Radiant Tube Heater Output to the Load

Radiant heat from gas- or electric-fired radiant tubes to a furnace load, from tube size, number, temperatures and emissivities, as a two-surface enclosure.

Method: Two-surface gray enclosure radiation

Input parameters

Unit system: SI

Parameter	Value	Unit
Tube outside diameter	150.00	mm
Heated tube length	2.0000	m
Number of tubes	10.000	
Tube surface temperature	950.00	°C
Load surface temperature	800.00	°C
Tube emissivity	85.000	%
Load emissivity	80.000	%
Tube area over load area	0.40000	

Calculated results

Parameter	Value	Unit
Tube surface area	9.4248	m²
Exchange factor	0.78341	
Heat to the load	381.83	kW
Flux on the tube	40.513	kW/m²

Notes for this case

• Radiant tubes keep combustion gases away from the load (for controlled-atmosphere heat treatment). Treating the tubes and the load as a two-surface enclosure with reradiating walls lumped in, the exchange factor is 1/(1/ε_t + (A_t/A_l)(1/ε_l − 1)). The rating falls sharply as the load approaches tube temperature, so heating time is set by the final soak. Tube life limits surface temperature (about 950–1050 °C for heat-resisting alloys).

Formula and method

$$Q = \sigma A_t F \left(T_t^4 - T_l^4\right), \quad F = \frac{1}{1/\varepsilon_t + (A_t/A_l)(1/\varepsilon_l - 1)}$$

Variables

d	Tube outside diameter	m
L	Heated tube length	m
n	Number of tubes	-
T_t	Tube surface temperature	K
T_l	Load surface temperature	K
ε_t	Tube emissivity	-
ε_l	Load emissivity	-
A_t/A_l	Tube area over load area	-
A_t	Tube surface area	m²
F	Exchange factor	-
Q	Heat to the load	W

q	Flux on the tube	W/m²

Method and standards

Radiant tubes.

Assumptions and limits

- Gray surfaces; reradiating walls.

References

Two-surface gray enclosure radiation

Report details

Report reference	FCC-XJPB-EDJ1 (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/radiant-tube-heat-transfer

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.