Fluid Mechanics Exam 2 Review 2017

Chapter 4 – Bernoulli Equation and Pressure Variation

Flow classifications (nonuniform vs. uniform, steady vs. unsteady, laminar vs. turbulent, viscous vs. inviscid, etc)

Convective acceleration (*f*(space)) vs. Local acceleration (*f*(time))

Bernoulli Equation

$$\frac{p_1}{\gamma} + z_1 + \frac{V_1^2}{2g} = const. = \frac{p_2}{\gamma} + z_2 + \frac{V_2^2}{2g}$$ (applies to short distances along a fluid streamline – steady flow & negligible energy loss – "inviscid")

Label your sketch with points 1 and 2!

Apply to locations where *p*, *z*, *V*, are known or well-defined:

- free jet, or water surface: $p_g = 0$
- large tank or water body: $V \approx 0$

Know difference between Piezometer, Stagnation tube, and Pitot tube:

Water surface elev in piezometer = $HGL = \frac{p}{\gamma} + z$ (hydrostatic or piezometric head)

Water surface elev in stagnation tube = $EGL = \frac{p}{\gamma} + z + \frac{V^2}{2g}$ (total head)

Stagnation pressure $= p + \frac{\rho V^2}{2}$

Pitot tube measures pressure difference (stagnation p – dynamic p) $= \Delta p = \frac{\rho V^2}{2}$

Cavitation: minimum allowable pressure head = $\left(\frac{v.p.}{\gamma}\right)_g$

Vapor pressure given in tables in *absolute* pressure, not gage – make sure you use *either* gage *or* absolute pressure on both sides of Bernoulli!

Chapter 6 - Momentum Equation

$$\sum \vec{F}_{on\,CV} = \rho Q_{out} \vec{V}_{out} - \rho Q_{in} \vec{V}_{in}$$

Important:

- draw a CV showing all the forces acting on the CV (including reactions) and the momentum vectors
- set up an coordinate system and *be consistent with signs*!
- write equation in separate *x, y, z* components to find reactions F_{Rx}, F_{Ry}, F_{Rz}

"What is the force *of* water" vs. "what force is needed to hold x in place"

Applications:

- Forces on pipe fittings (bends, nozzles, etc)
- Force of free jet on blade
- Force of open channel flow on a structure
- Propellers

Chapter 7 - Energy Equation

$$\frac{p_1}{\gamma} + z_1 + \alpha_1 \frac{V_1^2}{2g} + h_p = \frac{p_2}{\gamma} + z_2 + \alpha_2 \frac{V_2^2}{2g} + h_T + \sum h_L$$

Notes:

- Apply the equation along a streamline from upstream (1) to downstream (2)
- head losses include friction along the pipe and turbulent losses (expansion)
- pumps or turbines add work or extract work, respectively
- unless problem specifies laminar flow ($\alpha = 2$), use $\alpha = 1$

Power = $\gamma Q h$ where *h* is the pump head or turbine head (or, any other head)

Efficiency η (power output of a machine is always less than power input)

Power out = η * *Power in*

Know how to draw accurate HGLs and EGLs

$HGL = \frac{p}{\gamma} + z$ (dashed line) $\qquad$ $EGL = \frac{p}{\gamma} + z + \frac{V^2}{2g}$ (solid line)