$h_1 = h_2 = h_3 = h_4 = h$

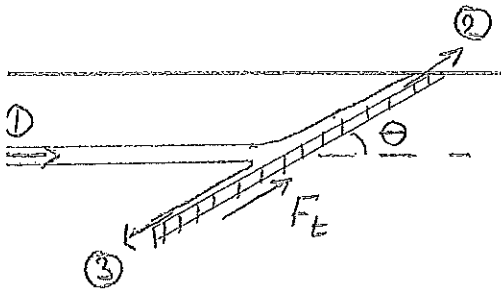
jmvkt:

$$p_1 + \rho_{H_2O} g h + \rho_x g h = (3h - h_5) g \rho_{Hg}$$

$$\rho_x = \frac{(3h - h_5) g \rho_{Hg} - \rho_{H_2O} g h - p_1}{gh} =$$

tabell: $\rho_{Hg} = 13550\ kg/m^3$, $\rho_{H_2O} = 998\ kg/m^3$ $\Rightarrow$

$\rho_x = 1271\ kg/m^3$



impulssatsen i tangentiell riktn.:

$F_t = 0$

$F_t = \Sigma((\dot{m}V)_{ut} - (\dot{m}V)_{in})$ (1)

$0 = \rho A_2 V_2^2 - \rho A_3 V_3^2 - \rho A_1 V_1^2 \cos\theta$ (2)

kE: $\rho V_1 A_1 = \rho V_2 A_2 + \rho V_3 A_3$ (3)

Bernoulli:

$p_1 + \rho V_1^2 = p_2 + \rho V_2^2 = p_3 + \rho V_3^2$ (4)

$\Rightarrow V_1 = V_2 = V_3$ (5)

(5) i (3) $\Rightarrow$

$A_1 = A_2 + A_3 \Rightarrow A_3 = A_1 - A_2$ (6)

(5)& (6) i (2) $\Rightarrow$

$0 = A_2 - (A_1 - A_2) + A_1 \cos\theta$

$2A_2 = A_1(1 + \cos\theta)$

$A_2 = A_1 \frac{(1+\cos\theta)}{2}$ (7)

$Q_2 = A_2 V_2 \overset{(7)}{=} A_1 \frac{(1+\cos\theta)}{2} V_2 =$

$(5) = \underbrace{A_1 V_1}_{Q_1} \frac{(1+\cos\theta)}{2} =$

$0.9\ m^3/s$

$Q_3 = Q_1 - Q_2 = 0.1\ m^3/s$

kraftjämvikt $F_D = F_t = mg$

$F_D = \frac{1}{2} C_D A \rho_L U^2 = mg$ (1)

$Re = \frac{UD}{\nu_L} = Re_m = \frac{U_m D}{\nu_V \cdot 10}$

$U_m = \frac{U \cdot 10}{15}$ (2)

gissa $U = 10$ m/s (2) =>
$U_m = 6,6$ m/s (tabell) =>
=> $F_m = 48,40$ N

$F_m = \frac{1}{2} C_D \left(\frac{D}{10}\right)^2 \rho_V U_m^2$ =>

$C_D = \frac{2 F_m}{\rho_V \left(\frac{D}{10}\right)^2 U_m^2}$ (3)

$C_D = \frac{22,2}{D^2}$ (4)

(4) i (1) => $F_D = 1325,7$ N
=> $m = 135$ kg

gissa $U = 5$ m/s (2) =>

$U_m = 3,33$ m/s (tabell) =>
$F_m = 1406$ N (3) =>
$C_D = \frac{25}{D^2}$ (1) =>

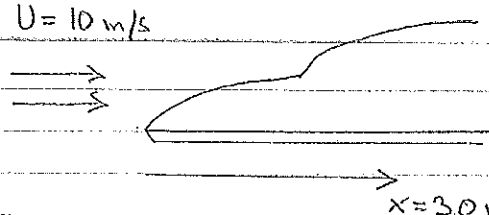
$F_D = 375$ N => $m = 38$ kg

gissa $U = 7,5$ m/s (2) =>

$U_m = 5$ m/s (tabell) =>
$F_m = 2920$ N (3) =>
$C_D = \frac{23,36}{D^2}$ (1) =>

$F_D = 788$ N => $m = 80$ kg

Svar: slutlhastigheten är 7,5 m/s



Luft

$T = 20°C$ => $\nu = 15,2 \cdot 10^{-6}$ m²/s
$\rho = 1,189$ kg/m³

$Re_x = \frac{Ux}{\nu} = \frac{10 \cdot 3,0}{15,2 \cdot 10^{-6}} = 1,974 \cdot 10^6 > Re_{kr} \approx 5 \cdot 10^5$

∴ turbulent gs vid $x = 3,0$ m. Antag omslag redan i framkanten.

a) (7.43) => $\hat{\tau}_w = 0,0135 \cdot \frac{\rho U^2}{\sqrt[7]{Re_x}} = 0,202$ Pa

=> $u^* = \sqrt{\frac{\tau_w}{\rho}} = \sqrt{\frac{0,202}{1,189}} = 0,4126$ m/s

b) $y = 0,010$ m => $\frac{u^* y}{\nu} = \frac{0,4126 \cdot 0,010}{15,2 \cdot 10^{-6}} = 271$

=> $10 < \frac{u^* y}{\nu} < 600$ =>

=> logaritmiska området

=> $\frac{\bar{u}}{u^*} = 2,44 \ln \frac{u^* y}{\nu} + 4,9 =$

$= 2,44 \ln 271 + 4,9 = 18,57$ s

=> $\bar{u} = 18,573 \cdot 0,4126 = 7,66$ m/s

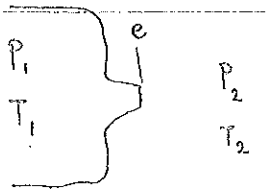
c) $y = 0,0001$ m => $\frac{u^* y}{\nu} = \frac{0,4126 \cdot 1 \cdot 10^{-4}}{15,2 \cdot 10^{-6}} = 2,71$

∴ $0 < \frac{u^* y}{\nu} < 10$ => viskösa underskiktet

=> $\frac{\bar{u}}{u^*} = \frac{u^* y}{\nu} = 2,71$

=> $\bar{u} = 0,4126 \cdot 2,71 = 1,12$ m/s

Svar a) 0,20 Pa
b) 7,7 m/s
c) 1,1 m/s



$P_{1a} = 280$ kPa $\quad T_{1a} = 298$ K

$P_{1b} = 130$ kPa $\quad T_{1b} = 288$ K

Omgivning: $P_2 = 100$ kPa $\quad T_2 = 293$ K

kritiskt tryckförhållande (9.32)

$$\frac{P^*}{P_1} = 0{,}5283$$

a) $\frac{P_2}{P_{1a}} = \frac{1}{2{,}8} = 0{,}357 < \frac{P^*}{P_1}$

$\therefore$ ljudhast. i mynningen

(9.46b) $\Rightarrow \dot{m}_{max} = 0{,}6847\, A^* \frac{P_{1a}}{\sqrt{RT_{1a}}}$

$A^* = 2{,}5 \cdot 10^{-4}\ m^2$, $R_{luft} = 287$ Nm/kg K

$$\dot{m} = 0{,}6847 \cdot 2{,}5 \cdot 10^{-4} \cdot \frac{2{,}8 \cdot 10^5}{\sqrt{287 \cdot 298}} = 0{,}164 \text{ kg/s}$$

b) $\frac{P_2}{P_{1b}} = \frac{1}{1{,}7} = 0{,}588 > \frac{P^*}{P_1}$

$\therefore$ underljudshast. i mynningen

(9.35) $\Rightarrow Ma_e^2 = 5\left[\left(\frac{P_{1b}}{P}\right)^{2/7} - 1\right] = 5\left[\left(\frac{1{,}7}{1}\right)^{2/7} - 1\right] = 0{,}8185$

(9.35) $\Rightarrow \frac{T_{1b}}{T_e} = \frac{Ma_e^2}{5} + 1 = 1{,}163 \Rightarrow T_e = \frac{288}{1{,}163} = 247{,}5$ K

$a_e = \sqrt{\gamma R T_e} = \sqrt{1{,}4 \cdot 287 \cdot 247{,}5} = 315{,}3$ m/s

$Ma_e = \sqrt{0{,}8185} = 0{,}905 = \frac{V_e}{a_e}$; $V_e = 315{,}3 \cdot 0{,}905 = 285$ m/s

Svar: $\dot{m}_a = 0{,}16$ kg/s, $V_e = 285$ m/s