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

		Formula for cabinet surface area A **[m²]** (H = Height W = Width D = Depth)
	Single enclosure free on all sides	A = 1.8 x H x (W + D) + 1.4 x W x D
	Single enclosure, wall mounted	A = 1.4 x W x (H + D) + 1.8 x D x H
	First or last enclosure in free standing row	A = 1.4 x D x (H + W) + 1.8 x W x H
	First or last enclosure in wall mounted row	A = 1.4 x H x (W + D) + 1.4 x W x D
	Middle enclosure in free standing row	A = 1.8 x W x H + 1.4 x W x D + D x H
	Middle enclosure in wall mounted row	A = 1.4 x W x (H + D) + D x H
	Middle enclosure in wall mounted row with covered top	A = 1.4 x W x H + 0,7 x W x D + D x H

Example: enclosure free on all sides, 2000mm high / 800mm wide / 600mm deep. A = 1.8 x 2.0 x (0.8 + 0.6) + 1.4 x 0.8 x 0.6 = 5.712m²

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

Steel sheet, painted	k ~ 5.5W/m² K
Steel sheet, stainless	k ~ 4.5W/m² K
Aluminium	k ~ 12W/m² K
Aluminium, double-walled	k ~ 4.5W/m² K
Polyester	k ~ 3.5W/m² K

4. Temperature difference ΔT **[K=Kelvin]**

$$\Delta T = Ti - Tu$$

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

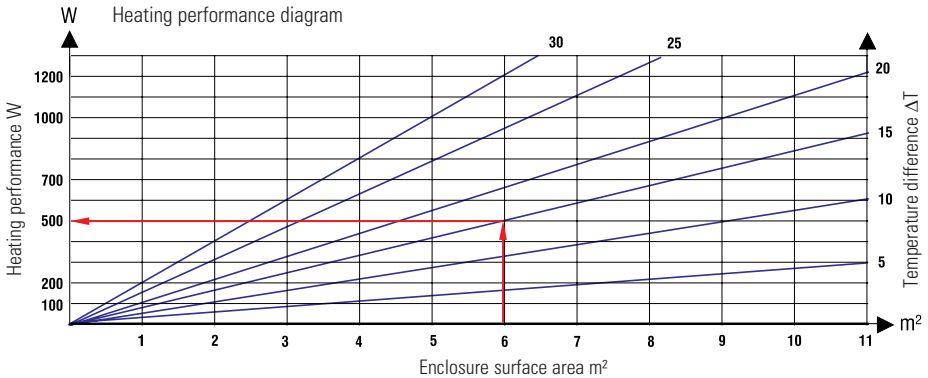
CALCULATION FORMULA FOR REQUIRED HEATING PERFORMANCE (HEATER):

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 = 5.712m² x 5.5W/m² K x 15K = 471.24W

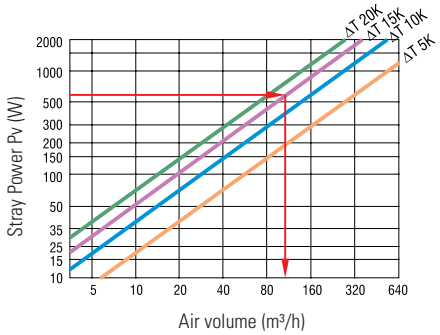
Result: Heater with 500W heating performance is required. If enclosure is situated outdoors the calculated heating performance must be doubled!

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):

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

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

*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