Sol-Air Temperature and Heat Gain Through a Sunlit Wall or Roof

Sol-air temperature of a sunlit wall or roof from outdoor temperature, solar irradiance and absorptance, and the steady heat gain through it.

Method: Sol-air temperature T_sa = T_o + αE_t/h_o − εΔR/h_o (ASHRAE Handbook—Fundamentals ch. 18)

Input parameters

Unit system: SI

Parameter	Value	Unit
Outdoor air temperature	35.000	°C
Total solar irradiance on the surface	0.80000	kW/m²
Solar absorptance of the surface Light colours about 0.3–0.5, dark colours 0.8–0.95.	70.000	%
Outside surface coefficient	17.000	W/(m²·K)
Long-wave sky correction ε ΔR ASHRAE uses about 63 W/m² for horizontal surfaces and 0 for vertical walls.	0.063000	kW/m²
U-value	0.50000	W/(m²·K)
Area	200.00	m²
Indoor temperature	24.000	°C

Calculated results

Parameter	Value	Unit
Sol-air temperature	64.235	°C
Steady heat gain U A (T_sa − T_i)	4.0235	kW
Gain without the sun U A (T_o − T_i)	1.1000	kW

Notes for this case

- Steady value: heavy walls and roofs delay and damp the peak, so the cooling load is lower and later.

Formula and method

$$T_{sa} = T_o + \frac{\alpha E_t}{h_o} - \frac{\varepsilon \Delta R}{h_o}, \quad \dot{Q} = UA(T_{sa} - T_i)$$

Variables

T_o	Outdoor air temperature	K
E_t	Total solar irradiance on the surface	W/m²
α	Solar absorptance of the surface	-
h_o	Outside surface coefficient	W/(m²·K)
$\varepsilon \Delta R$	Long-wave sky correction ε ΔR	W/m²
U	U-value	W/(m²·K)
A	Area	m²
T_i	Indoor temperature	K
T_{sa}	Sol-air temperature	K
$\dot{Q}$	Steady heat gain U A (T_sa − T_i)	W
$\dot{Q}_{air}$	Gain without the sun U A (T_o − T_i)	W

Method and standards

Surface energy balance.

Assumptions and limits

- Steady state.

References

- Sol-air temperature T_sa = T_o + αE_t/h_o − εΔR/h_o (ASHRAE Handbook—Fundamentals ch. 18)

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/hvac/loads/sol-air-temperature

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.