Greenhouse Fan-and-Pad Evaporative Cooling

Air leaving an evaporative pad, the air flow to hold a temperature rise across a greenhouse, the pad area and the number of fans.

Method: Greenhouse heat balance: cover conduction and air leakage

Input parameters

Unit system: SI

Parameter	Value	Unit
Floor area	1,000.0	m²
Heat gain per floor area (solar and other)	0.40000	kW/m²
Outside dry-bulb temperature	38.000	°C
Outside wet-bulb temperature	24.000	°C
Pad saturation efficiency	80.000	%
Allowed temperature rise from pad to fans	4.0000	K
Pad face velocity	1.2500	m/s
Capacity of one fan	35,000	m³/h

Calculated results

Parameter	Value	Unit
Air temperature leaving the pad	26.800	°C
Air temperature at the fans	30.800	°C
Air flow needed	304,085	m³/h
Pad area	67.574	m²
Fans needed	9.0000	

Notes for this case

• Air drawn through a wetted pad cools towards the wet-bulb temperature: T_p = T_db − ε(T_db − T_wb), with ε about 0.75–0.85 for 100–150 mm cellulose pads. Crossing the house it picks up the solar and other heat, so the air flow must be large enough to limit that rise: Q/(ρ c_p ΔT). The pad area is the flow over the face velocity (about 1.25 m/s for 100 mm pads). Fan-and-pad cooling works best in dry climates with a large wet-bulb depression.

Formula and method

$$T_p = T_{db} - \varepsilon(T_{db} - T_{wb}), \quad \dot{V} = \frac{q_s A_f}{\rho c_p \Delta T}, \quad A_p = \frac{\dot{V}}{v_p}$$

Variables

A_f	Floor area	m²
q_s	Heat gain per floor area (solar and other)	W/m²
T_{db}	Outside dry-bulb temperature	K
T_{wb}	Outside wet-bulb temperature	K
ε	Pad saturation efficiency	-
ΔT	Allowed temperature rise from pad to fans	K
v_p	Pad face velocity	m/s
$\dot{V}_f$	Capacity of one fan	m³/s
T_p	Air temperature leaving the pad	K

T_x	Air temperature at the fans	K
$\dot{V}$	Air flow needed	m³/s
A_p	Pad area	m²
n	Fans needed	-

Method and standards

Pad cooling.

Assumptions and limits

- Uniform pad wetting; steady conditions.

References

Greenhouse heat balance: cover conduction and air leakage

Report details

Report reference	FCC-TY7D-PQWZ (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/civil/irrigation-farm/greenhouse-pad-cooling

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Reopens the calculator with the inputs of this report.