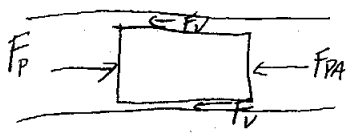
P1 DCL



$F_P = P \cdot A = P \cdot \frac{\pi D^2}{4}$

$F_{PA} = P_{atm} \cdot A = P_{atm} \cdot \frac{\pi D^2}{4}$

$F_V = \tau \cdot A$; Newton-Navier $\Rightarrow \tau = \mu \frac{dv}{dy} = \mu \frac{v}{e} \Rightarrow F_V = \mu \frac{v}{e} \cdot \pi D L$ (manto cilindro)

$v = cte \Rightarrow \sum \vec{F} = 0 \Rightarrow F_P = F_{PA} + F_V \Leftrightarrow P \frac{\pi D^2}{4} = P_{atm} \frac{\pi D^2}{4} + \mu \frac{v}{e} \pi D L$

$\frac{PD}{4} = \frac{P_{atm} D}{4} + \frac{\mu v L}{e} \Leftrightarrow P = P_{atm} + \frac{4 \mu v L}{D e} = cte$ (1)

1ª Ley Termodinámica: $\frac{dU}{dt} = \frac{d\hat{Q}}{dt} - \frac{dW}{dt}$; pero $U = nC_v dT$

$\frac{d\hat{Q}}{dt} = \dot{Q}$ (dato)

$W = P \cdot V \Rightarrow \frac{dW}{dt} = \frac{d(P \cdot V)}{dt} = P \cdot \frac{dV}{dt} = P \cdot \frac{\pi D^2}{4} \frac{dx}{dt} = P \frac{\pi D^2}{4} \cdot v$

$\Rightarrow nC_v \frac{dU}{dt} = \dot{Q} - P \frac{\pi D^2}{4} v$ (2)

Ley de gases: $PV = nR_0 T \Leftrightarrow T = \frac{PV}{nR_0}$; $\frac{dT}{dt} = \frac{P}{nR_0} \frac{dV}{dt} = \frac{P}{nR_0} \cdot \frac{\pi D^2}{4} v$; además, $C_v = \frac{5}{2} R_0$

En (2) $\Rightarrow n \frac{5}{2} R_0 \frac{P}{nR_0} \frac{\pi D^2}{4} v = \dot{Q} - P \frac{\pi D^2}{4} v \Leftrightarrow \dot{Q} = \frac{5}{8} P \pi D^2 v + P \frac{\pi D^2}{4} v = \frac{7}{8} P \pi D^2 v$ (3)

(1)·v $\Leftrightarrow Pv = P_{atm} \cdot v + \frac{4 \mu L}{De} v^2$; (3) $\Rightarrow Pv = \frac{8}{7} \frac{\dot{Q}}{\pi D^2}$; (1)=(3) $\Rightarrow \frac{4 \mu L}{De} v^2 + P_{atm} v - \frac{8}{7} \frac{\dot{Q}}{\pi D^2}$

$\mu = 4$ [cP] $= 4 \cdot 10^{-3} \left[\frac{kg}{m \cdot s}\right]$; $L = 0{,}2$ [m]; $e = 0{,}01$ [m]; $P_{atm} = 10.330 \left[\frac{kg}{m^2}\right] = 101.234 \left[\frac{N}{m^2}\right]$; $\dot{Q} = 100 \left[\frac{cal}{s}\right] = 419 \left[\frac{J}{s}\right]$; $D = 0{,}3$ [m]

$\Rightarrow 1{,}067 v^2 + 101.234 v - 1.693{,}6 = 0 \Leftrightarrow v = 0{,}0167$ [m/s]

b) $P = cte$; (3) $\Rightarrow P = \frac{8}{7} \frac{\dot{Q}}{\pi D^2} \cdot \frac{1}{v} = 101.234{,}285 \left[\frac{N}{m^2}\right]$

c) $T = \frac{PV}{nR_0}$; $T_0 = \frac{P_{atm} V_0}{nR_0} \Rightarrow \frac{T}{T_0} = \frac{PV}{P_{at} V_0} \Leftrightarrow T(t) = \frac{P}{P_{at}} \frac{\frac{\pi D^2}{4}(X_0 + vt)}{\frac{\pi D^2}{4} X_0} \cdot T_0 = \frac{P}{P_{at}} \frac{(X_0 + vt)}{X_0} \cdot T_0 \Rightarrow T(10) = 456{,}1\,°K = 183°C$ (293°K)