

Problem 11.1

Senne Hemelaur
4573404

$$\frac{f \gamma x}{D_H} = \frac{M^2 - M_0^2}{M^2 M_0^2} + \frac{\gamma + 1}{2} \ln \frac{M_0^2 (1 + \frac{\gamma-1}{2} M^2)}{M^2 (1 + \frac{\gamma-1}{2} M_0^2)}$$

$$= 7,41$$

$$D_H = \sqrt{\frac{5A}{R}} \quad \text{where} \quad A = 0,025^2 \cdot 12$$

$$D_H = 0,05$$

$$f = 0,005 \quad , \quad \gamma = \frac{7}{5}$$

$$\rightarrow \boxed{x = 13,25 \text{ m}}$$

$$p_1 = p_0 (1 + 0,2 M_1^2)^{-3,5}$$

$$p_1 = 234,86 \text{ kPa}$$

$$\frac{p_1}{p_0^*} = \frac{1}{M_1} \left[\frac{2 + 0,4 M_1^2}{2,4} \right]^{3,5} = 2,035$$

$$\frac{p_2}{p_0^*} = \frac{1}{M_2} \left[\frac{2 + 0,4 M_2^2}{2,4} \right]^{3,5} = 1,0021$$

$$p_2 = \frac{1,0021}{2,035} \cdot p_1$$

$$\boxed{p_2 = 115,66 \text{ kPa}}$$

$$L_{0,25} = 9,94$$

$$\frac{f \gamma L_{0,25}}{D_H} = 5,5664 = \frac{M^2 - 0,3^2}{M^2 \cdot 0,3^2} + 1,2 \ln \left(\frac{0,3^2 (1 + 0,2 M^2)}{M^2 (1 + 0,2 \cdot 0,3^2)} \right)$$

Solving for M yields:

$$\boxed{M_{0,25} = 0,4721}$$

$$\frac{p_{2,0,25}}{p_0^*} = \frac{1}{M_{0,25}} \left[\frac{2 + 0,4 M_{0,25}^2}{2,4} \right]^3 = 1,397$$

$$\boxed{p_{2,0,25} = 161,25 \text{ kPa}}$$