Flow Measurement
Basic Flow Measurement

- Many methods of flow measurement
- Bernoulli’s Equation
  - A statement of energy conservation

\[ p + \frac{1}{2} \rho v^2 + \rho g y = \text{constant} \]
Flow Pattern
Orifice Plate
Typical Orifice Plates
Beveled Edge on Orifice
Typical Transmitter Installation
Flange Taps
Vena Contracta Taps
Pro’s and Con’s

- High delta P
- Lots of data
- Low cost
- Easy replacement

- High pressure loss
- Erosion
Venturi Tube
Flow Nozzle
Elbow Taps
Pitot Tube
Annubar
Annubar
Annubar
Annubar
Annubar
Output of the Transmitter $\Delta P$
Square Root Extractor
Flow Loop with Square Root Extractor
Extractor at Low Inputs

\[
\text{Output} = \sqrt{\text{Input}}
\]

Input % Change

Square Root Extractor
Cutoff Relay
Effect of Process Conditions

- Flow measurements are inferential
  - Measure a pressure drop and infer a flow
- Affect by density of the fluid
  - Temperature
  - Pressure
  - Increasing density increases the indicated flow rate
Density Compensating

Flow

High Pressure Sensing Line

RTD

Low Pressure Sensing Line

Pressure Cell

DP Cell

Logic

4-20 mA Output
Flow Measurement Errors

- Erosion
- Over ranging the D/P cell
- Vapour formation in the throat
- Clogging
- Plugged or leaking impulse lines
For you to do

- Read pp. 18-32
- Answer Questions pp. 82-85, #6-14