

.1

f

Darcy-Weisbach friction factor $f = \frac{2hDg}{LV^2}$

Laminaire
 $f_{liss}(Re)$

2

Material	ϵ (mm)
Riveted steel	0.9-9
Concrete	0.3-3
Wood stave	0.18-0.9
Cast iron	0.25
Galvanized iron	0.15
Asphalted cast iron	0.12
Commercial steel	0.046
Drawn tubing	0.0015

Fluid at 20°C	ν (m ² /s)
Water	1.003e-06
Air (101.325 kPa)	1.511e-05

Latitude at sea level	g (m/s ²)
0° WGS 1984	9.78033
45° Standard	9.80665
90° WGS 1984	9.83219

$f_{liss}(Re)$

Smooth pipes, $r = 0$
 $1/\sqrt{f} = 2 \log(R\sqrt{f}) - 0.8$
Hagen-Poiseuille equation
 $R \leq 2300$, $f = 64/R$
Colebrook equation, $R \geq 2300$
 $1/\sqrt{f} = -2 \log(r/3.7 + 2.51/(R\sqrt{f}))$
Continuity equation, $Q = AV$
 $A = \pi D^2/4$, $V = 4Q/(\pi D^2)$

$r = 5e-006$

$r = 1e-006$

Rugueux

$r = .01$

$r = .001$

$r = .0001$

$f_{rug}(r)$

Relative roughness $r = \frac{\epsilon}{D}$ (ϵ in mm, D in mm)

Lisse

Re

