Parameters

$OD1 := 0.012m \quad OD2 := 0.006m \quad P1 := 550000Pa \quad P2 := 101325Pa$

$A1 := \pi \cdot \left(\frac{OD1}{2}\right)^2 \quad A2 := \pi \cdot \left(\frac{OD2}{2}\right)^2$

$A1 = 1.131 \times 10^{-4} m^2 \quad A2 = 2.827 \times 10^{-5} m^2$

$\rho 1 := 6.5 \cdot \frac{kg}{m^3} \quad \rho 2 := 1.204 \frac{kg}{m^3}$

Calculation of Velocity

$\begin{pmatrix} v1 \\ v2 \end{pmatrix} := \begin{pmatrix} 1 \\ 2000 \end{pmatrix} \frac{m}{s}$

Given

$v1 \cdot A1 = v2 \cdot A2 \quad P1 + \frac{\rho 1 \cdot v1^2}{2} = P2 + \frac{\rho 2 \cdot v2^2}{2}$ (Bernoulli's Equation)

$\begin{pmatrix} v1 \\ v2 \end{pmatrix} := Find(v1, v2)$

$v1 = 265.147 \frac{m}{s} \quad v2 = 1.061 \times 10^3 \frac{m}{s}$

Calculation of Flow Rate

$Qr := v2 \cdot A2 = 0.03 \frac{m^3}{s}$

Calculation of Required Flow Rate

Air Consumption of Valves Anti-Clockwise (Open):

$Vc := 0.00069m^3$

Volume of Piping (Assuming 10m Run):

$Vl := A2 \cdot 10m \quad Vl = 0.283L$

Assuming Operating Time (Full Stroke) of 0.5 seconds:

$Qa := \frac{(Vc + Vl)}{0.5s} = 1.945 \times 10^{-3} \frac{m^3}{s}$

Time Taken to Get Up To Pressure

Total Volume of Piping And Valve:

$$Vt := Vc + Vl = 0.973\,L$$

Therefore:

$$Tv := \frac{Vt}{Qr} = 0.032\,s$$

Graph To Show Flow Rate As A Function of Pipe Diameter

$OD4 := 0.004m \quad OD6 := 0.006m \quad OD8 := 0.008m \quad OD10 := 0.010m \quad OD12 := 0.012m$

$$ODrange := \begin{pmatrix} OD4 \\ OD6 \\ OD8 \\ OD10 \\ OD12 \end{pmatrix} \qquad Arange := \pi \cdot \left(\frac{ODrange}{2} \right)^2$$