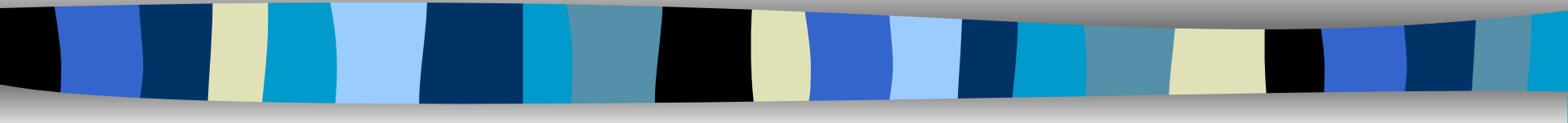


# Flow Measurement



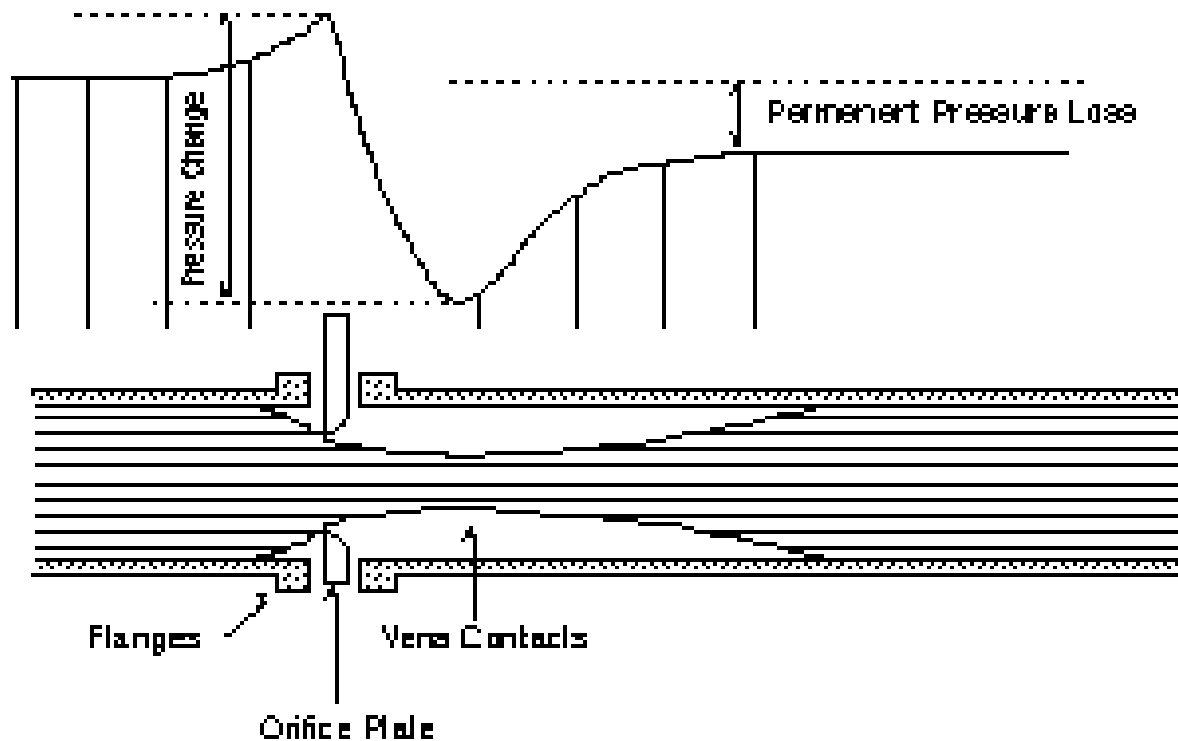


# Basic Flow Measurement

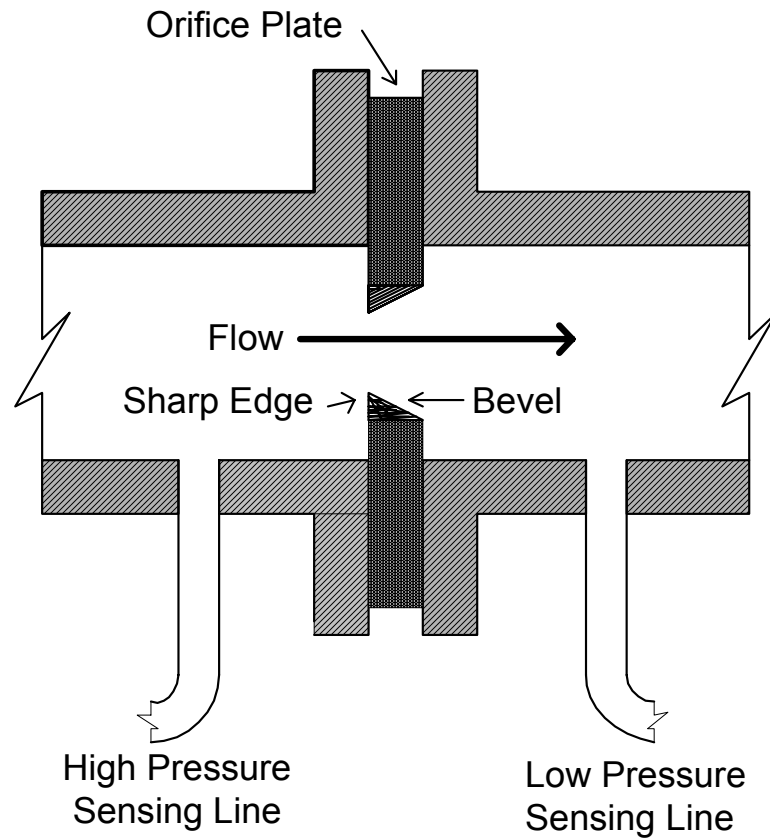
- Many methods of flow measurement
- Bernoulli's Equation
  - A statement of energy conservation

$$p + \frac{1}{2} \rho v^2 + \rho g y = \text{constant}$$

# Flow Pattern



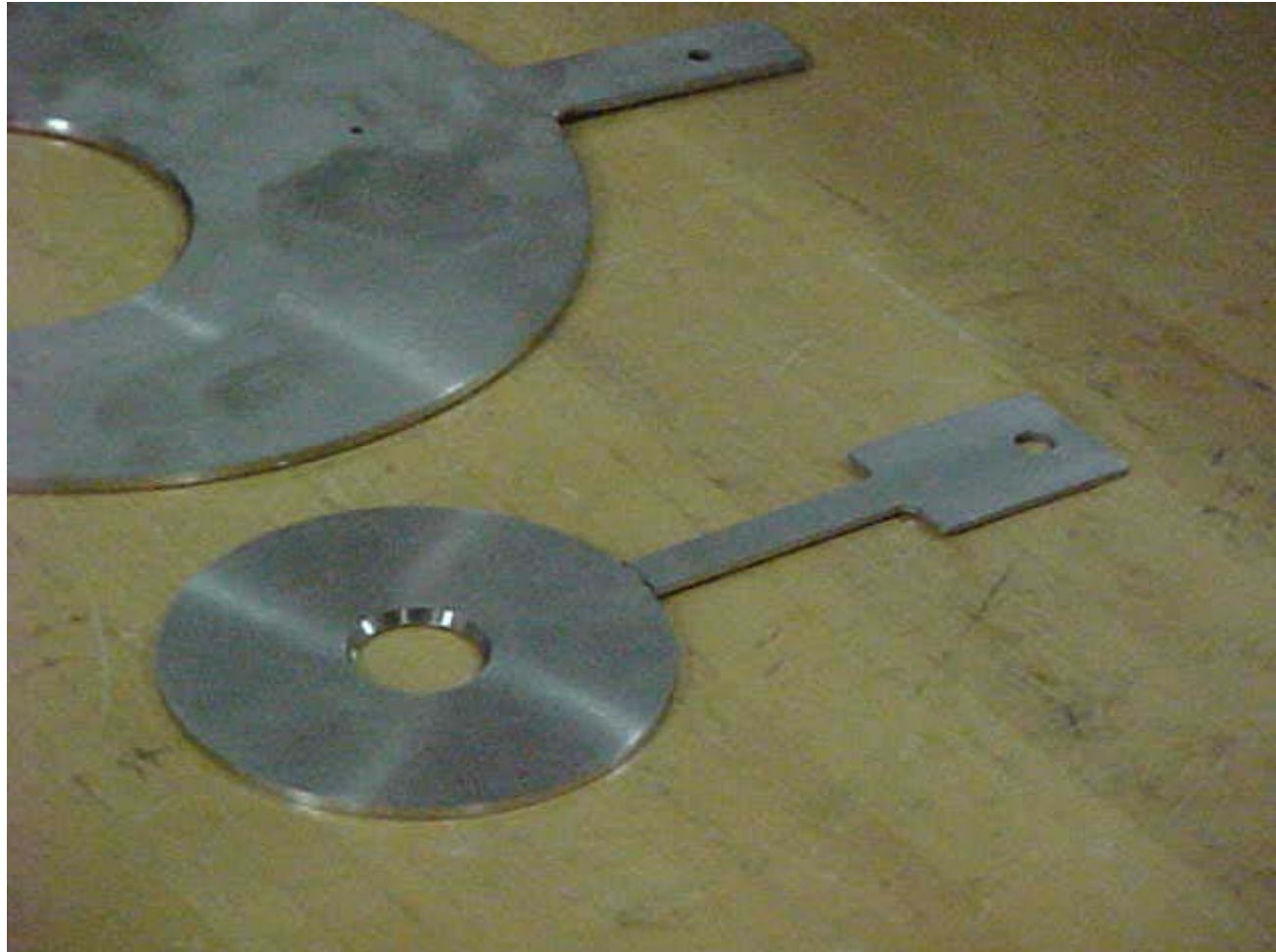
# Orifice Plate



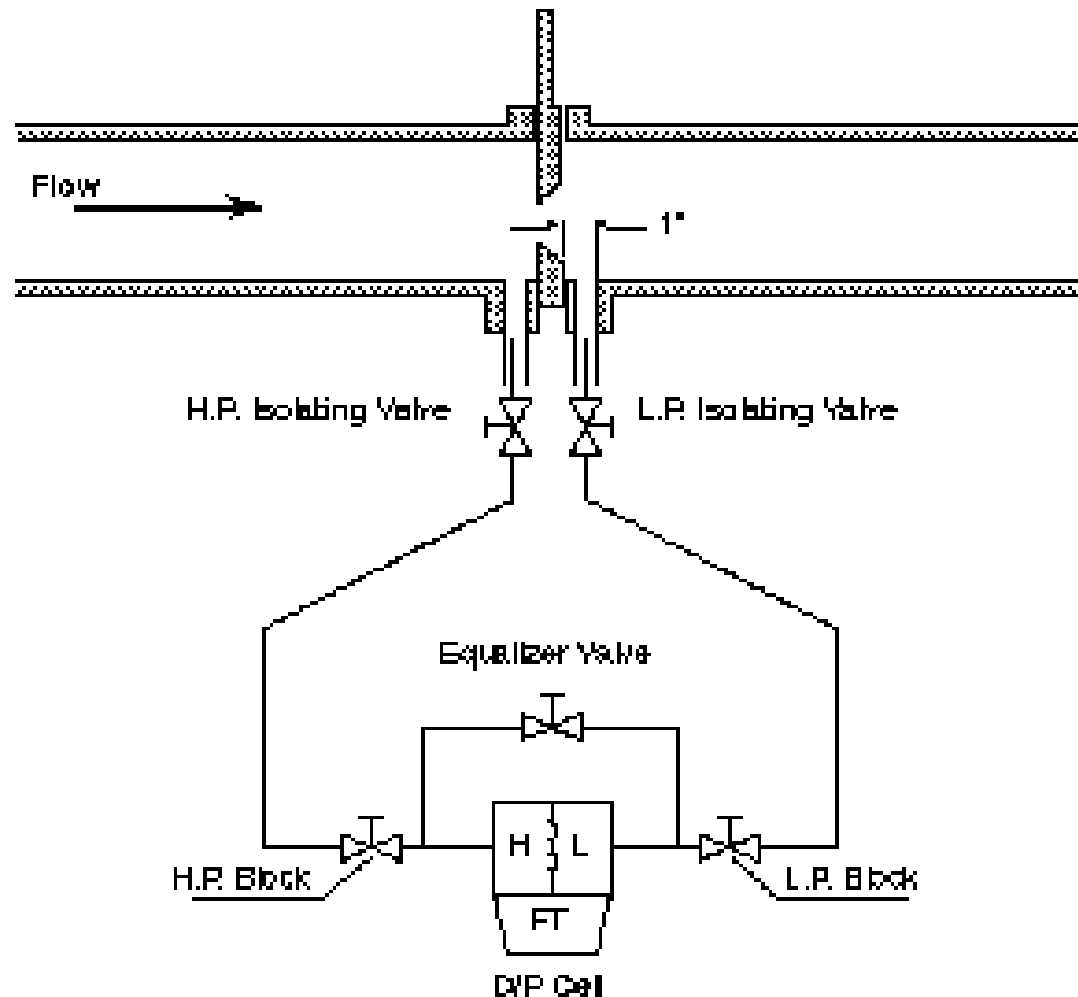
# Typical Orifice Plates



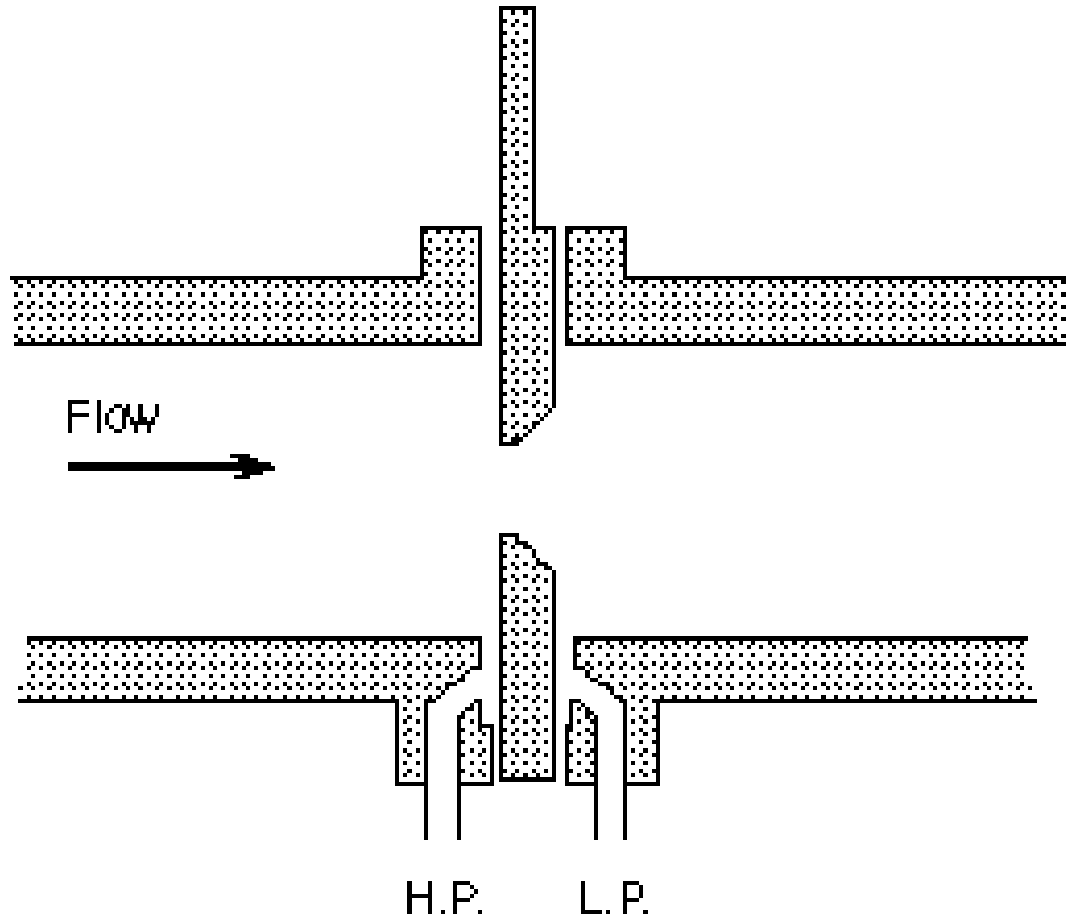
# Beveled Edge on Orifice



# Typical Transmitter Installation

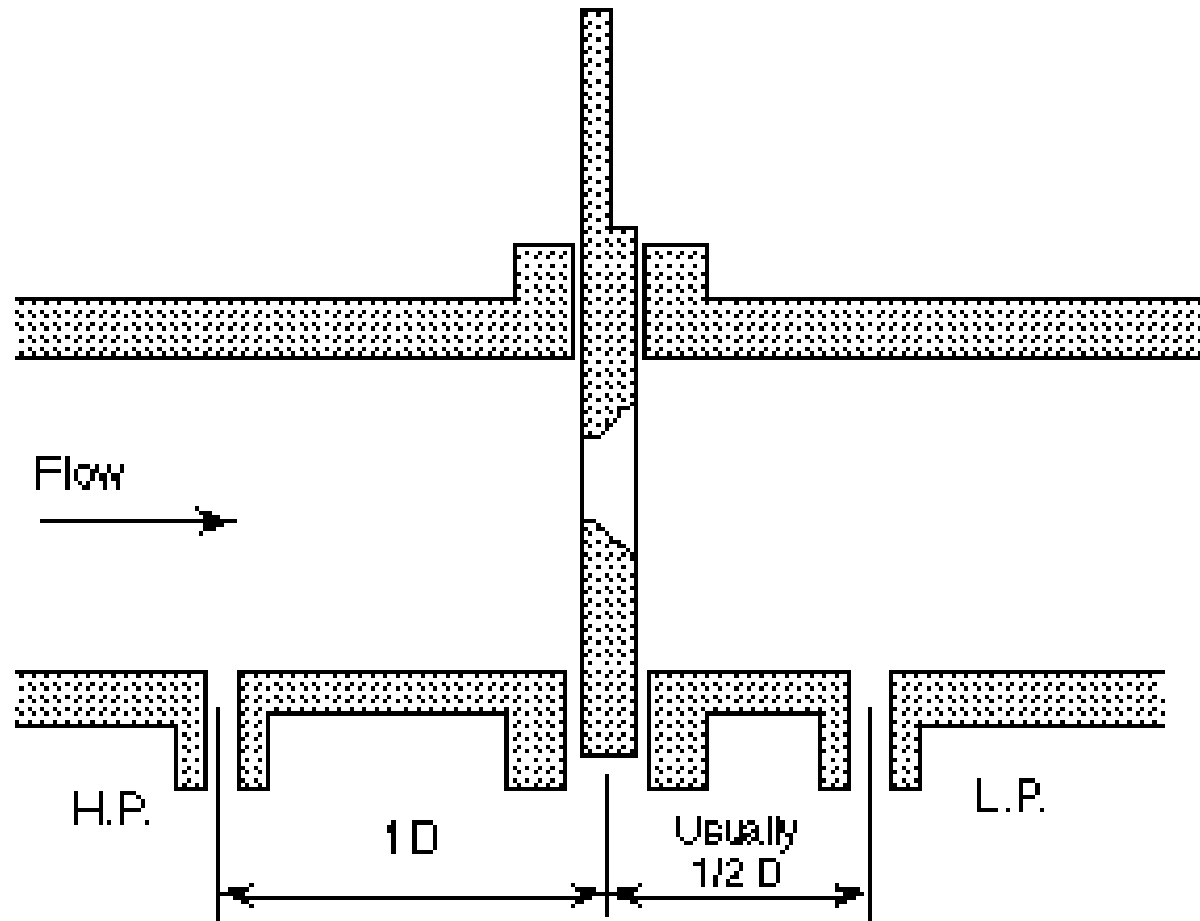


# Flange Taps





# Vena Contracta Taps

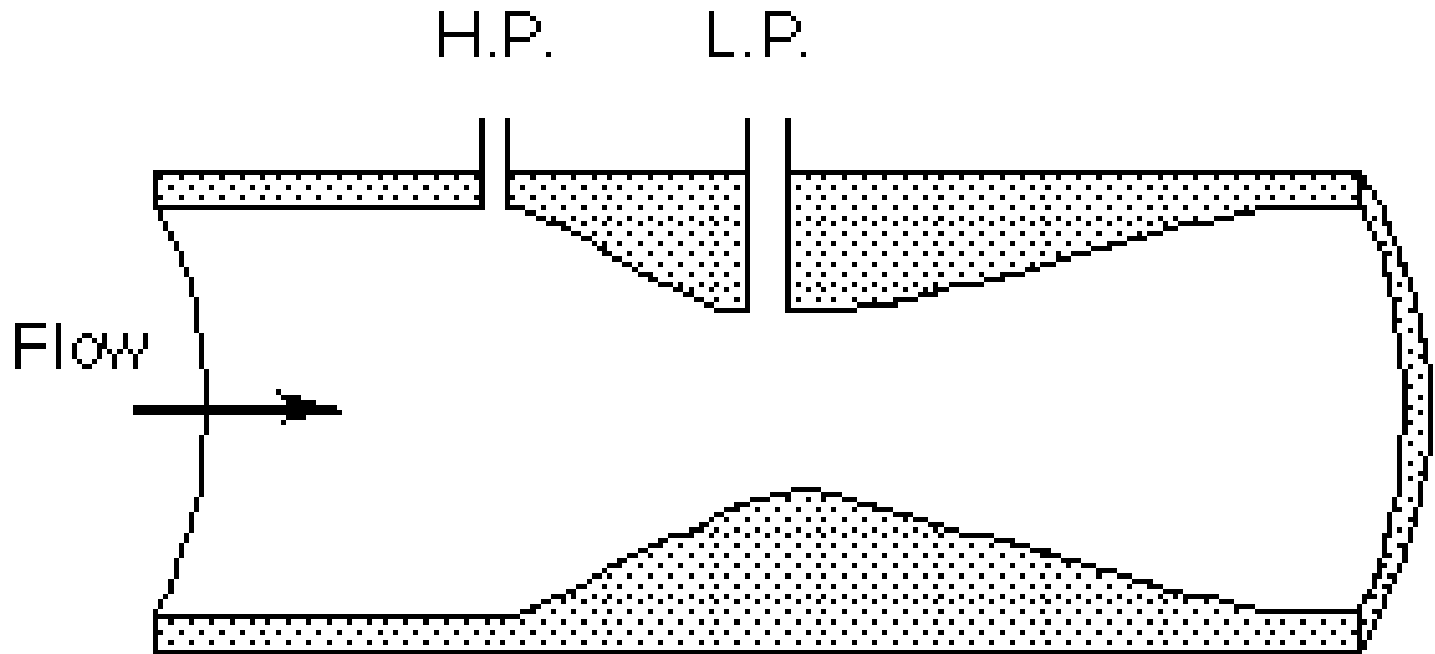




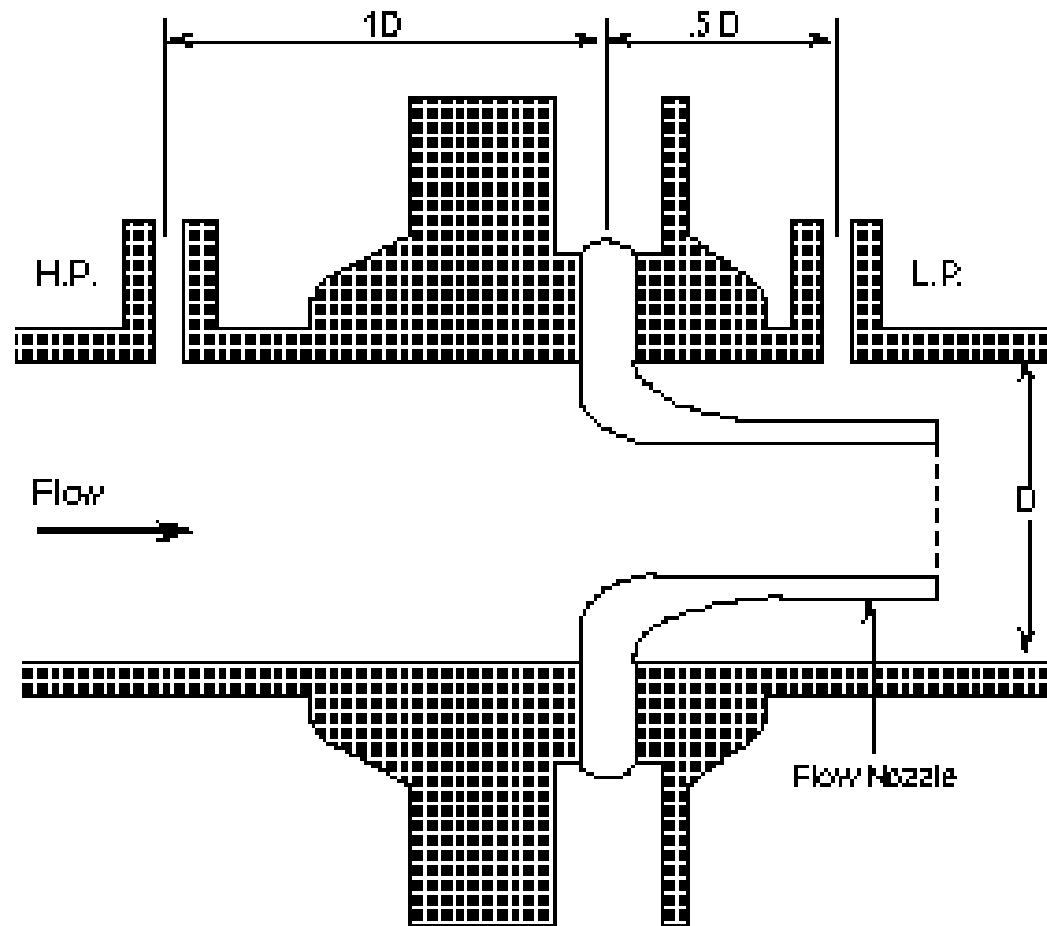
# Pro's and Con's

- High delta P
- Lots of data
- Low cost
- Easy replacement
- High pressure loss
- Erosion

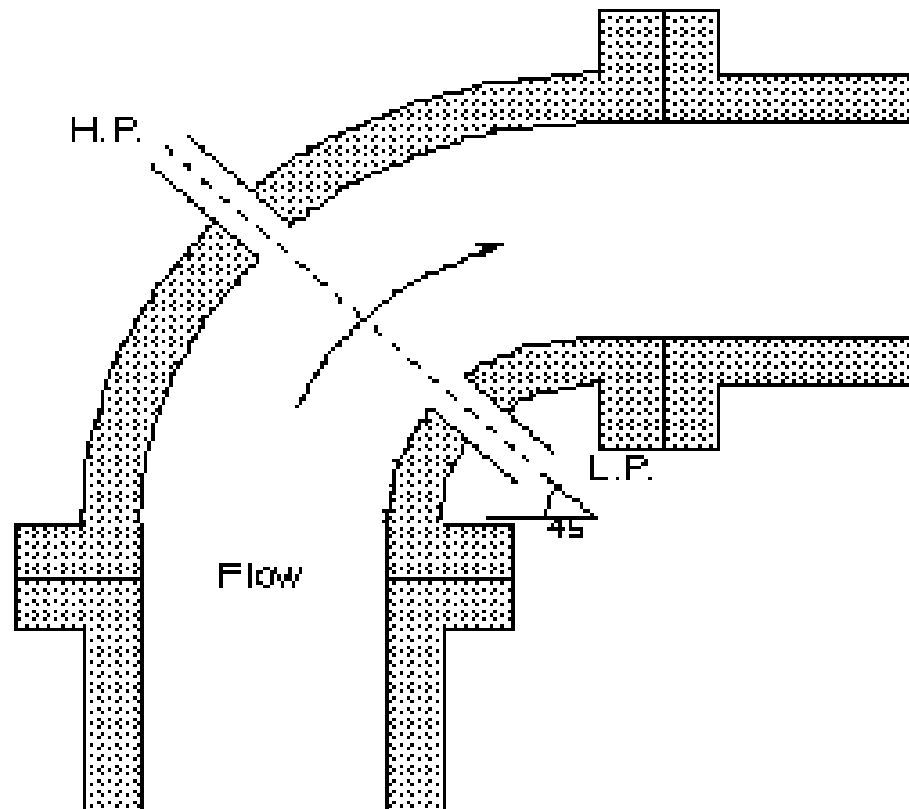
# Venturi Tube



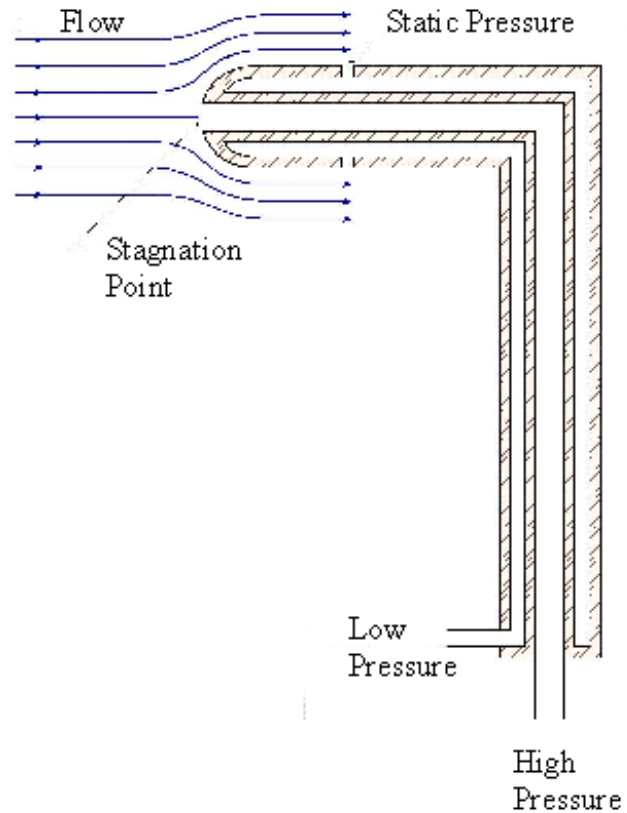
# Flow Nozzle



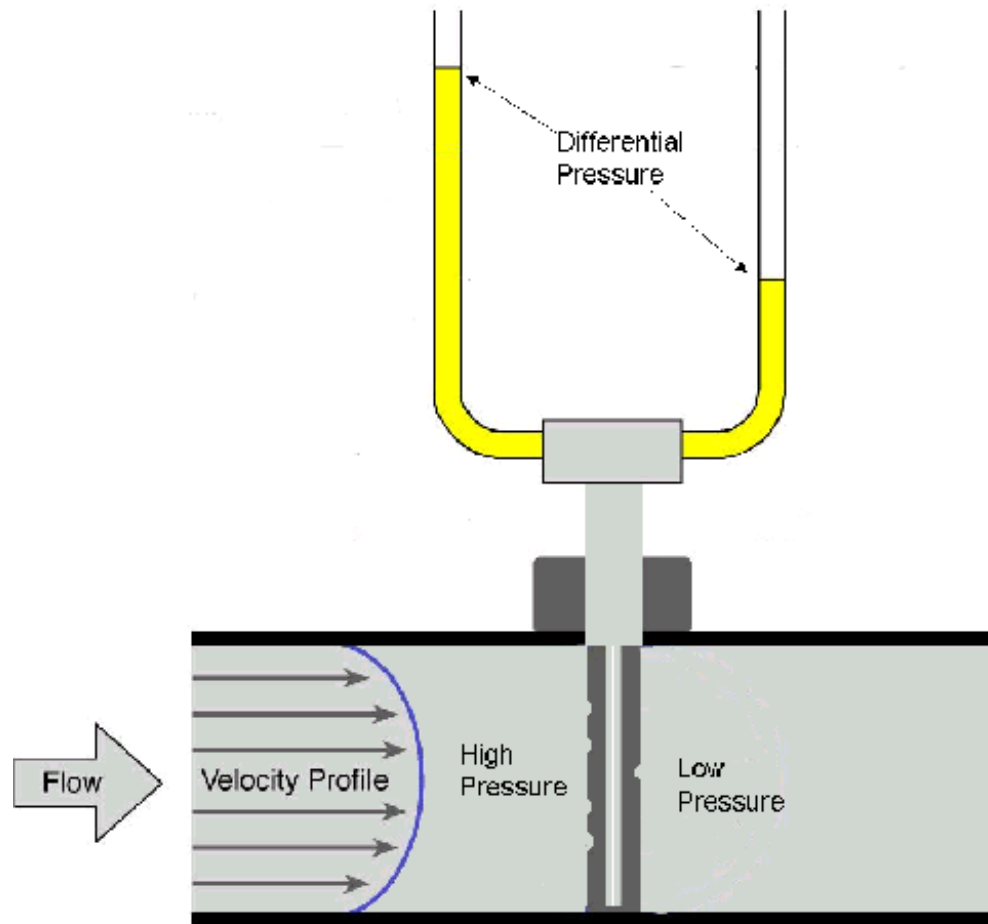
# Elbow Taps



# Pitot Tube



# Annubar



# Annubar





# Annubar



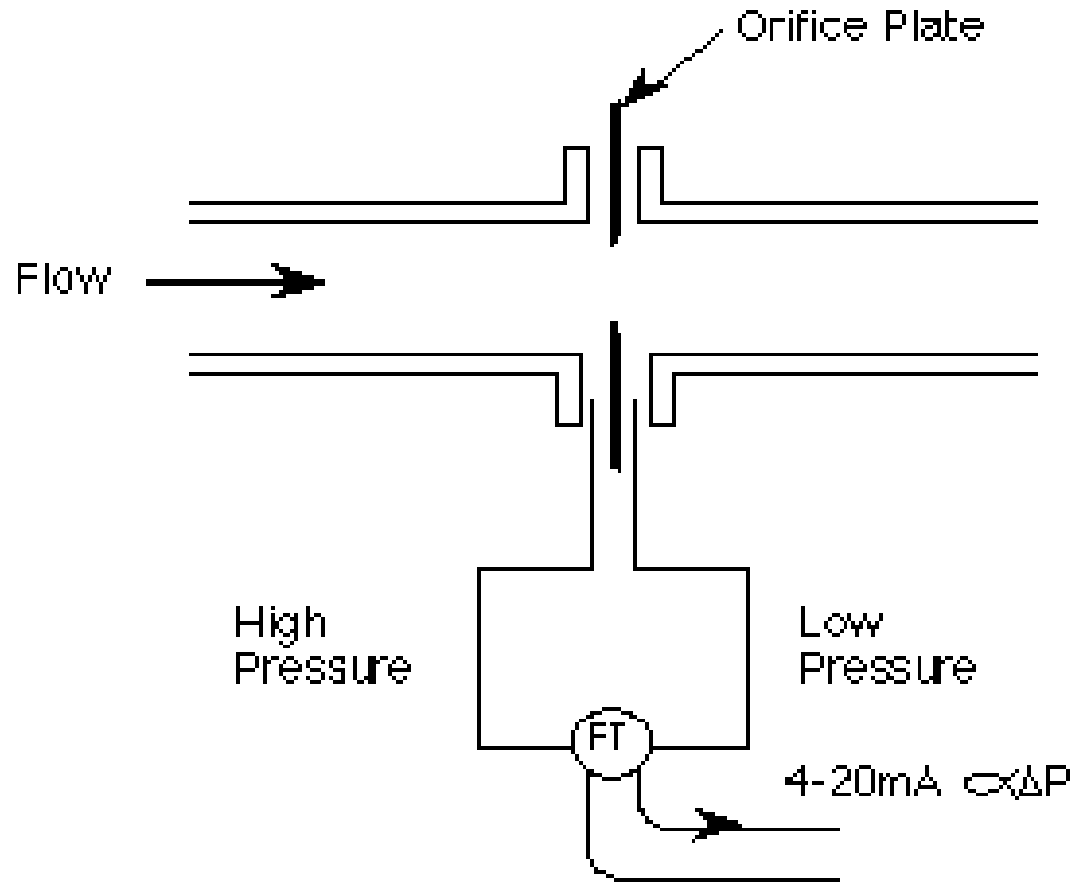
# Annubar



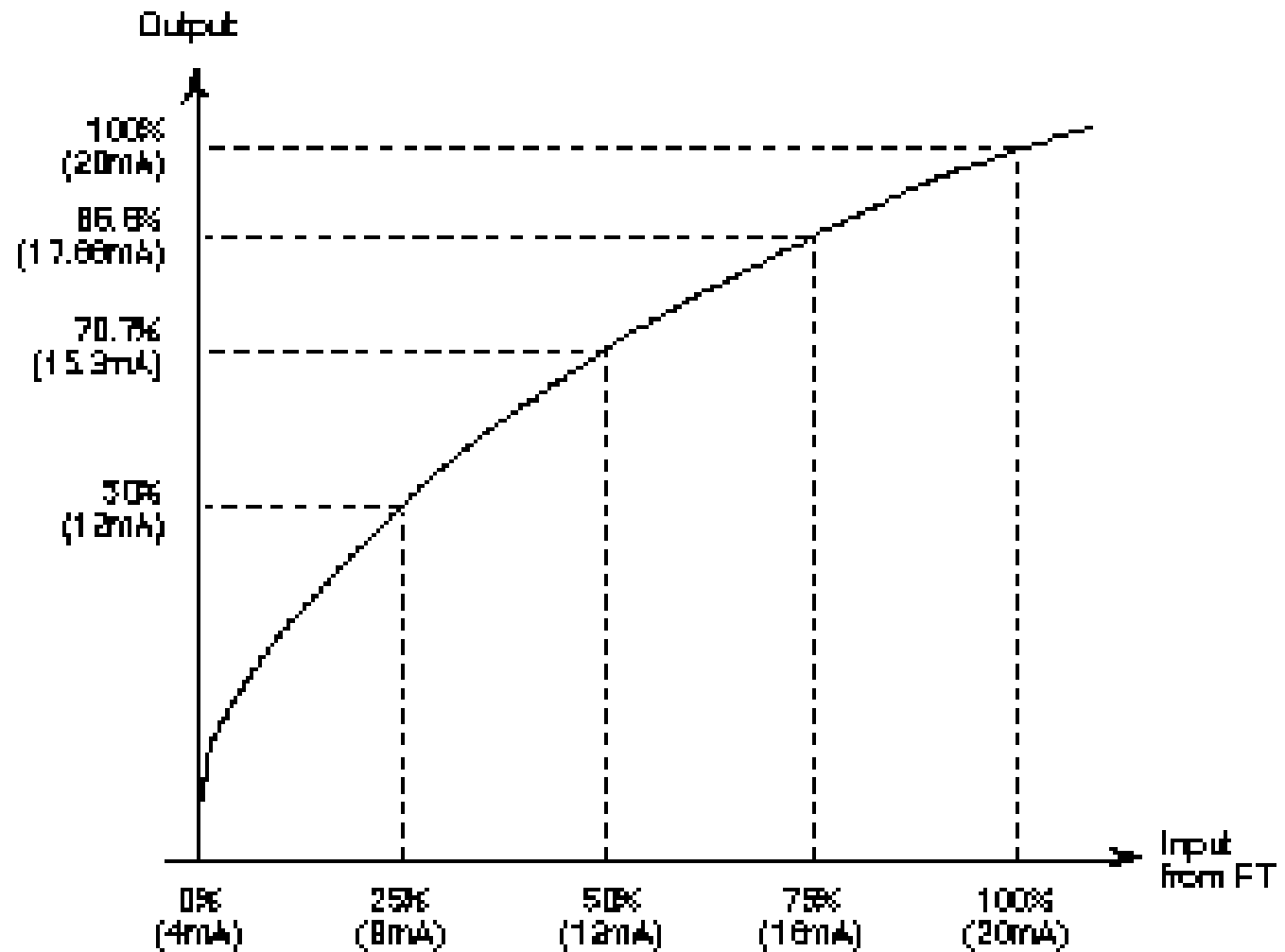
# Annubar



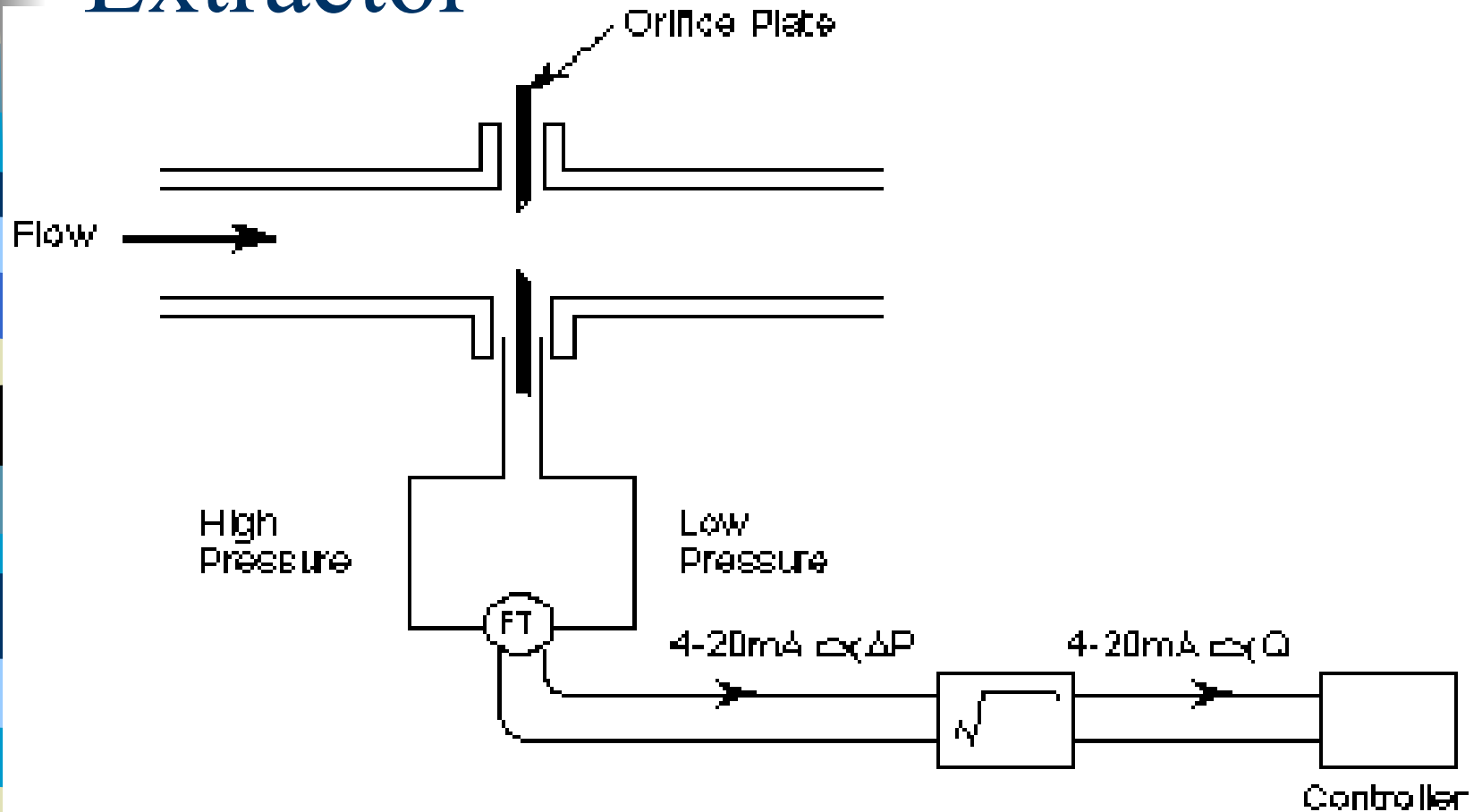
# Output of the Transmitter $\Delta P$



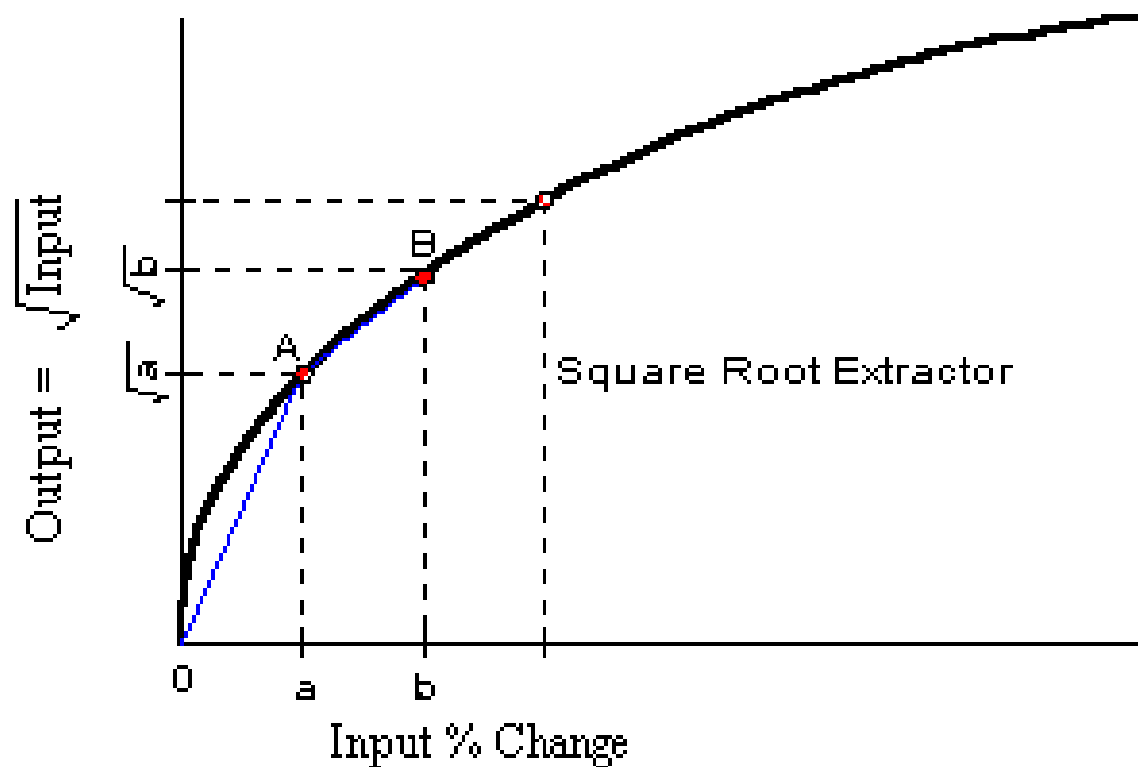
# Square Root Extractor



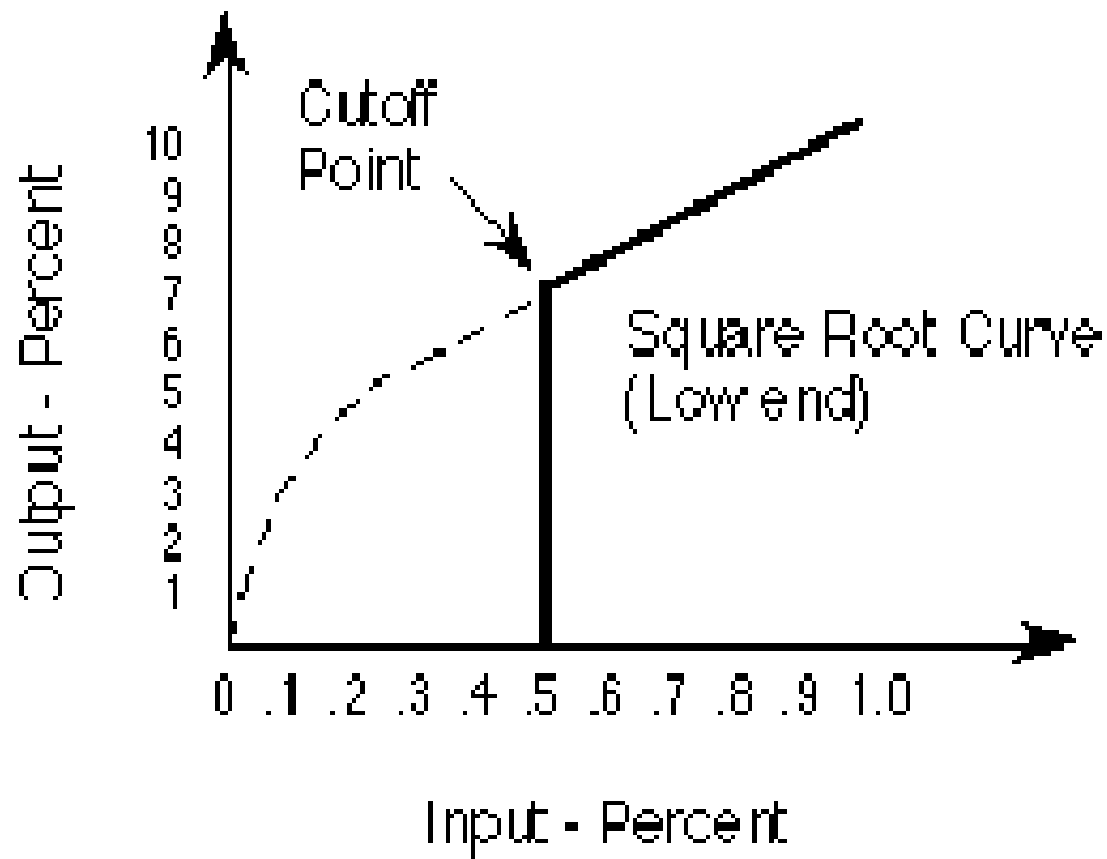
# Flow Loop with Square Root Extractor



# Extractor at Low Inputs



# Cutoff Relay



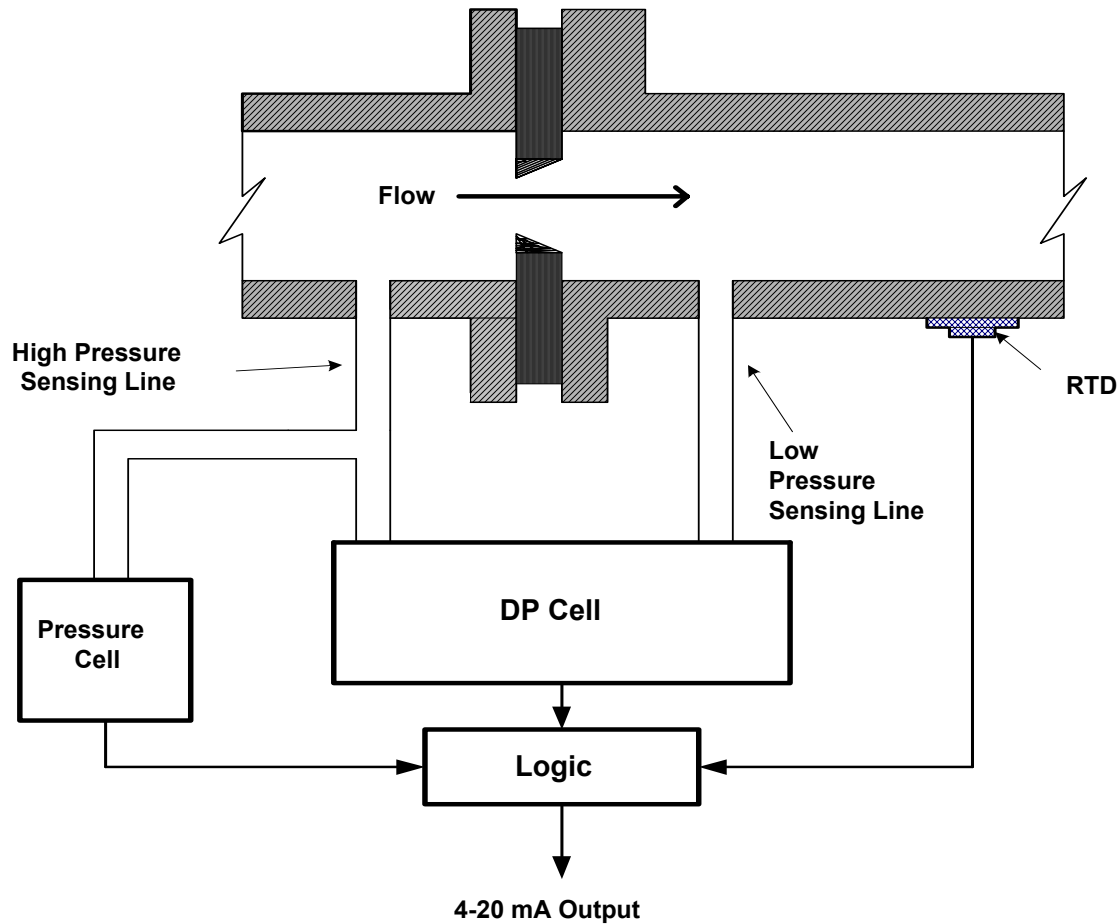




# Effect of Process Conditions

- 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 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