Heat Pipe Capillary Limit (Maximum Heat Transport)

Maximum heat a wicked heat pipe can carry before its wick dries out, from the working fluid, wick permeability, area and pore radius, length and tilt.

Method: Capillary limit of wicked heat pipes

Input parameters

Unit system: SI

Parameter	Value	Unit
Liquid density	975.00	kg/m³
Surface tension	64.000	mN/m
Latent heat	2,310.0	kJ/kg
Liquid viscosity	0.37000	mPa·s
Wick permeability	1.5000e-04	mm²
Wick cross-sectional area	20.000	mm²
Effective pore radius	0.050000	mm
Effective length (L_a + (L_e + L_c)/2)	250.00	mm
Total length	350.00	mm
Tilt (evaporator above condenser positive)	0	°

Calculated results

Parameter	Value	Unit
Maximum capillary pressure 2σ/r	2,560.0	Pa
Adverse gravity head	0	Pa
Capillary limit	187.00	W
Liquid flow at the limit	0.080951	g/s

Notes for this case

• The wick's capillary pressure 2σ/r_eff must drive the condensed liquid back to the evaporator against its viscous drop (Darcy's law, μ_lṁL_eff/(ρ_lKA_w)) and any adverse gravity head ρ_lgL_t sin ψ. Equating them gives the capillary limit Q = ρ_lσh_fg/μ_l·(KA_w/L_eff)·(2/r_eff − ρ_lgL_t sin ψ/σ) (Chi). The vapour pressure drop is neglected, which is reasonable for moderate lengths. Water has the highest figure of merit ρσh_fg/μ near 100–200 °C; sintered wicks have small pores (high pumping) but low permeability.

Formula and method

$$\dot{Q}_{max} = \frac{\rho_l \sigma h_{fg}}{\mu_l} \frac{K A_w}{L_{eff}} \left(\frac{2}{r_{eff}} - \frac{\rho_l g L_t \sin\psi}{\sigma} \right)$$

Variables

ρ_l	Liquid density	kg/m³
σ	Surface tension	N/m
h_{fg}	Latent heat	J/kg
μ_l	Liquid viscosity	Pa·s
K	Wick permeability	m²
A_w	Wick cross-sectional area	m²
r_{eff}	Effective pore radius	m

L_{eff}	Effective length (L_a + (L_e + L_c)/2)	m
L_t	Total length	m
ψ	Tilt (evaporator above condenser positive)	rad
Δp_c	Maximum capillary pressure 2σ/r	Pa
Δp_g	Adverse gravity head	Pa
$\dot{Q}_{max}$	Capillary limit	W
$\dot{m}$	Liquid flow at the limit	kg/s

Method and standards

Capillary limit.

Assumptions and limits

- Vapour pressure drop neglected; uniform wick; properties at the operating temperature.

References

Capillary limit of wicked heat pipes

Report details

Report reference	FCC-FWN6-S1CV (the same inputs always give the same reference)
Generated	23 November 2026, 18:08 UTC
Calculator	Heat Pipe Capillary Limit (Maximum Heat Transport)
Method last reviewed	17 November 2026
Software release	FireCAD Calc, release of 22 November 2026
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/heat-transfer/heat-pipe-capillary-limit

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.