Tentamen 25 juni 2010

2011 03 25

uitlaat:

a) $v_1 = 0.08643$ tabel A-4

b) $d_2 = 1.8\ m$ $\quad A_2 = \frac{\pi}{4} d^2$

$V_2 = 180\ m/s$

$p_2 = 6\ kPa = 0.060\ bar$

$v_2 = 21.840\ m^3/kg$

$$\dot{V}_2 = A_2 \cdot V_2 = \frac{\pi}{4} d^2 V_2$$

$$\dot{V}_2 = 2.54 \cdot 180 = 458\ m^3/s$$

$$\dot{m} = \frac{\dot{V}_2}{v_2} = \frac{\frac{\pi}{4} d^2 V_2}{v_2} = \frac{2.54 \cdot 180}{21.840} = 20.973\ kg/s$$

c) $$x = \frac{v_2 - v_2'}{v_2'' - v_2'}$$

(tabel A-3)

$$x = \frac{21.840 - 1.0064 \cdot 10^{-3}}{23.739 - 1.0064 \cdot 10^{-3}} = 0.920$$

$T_2 = T_{sat} = 36.16\ °C$ (tabel A.3)

d) $$\dot{W} = \underbrace{\dot{Q}}_{=0} - \dot{m}\Delta h - \Delta \dot{E}_k - \underbrace{\Delta \dot{E}_p}_{=0}$$

$$\dot{W} = -\dot{m}(h_2 - h_1) - \dot{m}\left(\frac{V_2^2}{2} - \underbrace{\frac{V_1^2}{2}}_{\approx 0}\right) = -\dot{m}\left[(h_2 - h_1) + \frac{V_2^2}{2}\right]$$

$h_1 = 3445.3\ kJ/kg$ (A.4)

$h_2 = h' + x(h'' - h') = h' + x\, h_{fg}$

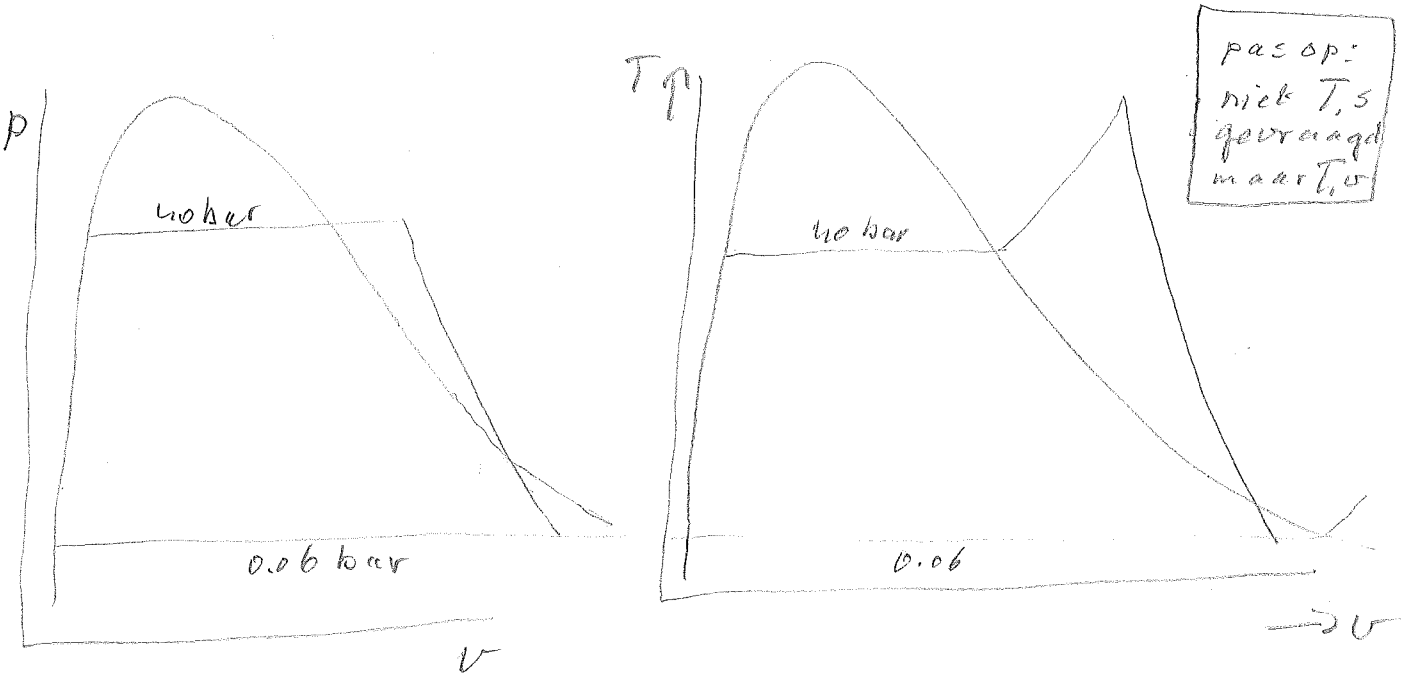
$h_2 = 151.53 + x \cdot 2415.9 = 2374.2\ kJ/kg$

$$\frac{V_2^2}{2} = \frac{180^2}{2} = 16\,200\ \frac{J}{kg}\ \left(= \frac{m^2}{s^2}\right) = 16.2\ \frac{kJ}{kg}$$

$$\dot{W} = -20.973 \left(\underbrace{2374.2 - 3445.3 + 16.2}_{-1054.9} \right) =$$

$$= 22\,124\ kW = 22.12\ MW$$

e)



f) Is al berekend onder d

$$\Delta \dot{E}_k = \dot{m}\left(\frac{V_2^2}{2} - \frac{V_1^2}{2}\right) \approx \dot{m}\,\frac{V_2^2}{2}$$

Deze energie wordt niet teruggewonnen

$$\Delta \dot{E}_k = 20.973 \cdot \frac{180}{2} = 339.8\ kW$$

$$\frac{\Delta \dot{E}_k}{\dot{W}} = \frac{340}{22\,124} = 0.015 \qquad 1.5\ \%$$

Dit zie ik niet als verwaarloosbaar, omdat rendementen van een centrale op 0.1 % nauwkeurig moet worden gegarandeerd.

Verder is elk goed onderbouwd antwoord goed gerekend.

g) $\dot{V}_1 = \dot{m}\, v_1 = 20.973 \cdot 0.00843 = 1.813\ m^3/s$

$$d = \sqrt{\frac{4A_1}{\pi}} = \sqrt{\frac{4}{\pi}\frac{\dot{V}_1}{V_1}} \qquad d = \sqrt{\frac{4}{\pi} \cdot \frac{1.813}{20}} = 0.340\ m$$

$$\dot{E}_{k_1} = \dot{m}\,\frac{V_1^2}{2} = 20.973 \cdot \frac{20^2}{2} = 4.195\ kW$$

$$\frac{\dot{E}_{k_1}}{\dot{W}} = \frac{4.2}{22124} = 0.02\ \%$$