# Chapter 5

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#### 5-1 Conversion of Mass

• Mass and Flow Rate:  $\dot{m}=
ho \dot{V}$ 

• Mass Balance:  $\sum_{in}\dot{m}=\sum_{out}\dot{m}$  • Incompressible Flow:  $\dot{V}_1=\dot{V}_2\Rightarrow v_1A_1=v_2A_2$ 

## 5-2 The Bernoulli Equation

The Bernoulli Equation is an approximate relation between pressure, velocity, and elevation, and is valid in regions of steady, incompressible flow where net frictional forces are negligible

$$rac{P_1}{
ho} + rac{V_1^2}{2} + gz_1 = rac{P_2}{
ho} + rac{V_2^2}{2} + gz_2$$

### The Bernoulli Equation

(For steady flow along a streamline)

General:

$$\int \frac{dP}{\rho} + \frac{V^2}{2} + gz = \text{constant}$$

Incompressible flow ( $\rho = \text{constant}$ ):

$$\frac{P}{\rho} + \frac{V^2}{2} + gz = \text{constant}$$

## 5-3 Energy Analysis of Steady Flows

$$\dot{m}\Big(rac{P_1}{
ho}+lpha_1rac{V_1^2}{2}+gz_1\Big)+\dot{W}_{
m pump,u}=\dot{m}\Big(rac{P_2}{
ho}+lpha_2rac{V_2^2}{2}+gz_2\Big)+\dot{W}_{
m turbine,e}+E_{
m mech,loss}$$

- $\alpha$ : the kinetic energy correction factor
- $\dot{W}_{\mathrm{pump},u}$ : the useful energy that the pump delivered
- $\dot{W}_{\mathrm{turbine}.e}$ : the energy used by turbine

+  $E_{\rm mech,loss}$ : the mechanical energy that lost