FD Fan Sizing (Forced Draught Fan)

Forced draught fan design flow, pressure, power and motor from the fuel analysis, firing rate, excess air, air-side resistances and site conditions.

Method: ASME PTC 4-2013 (air composition); ISO 5801 (fan power); ...

Input parameters

Unit system: SI

Parameter	Value	Unit
Carbon	45.000	%
Hydrogen	3.5000	%
Oxygen	5.0000	%
Nitrogen	1.0000	%
Sulphur	0.50000	%
Ash	35.000	%
Moisture	10.000	%
Fuel firing rate at MCR	12,000	kg/h
Excess air	20.000	%
Air humidity (kg water per kg dry air)	0.013000	kg/kg
Air temperature at the fan inlet The highest summer temperature gives the largest volume.	35.000	°C
Flow margin 20 % when the fan is sized from the boiler duty (peak load is 110 % of rating, plus wear and leakage). Default from FireCAD design practice; enter your specification's value.	20.000	%
Fans sharing the duty (1 = each fan 100 %)	1.0000	
Site pressure from	Altitude (ISO 2533 standard atmosphere)	
Site altitude above sea level	0	m
Barometric pressure at the site (absolute)	1.0132	bar
Air heater, air side	122.37	mmWC
Ducts, dampers and silencer	61.183	mmWC
Burner, windbox or grate and bed	152.96	mmWC
Pressure margin Enter your specification's pressure margin, if any.	0	%
Fan efficiency From the fan maker at the duty point. Default from FireCAD design practice; enter your specification's value.	80.000	%
Motor margin over the power absorbed 10 % for fan motors. Default from FireCAD design practice; enter your specification's value.	10.000	%

Calculated results

Parameter	Value	Unit
Design volume flow per fan (at the fan inlet)	95,261	m^3/h
Design fan pressure	336.51	mmWC
Standard motor rating (IEC 60072-1 to 1000 kW, R20 series	132.00	kW

Parameter	Value	Unit
above)		
Minimum motor rating (absorbed + margin)	120.07	kW
Power absorbed at the design point	109.15	kW
Design mass flow per fan (wet air)	108,280	kg/h
Air density at the fan inlet	1.1367	kg/m³
Barometric pressure used	1.0132	bar

Formula and method

$$\dot{m} = \dot{m}_f m_a (1+\omega)\frac{1+m_Q}{n} \qquad \rho = \frac{(1+\omega)\,p}{\left(\frac{1}{M_{da}}+\frac{\omega}{M_w}\right) R T_a} \qquad \dot{V} = \frac{\dot{m}}{\rho}$$

$$\Delta p = (\Delta p_{ah} + \Delta p_d + \Delta p_b)(1+m_p) \qquad P_s = \frac{\dot{V}\Delta p}{\eta_f} \qquad P_{m,min} = P_s\,(1+m_m)$$

Variables

$C\ H\ O\ N\ S$	carbon, hydrogen, oxygen, nitrogen, sulphur in the fuel as fired	–
A	ash	–
M	moisture	–
$\dot{m}_f$	fuel firing rate at MCR	kg/s
EA	excess air	–
ω	air humidity, kg water per kg dry air	kg/kg
T_a	air temperature at the fan inlet	K
m_Q	flow margin	–
n	fans sharing the duty	–
site	site pressure from altitude or entered	–
z	site altitude	m
p_s	barometric pressure entered	Pa
Δp_{ah}	air heater, air side	Pa
Δp_d	ducts, dampers and silencer	Pa
Δp_b	burner, windbox or grate and bed	Pa
m_p	pressure margin	–
η_f	fan efficiency	–
m_m	motor margin	–
$\dot{V}$	design volume flow per fan	m³/s
Δp	design fan pressure	Pa
P_{std}	standard motor rating	W
$P_{m,min}$	minimum motor rating	W
P_s	power absorbed	W
$\dot{m}$	design mass flow per fan	kg/s
ρ	air density at the fan inlet	kg/m³
p	barometric pressure used	Pa
m_a	dry air per kg of fuel	kg/kg

M_{da} M_w	molar mass of dry air and water	kg/kmol
R	universal gas constant, 8314.46 (per kmol, to match M in kg/kmol)	J/(kmol·K)

Method and standards

Combustion air from the exact-ratio balance with the ASME PTC 4-2013 air composition; humid-air density by the ideal-gas law; site pressure from ISO 2533; fan power as defined in ISO 5801; motor ratings from IEC 60072-1. Default efficiency and margins are FireCAD design practice (owner, 2026-11-10).

Assumptions and limits

- Resistances at MCR flow; the pressure margin covers fouling and uncertainty if your specification asks for it.
- Air heater leakage to the gas side is not added to the FD fan flow; add it to the excess air if the air heater leaks significantly.
- Incompressible fan power; above about 5 kPa the true power is slightly lower (ISO 5801).
- The air is for complete combustion of all the fuel carbon (no unburnt-carbon deduction); the fan inlet static pressure is taken as the barometric pressure.
- The site altitude is used as the geopotential altitude of ISO 2533; the difference from height above sea level is negligible below 5000 m.
- Motor ratings follow IEC 60072-1 up to 1000 kW and an R20 preferred-number series above.

References

ASME PTC 4-2013 (air composition), ISO 5801 (fan power), ISO 2533 (site pressure), IEC 60072-1 (motor ratings)

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/fd-fan-sizing

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Reopens the calculator with the inputs of this report.