Lösningar 110112 Termodynamik för C och D.

1a) $p = p_0 \, e^{-Mgh/RT} = 1\,\text{atm}\, e^{-29\cdot 10^{-3}\cdot 9{,}81\cdot 4810/8{,}31\cdot 273} = 0{,}55\,\text{atm} = 55\,\text{kPa}$

b) Tefyma: Mättnadstrycket är 55 kPa för 84 ^{o}C

2a. $P = Ae\sigma T^4$ ger $T = (P/(Ae\sigma))^{1/4} =$ (sin 60^{o} $\cdot$ 900 W/m^2 / 1 $\cdot$ 5,67 10^{-8} W/K^{4}m^2)$^{1/4}$=342 K=69 C^{o}

2b. Wiens förskjutningslag ger λ_{max}= 2,898 10^{-3} K$\cdot$ m/342 K = 8,5 μm

3a. $Q_{in} = mc\Delta T + mL_f$ = 20 kg (4,19 10^3 J/kgK $\cdot$ 10 K + 333 10^3 J/kg = 7,5 MJ

$W = Q_{in}/K_f$ = 7,5/2,5 MJ = 3 MJ

3b. $Q_{ut} = Q_{in} + W$= 7,5 MJ+3 MJ=10,5 MJ

3c. $V_f = Q_{ut}/W$ = 10,5/3 = 3,5

3d. 7,5 MJ $\cdot$ h/3600 s = 2,1 kWh, skulle kostat 2,1 kr, knappast värt arbetet, investera i värmepump.

4a. $R = \Delta T/P_{före}$= 12 K/600 W= 0,02 K/W

4b.

$$P_{före} = k_{före} A\Delta T \;\; ger \;\; k_{före} = \frac{P_{före}}{A\Delta T} = \frac{600\,\text{W}}{120\,\text{m}^2 \cdot 12\,\text{K}} = 0{,}417\,\text{W/m}^2 \cdot \text{K}$$

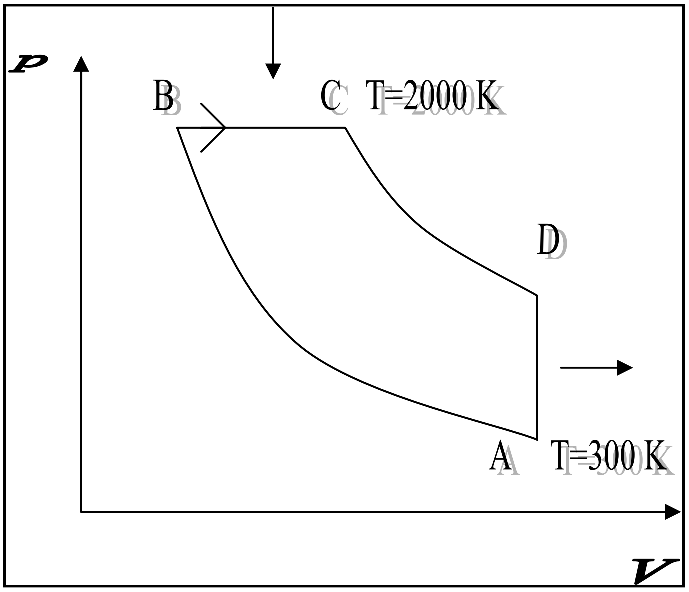
$$\frac{1}{k_{efter}} = \frac{1}{k_{före}} + \frac{L}{\lambda} = \frac{1}{0{,}417\;\text{W/m}^2 \cdot \text{K}} + \frac{0{,}1\,\text{m}}{0{,}04\,\text{W/m}\cdot\text{K}} = 4{,}90\,\text{m}^2\text{K/W}$$

$$P_{efter} = k_{efter} A\Delta T = \frac{120\cdot 12}{4{,}90} = 294\,\text{W}$$

5a. $$m_{is}\cdot L_f = m_v \cdot c_v \cdot \Delta T \Rightarrow m_v = \frac{0{,}050\cdot 333\cdot 10^3}{4190\cdot 20}\text{kg} = 199\,\text{g} = 2\,\text{dl}$$

b. $$\Delta S = \Delta S_{is} + \Delta S_v = \frac{0{,}050\cdot 333\cdot 10^3}{273}\text{J/K} + 0{,}199\cdot 4190\int_{293}^{273}\frac{dT}{T} = 61{,}0\,\text{J/K} - 59{,}0\,\text{J/K} = 2{,}0\,\text{J/K}$$

6.



$$\eta = 1 - \frac{Q_{ut}}{Q_{in}} = 1 - \frac{2{,}5 \cdot nR(T_D - T_A)}{3{,}5 \cdot nR(T_C - T_B)}, \quad r = \frac{V_A}{V_B} = 18, \quad V_A = V_D, \quad p_B = p_C$$

$$A \rightarrow B\ adiabat,\ Poisson: T_B = T_A\left(\frac{V_A}{V_B}\right)^{\gamma-1} = T_A \cdot r^{\gamma-1} = 300\,\mathrm{K} \cdot 18^{0,4} = 953{,}3\,\mathrm{K}$$

$$B \rightarrow C\ isobar: V_C = V_B\left(\frac{T_C}{T_B}\right) = \left(\frac{V_A}{r}\right) \cdot \left(\frac{T_C}{T_A r^{\gamma-1}}\right)$$

$$C \rightarrow D\ adiabat\quad Poisson: T_D = T_C\left(\frac{V_C}{V_D}\right)^{\gamma-1} = T_C\left(\frac{T_C}{T_A r^{\gamma}}\right)^{\gamma-1} = 2000\,\mathrm{K}\left(\frac{2000}{300 \cdot 18^{1,4}}\right)^{0,4} = 846{,}5\,\mathrm{K}$$

$$\eta = 1 - \frac{2{,}5(846{,}5 - 300)}{3;5(2000 - 953{,}3)} = 0{,}63$$