_L = 22{,}1°C = 295{,}1\,K$; $T_H = 43.5°C = 316.5\,K$; $\dot{W}_{net} = 14{,}5\,kW$

Coefficient of performance of reversible refrigerator:

$$COP_R = \frac{1}{\frac{316{,}5\,K}{295{,}1\,K} - 1} = 13{,}79$$

Now we have:

$$\dot{Q}_L = \dot{W}_{net} \cdot COP_R = 14{,}5\,kW \cdot 13{,}79$$
$$= 199.96\,kW$$