Fluid Mechanics

Control Volume Analysis

Prof. Yu-Jui Fan (范育睿)

Ray.yj.fan@tmu.edu.tw

Outline

- Newton's 2nd Law
- Control Volume Analysis
  - Mass, Energy,
  - Linear Momentum
  - Body Forces, Surface Forces
- Linear Momentum Correction Factor
- Application Examples

Newton's 2nd Law

- Newton's 2nd Law of Motion

a) $F = ma$

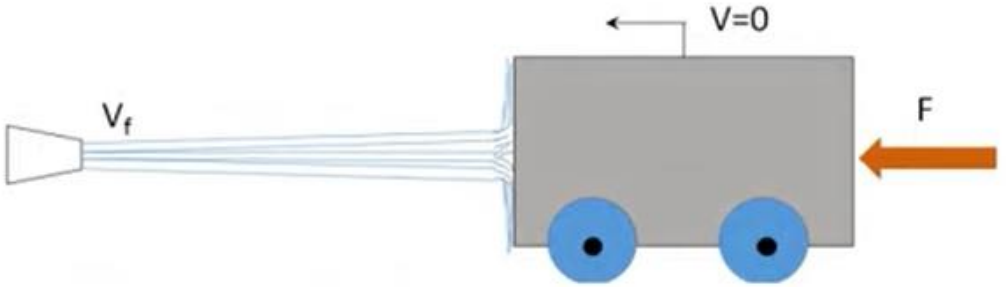
b) $F = m^*\Delta V/\Delta t$

c) $F^*\Delta t = \Delta(mv)$

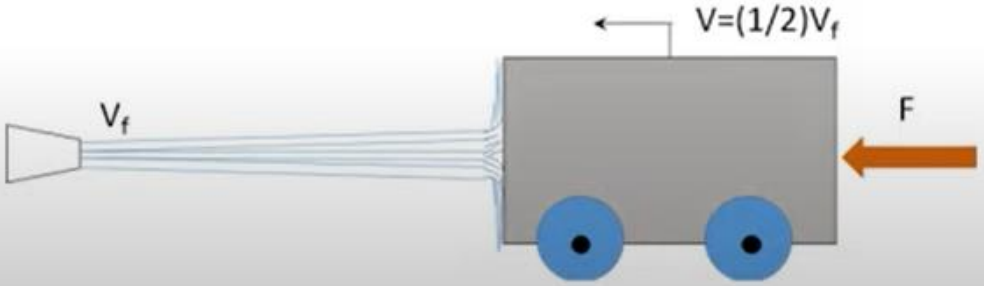
Germany Stamp

Examples

A horizontal water jet of velocity V_f hits a vertical flat plate and spashes off the sides.
A force of magnitude "F" is required to hold the cart stationary.

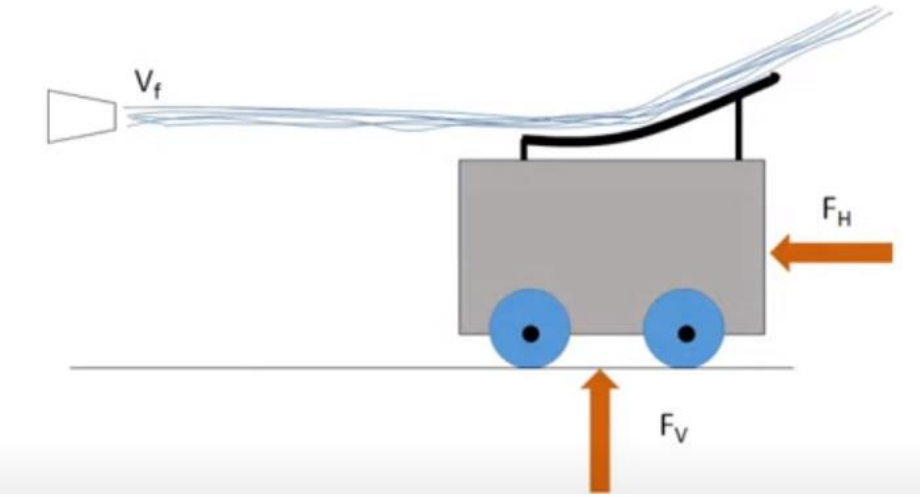


Now, the plate is moving toward the oncoming jet with velocity $(1/2)V_f$.
How much force is required to move the plate toward the water jet?



Example

- A horizontal water jet having velocity 35 m/s and 30 kg/s flowrate is diverted 30-degrees upward by a deflector plate on a cart. The cart weights 200N. Determine the
  (a) horizontal force
  (b) vertical force
  needed to keep the cart stationary.



Reverse Thrust*

Example

- A 8-cm-diameter water hose is connected to a 4-cm-diameter nozzle that shoots water horizontally. The flow rate of water is 450 L/min. Determine the force need to hold the nozzle stationary.

Linear Momentum Correction Factor

Example:

- Given the velocity profile $u(r)=u_{max}(1-r/R)^{1/7}$ for flow in a pipe, determine the

a) Average fluid speed, u_{AVG}

b) Kinetic energy correction factor, α=?

c) Linear momentum correction factor, β=?