Midterm 2 Fluids Notes

Sunday, October 25, 2015 9:49 PM

Newtonian Fluid: Viscosity doesn't Δ w/ shear Force

Fluid: Anything that takes the shape of its container

like stress → **Surface Tension:** Measure of (σ) "Cohesiveness" of a fluid when in contact w/ another material.

Gas: A "compressible" fluid

Gage Pressure: Pressure relative to atmospheric pressure.

Absolute Pressure: Pressure relative to vacuum (zero) pressure.

Lagrangian Approach: Follows fluid particles through time.

Eulerian Approach: Look at velocity field. Position Dependent

Control Surface: The boundary of a control volume

Incompressible: $\nabla \cdot \bar{v} = \emptyset$

Potential Flow: Φ, for inviscid & irrotational flows

Boundary Condition: Flow at boundaries is zero.

Mass Conservation (Most general form)

$$\frac{\partial \rho}{\partial t} + \nabla \cdot (\rho \bar{v}) = \emptyset$$

Bernoulli Eq. Along a Streamline

$$P + \frac{1}{2}\rho v^2 + \rho g y = \text{Constant}$$

Navier-Stokes EQ

$$\rho \frac{D\bar{v}}{Dt} = -\nabla P + \mu \nabla^2 \bar{v} + \rho \bar{g} = \rho\left(\frac{\partial \bar{v}}{\partial t} + \underbrace{(\bar{v}\cdot\nabla)\bar{v}}_{u\hat{i}\nabla + v\hat{j}\nabla + w\hat{k}\nabla}\right)$$

Reynold's #

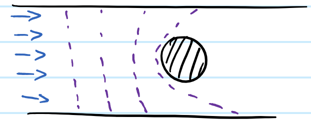
$$Re \equiv \frac{U_0 H}{\nu} \quad \& \quad \nu \equiv \frac{\mu}{\rho}$$

$$\nabla^2 \bar{v} = \left(\frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2}\right) + \left(\frac{\partial^2 v}{\partial x^2} + \frac{\partial^2 v}{\partial y^2}\right)$$

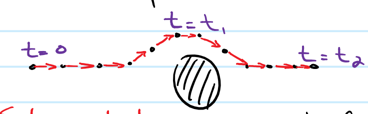
Stagnation Pt.

Highest Pressure ($v = 0$?)

Timeline: A line of adjacent fluid Particles that are marked at one time.



Pathline: The path or trajectory traced by a moving fluid particle



Streak line: Path defined by all the fluid Particles that pass by a fixed pt.

Dye steadily injected at a fixed pt extends along a streamline.

Streamline: Curves in the fluid flow that are tangent to the velocity vector at an instant in time.

$d\psi = -v\,dx + u\,dy = \emptyset$

$dy/dx = v/u$

By Def: They never intersect.

Control Mass:

- Constant Mass
- Volume can change
- heat, work, energy can enter/leave
- Boundaries can change

Control Volume

- Fixed Volume
- Non-fixed mass/energy/etc...
- $\sum \dot{Q}_{in} = \sum \dot{Q}_{out}$

$\dot{Q}$: Volumetric flow rate $V_{ei} \cdot A_e$

Circulation

$$\Gamma = \oint_c \bar{v} \cdot d\bar{s} = \iint_A (\nabla \times \bar{v}) \cdot d\bar{A} = \iint_A \bar{\omega} \cdot d\bar{A}$$

Incompressible Flow

$$\frac{\partial \bar{v}}{\partial t} + (\bar{v}\cdot\nabla)\bar{v} = \underbrace{-\frac{1}{\rho}\nabla P}_{\text{Pressure}} + \bar{g} + \frac{\mu}{\rho}\nabla^2 \bar{v}$$

Possible assumptions

- No slip @ Boundaries
- Steady State $\frac{\partial ()}{\partial t} = 0$
- Fully Developed Flow $\frac{\partial \bar{v}}{\partial x} \simeq \emptyset$
- Incompressible Flow

$$\nabla \cdot \bar{v} = \frac{1}{r} \cdot \frac{\partial (r v_r)}{\partial r} + \frac{1}{r} \cdot \frac{\partial (v_\theta)}{\partial \theta}$$