Problem 11.4

Senne Hemelaar
4573404

a.

$$\frac{4\gamma f}{D} x = 4\gamma \cdot 5{,}3 = 29{,}68$$

$\rightarrow M_2 = 0{,}17$ (Fanno line)

$$\frac{p_2}{p^*} = \frac{1}{M_2}\left[\frac{2 + 0{,}4 M_2^2}{2{,}4}\right]^3 = 3{,}464$$

$$p_2 = p_t (1 + 0{,}2 M_2^2)^{-3{,}5} = 6{,}86 \text{ bar}$$

$$p^* = \frac{p^*}{p_2} p_2 = 1{,}98 \text{ bar}$$

$p^* = p_{exit} = p_{rec}$

$$\boxed{p_{exit} = 6{,}86 \text{ bar}}$$

b.

$$\frac{4\gamma f}{D} \frac{1}{5} x = 5{,}936$$

$\rightarrow M_2 = 0{,}326$ (Fanno line)

$$\frac{p_2}{p^*} = \frac{1}{M_2}\left[\frac{2 + 0{,}4 M_2^2}{2{,}4}\right]^3 = 2{,}6118$$

$$p_2 = p_t (1 + 0{,}2 M_2^2)^{-3{,}5} = 6{,}5032 \text{ bar}$$

$$p^* = \frac{p^*}{p_2} p_2 = 2{,}49 \text{ bar}, \quad p^* = p_{exit}$$

$$\boxed{p_{exit} = 2{,}49 \text{ bar}}$$

c.