Note on Pressure Drop Calculations for Orifice Plates and Venturi Meters

For both devices, the pressure drop–flow rate relationship takes the form:

Q (volume/time) = $C_f A_o$ sqrt(2 $\Delta P/\rho$)

It is simplest if we work in SI units (*i.e. kg, m, s, Pa).* Here, Q is the volumetric flow rate [m^3/s], C_f is a dimensionless discharge coefficient (often called a flow coefficient), A_o is the cross-sectional area for fluid flow in the approaching stream [m^3], ΔP is the pressure drop [Pa], and ρ is the density of the fluid [kg/m^3]. For orifice plates, the discharge coefficient is typically 0.6 to 0.9. For Venturi devices, the discharge coefficient is typically 0.9 to 1. Note that for a given flow rate, the pressure drop is proportional to the fluid density, proportional to the square of the flow rate, and inversely proportional to the discharge coefficient. Pay careful attention to the definitions of flow or discharge coefficients when consulting literature since they may vary slightly. Liquids typically have densities on the order of 1000 kg/m^3 and gases near standard conditions (P= 1atm, T = 273°K) typically have densities on the order of 1 kg/m^3. Hence, for the same volumetric flow rates, the pressure drops for gases will often be about 1000 times less than for liquids.

Example:

Pipe: 5 cm ID (Ao = 0.00196 m^3)

Flow Rate: 0.1 m^3/s

Fluid: Gas ρ = 1 kg/m3

Orifice Plate with Discharge Coefficient of 0.6: ΔP = 3.6 kPa

Venturi with Discharge Coefficient of 0.9: ΔP = 1.6 kPa

Fluid Water: ρ = 1000 kg/m3

Orifice Plate with Discharge Coefficient of 0.6: ΔP = 3607 kPa

Venturi with Discharge Coefficient of 0.9: ΔP = 1600 kPa