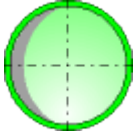




General Head Drop Formulations for Steady State and Incompressible Fluid Circular Cross-Section



Model description:

This component model brings together the main formulas relating to the calculation of pressure drops for incompressible fluids. These formulas apply to pipes of circular section and for stabilized flows.

Model formulation:

Cross-section area (m²):

$$S = \pi \cdot \frac{d^2}{4}$$

Mean velocity (m/s):

$$V = \frac{Q_v}{S}$$

Mass flow rate (kg/s):

$$Q_m = Q_v \cdot \rho$$

Reynolds number:

$$Re = \frac{V \cdot d}{\nu}$$

Flow coefficient A_v (m²):

$$A_v = Q_v \cdot \sqrt{\frac{\rho}{\Delta P}}$$

or:

$$A_v = S \cdot \sqrt{\frac{2}{\zeta}}$$

Flow coefficient C_v (gal/min US):

$$C_v = 41650 \cdot A_v$$

or:

$$Cv = Qv_{[gpm\ US]} \cdot \sqrt{\frac{G_{[-]}}{\Delta P_{[psi]}}}$$

where:

- Qv Volume flow rate (gal/min US)
- ΔP Pressure loss (psi)
- G Specific gravity of fluid (1 for water at 60°F)

Flow coefficient Kv (m^3/h):

$$Kv = 36023 \cdot Av$$

or:

$$Kv = Qv_{[m^3/h]} \cdot \sqrt{\frac{G_{[-]}}{\Delta P_{[bar]}}}$$

where:

- Qv Volume flow rate (m^3/h)
- ΔP Pressure loss (bar)
- G Specific gravity of fluid (1 for water at 15°C)

Pressure loss coefficient (ζ):

$$\zeta = \lambda \cdot \frac{L}{d}$$

Pressure loss (Pa):

$$\Delta P = \zeta \cdot \frac{\rho \cdot V^2}{2}$$

Head loss of fluid (m):

$$\Delta h = \zeta \cdot \frac{V^2}{2 \cdot g}$$

Hydraulic power loss (W):

$$Wh = \Delta P \cdot Qv$$

Symbols, Definitions, SI Units:

- d Pipe internal diameter (m)
- S Cross-sectional area (m^2)
- Qv Volume flow rate (m^3/s)
- Qm Mass flow rate (kg/s)
- V Mean velocity (m/s)
- Re Reynolds number ()
- Av Flow coefficient (m^2)
- Cv Flow coefficient (USG/min)

Kv	Flow coefficient (m ³ /h)
ζ	Pressure loss coefficient ()
λ	Friction coefficient ()
L	Straight length (m)
ΔP	Pressure loss (Pa)
Δh	Head loss of fluid (m)
Wh	Hydraulic power loss (W)
ρ	Fluid density (kg/m ³)
ν	Fluid kinematic viscosity (m ² /s)
g	Gravitational acceleration (m/s ²)

Validity range:

- Equations for the flow coefficients Av, Cv and Kv are valid only for turbulent flows.

Example of input data and results:

The screenshot shows the HydraulCalc 2016a software interface. The window title is "HydraulCalc 2016a - [General Head Drop Formulas]". The menu bar includes File, Edit, Preferences, Database, Tools, and Help. The toolbar contains icons for file operations and calculations. The main window is titled "General Head Drop Formulas for Steady State and Incompressible Fluid".

Fluid characteristics:

- Fluid: Water @ 1 atm [HC]
- Ref.: IAPWS IF97
- Temperature: 60.00001 °F
- Pressure: 2115.694 lbf/ft²
- Density: 62.3665 lbm/ft³
- Dynamic viscosity: 0.00075330 lbm/ft.s
- Kinematic viscosity: 1.20786E-05 ft²/s

Formulation:

$$\Delta P = 1/2 \cdot \zeta \cdot \rho \cdot V^2$$

$$\zeta = \lambda \cdot L / d$$

$$Q_v = V \cdot S$$

$$S = \pi \cdot d^2 / 4$$

$$Q_m = \rho \cdot Q_v$$

$$Re = V \cdot d / \nu$$

$$A_v = Q_v \cdot (\rho / \Delta P)^{0.5}$$

$$C_v = 41650 \cdot A_v$$

$$K_v = 36023 \cdot A_v$$

$$C_v = 1.15620 \cdot K_v$$

$$\zeta = 2 \cdot S^2 / A_v^2$$

$$\Delta h = \Delta P / (\rho \cdot g)$$

$$W_h = \Delta P \cdot Q_v$$

$$\nu = \mu / \rho$$

Numerical application:

- ΔP = 1699.584 lbf/ft²
- ζ = 20.85395
- λ = 0.01737829
- L = 200 m
- V = 9.17 ft/s
- Qv = 0.2000584 ft³/s
- d = 2 in
- S = 3.141593 in²
- Qm = 5.659446 kg/s
- Re = 126532.3
- Av = 0.0006276798 m²
- Cv = 26.14297 USG/min
- Kv = 22.61094 m³/h
- Δh = 27.25155 ft of fluid
- Wh = 461 W

The interface also includes a graph showing Density (lbm/ft³) vs. Temperature (°F) for water, and a sidebar with various fluid icons and the "Divers" logo.