Fanno Flow: Choking Length and Outlet Mach Number

Length of pipe that chokes an adiabatic gas flow from its inlet Mach number (Fanno line), and the outlet Mach number and pressure ratio for a given pipe length.

Method: Fanno-line relations for adiabatic flow of a perfect gas with friction (Shapiro, The Dynamics and Thermodynamics of Compressible Fluid Flow, 1953; Perry's Chemical Engineers' Handbook, 9th ed. (McGraw-Hill, 2019), sec. 6, adiabatic compressible flow)

Input parameters

Unit system: SI

Parameter	Value	Unit
Inlet Mach number (subsonic)	0.30000	
Ratio of specific heats	1.4000	
Darcy friction factor	0.018000	
Pipe inside diameter	102.30	mm
Pipe length	20.000	m

Calculated results

Parameter	Value	Unit
Fanno parameter at the inlet	5.2993	
Length to choke	30.117	m
Outlet Mach number	0.43337	
Static pressure ratio	0.68569	
Static temperature ratio	0.98115	

Formula and method

$$\frac{f_D L^*}{D} = \frac{1-M^2}{\gamma M^2} + \frac{\gamma+1}{2\gamma}\ln\frac{(\gamma+1)M^2}{2+(\gamma-1)M^2}$$

$$\frac{p}{p^*} = \frac{1}{M}\sqrt{\frac{\gamma+1}{2+(\gamma-1)M^2}}, \quad \frac{f_D L}{D} = \left.\frac{f_D L^*}{D}\right|_{M_1} - \left.\frac{f_D L^*}{D}\right|_{M_2}$$

Variables

M_1	Inlet Mach number (subsonic)	-
γ	Ratio of specific heats	-
f_D	Darcy friction factor	-
D	Pipe inside diameter	m
L	Pipe length	m
$f_D L^*/D$	Fanno parameter at the inlet	-
L^*	Length to choke	m
M_2	Outlet Mach number	-
p_2/p_1	Static pressure ratio	-
T_2/T_1	Static temperature ratio	-

Method and standards

Fanno line, subsonic branch.

Assumptions and limits

- Perfect gas; constant f; adiabatic; subsonic inlet.
- When the pipe is longer than L*, the inlet Mach number falls to the value M_1' whose choking length equals the pipe; the outlet is then sonic and the ratios are for M_1'.

References

• Fanno-line relations for adiabatic flow of a perfect gas with friction (Shapiro, The Dynamics and Thermodynamics of Compressible Fluid Flow, 1953; Perry's Chemical Engineers' Handbook, 9th ed. (McGraw-Hill, 2019), sec. 6, adiabatic compressible flow)

Report details

Report reference	FCC-B8G9-781K (the same inputs always give the same reference)
Generated	17 November 2026, 19:46 UTC
Calculator	Fanno Flow: Choking Length and Outlet Mach Number
Method last reviewed	13 November 2026
Software release	FireCAD Calc, release of 17 November 2026
Release checks	2 reference cases of this calculator, computed independently, are checked on every release

Results are for engineering estimation. Verify critical designs against the referenced standards and your own data.

This calculator online

https://calc.firecad.com/mechanical/fluid-mechanics/fanno-flow-choking-length

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.