Primary, Secondary and Over-Fire Air Split

Primary (PA), secondary (SA) and over-fire air flows in kg/s and actual m³/h from the total combustion air and the split for grate, AFBC, CFBC or PF firing.

Method: Ideal-gas humid air density; ASME PTC 4-2013 (air composition)

Input parameters

Unit system: SI

Parameter	Value	Unit
Total combustion air (wet) From the combustion air flow or FD fan sizing calculator.	93,600	kg/h
Primary air share Set by the firing system and the boiler maker.	40.000	%
Over-fire air share (0 if none)	15.000	%
Air temperature at the PA fan inlet Hot-air PA fans in some PF and AFBC plants take air after the air heater.	35.000	°C
Air temperature at the SA fan inlet	35.000	°C
Pressure at the fan inlets (absolute)	1.0132	bar
Air humidity (kg water per kg dry air)	0.013000	kg/kg

Calculated results

Parameter	Value	Unit
Primary air	37,440	kg/h
Secondary air	42,120	kg/h
Over-fire air	14,040	kg/h
Primary air, actual volume at the PA fan	32,938	m³/h
Secondary air, actual volume at the SA fan	37,056	m³/h
Over-fire air, actual volume (SA fan conditions)	12,352	m³/h
Secondary air share	45.000	%
Air density at the PA fan	1.1367	kg/m³
Air density at the SA fan	1.1367	kg/m³

Formula and method

$$\dot{m}_{PA} = x_{PA}\,\dot{m}_a \qquad \dot{m}_{OFA} = x_{OFA}\,\dot{m}_a \qquad \dot{m}_{SA} = \dot{m}_a - \dot{m}_{PA} - \dot{m}_{OFA} \qquad x_{SA} = 1 - x_{PA} - x_{OFA}$$

$$\rho = \frac{(1+\omega)\,p}{\left(\frac{1}{M_{da}} + \frac{\omega}{M_w}\right) RT} \qquad \dot{V}_{PA} = \frac{\dot{m}_{PA}}{\rho_{PA}} \qquad \dot{V}_{SA} = \frac{\dot{m}_{SA}}{\rho_{SA}} \qquad \dot{V}_{OFA} = \frac{\dot{m}_{OFA}}{\rho_{SA}}$$

Variables

$\dot{m}_a$	total combustion air, wet	kg/s
x_{PA}	primary air share	–
x_{OFA}	over-fire air share	–
T_{PA}	air temperature at the PA fan inlet	K
T_{SA}	air temperature at the SA fan inlet	K
p	pressure at the fan inlets	Pa
ω	air humidity	kg/kg

$\dot{m}_{PA}$	primary air	kg/s
$\dot{m}_{SA}$	secondary air	kg/s
$\dot{m}_{OFA}$	over-fire air	kg/s
$\dot{V}_{PA}$	primary air, actual volume	m³/s
$\dot{V}_{SA}$	secondary air, actual volume	m³/s
$\dot{V}_{OFA}$	over-fire air, actual volume	m³/s
x_{SA}	secondary air share	–
ρ_{PA}	air density at the PA fan	kg/m³
ρ_{SA}	air density at the SA fan	kg/m³
M_{da} M_w	molar mass of dry air and water	kg/kmol
R	universal gas constant, 8 314.46	J/(kmol·K)

Method and standards

Mass split of the combustion air; humid-air densities by the ideal-gas law with the ASME PTC 4-2013 dry-air molar mass.

Assumptions and limits

- Over-fire air is taken from the SA fan (at SA conditions); if it has its own fan, use that fan's temperature.
- Seal air, coal-feeder air and sweep air are not split out; include them in the shares.
- Both fans are taken at the same inlet pressure; the fans' pressure rise and the air heater leakage on each side are not modelled (add leakage to the fan flows yourself).
- The shares are not checked against typical values for the firing system; they come from the boiler maker.

References

Ideal-gas humid air density; ASME PTC 4-2013 (air composition)

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/boiler-auxiliaries/sa-pa-fan-air-split

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Reopens the calculator with the inputs of this report.