FBC Bed Inventory, Bed Drain and Sand Make-Up

Bed inventory of a fluidised bed boiler, the bed drain rate that holds the bed level, the residence time of bed material and the daily sand make-up.

Method: Mass balance on the bed

Input parameters

Unit system: SI

Parameter	Value	Unit
Bed plan area	20.000	m²
Static (settled) bed height	400.00	mm
Bulk density of the settled bed	1,500.0	kg/m³
Fuel firing rate	10.000	t/h
Ash in fuel, as fired	30.000	%
Share of the ash that leaves as bed drain The rest leaves as fly ash; from ash weighings or the boiler maker.	30.000	%
Sand make-up rate	0.20000	t/h
Share of make-up sand lost as fines with the fly ash	20.000	%

Calculated results

Parameter	Value	Unit
Bed inventory	12.000	t
Bed drain rate to hold the level	1.0600	t/h
Mean residence time of bed material	11.321	h
Sand make-up per day	4.8000	t
Sand carried out with the fly ash	40.000	kg/h

Notes for this case

- Steady bed level: the solids that stay in the bed are drained at the rate they arrive. Limestone residue, if limestone is fed, and unburnt carbon add to the drain; they are not included.

Formula and method

$$W_b = A_b H_s \rho_b$$

$$\dot{m}_d = \dot{m}_f A f_b + \dot{m}_{mu}(1 - e)$$

$$\tau = W_b / \dot{m}_d$$

$$W_{mu} = \dot{m}_{mu} \times 86\,400 \text{ s}, \quad \dot{m}_{fs} = e\,\dot{m}_{mu}$$

Variables

A_b	bed plan area	m²
H_s	static (settled) bed height	m
ρ_b	bulk density of the settled bed	kg/m³
$\dot{m}_f$	fuel firing rate	kg/s
A	ash in fuel, as fired	-
f_b	share of the ash drained from the bed	-
$\dot{m}_{mu}$	sand make-up rate	kg/s
e	share of make-up lost as fines	-

W_b	bed inventory	kg
$\dot{m}_d$	bed drain rate	kg/s
$\mathcal{T}$	mean residence time	s
W_{mu}	sand make-up per day	kg
$\dot{m}_{fs}$	sand carried out with the fly ash	kg/s

Method and standards

A steady mass balance on the bed: to hold the level, solids are drained at the rate they arrive and stay. The inventory is the settled bed volume times its bulk density; the mean residence time is inventory over drain rate.

Assumptions and limits

- Steady bed level and size distribution.
- Limestone and its residue not included; unburnt carbon in the drain not included.
- Bulk density of the settled bed, not of the particles.

References

- Mass balance on the bed

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/bed-material-make-up

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.