

Kul-34.3100 Virtausmekaniikan perusteet

Tentti

22.5.2012

Muistathan, että perustelut ovat tärkeä osa laskua ja arvostelua!

Properties of air

density: $\rho_{\text{air}} = 1.23 \text{ kg/m}^3$

(dynamic) viscosity: $\mu_{\text{air}} = 1.79 \times 10^{-5} \text{ N}\cdot\text{s/m}^2$

Properties of water

density: $\rho_{\text{water}} = 1000 \text{ kg/m}^3$

(dynamic) viscosity: $\mu_{\text{water}} = 1.12 \times 10^{-3} \text{ N}\cdot\text{s/m}^2$

Gravitational acceleration: $g = 9.81 \text{ m/s}^2$

Equations When you use these equations, please explain what you are doing and what principle you are applying. Not all the equations may be needed.

Bernoulli equation: $p + \rho g h + \frac{1}{2} \rho V^2 = p_T$

Energy balance:

$$(p + \rho g h + \frac{1}{2} \rho V^2)_{\text{out}} = (p + \rho g h + \frac{1}{2} \rho V^2)_{\text{in}} + \text{work done on the CV} - \text{losses}$$

Losses: $\Delta p_{\text{friction}} = \left(f \frac{L}{D}\right) \frac{1}{2} \rho V^2$ and $\Delta p_{\text{loss}} = K \frac{1}{2} \rho V^2$

Reynolds number: $Re_l = \frac{\rho V l}{\mu} = \frac{V l}{\nu}$

Power: $P = \Delta p Q$

Mass flux: $\dot{m} = \int_A \rho \vec{V} \cdot \vec{n} dA$

Momentum flux: $\int_A \vec{V} \rho \vec{V} \cdot \vec{n} dA$

Momentum balance: $\sum \vec{F} = \text{momentum flux out} - \text{momentum flux in}$

Moment-of-momentum equation:

$$\begin{aligned} \Sigma \vec{T} &= \dot{m}_{\text{out}} (\vec{r} \times \vec{V})_{\text{out}} - \dot{m}_{\text{in}} (\vec{r} \times \vec{V})_{\text{in}} \\ \vec{r} \times \vec{V} &= \pm r V_{\theta} \end{aligned}$$

Euler turbomachine equation:

$$P = \dot{m} (\pm U V_{\theta})_{\text{out}} - \dot{m} (\pm U V_{\theta})_{\text{in}}$$