Grate Boiler Air Split: Undergrate Zones and Overfire Air

Total combustion air of a grate-fired boiler, the overfire air, the undergrate air to each of four grate zones and the undergrate air per m² of grate.

Method: Combustion air mass balance

Input parameters

Unit system: SI

Parameter	Value	Unit
Fuel firing rate	10.000	t/h
Stoichiometric air per kg fuel Dry air per kg of fuel as fired, from the combustion calculator for the fuel analysis. The results are then dry air; add the air humidity for wet air flows.	5.5000	kg/kg
Excess air	35.000	%
Overfire air share of the total air	25.000	%
Zone 1 (front) share of the undergrate air	15.000	%
Zone 2 share	35.000	%
Zone 3 share	35.000	%
Zone 4 (rear) share	15.000	%
Active grate area	25.000	m²

Calculated results

Parameter	Value	Unit
Total combustion air	74.250	t/h
Overfire air	18.562	t/h
Undergrate air	55.688	t/h
Air to zone 1	8.3531	t/h
Air to zone 2	19.491	t/h
Air to zone 3	19.491	t/h
Air to zone 4	8.3531	t/h
Undergrate air per m² of grate	0.61875	kg/(m²·s)

Formula and method

$$\dot{m}_a = \dot{m}_f a_{st}(1 + EA)$$

$$\dot{m}_{OFA} = f_{OFA}\dot{m}_a, \quad \dot{m}_{UGA} = (1 - f_{OFA})\dot{m}_a$$

$$\dot{m}_i = z_i \dot{m}_{UGA}, \quad G_{UGA} = \dot{m}_{UGA}/A_g$$

Variables

$\dot{m}_f$	fuel firing rate	kg/s
a_{st}	stoichiometric air per kg fuel	kg/kg
EA	excess air	-
f_{OFA}	overfire air share	-
z_1	zone 1 share of undergrate air	-
z_2	zone 2 share	-
z_3	zone 3 share	-

z_4	zone 4 share	-
z_i	share of zone i	-
A_g	active grate area	m²
$\dot{m}_a$	total combustion air	kg/s
$\dot{m}_{OFA}$	overfire air	kg/s
$\dot{m}_{UGA}$	undergrate air	kg/s
$\dot{m}_1$	air to zone 1	kg/s
$\dot{m}_2$	air to zone 2	kg/s
$\dot{m}_3$	air to zone 3	kg/s
$\dot{m}_4$	air to zone 4	kg/s
$\dot{m}_i$	air to zone i	kg/s
G_{UGA}	undergrate air per m² of grate	kg/(m²·s)

Method and standards

Total air is the stoichiometric air for the fuel times one plus the excess air. The overfire share is taken off the top; the rest is split between the grate zones by the chosen shares, which must add up to 100 %.

Assumptions and limits

- Air leakage through grate seals not included.
- Stoichiometric air from the combustion calculator for the fuel, as dry air per kg of fuel as fired; the flows are dry air.
- A note appears when the overfire share is outside 20–35 %. The undergrate air per m² is not checked against a limit; the grate maker gives the range for the fuel.
- Four zones; merge or split shares for other grates.

References

- Combustion air mass 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/boilers-power-plant/combustion/undergrate-air-split

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.