Ladle Steel Temperature Loss during Holding

Rate of temperature fall of liquid steel in a ladle from radiation off the top surface and conduction into the refractory, and the drop over a holding time.

Method: Radiation and refractory heat balance

Input parameters

Unit system: SI

Parameter	Value	Unit
Steel mass	120.00	t
Liquid steel specific heat	0.82000	kJ/(kg·K)
Steel temperature	1,600.0	°C
Free top surface area	7.0000	m²
Effective emissivity of the surface (lower with slag cover)	40.000	%
Surroundings temperature	50.000	°C
Wetted refractory area	30.000	m²
Heat flux into refractory	15.000	kW/m²
Holding time	30.000	min

Calculated results

Parameter	Value	Unit
Radiation from the top	1,952.9	kW
Loss to refractory	450.00	kW
Temperature fall rate	1.4652	K/min
Drop over the holding time	43.955	K

Notes for this case

• dT/dt = −[εσA_t(T⁴ − T₀⁴) + q_wA_w]/(mc_l), applied linearly over the holding time (rates change little over tens of kelvin). A good slag cover and a lid cut the radiation many times; refractory flux is highest in a cold ladle and falls as it soaks, so preheated, circulating ladles lose far less. Typical losses are 0.5–2 K/min.

Formula and method

$$\dot{T} = \frac{\varepsilon \sigma A_t (T^4 - T_0^4) + q_w A_w}{m c_l}, \quad \Delta T = \dot{T} t_h$$

Variables

m	Steel mass	kg
c_l	Liquid steel specific heat	J/(kg·K)
T	Steel temperature	K
A_t	Free top surface area	m²
ε	Effective emissivity of the surface (lower with slag cover)	-
T_0	Surroundings temperature	K
A_w	Wetted refractory area	m²
q_w	Heat flux into refractory	W/m²
t_h	Holding time	s
$\dot{Q}_r$	Radiation from the top	W

$\dot{Q}_w$	Loss to refractory	W
$\dot{T}$	Temperature fall rate	K/s
ΔT	Drop over the holding time	K

Method and standards

Ladle cooling.

Assumptions and limits

- Uniform bath temperature; constant losses over the hold.

References

Radiation and refractory heat balance

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/materials/steelmaking-foundry/ladle-temperature-loss

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.