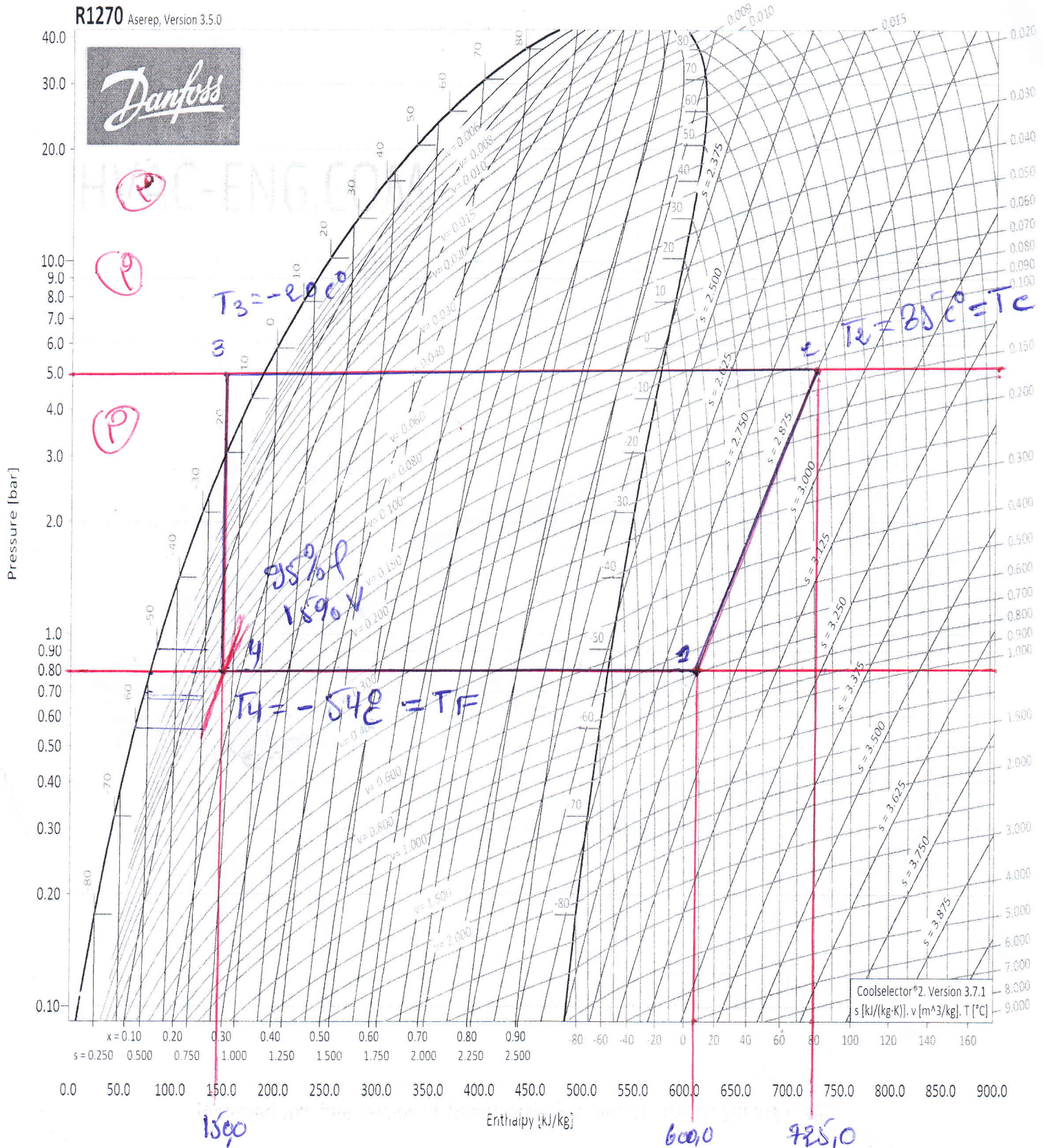


Examen de la Cinquième Année du Génie des Procédés en
Thermodynamique Appliquée

Exo: 02

HVAC-ENG.COM



Remarque : On prend 2 chiffres significatifs après la virgule dans tous le calcul

$$3) \eta_{\text{stirling}} = 1 - \frac{T_F \ln 2 + \frac{T_C - T_F}{r-1}}{T_C \ln 2 + \frac{T_C - T_F}{r-1}}$$

$$\eta_{\text{stirling}} = 1 - \frac{292,62 \ln 2 + \frac{500 - 292,62}{1,4 - 1}}{500 \ln 2 + \frac{500 - 292,62}{1,4 - 1}} = 0,21$$

$$\eta_{\text{stirling}} = 21\%$$

$$\eta_C = 1 - \frac{T_F}{T_C} = 1 - \frac{292,62}{500} = 0,41 = 41\%$$

$$\Rightarrow \eta_{\text{stirling}} < \eta_{\text{carnot}}$$

$$4) \lim_{T_F \rightarrow T_C} \eta_{\text{stirling}} = 1$$

$$\lim_{T_F \rightarrow T_C} \eta_{\text{stirling}} = 1 - \frac{T_F \ln 2 + \frac{T_F - T_F}{r-1}}{T_C \ln 2 + \frac{T_F - T_F}{r-1}} = \frac{T_F \ln 2}{T_C \ln 2}$$

$$= 1 - \frac{T_F \ln 2}{T_C \ln 2} = 1 - \frac{T_F}{T_C} = \eta_{\text{carnot}}$$

$$5) \Delta S_{\text{cycle}} = \Delta S_{\text{échange}} + \Delta S_{\text{créé}}$$

$$\Delta S_{\text{cycle}} = 0 \text{ (puisque } S \text{ est une fonction d'état)}$$

$$\Delta S_{\text{créé}} \geq 0 \text{ (constat expérimental)}$$

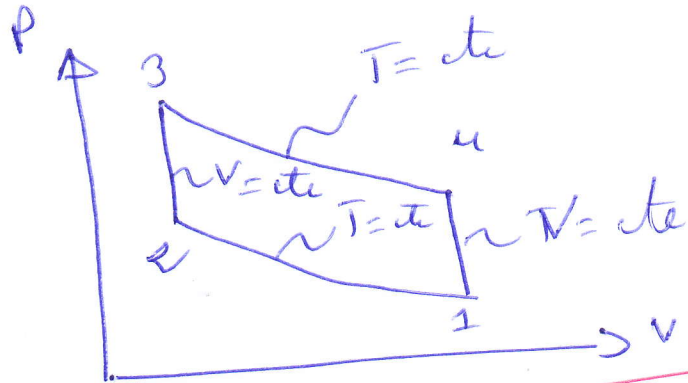
$$\Rightarrow \Delta S_{\text{échange}} = -\Delta S_{\text{créé}} \leq 0$$

$$\Rightarrow \Delta S_{\text{échange}} = \frac{Q_C}{T_C} + \frac{Q_F}{T_F} \leq 0$$

2

Exo 01

① le cycle de Stirling



Données

$$n = 0,25 \text{ mol}, P_1 = 1 \text{ atm}$$

$$V_2 = 2 \text{ l}, T_3 = 500 \text{ K}$$

$$\gamma = 3, \gamma = 1,4$$

② $d = \frac{V_1}{V_2} = \frac{V_4}{V_3} \Rightarrow V_1 = 2V_2 = 3 \times 2 = 6 \text{ l}$

$$V_1 = V_4 = 6 \text{ l}$$

$$V_2 = V_3 = 2 \text{ l}$$

$$\Rightarrow P_1 V_1 = n R T_1 \Rightarrow T_1 = \frac{P_1 V_1}{n R} = \frac{1 \times 6}{0,25 \times 0,082} = 292,68 \text{ K}$$

$$T_2 = T_1 = 292,68 \text{ K}$$

$$P_2 V_2 = n R T_2 \Rightarrow P_2 = \frac{n R T_2}{V_2} = \frac{0,25 \times 0,082 \times 292,68}{2} = 3 \text{ atm}$$

$$P_3 V_3 = n R T_3 \Rightarrow P_3 = \frac{n R T_3}{V_3} = \frac{0,25 \times 0,082 \times 500}{2} = 5,12 \text{ atm}$$

$$T_3 = T_4 = 500 \text{ K}$$

$$P_4 V_4 = n R T_4 \Rightarrow P_4 = \frac{n R T_4}{V_4}$$

$$\Rightarrow P_4 = \frac{0,25 \times 0,082 \times 500}{6} = 1,70 \text{ atm}$$

	1	2	3	4
P[atm]	1	3	5,12	1,70
V[l]	6	2	2	6
T[K]	292,68	292,68	500	500

4) $\phi_{2-3} = h_3 - h_2 = 150,0 - 725,0 = -575 \text{ kJ} \cdot \text{kg}^{-1} < 0$
 $\phi_{4-1} = h_1 - h_4 = 600,0 - 150,0 = 450 \text{ kJ} \cdot \text{kg}^{-1} > 0$

(2)

5) $w_{1-2} = h_2 - h_1 = 725,0 - 600 = 125 \text{ kJ} \cdot \text{kg}^{-1} > 0$

6) $\text{COP}_{\text{condenseur}} = - \frac{\phi_{2-3}}{w_{1-2}} = \frac{-(-575)}{125} = 4,6$

$\text{COP}_{\text{évaporateur}} = \frac{\phi_{1-4}}{w_{1-2}} = \frac{450}{125} = 3,6$

$\text{COP}_{\text{source chaude}} = \frac{T_c}{T_c - T_F} = \frac{25 + 273}{25 + 273 - (-54 + 273)}$
 $= \frac{358}{358 - 219} = \frac{358}{139} = 2,57$

$\text{COP}_{\text{source froide}} = \frac{T_F}{T_c - T_F} = \frac{-54 + 273}{139} = 1,57$

(2)