1 a) $\forall_1 = \forall_2 = V_2 A_2 \Rightarrow V_2 = \frac{\forall_1}{A_2} = \frac{0,2}{1,6 \cdot 10^{-3} \pi} = 39,79 m/s$

$\forall_1 = 12 \, m^3/min = 0,2 \, m^3/s$

$A_2 = \pi \cdot (0,04)^2 = 1,6 \cdot 10^{-3} \pi \, m^2$

$\boxed{V = 39,79 m/s}$

2 b) $\sum F = \sum saida - \underbrace{\sum entrada}_{0}$ SC $\rho = 10^3 Kg/m^3$

$F_r = \dot{m} \vec{V}$

$\dot{m} = \rho V A = 10^3 \cdot 39,79 \cdot 1,6 \cdot 10^{-3} \pi = 200 \, Kg/s \Rightarrow F_r = 200 \cdot 39,79 = 7958$

$\boxed{F = 7,9 KN}$

② $B = m \quad b = 1$

$$\frac{dm}{dt} = \int_{vc} \frac{\partial \rho d\forall}{\partial t} + \int_{sc} \rho \vec{V} \cdot \vec{n} dA$$

regime permanente: $\frac{dm}{dt} = \frac{\partial \rho}{\partial t} = 0$

$$\rho \int_{sc} \vec{V} \cdot \vec{n} dA = 0 \Rightarrow \int_{sc} \vec{V} \cdot \vec{n} dA = 0 = \int_{ab} \vec{V} \cdot \vec{n} dA + \dot{m}_{bc} + \int_{cd} \vec{V} \cdot \vec{n} dA$$

$$\dot{m}_{bc} = \rho U w \delta - \rho U w \delta \int_0^1 3 \frac{y}{\delta} - 2 \frac{y}{\delta}^{1,5} d\left(\frac{y}{\delta}\right) - \rho V_0 w L$$

$$= \rho w \left[U\delta - U\delta \left[\frac{3}{2} \left(\frac{y}{\delta} \right)^2 - \frac{2}{2,5} \left(\frac{y}{\delta} \right)^{2,5} \right]_0^1 V_0 L \right]$$

$$= \rho w \left(U\delta - U\delta \left(\frac{3}{2} - \frac{2}{2,3} \right) \right] - V_{01} = \rho w (0,3 U\delta - V_{01})$$

$$\boxed{\dot{m} = 1,42 \text{ Kg/s}}$$

3 $\sum F_x = \dot{m}(\beta_2 V_{2\alpha} - \beta_1 V_{1\alpha})$ $\sum F_x = -F$

$\beta_1 = \beta_2 = 1$

$V_{1,\alpha} = V - V_c$ $V_{2,\alpha} = 0$ $\dot{m} = \rho V_{1,\alpha} A$

$-F = \dot{m}(1 \cdot 0 - 1(V - V_c)) = \dot{m}(V_c - V) = 25(15-5) = 250\,N$

$W = F \cdot V_c = 250 \cdot 5 = 1250\,W$

$F = 250\,N$
$W = 1250\,W$

4) $A_1 = 2{,}6 \cdot 10^{-3}\ m^2 \qquad A_2 = 6{,}5 \cdot 10^{-4}\ m^2 \qquad \rho = 10^3\ Kg/m^3$

$B = m v \Rightarrow b = m$

$$\frac{\partial mv}{dt} = \int_{vc} \frac{\partial \vec{V}\rho}{\partial t}\, d\forall + \int_{sc} \vec{V}\rho\, (\vec{V}\cdot\vec{n})\, dA$$

$$\vec{F}_{sx} + \vec{F}_{Bx} = \int_{sc} \vec{V}\rho\,(\vec{V}\cdot\vec{n})\, dA = V_1(-\rho V_1 A_1) - V_2(\rho V_2 A_2)$$

$$F_x = -P_1 A_1 - \rho(V_1^2 A_1 + V_2^2 A_2)$$

$$V = \frac{V_1 A_1}{A_2} = \frac{3{,}05 \cdot 2{,}6 \cdot 10^{-3}}{6{,}5 \cdot 10^{-4}} = 12{,}2\ m/s$$

$$F_x = -96 \cdot 10^3 \cdot 2{,}6 \cdot 10^{-3} - 10^3(3{,}05^2 \cdot 2{,}6 \cdot 10^{-3} + 12{,}2^2 \cdot 6{,}5 \cdot 10^{-4})$$

$$\boxed{\vec{F}_x = -370{,}53\ N}$$