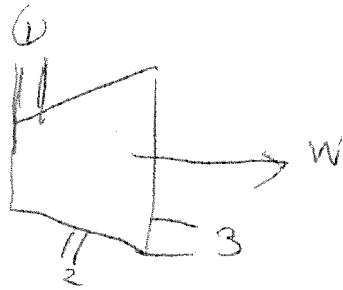


4.11)



$$P_1 = 160 \cdot 10^5 \text{ Pa}$$

$$T_1 = 480^\circ \text{C}$$

$$\dot{m} = 800/60 \text{ m}^3/\text{s}$$

18% op s bar

$$(2) \quad 290^\circ \text{C}$$

$$V = 25 \text{ m/s}$$

$$(3) \quad P_3 = 0,06 \text{ bar}$$

$$x = 0,94$$

$$m_1 = \frac{V_1 A_1}{v_1}$$

tabel A-4

$$V = 400 \text{ m/s}$$

$$v_1 = 0,01842 \text{ m}^3/\text{kg}$$

$$\dot{m}_1 = \frac{800/60}{0,01842} = 724 \text{ kg/s}$$

$$\dot{m}_2 = 0,18 \cdot 724 = 130,3 \text{ kg/s}$$

$$\frac{dm}{dt} = \dot{m}_1 - \dot{m}_2 - \dot{m}_3$$

$$= 0$$

$$\dot{m}_3 = \dot{m}_1 - \dot{m}_2 = 593,6 \text{ kg/s}$$

$$\dot{m}_2 = \frac{A_2 V_2}{v_2}$$

$$A_2 = \frac{\dot{m}_2 v_2}{V_2}$$

A-4

$$v_2 = 0,4646 \text{ m}^3/\text{kg}$$

$$A_2 = \frac{593,6 \cdot 0,4646}{25} = 11,1 \text{ m}^2$$

tabel A-3

$$P_3 = 0,06 \text{ bar}$$

$$x = \frac{v_g - v_f}{v_g - v_{fg}} = 0,94$$

$$v_3 = 22,3 \text{ m}^3/\text{kg}$$

$$A_3 = 33,1 \text{ m}^2$$

4.18)

①

②

steam

$$T_1 = 320^\circ\text{C} \quad p_1 = 30 \cdot 10^5 \text{ Pa}$$

$$V_1 = 100 \text{ m/s}$$

$$p_2 = 10 \cdot 10^5 \text{ Pa}$$

$$T_2 = 200^\circ\text{C}$$

$$m = 2 \text{ kg/s}$$

$$V_2 = ?$$

$$Q = \dot{W} + m \left[ (h_1 - h_2) + \left( \frac{V_1^2}{2} - \frac{V_2^2}{2} \right) \right]$$

$$V_2^2 = 2(h_1 - h_2) + V_1^2$$

tabel A-4

$h_1 =$	<del>3034</del>	3043	kJ/kg
$h_2$		2828	kJ/kg

$$V_2^2 = 2(3043 - 2828) + 100^2$$

$$V_2 = 664 \text{ m/s}$$

$$\dot{m}_1 = \rho_1 V_1 A_1 = \frac{V_1 A_1}{v_1}$$

$$A_1 = \frac{m V_1}{V_1} = \frac{2 \cdot 0,0050}{100} = 17 \cdot 10^{-6} \text{ m}^2$$

$$A_2 = \frac{2 \cdot 0,206}{664} = 6,2 \cdot 10^{-4} \text{ m}^2$$

4.20)



$$h_1 = 3000 \text{ kJ/kg} \quad m = 0,5 \text{ kg/s}$$

$$h_2 = 1700 \text{ kJ/kg} \quad = 0$$

$$Q_c = \cancel{W_c} + m(h_2 - h_1) + m\left(\frac{V_2^2}{2} - \frac{V_1^2}{2}\right) + mg(z_2 - z_1)$$

$= 0$

$$Q_c = -0,5 \cdot (3000 - 1700) = -650 \text{ kJ/s} = \underline{\underline{-650 \text{ kW}}}$$

4.19



CH4

$$Q = 0$$

$$T_1 = 800^\circ\text{C}$$

$$V_1 = 10 \text{ m/s}$$

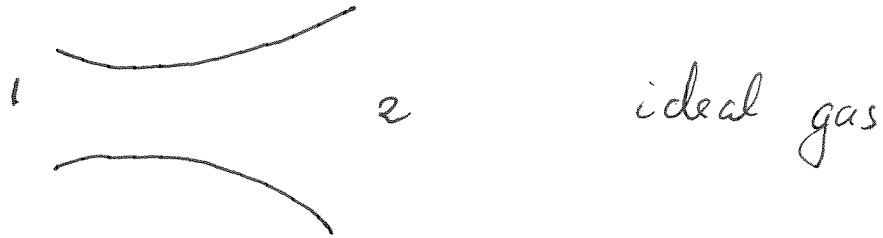
$$Q = \cancel{W} + m(h_2 - h_1) + \frac{V_2^2}{2} - \frac{V_1^2}{2} + g(z_2 - z_1)$$

$$h_2 - h_1 + \frac{V_2^2}{2} - \frac{V_1^2}{2} = 0$$

$$V_2 = 500 \dots 600 \text{ m/s}$$

label A-21

4.21



$$\begin{aligned} P_1 &= 1 \cdot 10^5 \text{ Pa} \\ T_1 &= 300 \text{ K} \\ V_1 &= 250 \text{ m/s} \end{aligned}$$

$$\left. \begin{array}{l} \\ \\ \\ \end{array} \right\} P_1 = \rho_1 R T_1 \quad \rho_1 = \frac{P_1}{R T_1}$$

$$\begin{aligned} P_2 &= 1.13 \cdot 10^5 \text{ Pa} \\ T_2 &= ? \\ V_2 &= 140 \text{ m/s} \end{aligned}$$

$$\rho_1 = \frac{1 \cdot 10^5}{\frac{0.314}{29} \cdot 300} = 1.16 \text{ kg/m}^3$$

$$\cancel{Q} = \cancel{W} + \dot{m} \left[ h_2 - h_1 + \frac{V_2^2}{2} - \frac{V_1^2}{2} + g(z_2 - z_1) \right]$$

=0 =0

isolated

$$2(h_2 - h_1) + V_2^2 - V_1^2 = 0$$

$$h_1 = \text{tabel A-22} \quad 300.19 \frac{\text{kJ}}{\text{kg}}$$

$$h_2 = h_1 + \frac{250^2 - 140^2}{2} = 321.64 \text{ kJ/kg}$$

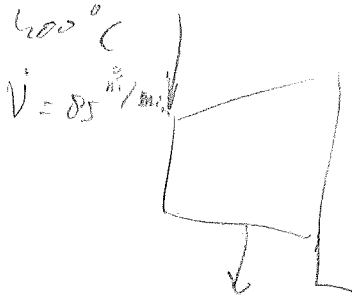
interpolasi tabel A-22  $T_2 = 321.3 \text{ K}$ 

$$\rho_2 = \frac{P_2}{R T_2} = \frac{1.13 \cdot 10^5}{\frac{0.314}{29} \cdot 321.3} = 1.23 \text{ kg/m}^3$$

$$\dot{m} = \rho_1 V_1 A_1 = \rho_2 V_2 A_2 \quad \frac{A_2}{A_1} = \frac{\rho_1 V_1}{\rho_2 V_2} = \frac{1.16 \cdot 250}{1.23 \cdot 140} = 1.69$$

Opgave 4.2 g

$\Rightarrow 17 \text{ Pa} = 30 \text{ bar}$



$0.5 \text{ MPa} = 5 \text{ bar}$   
 $180^\circ\text{C}$   
 $V = 20 \text{ m/s}$

$\dot{m}_1 = \dot{m}_2 + \dot{m}_3$

$\dot{Q} = \dot{W} + \dot{m}_2 \left\{ (h_2 - h_1) + \frac{V_2^2}{2} - \frac{V_1^2}{2} \right\} + \dot{m}_3 \left\{ (h_3 - h_1) + \frac{V_3^2}{2} - \frac{V_1^2}{2} \right\}$

Kinetische energie

$\frac{V_1^2}{2} = ?$  geen info over  $V_1$

$\frac{V_2^2}{2} = \frac{(20 \frac{\text{m}}{\text{s}})^2}{2} = 200 \frac{\text{J}}{\text{kg}} = 0.2 \frac{\text{kJ}}{\text{kg}}$   
 $\hookrightarrow$  is klein

$\frac{V_3^2}{2} = ?$  geen info over  $V_3$

$P = \dot{W} = 11400 \text{ kW}$

a)  $\dot{m}_2$   $\dot{m}_3$  in kg/hr

b)  $d_2$

$\dot{Q} = 0 \quad \dot{W} = -\dot{m}_2 \{ h_2 - h_1 \} - \dot{m}_3 \{ h_3 - h_1 \}$   
 $= \dot{m}_2 (h_1 - h_2) + \dot{m}_3 (h_1 - h_3)$

$h_1$  (30 bar, 400°C)

$h_1 = 3230.9 \frac{\text{kJ}}{\text{kg}}$  (tabel A-4)

$v_1 = 0.0994 \frac{\text{m}^3}{\text{kg}}$

$\dot{V}_1 = \dot{m}_1 v_1$

$\dot{m}_1 = \frac{\dot{V}_1}{v_1} = \frac{85}{0.0994} = 14.252 \frac{\text{kg}}{\text{s}} (= 51307 \frac{\text{kg}}{\text{h}})$

$h_2$  (5 bar 180°C)

$h_2 = 2812.0$

$v_2 = 0.4045$

$h_3 = (1-x)h_f + x h_g$  bij 0.06 bar

tabel A-3  $0.1 \cdot 151.53 + 0.9 \cdot 2567.4 = 2325.313 \frac{\text{kJ}}{\text{kg}}$

$v_3 = (1-x)v_f + x v_g = 0.1 \cdot 1.0064 \cdot 10^{-3} + 0.9 \cdot 23.739 = 21.3652 \frac{\text{m}^3}{\text{kg}}$

x	p bar	T °C	h $\frac{\text{kJ}}{\text{kg}}$	v $\frac{\text{m}^3}{\text{kg}}$	$\dot{m}$ $\frac{\text{kg}}{\text{s}}$
(l)/super	30	400	3230.9	0.0994	14.25
(l)/super	5	180	2812.0	0.4045	3.096
0.90	0.06	$T_{\text{sat}} = 36.16$	2325.3	21.365	

$$\dot{W} = \dot{m}_2 (h_1 - h_2) + \dot{m}_3 (h_1 - h_3)$$

$$\dot{m}_1 = \dot{m}_2 + \dot{m}_3 \rightarrow \dot{m}_3 = \dot{m}_1 - \dot{m}_2$$

$$\begin{aligned} \dot{W} &= \dot{m}_2 (h_1 - h_2) + (\dot{m}_1 - \dot{m}_2)(h_1 - h_3) = \dot{m}_1 (h_1 - h_3) + \\ &\quad + \dot{m}_2 \{ (h_1 - h_2) - (h_1 - h_3) \} \\ &= \dot{m}_1 (h_1 - h_3) - \dot{m}_2 (h_2 - h_3) \end{aligned}$$

$$\begin{aligned} \dot{m}_2 &= \frac{-\dot{W} + \dot{m}_1 (h_1 - h_3)}{h_2 - h_3} = \frac{-11400 + 14.252(3230.9 - 2325.3)}{2325.3 - 2812.0} = \\ &= \frac{-11400 \frac{\text{kJ}}{\text{s}} + 12907 \frac{\text{kJ}}{\text{s}}}{436.7 \frac{\text{kJ}}{\text{kg}}} = \frac{1507}{436.7} = 3.45 \text{ kg/s} \\ &= 11145 \text{ kg/h} \end{aligned}$$

$$\dot{m}_3 = \dot{m}_1 - \dot{m}_2 = 14.252 - 3.45 = 10.802 \text{ kg/s} \quad 40163 \text{ kg/hr}$$

$$b) \quad d_2 = \sqrt{\frac{4A_2}{\pi}}$$

$$A_2 = \frac{\dot{V}_2}{V_2} = \frac{\dot{m}_2 v_2}{V_2} = \frac{3.45 \cdot 0.4045}{20} = 0.0626 \text{ m}^2$$

$$d_2 = 0.282 \text{ m}$$

4.58)

- 1) warmte overdracht
- 2) Coeff of performance

$$1) \quad \dot{Q} = \dot{W} + \dot{m}(h_2 - h_1)$$

$$\dot{m} = 4.6 \text{ kg/min} \\ = 0,076 \text{ kg/s}$$

$$h_2 = 270 \text{ kJ/kg}$$

$$h_1 = ?$$

$$\begin{cases} \text{R134} \\ P_1 = 1.8 \text{ bar} \\ T_1 = -10^\circ \text{C} \end{cases} \Rightarrow T_{A12} \Rightarrow h_1 = 242 \text{ kJ}$$

$$\dot{Q} = \dot{W} + \dot{m}(h_2 - h_1) = -2.5 + \frac{4.6}{60} (270 - 242) \\ = \underline{\underline{-0.372 \text{ kW}}}$$

2) COP vgl (2.47)

$$j = \frac{Q_{out}}{W_c}$$

$$Q_{out} = m(h_3 - h_2)$$

$h_3 = ?$  op  $h_3$  is R134 gecondenseerd dus condensatie enthalpie is van belang

$$h = h_f \text{ (tabel 10)}$$

$$h = h_f = 91.5 \text{ kJ/kg}$$

$$Q_{out} = m(h_3 - h_2) = \frac{4.6}{60} (91.5 - 270) = -13.6 \text{ kW}$$

$$j = \frac{13.6}{2.5} = \underline{\underline{5.4}}$$