A Fundamental Formulation for the Velocity of a Fluid Passing Through an Orifice Plate Based Upon the First Law of Thermodynamics

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This work presents a new equation to calculate the mass flow rate through an orifice plate for both natural gas and air samples using a fundamental approach. This simple equation does not require an iterative solution because the Reynold's number does not appear in the equation. Moreover, expansion factor and discharge coefficient expressions also do not appear. The energy balance for the orifice plate and experimental values (pressure, temperature, molar composition, densities, geometrical dimensions, and mass flow) reported for several set of data covering natural gas and air permit calculation of kinetic energy changes. It is possible to describe the kinetic energy change by applying a fit using dimensionless numbers ($\Delta P/P$, diameter ratio, and heat capacity ratio). The expression calculates mass flow rate values within ±0.4 % for $0 < \Delta P/P < 0.3$ and diameter ratio of $0.2 < b < 0.6$.