

Calculation of temperature control in enclosures








What's needed:

1. The dimensions of the enclosure (Height, Width, Depth) [m]
2. The enclosure position (e.g. single enclosure, enclosure in a row) according to calculation formula, enclosure surface area A [m²]
3. The enclosure material (metal, plastic) heat transfer coefficient from table, k [W/m² K]
4. The temperature difference between desired enclosure interior temperature Ti [°C] and the expected ambient temperature Tu [°C] (e.g. day/night, summer/winter, climate zones) ΔT [K=Kelvin]
5. The stray power (self-warming) of all installed components during operation (e.g. transformers, relays, semiconductors) Pv [W]

Calculation and selection of parameters: enclosure surface area - heat transfer coefficient - temperature difference

1. Enclosure surface area from dimensions

2. Enclosure position (plan view) according to VDE 0660 part 500

	Single enclosure free on all sides
	Single enclosure, wall mounted
	First or last enclosure in free standing row
	First or last enclosure in wall mounted row
	Middle enclosure in free standing row
	Middle enclosure in wall mounted row
	Middle enclosure in wall mounted row with covered top

Formula for cabinet surface area A [m²]

(H = Height W = Width D = Depth)

$$A = 1.8 \times H \times (W + D) + 1.4 \times W \times D$$

$$A = 1.4 \times W \times (H + D) + 1.8 \times D \times H$$

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$$A = 1.8 \times W \times H + 1.4 \times W \times D + D \times H$$

$$A = 1.4 \times W \times (H + D) + D \times H$$

$$A = 1.4 \times W \times H + 0,7 \times W \times D + D \times H$$

Example: enclosure free on all sides, 2000mm high / 800mm wide / 600mm deep. $A = 1.8 \times 2.0 \times (0.8 + 0.6) + 1.4 \times 0.8 \times 0.6 = 5.712\text{m}^2$

3. Enclosure material and its heat transfer coefficient k [W/m² K]

Steel sheet, painted	k ~ 5.5W/m ² K
Steel sheet, stainless	k ~ 4.5W/m ² K
Aluminium	k ~ 12W/m ² K
Aluminium, double-walled	k ~ 4.5W/m ² K
Polyester	k ~ 3.5W/m ² K

4. Temperature difference ΔT [K=Kelvin]

$$\Delta T = T_i - T_u$$

i.e. the temperature difference between the interior and exterior temperatures

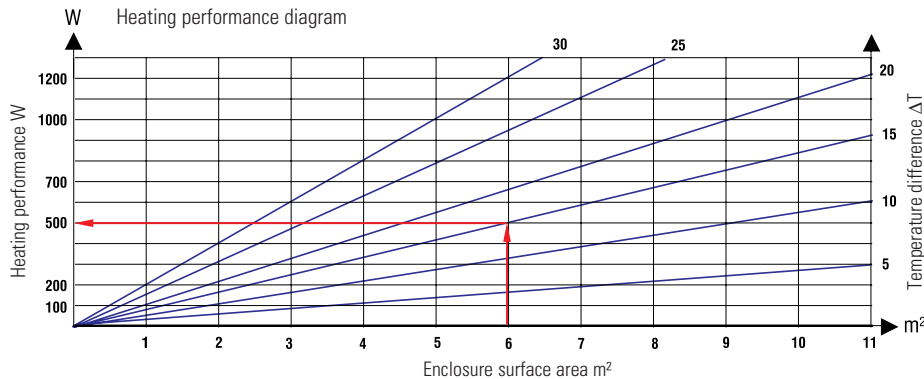
CALCULATION FORMULA FOR REQUIRED HEATING PERFORMANCE (HEATER):

Required heating performance P_H [W] = enclosure surface area A [m²] x heat transfer coefficient k [W/m² K] x temperature difference ΔT [K]

Example: $W = 5.712\text{m}^2 \times 5.5\text{W/m}^2\text{K} \times 15\text{K} = 471.24\text{W}$

Result: Heater with 500W heating performance is required. If enclosure is situated outdoors the calculated heating performance must be doubled!

OR CHOOSE REQUIRED HEATING PERFORMANCE FROM DIAGRAM:



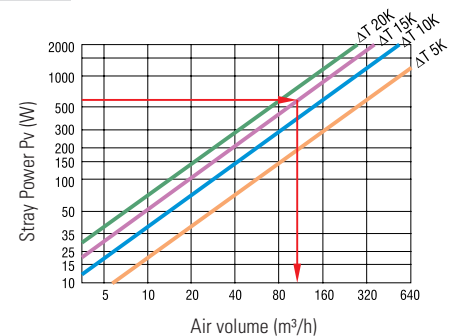
5. In the case of continuous stray power Pv [W] (self-warming) this must be deducted from the calculated heating performance.

CHOOSE REQUIRED COOLING PERFORMANCE FROM DIAGRAM:

OR CALCULATE USING FORMULA FOR REQUIRED COOLING PERFORMANCE (FILTER FAN):

$$\text{Required air volume } V \text{ [m}^3\text{/h]} = \frac{\text{installed stray power } P_v \text{ [W]}}{\text{temperature difference } \Delta T \text{ [K]}} \times \text{air constant } f^* \text{ [3.3m}^3 \text{ K/Wh]}$$

$$\text{Example: } V = \frac{600\text{W}}{15\text{K}} \times 3.3\text{m}^3 \text{ K/Wh} = 132\text{m}^3\text{/h}$$



*f (0-100) = 3.1m³ K/Wh, f (100-250) = 3.2m³ K/Wh, f (250-500) = 3.3m³ K/Wh, f (500-750) = 3.4m³ K/Wh, f (750-1000) = 3.5m³ K/Wh