Boiler Surface Radiation and Convection Loss

Heat lost from a boiler casing by natural convection and radiation from its area and surface temperature (ISO 12241 vertical-wall equations), as a share of heat input.

Method: ISO 12241:2008 Thermal insulation for building equipment and industrial installations (vertical walls); ASME PTC 4-2013 §5.14 (surface radiation and convection loss)

Input parameters

Unit system: SI

Parameter	Value	Unit
Outer surface area of casing, ducts and headers	400.00	m²
Mean outer surface temperature Measure with an infrared thermometer at many points and average by area.	55.000	°C
Surrounding air temperature	30.000	°C
Emissivity of the surface Aluminium cladding about 0.05–0.15, galvanised steel 0.25, painted surfaces about 0.9.	0.15000	
Height of the walls	12.000	m
Heat input from fuel (for the % loss; on the basis of your efficiency, GCV or NCV)	80.000	MW

Calculated results

Parameter	Value	Unit
Surface loss, % of heat input	0.076993	%
Heat lost from the surface	61.595	kW
Heat loss per m²	153.99	W/m²
Convection coefficient	5.0878	W/(m²·K)
Radiation coefficient	1.0717	W/(m²·K)

Formula and method

$$h_{cv} = 1.32\left(\frac{\Delta T}{H}\right)^{1/4} \;(H^3\Delta T \le 10) \qquad h_{cv} = 1.74\,\Delta T^{1/3}\;(\text{otherwise})$$

$$h_r = \varepsilon\,\sigma\,\frac{T_s^4 - T_a^4}{T_s - T_a} \qquad \dot{Q}_r = (h_{cv} + h_r)\,A\,(T_s - T_a) \qquad q = \dot{Q}_r / A \qquad L_r = \dot{Q}_r / \dot{Q}_{in}$$

Variables

A	outer surface area	m²
T_s	mean outer surface temperature	K
T_a	surrounding air temperature	K
ΔT	surface minus air temperature	K
$\mathcal{E}$	surface emissivity	–
H	wall height	m
$\dot{Q}_{in}$	heat input from fuel, on the basis (GCV or NCV) of the efficiency it is compared with	W
L_r	surface loss, fraction of input	–
$\dot{Q}_r$	heat lost from the surface	W
q	heat loss per unit area	W/m²

h_{cv}	natural convection coefficient	W/(m²·K)
h_r	radiation coefficient	W/(m²·K)
σ	Stefan–Boltzmann constant, 5.670 374 419 × 10^{-8}	W/(m²·K⁴)

Method and standards

Natural convection from vertical walls in still air by the ISO 12241 equations (laminar 1.32 (ΔT/H)^¼, turbulent 1.74 ΔT^⅓, switching at $H^3\Delta T$ = 10 m³·K) and radiation to surroundings at air temperature. ASME PTC 4 §5.14 lets the surface loss be measured this way or taken from the ABMA curve; this calculator measures it.

Assumptions and limits

- Still air; surroundings at air temperature; all the area treated as vertical wall of one height. Roofs, horizontal ducts and pipes have other convection coefficients (ISO 12241 gives them); calculate those parts separately if they are large.
- ASME PTC 4 measures this loss with its own coefficients and air velocity; the ISO 12241 still-air result is close but not identical.
- One mean surface temperature and emissivity for the whole area.

References

• ISO 12241:2008 Thermal insulation for building equipment and industrial installations (vertical walls)
• ASME PTC 4-2013 §5.14 (surface radiation and convection loss)

Report details

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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/boilers-power-plant/boilers/surface-radiation-convection-loss

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.