

Lösungen zur Klausur „Einf. i.d. Fluid- und Thermodynamik“ vom 26.03.2011

Auf. 1)

$$p_{dyn.} = \frac{\rho}{2} c_2^2 = \rho_M \cdot g \cdot \Delta h_3 \quad \Rightarrow \quad c_2 = \sqrt{\frac{2}{\rho} \rho_M \cdot g \cdot \Delta h_3}$$

$$\dot{m} = \rho c_1 \frac{\pi}{4} D^2 = \rho c_2 \frac{\pi}{4} (D^2 - d^2) \quad \Rightarrow \quad c_1 = c_2 \frac{D^2 - d^2}{D^2}$$

$$p_{ges.} = konst. \quad \Rightarrow \quad \frac{\rho}{2} c_1^2 + (p_a - \rho_M \cdot g \cdot \Delta h_1) = (p_a + \rho_M \cdot g \cdot \Delta h_4)$$

$$\text{mit } c_1 = c_2 \frac{D^2 - d^2}{D^2} \text{ und } c_2 = \sqrt{\frac{2}{\rho} \rho_M \cdot g \cdot \Delta h_3}$$

$$\Rightarrow \quad \Delta h_4 = \Delta h_3 \left(1 - \frac{d^2}{D^2} \right)^2 - \Delta h_1$$

Auf. 2)

$$\dot{m} = \rho^* a^* A^* \quad \Rightarrow \quad A^* = \frac{\dot{m}}{\rho^* a^*}$$

$$\frac{p_0}{p_a} = \left(1 + \frac{\kappa - 1}{2} M_1^2 \right)^{\frac{\kappa}{\kappa - 1}} \quad \Rightarrow \quad M_1 = \sqrt{\frac{2}{\kappa - 1} \left[\left(\frac{p_0}{p_a} \right)^{\frac{\kappa - 1}{\kappa}} - 1 \right]}$$

$$\frac{a_0}{a_1} = \left(1 + \frac{\kappa - 1}{2} M_1^2 \right)^{\frac{1}{2}} \quad \Rightarrow \quad a_0 = a_1 \left(1 + \frac{\kappa - 1}{2} M_1^2 \right)^{\frac{1}{2}}$$

$$a^* = a_0 \sqrt{\frac{2}{\kappa + 1}} \quad \Rightarrow \quad a^* = a_1 \left(1 + \frac{\kappa - 1}{2} M_1^2 \right)^{\frac{1}{2}} \left(\frac{2}{\kappa + 1} \right)^{\frac{1}{2}}$$

$$a_0 = \sqrt{\kappa \cdot R \cdot T_0} \quad \Rightarrow \quad T_0 = \frac{a_0^2}{\kappa R} = \frac{a_1^2}{\kappa R} \left(1 + \frac{\kappa - 1}{2} M_1^2 \right)$$

$$p_0 = \rho_0 R T_0 \quad \Rightarrow \quad \rho_0 = \frac{p_0}{R T_0} = \frac{p_0 \kappa}{a_1^2} \left(1 + \frac{\kappa - 1}{2} M_1^2 \right)^{-1}$$

$$\rho^* = \rho_0 \left(\frac{2}{\kappa + 1} \right)^{\frac{1}{\kappa - 1}} \quad \Rightarrow \quad \rho^* = \frac{p_0 \kappa}{a_1^2} \left(1 + \frac{\kappa - 1}{2} M_1^2 \right)^{-1} \left(\frac{2}{\kappa + 1} \right)^{\frac{1}{\kappa - 1}}$$

$$A^* = \frac{\dot{m}}{\rho^* a^*} = \dot{m} \left\{ \frac{p_0 \kappa}{a_1^2} \left(1 + \frac{\kappa - 1}{2} M_1^2 \right)^{-1} \left(\frac{2}{\kappa + 1} \right)^{\frac{1}{\kappa - 1}} a_1 \left(1 + \frac{\kappa - 1}{2} M_1^2 \right)^{\frac{1}{2}} \left(\frac{2}{\kappa + 1} \right)^{\frac{1}{2}} \right\}^{-1}$$