

# Pipe Flow Friction Losses @model

The pressure drop in pipe flow due to fluid friction with pipe walls depends on [mass flux](#) density and friction factor distribution along the pipe.

$$(1) \quad \left( \frac{dp}{dl} \right)_f = -\frac{j_m^2}{2d} \cdot \frac{f(l)}{\rho(l)}$$

where

$l$	pipe length
$j_m = \dot{m}/A = \rho_0 q_0 / A$	<a href="#">mass flux</a>
$\dot{m}(l) = \dot{m} = \text{const}$	<a href="#">mass flowrate</a>
$q_0$	intake flowrate
$\rho_0$	intake fluid density
$d$	pipe diameter
$A = 0.25 \pi d^2$	pipe cross-section area
$f = f(\text{Re}, \epsilon)$	<a href="#">Darcy friction factor</a>
$\epsilon$	inner pipe walls roughness
$\text{Re} = \frac{j_m d}{\mu}$	Reynolds number
$\mu(T, p)$	<a href="#">dynamic viscosity</a> as function of fluid temperature $T$ and pressure $p$

The accurate calculations require solving of a self-consistent equation of [Pressure Profile in Homogeneous Quasi-Isothermal Steady-State Pipe Flow @model](#).

There are few popular practical approximations based on assumption of constant friction factor and linear density-pressure equation of state.

## Approximations

---

(2) $\Delta p(L) = -\frac{j_m^2}{\rho_0} \cdot \frac{f_0 L}{2d} = -\frac{8}{\pi^2} \frac{\rho_0 q_0^2}{d^5} f_0 L$	$f(l) = f_0 = \text{const}$ $\rho(l) = \rho_0 = \text{const}$	<a href="#">Incompressible fluid</a>
(3) $\Delta p(L) = -\frac{\rho_0}{c^*} \cdot \left[ 1 - \sqrt{1 - j_m^2 \cdot \frac{c^* \rho^*}{\rho_0^2} \cdot \frac{f_0 L}{d}} \right]$	$f(l) = f_0 = \text{const}$ $\rho(l) = \rho^* \cdot (1 + c^* p)$ $c^* p \ll 1$	<a href="#">Slightly compressible fluid</a>

$(4) \quad \Delta p(L) = -p_0 \cdot \left[ 1 - \sqrt{1 - \frac{j_m^2}{\rho_0 p_0} \cdot \frac{f_0 L}{d}} \right]$	$f(l) = f_0 = \text{const}$ $\rho(l) = \frac{\rho_0}{p_0} \cdot p$	<b>Ideal gas</b>
$(5) \quad \Delta p(L) = -\frac{j_m^2}{\rho_0} \cdot \frac{f_0}{2 d} \cdot \frac{1 - \exp(-c^* \rho^* G L)}{c^* \rho^* G}$	$f(l) = f_0 = \text{const}$ $\rho(l) = \rho_0 \cdot \exp(c^* \rho^* G l)$	<b>Gravity dominated fluid density distribution</b>

## See also

---

[Physics / Fluid Dynamics / Pipe Flow Dynamics / Pipe Flow Simulation / Pressure Profile in Homogeneous Quasi-Isothermal Steady-State Pipe Flow @model](#)

[\[ Darcy friction factor \]](#) [\[ Darcy friction factor @model \]](#) [\[ Reynolds number in Pipe Flow \]](#)

[\[ Fluid friction with pipeline walls \]](#) [\[ Darcy friction factor in water producing/injecting wells @model \]](#)