TU Delft
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Werktuigbouwkunde en
Maritieme Techniek

(invullen met blokletters)
Naam: .....
Adres: .....
Woonplaats: .....
Studierichting: ..... Vak: .....
Examennummer: ..... Tentamen .....
Aantal ingeleverde vellen: .....

Opgave 1

a)

leiding	T(°C)	p(bar)	T_{sat}(°C)	medium	
1	-10	2	-10,09	damp	1
2	64	14	52.43	damp	1
3	20	14	52.43	vloeistof	1
4	-8	P_{sat} = 2.1704	$= T_{sat}$	mengsel	1

(4)

↳ is beter te concluderen na b en evt. c

b) $h_1 = h(2\,bar, -10°C) = 241,38\ kJ/kg$ | 1 | tabel A-12

$h_2 = h(14\,bar, 64°C)$

$h_2 = h(60°C) + \frac{h(70°C) - h(60°C)}{T(70°C) - T(60°C)} (T_2 - T(60°C))$ | 1 =

$= 283,10 + \frac{295,31 - 283,10}{70 - 60} (64 - 60) = 283,10 + 0,4 \cdot 12,21 =$

$= 297,98\ \frac{kJ}{kg}$ | 1

$h_3 = h(14\,bar, 20°C)$

$h_3 = u_f(20°C)$ | 1 $+ p_3 v_f(20°C)$ | 1 =

$= 76,80 \left[\frac{kJ}{kg}\right] + 1400 \left[\frac{kJ}{m^3}\right] \cdot 0.0157 \cdot 10^{-3} \left[\frac{m^3}{kg}\right] = 76,80 + 1,142 = 77,94\ \frac{kJ}{kg}$ | 1

(7)

$h_4 = h_3 = 77,94\ \frac{kJ}{kg}$ | 1

	p	T	h	x
1	2	-10	241,38	1
2	14	64	297,98	1
3	14	20	77,94	0
4	2,1704	-8	77,94	0,189

c) leiding 1 ~~licht~~ oververhitte damp → $x = 1$ ¹

vdgl ook uit $x = \frac{h - h_f}{h_g - h_f}$ met $0 \le x \le 1$

leiding 2 oververhitte damp → $x = 1$ ¹

leiding 3 vloeistof ($T < T_{sat}$) → $x = 0$ ¹

(4)

leiding 4 $T = T_{sat}$

$$x_4 = \frac{h_4 - h_f}{h_g - h_f} = \frac{77.94 - 39.54}{242,54 - 39.54} = \frac{38.40}{203.00} = 0.1892$$ ¹

h_g en h_f bij $T = 8°C$ $x_4 = 0.189$

d) Condensor (opp. 2)

$\dot{Q} = \dot{m}(h_{out} - h_{in}) + \dot{W}$ $\dot{W} = 0$ $\dot{Q} = 0$

$\dot{m}_w (h_{w,out} - h_{w,in}) + \dot{m}_R (h_3 - h_2) = 0$ of $\dot{Q}_w + \dot{Q}_R = 0$ ¹

$\dot{m}_w = 10\ ^{kg}/_{min} = \frac{10}{60}\ kg/s$

$$\dot{m}_R = \frac{-\dot{m}_w (h_{w,out} - h_{w,in})}{h_3 - h_2} = \frac{-\dot{m}_w c_p (T_{w,out} - T_{w,in})}{h_3 - h_2}$$ ¹

$$= \frac{-\frac{10}{60} \cdot 4.18 (45 - 15)}{77.94 - 287.98} = \frac{-20.9}{-210.04} = 0.09950\ ^{kg}/_{s}$$ ¹

(3)

$\dot{m}_R = 0.0995\ kg/s$

of $\dot{m}_R = 5.97\ kg/min$

n.t.t. $h_3 = 80\ ^{kJ}/_{kg}$

$$\dot{m}_R = \frac{-\frac{10}{60} \cdot 4.18 (45 - 15)}{80 - 287.98} = \frac{-20.9}{-207.98} = 0.1005\ ^{kg}/_{s}$$

of $\dot{m}_R = 6.03\ kg/min$

e) compressorvermogen

$\dot{Q}_{12} = \dot{m}(h_2 - h_1) + \dot{W}_{12}$ $\quad \dot{Q}_{12} = 0$ (adiabaat)

$\dot{W}_{12} = -\dot{m}(h_2 - h_1) = -0.0995 (287.98 - 241.38) =$ (2)

$= -0.0995 \cdot 46.60 = -4.64$ kW

met $h_3 = 90 \frac{kJ}{kg}$ $\quad \dot{W}_{12} = -4.65$ kW

f) $\gamma = \frac{\dot{Q}_{out}}{\dot{W}_{in}} = \frac{-\dot{Q}_{23}}{-\dot{W}_{12}} = \frac{20.9}{4.637} = 4.507$ (2) $\quad \boxed{\gamma = 4.51}$

met $h_3 = 90 \frac{kJ}{kg}$ $\quad \gamma = 4.46$

g) (6)