Siphon Flow Rate and Maximum Height

Flow through a siphon from the level difference, pipe size, length and losses, the pressure at the crest and the highest crest before the liquid boils off.

Method: Bernoulli with losses between the surfaces and to the crest (Textbook fluid mechanics (White, Fluid Mechanics))

Input parameters

Unit system: SI

Parameter	Value	Unit
Level difference between the two surfaces	3.0000	m
Height of the crest above the upper surface	2.0000	m
Pipe inside diameter	50.000	mm
Loss coefficient: entry, bends and friction f L/d, without the exit	6.0000	
Loss coefficient from the inlet to the crest	2.0000	
Liquid density	998.00	kg/m³
Vapour pressure of the liquid	0.023390	bar
Atmospheric pressure	1.0132	bar

Calculated results

Parameter	Value	Unit
Velocity in the pipe	2.8993	m/s
Flow	20.494	m³/h
Absolute pressure at the crest	0.69168	bar
Highest crest before the pressure reaches vapour pressure	8.8283	m

Notes for this case

- The exit loss is the velocity head, the 1 in (1 + K_t): do not include it in K_t as well.

Formula and method

$$v = \sqrt{\frac{2gH}{1+K_t}}, \quad p_c = p_a - \rho g z_c - (1+K_c)\frac{\rho v^2}{2}$$

$$Q = v\frac{\pi d^2}{4}, \quad z_{max} = \frac{p_a - p_v - (1+K_c)\rho v^2/2}{\rho g}$$

Variables

H	Level difference between the two surfaces	m
z_c	Height of the crest above the upper surface	m
d	Pipe inside diameter	m
K_t	Loss coefficient: entry, bends and friction f L/d, without the exit	-
K_c	Loss coefficient from the inlet to the crest	-
ρ	Liquid density	kg/m³
p_v	Vapour pressure of the liquid	Pa
p_a	Atmospheric pressure	Pa
v	Velocity in the pipe	m/s

Q	Flow	m^3/s
p_c	Absolute pressure at the crest	Pa
z_{max}	Highest crest before the pressure reaches vapour pressure	m
g	Standard gravity, 9.806 65	m/s^2

Method and standards

Bernoulli with losses.

Assumptions and limits

- Steady, full-bore flow.
- K_t covers entry, bends and friction; the exit loss (one velocity head) is already in the formula as the 1.
- When the crest pressure would fall below the vapour pressure the siphon breaks: flow, velocity and crest pressure are not shown.

References

- Bernoulli with losses between the surfaces and to the crest (Textbook fluid mechanics (White, Fluid Mechanics))

Report details

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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/siphon-flow

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Reopens the calculator with the inputs of this report.