

1- Voir le tracé du diagramme.

2- $T_2 = 75^\circ\text{C}$, $T_4 = -10^\circ\text{C}$, $BP = P_1 = P_4 = 2\text{ bar}$, $HP = P_2 = P_3 = 10\text{ bar}$

3- $H_1 = 416.923\text{ KJ.Kg}^{-1}$, $H_2 = 456.153\text{ KJ.Kg}^{-1}$, $H_3 = H_4 = 211.538\text{ KJ.Kg}^{-1}$, $S_1 = S_2 = 1.825\text{ KJ.Kg}^{-1}\text{K}^{-1}$

4- $Q_{2-3} = H_3 - H_2 = -244.615\text{ KJ.Kg}^{-1}$, $Q_{4-1} = H_1 - H_4 = 205.385\text{ KJ.Kg}^{-1}$, $W_{1-2} = H_2 - H_1 = 39.230\text{ KJ.Kg}^{-1}$

5- $COP_{\text{Condenseur}} = \frac{-Q_{2-3}}{W_{1-2}} = \frac{244.615}{39.230} = 6.235$, $COP_{\text{Evaporateur}} = \frac{Q_{4-1}}{W_{1-2}} = \frac{205.385}{39.230} = 5.235$

Verification: $COP_{\text{Condenseur}} - COP_{\text{Evaporateur}} = 6.230 - 5.230 = 1$

6- $a = \frac{27R^2T_c^2}{64P_c} = \frac{27 \times 8.314^2 \times (100 + 273)^2}{64 \times 40 \times 10^5} = 1.014\text{ Pa.m}^6.\text{mol}^{-2}$

$b = \frac{RT_c}{8P_c} = \frac{8.314 \times (100 + 273)}{8 \times 40 \times 10^5} = 0.0000969\text{ m}^3.\text{mol}^{-1} = 0.969 \times 10^{-4}\text{ m}^3.\text{mol}^{-1}$

7- D'après relation de Clausius-Clapeyron, on a :

$$\ln P_s = -\frac{\Delta H_{\text{latente}}}{R} \frac{1}{T_s} + C \Rightarrow C = \ln P_s + \frac{\Delta H_{\text{latente}}}{R} \frac{1}{T_s}$$

A partir du diagramme on trouve :

$T_s = 30^\circ\text{C} = 303\text{ K}$, $P_s = 7.800\text{ bar}$, $\Delta H_{\text{latente}} = 416.923 - 243.076 = 173.847\text{ KJ.Kg}^{-1}$

$\Rightarrow C = \ln 7.800 + \frac{1000 \times 173.847}{8.314} \frac{1}{303} = 71.064 \Rightarrow \ln P_s = -\frac{\Delta H_{\text{latente}}}{R} \frac{1}{T_s} + 71.064$

Verification pour $T_s = 20^\circ\text{C} = 293\text{ K}$, $P_s = 5.785\text{ bar}$, $\Delta H_{\text{latente}} = 404.615 - 235.785 = 168.836\text{ KJ.kg}^{-1}$

$\Rightarrow \ln P_s = -\frac{\Delta H_{\text{latente}}}{R} \frac{1}{T_s} + 71.064 = \ln P_s = -\frac{1000 \times 168.836}{8.314} \frac{1}{293} + 71.064 \Rightarrow \ln P_s = 1.755 \Rightarrow P_s = 5.785\text{ bar}$

8- D'après relation de Rankine, on a :

$$\ln P_s = A + \frac{B}{T_s} \Rightarrow \begin{cases} \ln P_{1,s} = A + \frac{B}{T_{1,s}} \\ \ln P_{2,s} = A + \frac{B}{T_{2,s}} \end{cases} \Rightarrow \begin{cases} \ln \frac{P_{2,s}}{P_{1,s}} = B \frac{T_{2,s} - T_{1,s}}{T_{2,s} T_{1,s}} \Rightarrow B = \frac{T_{2,s} T_{1,s}}{T_{1,s} - T_{2,s}} \ln \frac{P_{2,s}}{P_{1,s}} = \frac{283 \times 303}{283 - 303} \ln \frac{7.800}{4.183} = -2671.081 \\ \text{et } \ln P_{1,s} = A + \frac{B}{T_{1,s}} \Rightarrow A = \ln P_{1,s} - \frac{B}{T_{1,s}} = \ln 4.183 - \frac{-2671.081}{283} = 10.869 \end{cases}$$

Alors : $\ln P_s = 10.869 - \frac{2671.081}{T_s}$

Verification : $T_s = 20^\circ\text{C} = 293\text{ K}$: $\ln P_s = 10.869 - \frac{2671.081}{293} = 1.752 \Rightarrow P_s = 5.770\text{ bar}$

9- A partir du diagramme on trouve $x_g = 0.51 = 51\%$ et $x_l = 0.49 = 49\%$

10- $v = c - r - k - \varphi + n = 1 - 0 - 0 - 2 + 2 = 1$

R134a

Ref: J.P. Wilson & R.S. Bass, ASHRAE TRANSACTIONS 1988, Vol. 94 part 2.

DTU, Department of Energy Engineering
Energy Systems, Refrigeration
• in [kJ/(kg K)], • in [m³/kg], T in [°C]
M.J. Skovrup & H.J.H. Knudsen, 99-10-25

