Summary | Fluid Dynamics

Introduction

Flow

Motion with relative movement between fluid particles where continuous deformation happens.

Classification of fluid flow

Density

Incompressible

Density doesn’t vary significantly.

Examples:

- Pipe and channel flows of liquids
- Gas flows in pipes

$$\frac{|\Delta\rho|}{\rho} \ll 1$$

Compressible

Density varies significantly.

Examples:

- Pressure surges in pipes

Viscosity

Non-viscous

Fluid doesn’t show any resistance to the flow.

Viscous

Fluid shows any resistance to the flow.

- **Newtonian**: μ is constant
  Examples: Water
- **Non-newtonian**: μ is not constant
  Examples: Paints, Clay, Plastics

Variation of parameters

The parameters:

- Velocity V
- Pressure P
- Flow rate Q

Temporal Variation

The variation of the parameters with time.

- Steady: no variation with time
  $V = f(x, y, z)$
- Unsteady: variation of flow parameters with time
  $V = f(t, x, y, z)$

Spatial Variation

The variation of the parameters with coordinates.

- Uniform: no variation with spatial parameters
  $V = f(t)$
- Non-uniform: spatial variation of flow parameters
  $V = f(t, x, y, z)$

Dimensional

If a variation of flow parameter in a certain direction can be neglected, that can reduce the calculations.

Nature of movement

- Orderly (aka. Laminar)
- Disorderly (aka. Turbulent)

Rotation of particles

- Rotational
  Usually due to shear forces. Flow of real fluids.
- Non-rotational Flow of frictionless forces.

Flow patterns

Streamline

A line tangential to the flow velocity.

Streamtube

A passage enclosed by a collection of streamlines.

Pathline

Path traced by an individual fluid particle.

Streakline

Suppose a dye is injected into a fluid flow. Streakline indicates the positions of all particles passed through the point of injection.

> **Note**
> In steady flow: streamline, pathline and streakline all coincide.