Transmitters

Differential Pressure Transmitters – Pneumatic Design

**FOXBORO 13A D/P Cell**

*Oldest design, developed during WW 2. Can be used for flow, level, and pressure, vent low side. Several ranges 0 to 5 inches water to 1 to 1000 inches of water.*
Electronic Pressure Transmitters with HART Communication Protocol
Absolute and Gauge Pressure Measurement

Intelligent, two-wire transmitters provide measurement of gauge or absolute pressure, and transmit a 4 to 20 mA output signal with a superimposed HART digital signal for remote configuration and monitoring.
The interior of the bellows and centerplate are filled with a clean, non-corrosive, low freezing point liquid. A free-floating bellows is attached to the high-pressure bellows to allow for expansion or contraction of the fill liquid, thus providing positive temperature compensation. If the bellows are subjected to a pressure difference greater than the differential pressure rating of the unit, a valve mounted on the center stem seals against its corresponding valve seat. As the valve closes, it "traps" the fill liquid in the bellows; thus the bellows are fully supported and cannot be ruptured regardless of the over pressure applied. Since opposed valves are used, protection against "overrange" is provided in either direction. Operation Pressure is applied to the high and low chambers surrounding the bellows. Any difference in pressure causes the bellows to move until the spring effect of the unit balances out for force thus generated. The linear motion of the bellows (proportional to the DP) is transmitted as a rotary motion through torque tube assembly.
Extended Diaphragms used for tank level, slurry service
Magnetic Flowmeter Systems

Electrode Voltage proportional to the velocity of the flowing liquid, Faraday’s law.
Vector Cross Product of:
\[ B - \text{Magnetic Field Intensity} \quad V - \text{Fluid Velocity} \]
\[ E = B \times V \quad \text{(vector cross product)} \]
Voltage is small 1 to 2 mv. Electrodes made of Platinum or Titanium. Tube material non-conductive, Teflon or ceramic.
The meter must have a solution ground. The largest problem is the ground.
Coriolis Mass Flow Meter

Micro Motion
Tutorial on web

http://www.emersonprocess.com/micromotion/tutor/default.html

Principles of Operation

Introduction to Coriolis:

Whether for liquid, gases or slurries, Micro Motion’s Coriolis technology offers many advantages over traditional volumetric technologies.

- Multi-variable measurement:
  - Mass flow rate
  - Volumetric flow rate
  - Density
  - Temperature

- High accuracy (+/-0.1%) and repeatability which means improved product quality and reduced waste.

- Easy installation because there are no special mounting, no flow conditioning, and no straight pipe run requirements.

- Low maintenance because there are no moving parts, and it’s non-intrusive.

Flow - Coriolis Effect:

When fluid is moving through the sensor’s tubes, Coriolis forces are induced. These forces cause the flow tubes to twist in opposition to each other. When the tube is moving upward during half of its vibration cycle, the fluid flowing into the sensor resists moving upward, by pushing down on the tube.

Having the tube’s upward momentum as it travels around the bend, the fluid flowing out of the sensor resists having its vertical motion decreased by pushing up on the tube. This causes the tube to twist.

Problems with coating, amalgamation, tube corrosion, stress cracking.

Pulsing flow and vibration can cause errors.

Work closely with supplier, very specialized, engineered.
Vortex Shedding Meter

*Flowing liquid or gas hits a blunt object, the flow separates and oscillates around the object. This pulsing frequency is proportional to the flow rate. Can be sensed by pressure transducers, stress pulses in the blunt object or by temperature change.*

**Von Karman Effect**

*Need high Reynolds numbers, turbulent flow.*

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*Velocity Increase*  
*Pressure Decrease*

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*Flow*  
*Velocity Decrease*  
*Pressure Increase*  
*Net Pressure*

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*Straight runs required the same concept as orifice plates, but shorter, 10 dia up 5 dia down. Popular; inexpensive, no extra piping required.*

*Caution for use with steam, Condensate can travel at a high velocity and damage the bluff body.*

*Competitive costs below 4" line size, easy to install. Require 3 to 12 feet/second liquid velocity. 15 to 1 turndown.*

*Meter measures velocity, rather than mass.*
Piston Positive Displacement Flowmeter

Can be used for low flows and viscous fluids viscosity to 100,000 centipoises. Must filter the inlet flow. Aqueous based fluids require titanium coating of pistons and bearings because of the non-lubricating properties of water.

Declining in popularity.
Frequently self contained, with digital indicator, used on fuel trucks, etc.
The positive displacement piston flow meter measures process fluid flow by utilizing four pistons driven by the flow of the fluid. The pistons drive a crankshaft through connecting rods in a fashion similar to a radial internal combustion engine. The rotational velocity of the crankshaft is directly proportional to the volumetric flow rate through the flow meter. The crankshaft is equipped with a four-pole magnet element, which in turn drives a magnetically coupled photo optic transmitter to provide the required output signal.

EMCO Flowmeters

Tend to drift to a lower than normal reading as the parts wear out.
Turbine Meters

The turbine meter consists of a multi-bladed, free spinning permeable metal rotor housed in a non-magnetic body. A magnetic pickup containing a permanent magnet and a coil is mounted in the body in such a position that each passage of a rotor blade causes the pickup to generate a frequency signal proportional to the fluid flow rate.

TYPICAL SPECIFICATIONS: used for clean low viscosity liquids or gasses

- **Over-range**: 150% of maximum flow (intermittently).
- **Linearity**: ±0.5% of reading (±0.25% typical) over tabulated linear flow range.
- **Repeatability**: ±0.1% (±0.05% typical) over tabulated repeatable range.
- **Pressure Drop**: 4 to 5 PSID at maximum linear flow rate.
- **Turn Down Range**: 10:1 to 100:1.
- **Temperature Range**: -450°F to +450°F Standard.
- **End Fittings**: Available in NPT, flared and flanged.
- **Bearing Styles**: Ceramic hybrid ball bearings, sleeve bearings in tungsten carbide, teflon and hard carbon composite.
- **Materials**: 316 stainless steel standard.
- **Pickup Coils**: Either Magnetic or RF coil. *Moisture can affect RF pickup.*

**Bearings are critical, wrong type of bearing material will cause galling.**

*Problems: Can “overspeed” (damage the bearings) a liquid meter if a gas is used to clean the line, i.e. blow out the line. Declining in popularity.*
Variable Area Meter, Rotameter

Tapered tube, either metal or glass with “float” that moves up the tube, increases linearly with flow.

BROOKS

Variable area tube, pressure drop “constant” through flow range. Cannot read the bottom 8% of the range.
Corrections required for viscosity and density.

Safety issues are a concern. Can thermally shock the glass tube.
Current Flowmeter Survey