Self-Priming Pump: Time to Evacuate the Suction Line

Time a self-priming pump takes to draw the air out of its suction line against a suction lift, from its air-handling capacity and the line volume.

Method: Isothermal evacuation of a fixed volume

Input parameters

Unit system: SI

Parameter	Value	Unit
Suction pipe inside diameter	102.30	mm
Suction pipe length	8.0000	m
Air volume in the pump casing	5.0000	L
Static suction lift	4.0000	m
Air-handling capacity of the pump while priming	25.000	m³/h
Atmospheric pressure	1.0132	bar
Liquid density	998.00	kg/m³

Calculated results

Parameter	Value	Unit
Air volume to evacuate	70.755	L
Pressure needed at the pump to lift the liquid	0.62177	bar
Priming time	4.9757	s

Notes for this case

• While priming, the pump acts as a vacuum pump on a fixed volume: the pressure falls as p = p_a e^(−St/V), and the liquid reaches the pump when the pressure is p_a − ρgh_s, so t = (V/S) ln[p_a/(p_a − ρgh_s)]. The rising liquid column shrinks the air volume, so the real time is a little shorter; leaks at joints and the shaft seal make it longer, or stop priming altogether. Makers rate self-priming pumps by the time to prime a given lift and pipe size; the air-handling capacity here is the figure that matches it.

Formula and method

$$t = \frac{V}{S}\ln\frac{p_a}{p_a - \rho g h_s}, \quad V = \frac{\pi d^2}{4}L + V_c$$

Variables

d	Suction pipe inside diameter	m
L	Suction pipe length	m
V_c	Air volume in the pump casing	m³
h_s	Static suction lift	m
S	Air-handling capacity of the pump while priming	m³/s
p_a	Atmospheric pressure	Pa
ρ	Liquid density	kg/m³
V	Air volume to evacuate	m³
p_e	Pressure needed at the pump to lift the liquid	Pa
t	Priming time	s

Method and standards

Priming time.

Assumptions and limits

- Isothermal air; constant air-handling capacity; no leaks.

References

Isothermal evacuation of a fixed volume

Report details

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Release checks	3 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/pumps/pump-self-priming-time

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.