

Pipe flow simulator

This is a library to simulate incompressible flow in a pipeline. It solves the pressure gradient equation:

$$\frac{dP}{dx} = [\text{advective term}] + [\text{gravitational term}] + [\text{friction term}]$$
$$\frac{dP}{dx} = -\rho v \frac{dv}{dx} - \rho g \sin \theta - \frac{f \rho v^2}{2D}$$

The following table describes the variables involved in this problem.

P	Fluid pressure	Pa
ρ	Fluid density	kg/m ³
v	Fluid velocity	m/s
x	Pipe length	m
θ	Pipe angle	rad
D	Pipe diameter	m
g	Gravity acceleration	m/s ²
f	Friction factor	-
ε	Roughness height	m
Re	Reynolds number	-
μ	Dynamic Viscosity	Pa.s

When the flow is laminar, the following equation is applied:

$$f = \frac{64}{Re}$$

If it is a turbulent or transition flow regime, it is computed from the following equation:

$$\frac{1}{\sqrt{f}} = -2 \log_{10} \left(\frac{\varepsilon}{3.7D} + \frac{2.51}{Re \sqrt{f}} \right)$$

Re is the Reynolds number, computed as:

$$Re = \frac{\rho v D}{\mu}$$

The flow is laminar when the Reynolds number is < 2300. If it is between 2300 and 4000, it is a transition flow, otherwise it is turbulent.