ID Fan Sizing (Induced Draught Fan)

Induced draught fan design flow, pressure, power and motor from the fuel analysis, firing rate, excess air, air in-leakage and gas temperature, with the cold-start power.

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 in-leakage up to the fan, as a share of combustion air Leakage at the air heater, casing, dust collector and ducts. Enter your design value.	10.000	%
Gas temperature at the fan inlet	140.00	°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
Suction at the fan inlet (below barometric) Sets the gas density at the inlet.	203.94	mmWC
Fan pressure required at MCR (from the draught balance)	254.93	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	%
Air temperature for the cold-start check	30.000	°C

Calculated results

Parameter	Value	Unit
Design volume flow per fan (at the fan inlet)	151,365	m^3/h

Parameter	Value	Unit
Design fan pressure	254.93	mmWC
Standard motor rating (IEC 60072-1)	160.00	kW
Minimum motor rating (absorbed + margin)	144.53	kW
Power absorbed at the design point	131.39	kW
Power with cold air at the same speed and flow	176.71	kW
Design mass flow per fan	128,468	kg/h
Gas density at the fan inlet	0.84873	kg/m³
Molar mass of the gas	29.353	kg/kmol
Absolute pressure at the fan inlet	0.99325	bar

Notes for this case

- Started on cold air at the same speed and flow the fan absorbs 177 kW, more than the 160 kW motor: start with the inlet damper or vanes closed, use a variable speed drive, or choose a motor that covers the cold start.

Formula and method

$$\dot{m}_g = \dot{m}_f \left[m_g + l\, m_a (1+\omega) \right] \qquad \dot{n}_g = \dot{m}_f \left[n_g + l \left(\frac{m_a}{M_{da}} + \frac{m_a\, \omega}{M_w} \right) \right] \qquad M_g = \frac{\dot{m}_g}{\dot{n}_g}$$

$$p_{in} = p - \Delta p_{in} \qquad \rho_g = \frac{p_{in}\, M_g}{R\, T_g} \qquad \dot{m} = \dot{m}_g \frac{1+m_Q}{n} \qquad \dot{V} = \frac{\dot{m}}{\rho_g}$$

$$\Delta p = \Delta p_{req} (1+m_p) \qquad P_s = \frac{\dot{V} \Delta p}{\eta_f} \qquad P_{m,min} = P_s (1+m_m) \qquad P_c = P_s \frac{\rho_{air}(T_c)}{\rho_g}$$

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/kg
l	air in-leakage as a share of combustion air	–
T_g	gas 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_{in}	suction at the fan inlet	Pa
Δp_{req}	fan pressure required at MCR	Pa
m_p	pressure margin	–
η_f	fan efficiency	–
m_m	motor margin	–
T_c	air temperature at a cold start	K

$\dot{V}$	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
P_c	power on cold air at the same speed and flow	W
$\dot{m}$	design mass flow per fan	kg/s
ρ_g	gas density at the fan inlet	kg/m³
M_g	molar mass of the gas	kg/kmol
p_{in}	absolute pressure at the fan inlet	Pa
m_g n_g	wet flue gas per kg of fuel, by mass and in kmol	kg/kg, kmol/kg
m_a	dry air per kg of fuel	kg/kg
p	barometric pressure	Pa

Method and standards

Flue gas from the exact-ratio combustion balance with ASME PTC 4-2013 air, plus air in-leakage; ideal-gas density at the fan inlet; site pressure from ISO 2533; fan power as V Δp / η with the fan pressure and efficiency on the same basis (both total or both static), in the ISO 5801 form with the compressibility coefficient taken as 1, which slightly overstates the power at high fan pressures (a few per cent at 10 kPa); motor ratings IEC 60072-1. The cold-start power follows the fan laws at constant speed and volume (power in proportion to density). Default efficiency and margins are FireCAD design practice (owner, 2026-11-10).

Assumptions and limits

- Gas temperature at the fan inlet is your design value; the leaking air is taken as already mixed in at that temperature.
- Fly ash is not part of the gas flow.
- The cold-start check assumes the fan reaches full speed with the dampers open on ambient air; real starts are usually made with dampers closed. The cold air is taken as dry, at the same inlet pressure as the hot design case.
- Only the mass flow carries a margin; for a fouled or aged boiler, enter the higher gas temperature yourself.

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/id-fan-sizing

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Reopens the calculator with the inputs of this report.