Heliostat Cosine Efficiency and Atmospheric Attenuation

Cosine efficiency of a heliostat from sun position and its location relative to the tower receiver, with the slant range and atmospheric attenuation.

Method: Heliostat geometry and atmospheric attenuation

Input parameters

Unit system: SI

Parameter	Value	Unit
Sun elevation	50.000	°
Sun azimuth (clockwise from north)	180.00	°
Heliostat position east of the tower	0	m
Heliostat position north of the tower	300.00	m
Receiver height above the heliostat	150.00	m

Calculated results

Parameter	Value	Unit
Cosine efficiency	97.916	%
Incidence angle on the mirror	11.717	°
Slant range to the receiver	335.41	m
Atmospheric transmission	95.598	%
Product	93.606	%

Notes for this case

• The mirror normal bisects the sun direction and the direction to the receiver: cos θ = √[(1 + ŝ·t̂)/2]. Attenuation by a common clear-day fit, 0.99321 − 1.176 × 10⁻⁴S + 1.97 × 10⁻⁸S² (S in m, up to 1 km). Heliostats north of the tower (in the northern hemisphere) have the best cosine efficiency.

Formula and method

$$\cos\theta = \sqrt{\frac{1+\hat{s}\cdot\hat{t}}{2}}, \quad \eta_{att} = 0.99321 - 1.176\times10^{-4}S + 1.97\times10^{-8}S^2$$

Variables

α_s	Sun elevation	rad
γ_s	Sun azimuth (clockwise from north)	rad
x	Heliostat position east of the tower	m
y	Heliostat position north of the tower	m
H	Receiver height above the heliostat	m
$\cos\theta$	Cosine efficiency	-
θ	Incidence angle on the mirror	rad
S	Slant range to the receiver	m
η_{att}	Atmospheric transmission	-
$\eta_{cos}\eta_{att}$	Product	-

Method and standards

Heliostat geometry.

Assumptions and limits

- Flat ideal mirror; clear atmosphere.

References

Heliostat geometry and atmospheric attenuation

Report details

Report reference	FCC-XDE6-ET89 (the same inputs always give the same reference)
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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/environmental/solar-thermal/heliostat-cosine-efficiency

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.