

## 1.1 Flow Technologies

### 1.1.1 Differential Pressure

Historically, differential pressure measurements have been the most common flow rate meters. Differential pressure flowmeters employ the [Bernoulli Equation](#) that describes the pressure difference that results when a restriction is placed in a pipe. At the restriction, the flow velocity increases which in turn decreases the static pressure downstream. The pressure difference generated is a measure of the fluid flow rate through the restriction and the pipe. The two key components found in differential pressure flowmeters are a restriction to cause a pressure drop in the flow (differential producer) and a method of measuring the pressure drop across the obstruction (differential pressure transducer).

The basic principle on which differential pressure flow meters operate is the conversion of energy from one form to another. For liquid flows, only kinetic energy and the energy due to static pressure are considered. For gases or vapors, the internal energy of the compressed fluid is also involved.

The equation for mass flow rate of fluids thru the orifice, venturi, flow nozzle can be calculated by the following equation:

$$m = \frac{C_0 A_0 Y}{\sqrt{1 - \left(\frac{D_0}{D_1}\right)^4}} \sqrt{2\Phi\rho(p_1 - p_2)}$$

m is the mass flow rate (lbm/s)

C<sub>0</sub> is the DP device coefficient

A<sub>0</sub> is the cross sectional area of the instrument (ft<sup>2</sup>)

Y is a correction factor supplied by the vendor (Y=0 for liquids)

p<sub>1</sub> and p<sub>2</sub> are upstream and downstream pressures (psi)

ρ is the density of the fluid (lb/ft<sup>3</sup>)

D<sub>0</sub> and D<sub>1</sub> (ft)

Φ is a constant 4633.24 (in<sup>2</sup>\*lbm)/(ft\*lbf\*s<sup>2</sup>)

#### A. Orifice Plates

One of the most common primary flow devices is the orifice plate. For pipes above 2 inches in diameter, orifice plates are mounted between bolted flanges. The flanges are threaded or welded to the pipe depending on pipe size and operating line pressures.

Most orifice plates have sharp, square or rounded upstream edges. Concentric plates are the most common design used since the accuracy is