Electric Arc Furnace Energy per Tonne and Power-On Time

Heat to melt and superheat steel and slag in an arc furnace, less chemical energy, as electricity per tonne for an efficiency, and the power-on time.

Method: EAF energy balance

Input parameters

Unit system: SI

Parameter	Value	Unit
Tapping temperature	1,640.0	°C
Melting temperature	1,520.0	°C
Mean specific heat of solid steel	0.68000	kJ/(kg·K)
Latent heat of fusion	270.00	kJ/kg
Specific heat of liquid steel	0.82000	kJ/(kg·K)
Slag per tonne of steel	120.00	kg/t
Slag heat content	2.0000	MJ/kg
Chemical energy (oxygen, fuel) per tonne	600.00	kJ/kg
Electrical-to-bath efficiency	70.000	%
Active power to the arc	80.000	MW
Tap weight	120.00	t
Charge temperature	25.000	°C

Calculated results

Parameter	Value	Unit
Heat in liquid steel	384.72	kWh/t
Heat in slag	66.667	kWh/t
Electrical energy	406.75	kWh/t
Power-on time	36.607	min

Notes for this case

• Steel heat = c_s(T_m − T₀) + L_f + c_l(T_tap − T_m), about 380–400 kWh/t at 1,640 °C; add slag heat, subtract chemical energy from oxygen and burners, divide by the electrical efficiency to the bath. Modern scrap furnaces use about 350–450 kWh/t of electricity; hot metal, DRI and preheated scrap change this a lot.

Formula and method

$$h_{st} = c_s(T_m - T_0) + L_f + c_l(T_{tap} - T_m), \quad e_{el} = \frac{h_{st} + m_{sl}h_{sl} - q_{chem}}{\eta_e}, \quad t_{on} = \frac{e_{el}m_{tap}}{P}$$

Variables

T_{tap}	Tapping temperature	K
T_m	Melting temperature	K
c_s	Mean specific heat of solid steel	J/(kg·K)
L_f	Latent heat of fusion	J/kg
c_l	Specific heat of liquid steel	J/(kg·K)
m_{sl}	Slag per tonne of steel	kg/kg
h_{sl}	Slag heat content	J/kg

q_{chem}	Chemical energy (oxygen, fuel) per tonne	J/kg
η_e	Electrical-to-bath efficiency	-
P	Active power to the arc	W
m_{tap}	Tap weight	kg
T_0	Charge temperature	K
h_{st}	Heat in liquid steel	J/kg
e_{el}	Electrical energy	J/kg
t_{on}	Power-on time	s

Method and standards

EAF energy.

Assumptions and limits

- Mean properties; losses lumped in the efficiency.

References

EAF energy balance

Report details

Report reference	FCC-E13Z-NV5K (the same inputs always give the same reference)
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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/arc-furnace-energy-per-tonne

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.