Surface Heat Losses of an Induction-Heated Workpiece

Free convection and radiation loss density from a hot workpiece surface by the engineering formulas, and the total surface loss power for its area.

Input parameters

Unit system: SI

Parameter	Value	Unit
Surface temperature	900.00	°C
Ambient temperature	30.000	°C
Emissivity of the surface	0.75000	
Exposed surface area	0.15708	m²

Calculated results

Parameter	Value	Unit
Convection loss density, 1.86ΔT^1.3	12.328	kW/m²
Convection loss density, 1.54ΔT^1.33	12.505	kW/m²
Radiation loss density	80.195	kW/m²
Total loss density	92.700	kW/m²
Total surface loss	14.561	kW
Radiation share	86.510	%

Notes for this case

• Free convection from a stationary surface in still air; forced convection on moving strip can be 5–10 times higher. The total uses the 1.54ΔT^1.33 formula. Thermal insulation (a refractory lining in the coil) cuts these losses sharply at forging temperatures.

Formula and method

$$q_{conv} = 1.86(T_s - T_a)^{1.3}, \quad q_{conv}{}' = 1.54(T_s - T_a)^{1.33}\ [\mathrm{W/m^2}], \quad q_{rad} = \sigma\varepsilon(T_s^4 - T_a^4)$$

Variables

T_s	Surface temperature	K
T_a	Ambient temperature	K
ε	Emissivity of the surface	-
A	Exposed surface area	m²
q_{conv}	Convection loss density, 1.86ΔT^1.3	W/m²
$q_{conv}{}'$	Convection loss density, 1.54ΔT^1.33	W/m²
q_{rad}	Radiation loss density	W/m²
q	Total loss density	W/m²
P_{loss}	Total surface loss	W
q_{rad}/q	Radiation share	-

Method and standards

Free convection and grey-body radiation.

Assumptions and limits

- Free convection; grey surface radiating to large surroundings.

Report details

Report reference	FCC-22F6-DE9Q (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/materials/steelmaking-foundry/induction-surface-heat-losses

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.