eyc-tech

Common Airflow Conversion Table

Air velocity and airflow are critical parameters in fields such as environmental monitoring, HVAC systems, industrial automation, clean air systems, and compressed air systems. Premise measurement and conversion of these parameters are essential for evaluating and optimizing system performance. This document provides a comprehensive guide for converting air velocity and airflow units, helping professionals better understand and apply these conversions.

| Definitions of Air Velocity and Airflow |

■ Air Velocity

Air velocity refers to the movement velocity of air within a pipeline per unit of time, commonly expressed in units such as meters per second (m/s), kilometers per hour (km/h), feet per minute (ft/min), etc.

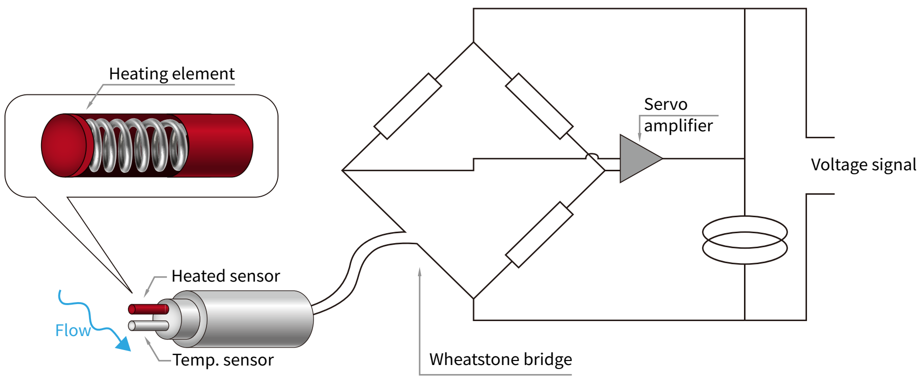
■ Airflow

Airflow refers to the volume of air passing through a cross-section per unit of time. Common units include cubic meters per hour (m^3/h), cubic feet per minute (CFM), cubic meters per second (m^3/s), etc.

| Common Measurement Principles |

Hot-wire Principle

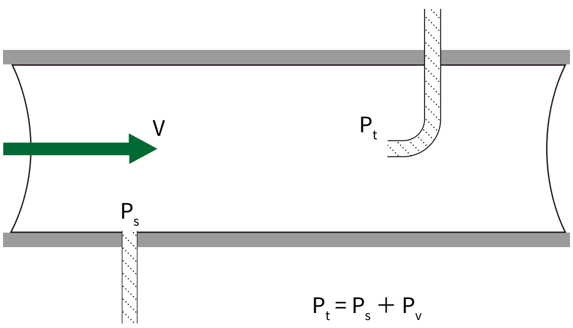
The basic principle of a hot-wire air flow meter is to place a metal wire in a fluid, heat the wire by passing a current through it, and measure the temperature change of the wire caused by the air flow and the amount of heat conducted away by the air flow. This way, the air flow can be calculated based on the wire temperature, heat conduction properties, and air properties. In addition to metal wires, other heating elements can also be used as substitutes.



Differential Pressure Principle

This method measures fluid flow rate based on pressure difference, which includes types of Pitot tube and Venturi tube, is widely used in various flowmeters.

● Pitot tube : Measures the pressure difference between the total pressure and the static pressure to calculate the fluid velocity. The difference between total pressure and static pressure is the dynamic pressure, which is caused by the fluid's velocity. Dynamic pressure is proportional to the square of the air velocity, thus allowing calculation of fluid velocity through the measured dynamic pressure.



$P_t = P_s + P_v$

■ Formula

$$V = \sqrt{\frac{2(P_t - P_s)}{\rho}}$$

V : Velocity

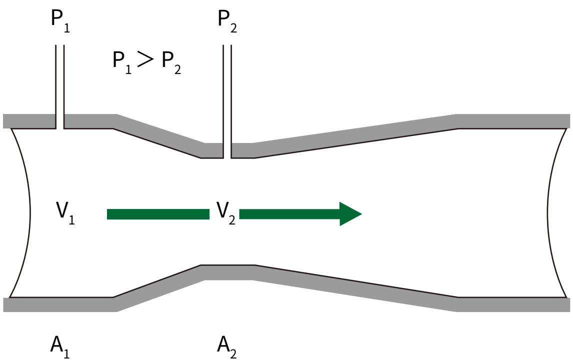
P_t : Total pressure

P_s : Static pressure

P_v : Dynamic pressure

ρ : Density

● Venturi tube : The Venturi tube is a flow measurement device designed based on the Venturi effect and is often used in conjunction with differential pressure transmitters. When flow passes through the narrow center of the Venturi tube, its velocity increases while the pressure decreases; this phenomenon is known as the Venturi effect. According to Bernoulli's principle and the continuity equation, the pressure difference between the inlet section and the narrow center is proportional to the square of the fluid velocity, and the product of the velocity and the cross-sectional area at different points remains constant. Therefore, by measuring the differential pressure, the velocity at the narrow center can be calculated. The Venturi tube has significant advantages in flow measurement, including high accuracy and low pressure loss, allowing for precise measurement while minimizing energy loss. It is suitable for various fluids, including gases, liquids, and steam. Its robust structure, with no moving parts, requires minimal maintenance, reducing operational costs.



■ Formula

$$P_1 - P_2 = \frac{\rho}{2}(V_2^2 - V_1^2)$$

$$A_1V_1 = A_2V_2$$

P_1 : Pressure 1
P_2 : Pressure 2
ρ : Density
V_1 : Velocity 1
V_2 : Velocity 2
A_1 : Cross-sectional area 1
A_2 : Cross-sectional area 2

| Considerations for Measuring Air Velocity and Airflow |

■ Selection of Measurement Location

Choose a location where the airflow is stable. Ensure a straight section of the pipeline according to the product manual. A stable airflow in the straight pipe section minimizes measurement errors.

■ Environmental Conditions

Pay attention to factors like temperature, humidity, and pressure, which can affect air density and transmitter performance, impacting the precision of air velocity calculations and measurements.

■ Calibration and Maintenance

3. Regularly calibrate transmitters to ensure measurement precision.

| Air Velocity to Airflow Conversion |

Airflow is the volume of air passing through a duct cross-section per unit of time. When air velocity and duct cross-sectional area are known, airflow can be calculated. Common airflow units are cubic meters per second (m^3/s) or cubic meters per hour (m^3/h), and the shape of the duct affects the cross-sectional area calculation.

Conversion Formula for Air Velocity to Airflow

Air Flow = Cross-sectional area X Air Velocity

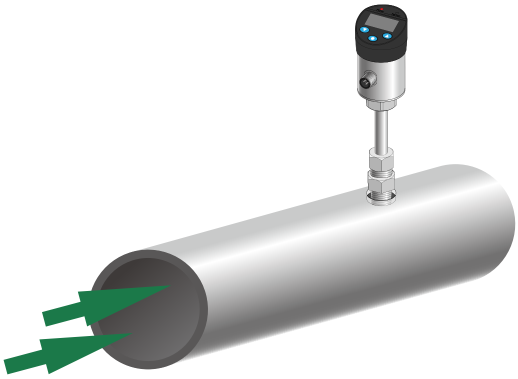
■ Circular Duct Calculation Example

- Working conditions

Radius : 0.025 m

Air velocity : 60 m/s

Airflow (CMS) = 0.025*0.025*3.1416*60 = 0.11781 m^3/s



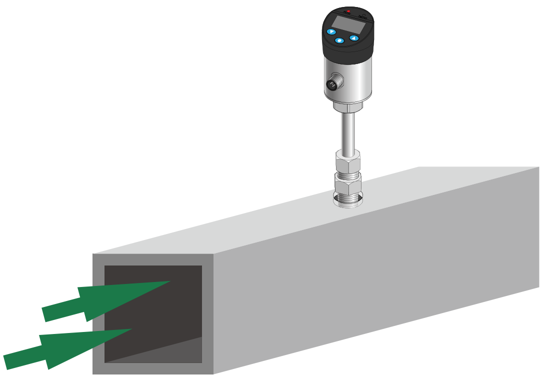
■ Square Duct Calculation Example

- Working conditions

Both length : 0.2 m

Air velocity : 10 m/s

Airflow (CMS) = 0.2*0.2*10 = 0.4 m^3/s



* The above calculations ignore installation angle, depth, and pressure loss during transmitter installation.

| Common Unit Conversions |

Airflow Unit Conversion

Find the initial unit in the first row (e.g., CFS).

Convert to the desired unit in the corresponding column (e.g., CFM, CMS).

Calculation Example : 1 CFS = 60 CFM = 0.0283 CMS

10 CFS = 600 CFM = 0.283 CMS

Step 2 ⬇

Step 1 ➡

Unit	CFS	CFM	CMS	CMM	CMH	L/s	L/min
CFS	1	60	0.0283	1.698	101.9	28.3	1690
CFM	0.167	1	0.00047	0.0283	1.698	0.472	28.3
CMS	35.3	2118	1	60	3600	1000	60000
CMM	0.588	35.35	0.0167	1	60	16.7	1000
CMH	0.00981	0.588	0.000277	0.0167	1	0.277	16.7
L/s	0.0353	2.118	0.001	0.06	3.6	1	60
L/min	0.000588	60	0.0000167	0.001	0.06	0.0167	1

CFS : Cubic Feet Per Second (ft^3/s)

CFM : Cubic Feet Per Minute (ft^3/min)

CMS : Cubic Meter Per Second (m^3/s)

CMM : Cubic Meter Per Minute (m^3/min)

CMH : Cubic Meter Per Hour (m^3/h)

L/s : Liter Per Second (L/s)

L/min : Liter Per Minute (L/min)

Air Velocity Unit Conversion

1 ft/min = 1/60 ft/s = 0.00508 m/s = 0.3048 m/min

Calculation Example : 10 ft/min = 1/6 ft/s = 0.0508 m/s = 3.048 m/min

Air flow - Conversion Table

Air velocity and Airflow Conversion Table

Find the pipe diameter (DN).

Find the internal velocity (m/s).

Match the value in the white area to find the internal airflow.

For example: DN15(1/2”), internal velocity 5m/s ➡ internal airflow 3.2m³/h

	ID of pipe	Step 2 ⬇ Air velocity inside pipe						
		5m/s	10m/s	20m/s	40m/s	60m/s	90m/s	120m/s
Step 1 ➡	DN15 (1/2")	3.2 m³/h	6.4 m³/h	12.7 m³/h	25.4 m³/h	38.2 m³/h	57.3 m³/h	76.3 m³/h
	DN25 (1")	8.8 m³/h	17.7 m³/h	35.3 m³/h	70.7 m³/h	106 m³/h	159 m³/h	212.1 m³/h
	DN40 (1.5")	22.6 m³/h	45.2 m³/h	90.5 m³/h	181 m³/h	271.4 m³/h	407.2 m³/h	542.9 m³/h
	DN50 (2")	35.3 m³/h	70.7 m³/h	141.4 m³/h	282.7 m³/h	424.1 m³/h	636.2 m³/h	848.2 m³/h
	DN80 (3")	90.5 m³/h	181 m³/h	361.9 m³/h	723.8 m³/h	1085.7 m³/h	1628.6 m³/h	2171.5 m³/h
	DN100 (4")	141.4 m³/h	282.7 m³/h	565.5 m³/h	1131 m³/h	1696.5 m³/h	2544.7 m³/h	3392.9 m³/h
	DN125 (5")	220.9 m³/h	441.8 m³/h	883.6 m³/h	1767.2 m³/h	2650.7 m³/h	3976.1 m³/h	5301.5 m³/h
	DN150 (6")	318.1 m³/h	636.2 m³/h	1272.3 m³/h	2544.7 m³/h	3817 m³/h	5725.6 m³/h	7634.1 m³/h

| Differential Pressure to Air Velocity Conversion |

The conversion between differential pressure (Pa) and air velocity (m/s) is usually applied while using devices such as Pitot tubes. These devices can measure the total pressure and static pressure of the fluid within the pipeline. The difference between these two values is the dynamic pressure, which can be used to calculate the air velocity.

Conversion Table

Differential pressure (Pa) and air velocity (m/s) conversion as below

Diff Pressure Value (Dynamic pressure)				Air Velocity			
inAq	mmAQ	mBar	Pa	ft/min	ft/s	m/s	m/min
0.004	0.10	0.01	1	254	4.2	1.29	77
0.008	0.20	0.02	2	359	6.0	1.82	109
0.012	0.31	0.03	3	439	7.3	2.23	134
0.020	0.51	0.05	5	567	9.5	2.88	173
0.040	1.02	0.1	10	802	13.4	4.07	244
0.101	2.55	0.25	25	1268	21.1	6.44	386
0.202	5.10	0.5	50	1793	29.9	9.11	547
0.304	7.65	0.75	75	2196	36.6	11.16	669
0.405	10.19	1	100	2536	42.3	12.88	773
1.214	30.58	3	300	4393	73.2	22.31	1339
2.023	50.97	5	500	5671	94.5	28.81	1728
4.047	101.94	10	1000	8020	133.7	40.74	2444
6.475	163.10	16	1600	10144	169.1	51.53	3092
10.117	254.84	25	2500	12680	211.3	64.42	3865
20.235	509.68	50	5000	17933	298.9	91.10	5466
30.352	764.53	75	7500	21963	366.0	111.57	6694
40.470	1019.37	100	10000	25360	422.7	128.83	7730

*The data in the table above are calculated based on the density of air at 1 atmosphere and 20°C, which is 1.205 kg/m³.

| Recommend Transmitters |

Hot-wire Type Air Flow Measurement

FTM94/95

Industrial Transmitter

Features : Resistant to high temperature,
high pressure, dust, and corrosion.
Measuring range : 0 ... 120 m/s
Output : Analog / RS-485
Accuracy : ±1.5% F.S.
IP rating : IP67(Probe) / IP65(Housing)

FTM06D

Industrial Transmitter

Features : Designed for clean air system
Measuring range : 0 ... 120 m/s
Output : Analog / RS-485 / Frequency / Pulse
Accuracy : ±1.5% F.S.
IP rating : IP65

FTM06D-I

Industrial Transmitter

Features : Designed for compressed
dry air system
Measuring range : 0.1 ... 848 m^3/h
Output : Analog / RS-485 / Frequency / Pulse
Accuracy : ±1.5% F.S.
IP rating : IP65

FTS140

HVAC Transmitter

Features : Economic model for HVAC application
Measuring range : 0 ... 20 m/s
Output : 4 ... 20 mA / 0 ... 10 V
Accuracy : ±3% F.S.
IP rating : IP54

FTE120

Small-sized Equipment Transmitter

Features : Compact model for small-sized
equipment
Measuring range : 0 ... 30 m/s
Output : 4 ... 20 mA / 0 ... 10 V / RS-485
Accuracy : ±2% F.S.
IP rating : IP65

Differential Pressure Type Air Flow Measurement

FDM06S

Diff.Pressure Type Air Flow Transmitter

Features : Bi-direction.
Calculate density and flow rate
Measuring range : ± (0.8 ... 40 m/s)
± (20 ... 200 m/s)
Output : Analog / RS-485 / Frequency / Pulse
Accuracy : ±1.5% F.S.
IP rating : P65 (Body) / IP20 (Probe)

AFMT

Average Flow Measuring Tube

Features : Pitot tube for air velocity
Multi-point averaging
Operating pressure : Max.10 bar
Operating temperature : Max.600°C
Length : 4" ... 40"(100 ... 1000 mm)

PHD330

Differential Pressure Transmitter

Features : Industrial model.
Wide measuring range
Measuring range : ±50 ... ±10000 Pa
Output : 4 ... 20 mA / 0 ... 10 V / RS-485
Accuracy : ±2.0% F.S.
IP rating : IP65