SNS COLLEGE OF TECHNOLOGY

Coimbatore-35
An Autonomous Institution

Accredited by NBA – AICTE and Accredited by NAAC – UGC with 'A+' Grade
Approved by AICTE, New Delhi & Affiliated to Anna University, Chennai

DEPARTMENT OF AEROSPACE ENGINEERING

23AST206 – AERODYNAMICS

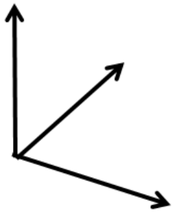
II YEAR IV SEM

UNIT 1 – BASIC AERODYNAMICS AND FLUID MECHANICS

TOPIC – Introduction to Aerodynamics

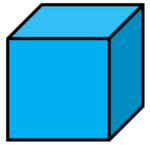
INTRODUCTION TO AERODYNAMICS

Basic Quantities



Space - Length

Time

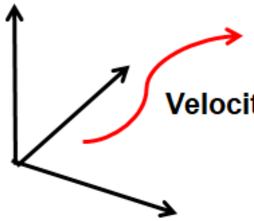


Matter - Mass

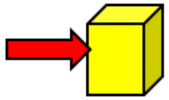
Charge - Electro-magnetic

Derived Quantities

Combinations of Basics

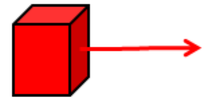


$$\text{Velocity} = \frac{\text{Length}}{\text{Time}}$$



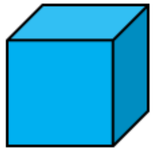
$$\text{Force} = \frac{\text{Mass}\ \ \text{Length}}{\text{Time}^{\,2}}$$

Dimensionality



$$\text{Momentum} = \frac{\text{Mass}\ \ \text{Length}}{\text{Time}}$$

$$\text{Energy} = \frac{\text{Mass}\ \ \text{Length}^{\,2}}{\text{Time}^{\,2}}$$



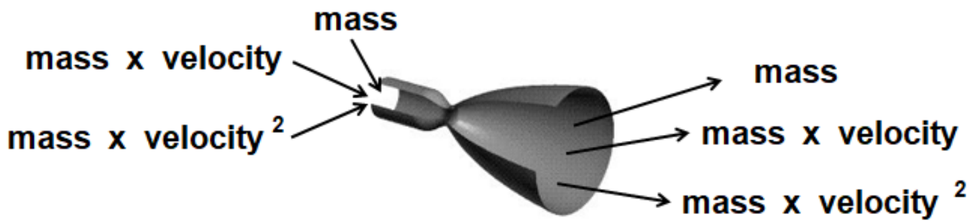
$$\text{Density} = \frac{\text{Mass}}{\text{Length}^{\,3}}$$

Conservation Laws

Observations of the Relations between Derived Quantities

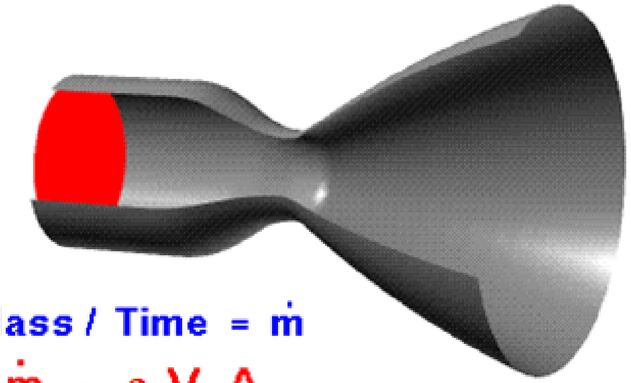
For any fluid system:

1) Mass is neither created nor destroyed.
   Conservation of Mass - Continuity
2) Momentum is neither created nor destroyed.
   Conservation of Momentum (3 directions)
3) Energy is neither created nor destroyed.
   Conservation of Energy



Mass Flow Rate

ρ = Density
V = Velocity
A = Area



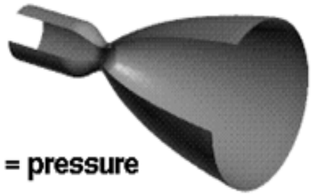
Mass Flow Rate = Mass / Time = $\dot{m}$

$$\dot{m} = \rho V A$$

Units Check: $\frac{\text{mass}}{\text{length}^3} \frac{\text{length}}{\text{time}} \text{length}^2 = \frac{\text{mass}}{\text{time}}$

Continuity : $\rho V A = \text{Constant}$

Dynamic Pressure



p = pressure
ρ = density
u = velocity

From the conservation of fluid momentum:

$$\rho u \frac{du}{dx} = -\frac{dp}{dx}$$

Algebra: $$\frac{dp}{dx} + \rho u \frac{du}{dx} = 0$$

Simplify: $$\frac{dp}{dx} + \frac{d}{dx}\left(\frac{\rho u^2}{2}\right) = 0$$

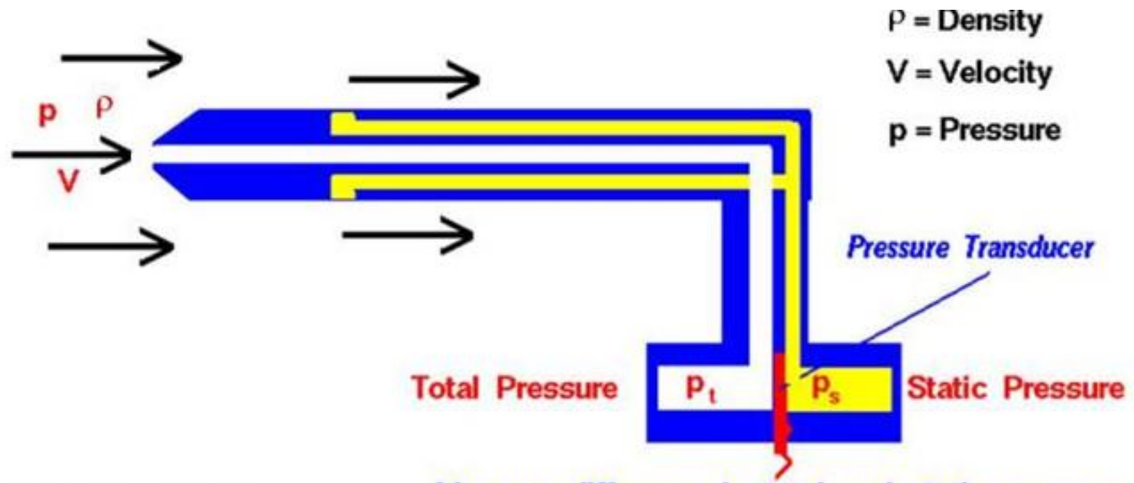
Collect: $$\frac{d}{dx}\left(p + \frac{\rho u^2}{2}\right) = 0$$

Integrate: $$p_s + \frac{\rho u^2}{2} = \text{constant} = p_t$$

p_s: static pressure; $\frac{\rho u^2}{2}$: dynamic pressure; p_t: total pressure

$$\text{dynamic pressure} = q = \frac{\rho u^2}{2}$$

Pitot–Static Tube



Bernoulli's Equation:

static pressure + dynamic pressure = total pressure

$$\left(p_s + \rho \times \frac{V^2}{2}\right) = p_t$$

Measure difference in total and static pressure

Solve for Velocity: $$V^2 = \frac{2(p_t - p_s)}{\rho}$$


Thank You