Parabolic Trough Geometry: Rim Angle, Image Width and Concentration

Rim angle, focal image width, receiver diameter for full interception and the resulting concentration ratio of a perfect linear parabolic concentrator.

Input parameters

Unit system: SI

Parameter	Value	Unit
Aperture width	5.7700	m
Focal length	1.7100	m
Half-angle of the sun plus errors	0.60000	°

Calculated results

Parameter	Value	Unit
Focal length to aperture ratio	0.29636	
Rim angle	80.300	°
Mirror radius at the rim	2.9268	m
Image width in the focal plane	387.57	mm
Cylindrical receiver diameter for full interception	61.299	mm
Concentration ratio, flat receiver (a/W)	14.888	
Concentration ratio, cylindrical receiver (a/πD)	29.962	

Notes for this case

• Perfect mirror and tracking; real troughs add mirror slope, tracking and receiver alignment errors to the sun's 0.267° half-angle, which widens the image several times. A rim angle near 90° gives the smallest cylindrical receiver.

Formula and method

$$\phi_r = \tan^{-1}\frac{8(f/a)}{16(f/a)^2-1}, \quad W = \frac{a\sin\theta_s}{\sin\phi_r\cos(\phi_r+\theta_s)}, \quad D = \frac{a\sin\theta_s}{\sin\phi_r}$$

Variables

a	Aperture width	m
f	Focal length	m
θ_s	Half-angle of the sun plus errors	rad
f/a	Focal length to aperture ratio	-
ϕ_r	Rim angle	rad
r_r	Mirror radius at the rim	m
W	Image width in the focal plane	m
D	Cylindrical receiver diameter for full interception	m
C_{flat}	Concentration ratio, flat receiver (a/W)	-
C_{cyl}	Concentration ratio, cylindrical receiver (a/πD)	-

Method and standards

Image geometry of a perfect linear parabolic concentrator.

Assumptions and limits

- Perfect specular mirror; sun as a uniform disc.

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/environmental/solar-thermal/parabolic-concentrator-geometry

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Reopens the calculator with the inputs of this report.