Stack Gas Velocity and Flow by Pitot Tube

Flue gas velocity and flow in a stack or duct from a pitot tube's velocity pressure, pitot coefficient and gas temperature, pressure and molar mass, also at normal conditions.

Method: Pitot-tube velocity equation; the principle of US EPA Method 2

Input parameters

Unit system: SI

Parameter	Value	Unit
Average velocity pressure (pitot reading)	250.00	Pa
Pitot tube coefficient From the pitot's calibration; S-type tubes are about 0.84, standard (Prandtl) tubes about 0.99.	0.84000	
Gas temperature	140.00	°C
Gas pressure in the stack (absolute)	0.99500	bar
Molar mass of the wet gas	29.500	kg/kmol
Stack inside diameter	2.5000	m

Calculated results

Parameter	Value	Unit
Gas velocity	20.319	m/s
Actual volume flow	359,075	m³/h
Flow at normal conditions (wet)	233,123	Nm³/h
Gas density in the stack	0.85448	kg/m³

Notes for this case

- Average the square roots of the velocity pressures over a traverse, not the pressures themselves; a single point does not give the mean velocity.

Formula and method

$$\rho = \frac{p\,M}{R\,T} \qquad v = C_p\sqrt{\frac{2\,\Delta p}{\rho}} \qquad \dot{V} = v\,\frac{\pi D^2}{4} \qquad \dot{V}_n = \dot{V}\,\frac{p}{p_n}\,\frac{T_n}{T}$$

Variables

Δp	velocity pressure	Pa
C_p	pitot coefficient	–
T	gas temperature	K
p	gas pressure	Pa
M	molar mass of the wet gas	kg/kmol
D	stack diameter	m
v	velocity	m/s
$\dot{V}$	actual flow	m³/s
$\dot{V}_n$	flow at normal conditions	Nm³/s
ρ	gas density	kg/m³
R	universal gas constant	J/(kmol·K)
p_n, T_n	101 325 Pa and 273.15 K	Pa, K

Method and standards

Pitot-tube equation with ideal-gas density, the principle behind US EPA Method 2; flow at normal conditions by the ideal-gas law.

Assumptions and limits

- Ideal gas; uniform flow across each traverse point.
- The normal flow is on a wet basis; for emission reporting convert to dry gas (multiply by 1 − the water vapour fraction) and to the reference O_2 separately.

References

- Pitot-tube velocity equation
- the principle of US EPA Method 2

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/instrumentation/flow/pitot-stack-velocity

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.