ChEn 374
Fluid Mechanics

Bernoulli Applications

Exam

- Testing Center
- Friday, Saturday, Monday (10 am-12 pm)
- 2 hour exam
- Closed book, closed notes
- You can bring 1 sheet (one side) of handwritten notes.
- Book info (like tables, units, properties) are provided.

Bernoulli Applications

BE: $$\left(\frac{P}{\rho}+\frac{1}{2}v^2+gz\right)_1=\left(\frac{P}{\rho}+\frac{1}{2}v^2+gz\right)_2$$

Units:
(J/kg)
* ρ → (N): Pressure form
/ g → (m): Head form

Assumptions:

SS	Ws = 0
Const ρ	Q = 0
No friction	Streamline

Interactions among terms:

Const z:	If v up, P down If v down, P up	Stagnation
Const v:	If z up, P down If z down, P up	Statics, weight
Const P:	If z up, v down If z down, v up	Falling fluid

Problem Solving

- B.E. → apply widely
  - How?
- Ask and answer questions
  - What do I know?
  - What is wanted?
  - What is happening physically
  - What relationships do I have?

} – Write them down
– Draw a picture

Problem → Equations → Solve → Assess

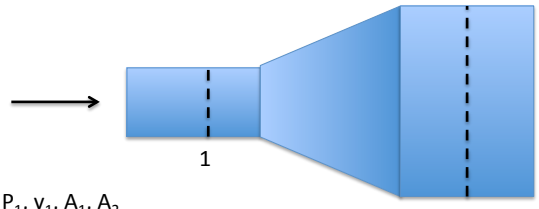
Bernoulli Equation

$$\left(\frac{P}{\rho}+\frac{1}{2}v^2+gz\right)_1=\left(\frac{P}{\rho}+\frac{1}{2}v^2+gz\right)_2$$

- Write Equation
- Pick points for application
- May require more than one application
- May need an auxiliary relation:
  - $\Delta P = \rho g h$,
  - $m=\rho A v$
  - $v_2 = v_1(A_1/A_2)$
- Practice!
  - Do your homework
  - Do book examples (try yourself before reading solution)
- Reading and understanding a solution is NOT the same as being able to come up with a solution yourself.

Sample Problem

Diffuser



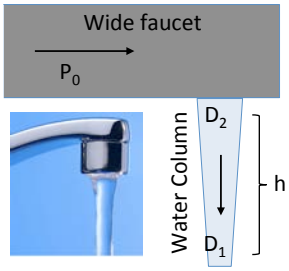
Given P_1, v_1, A_1, A_2
Find P_2, v_2

Ask:

What's happening?
What do I expect? For P? for v?
What equations?

Sample Exam Problem

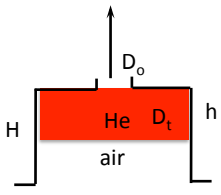
Your friend gives you a photograph of a water faucet (with an assumed large area).
To impress your friend with your Fluids skills, you **COMPUTE the volumetric flow rate** (L/min) of the water, **and the gage pressure** (Pa) of the water in the faucet.
As the water falls, it accelerates, and the diameter of the water column decreases.
From the photo, you measure the diameter of the column at two points, and its height.
Take h=0.3 m, D_2=1 cm, D_1 = 0.85 cm.



Sample Exam Problem

Helium (He) flows out of a round tank through a round hole in the top.
The tank is open to the atmosphere at the outlet hole and at the bottom of the tank.
As He flows out the top, air fills in from the bottom (but doesn't mix with the He).
The hole diameter, tank diameter, and tank height are **D_o = 2 cm, D_t = 20 cm, H = 1 m**.
Initially, the tank is full of He, so h=H (h is the height of the helium column).
Take **MW_{He} = 4, MW_{air} = 29 kg/kmol**.
The tank is considered so much bigger than the hole, that at any instant the system is At steady state.

(a) Find the initial velocity of He through the hole.
(b) Find the time for all the He to leave the tank.



- Read carefully.
- Relate words to system and assumptions
- Break it up.
- What are the key principles involved?
- How do they relate to my unknowns?
- Do numbers last.