

# PROCESS HYDRAULICS TOOLBOX

## FLOW MODELS

**A. Single phase (liquid)** - Liquid phase pressure drops are calculated from the Darcy equations as presented in CRANE 410.

**B. Single phase (gas)** - Two models are available for gas phase pressure drop calculations.

*Incompressible model.* With this model, the pressure drop is calculated from the Darcy equations as presented in CRANE 410. The average of the inlet and outlet density is used (based on calculated pressures). If acceleration pressure drop is included, the accuracy is comparable with the isothermal compressible method.

*Isothermal compressible model.* With this model, the pressure drop is calculated from the isothermal compressible equations as presented in CRANE 410.

**C. Two-phase calculations (0.9999 < liquid fraction > .0001)**

Pipe pressure drop is based on the average of the inlet and outlet properties and conditions. For pipes with significant changes in liquid fraction or properties, this may lead to erroneous results, and the pipe should be split into multiple pipes. Process Hydraulics Toolbox supports 6 different methods for 2-phase pressure drop calculations.

**Homogeneous model (Dukler Case 1)** - This method uses the Dukler Case 1 homogeneous (no slip) model (AIChE, 1964). Also refer to the notes below.

**Dukler's constant slip model (Dukler Case 2)** - This method uses the Dukler Case 2 constant slip model (AIChE, 1964). The liquid holdup can be calculated from the Hughmark method (Chem Eng Prog, 1962 and Chem Eng, 1970) or graphs presented in the GPSA manuals (10 th edition) and attributed to Dukler. The user can use smooth pipe or rough pipe friction factors. In previous versions, the "GPSA" holdup method was called the "Dukler" holdup method.

**Lockhart-Martinelli model** - This method uses the empirical Lockhart-Martinelli model (Chem Eng Prog, 1949).

**Chisholm modification of the Lockhart-Martinelli equation** - This method uses the semi-empirical modifications proposed by Chisholm (Int J Heat Mass Transfer, 1967) to the Lockhart-Martinelli method.

**Chenoweth-Martin method** - This method uses the empirical model presented by Chenoweth-Martin (Petroleum Refiner, 1955). The graphs were extrapolated to cover a wider range.

**Beggs-Brill model** - This method uses the Beggs and Brill model (J of Pet Tech, 1973/1991) for horizontal pipes. The user can use smooth pipe or rough pipe friction factors. For all 2-phase methods the acceleration pressure drop is estimated based on the homogenous inlet and outlet density.

