CFBC Solids Circulation Rate and Circulation Ratio

Solids circulation rate of a circulating fluidised bed boiler from the riser solids flux, the circulation ratio to fuel, and the heat the returning solids carry.

Method: Mass and heat balance on the solids loop

Input parameters

Unit system: SI

Parameter	Value	Unit
Riser (furnace) cross-section	30.000	m²
Net solids flux up the riser From a loop-seal or pressure-profile measurement, or the boiler maker's design.	10.000	kg/(m²·s)
Fuel firing rate	20.000	t/h
Specific heat of the solids	0.83736	kJ/(kg·K)
Solids temperature leaving the furnace	870.00	°C
Solids temperature returning to the furnace Lower than the furnace when an external heat exchanger cools the returning solids; equal otherwise.	820.00	°C

Calculated results

Parameter	Value	Unit
Solids circulation rate	1,080.0	t/h
Circulation ratio (solids per kg fuel)	54.000	kg/kg
Heat given up by the circulating solids	12,560	kW

Formula and method

$$\dot{m}_s = G_s A_r$$

$$\dot{m}_s / \dot{m}_f$$

$$Q_s = \dot{m}_s c_s (T_1 - T_2)$$

Variables

A_r	riser cross-section	m²
G_s	net solids flux up the riser	kg/(m²·s)
$\dot{m}_f$	fuel firing rate	kg/s
c_s	specific heat of the solids	J/(kg·K)
T_1	solids temperature leaving the furnace	K
T_2	solids temperature returning	K
$\dot{m}_s$	solids circulation rate	kg/s
$\dot{m}_s/\dot{m}_f$	circulation ratio	kg/kg
Q_s	heat given up by the solids	W

Method and standards

The circulation rate is the net upward solids flux times the riser cross-section; the ratio to fuel is the usual design figure. The heat the solids give up between leaving the furnace and returning (in an external heat exchanger, or none) is circulation rate times specific heat times temperature drop. Default solids specific heat is FireCAD's ash value, 0.2 Btu/(lb·°F).

Assumptions and limits

- Net solids flux is an input, from measurement or design.
- Mean specific heat of the solids.

- Steady circulation.

References

- Mass and heat balance on the solids loop

Report details

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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/boilers-power-plant/fluidised-bed/cfbc-circulation-rate

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Reopens the calculator with the inputs of this report.