Technical Explanation for Axial Fans

Introduction

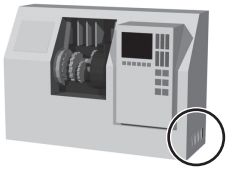
What Is an Axial Fan?

Axial fans are used for stable cooling in many different applications and locations.
If the temperature of a device increases, the lives of its internal parts will be reduced and malfunctions could result.
Particularly devices and parts that generate heat are greatly affected by heat.
Device internal cooling and fan selection are extremely important to long-term usage of the parts inside devices.

Application Examples

Control Panels

Machine Tools

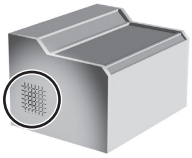


Solder Smoke Absorbers

Measurement Devices

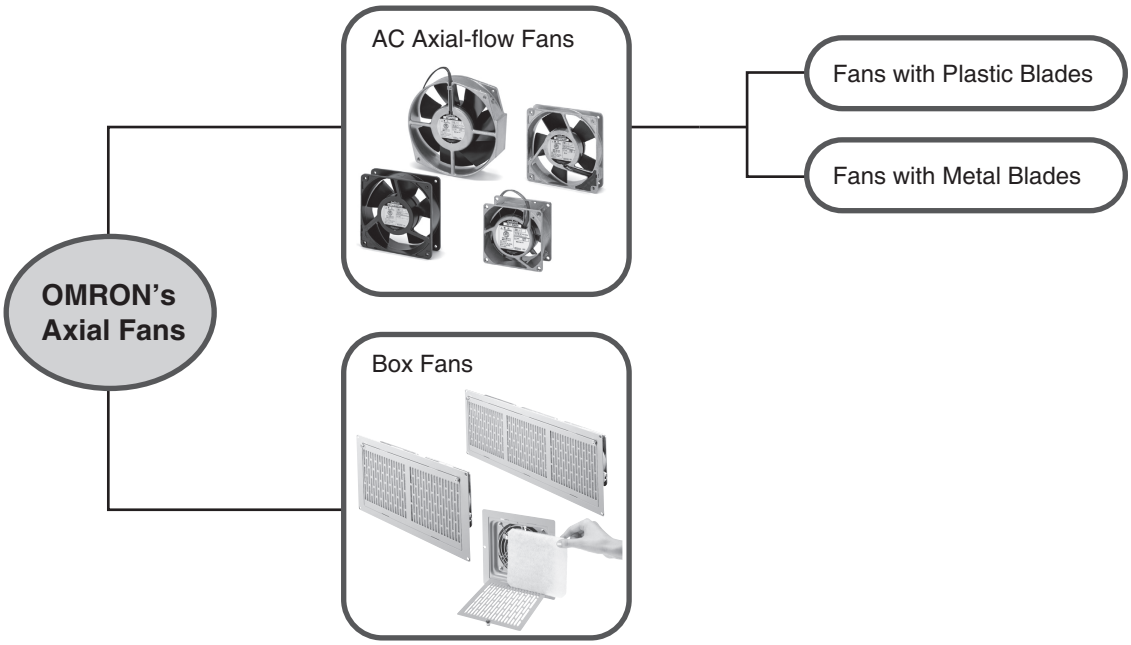
Medical Equipment

Vending Machines and Showcases



Classification

OMRON's Axial Fans are classified as shown below.

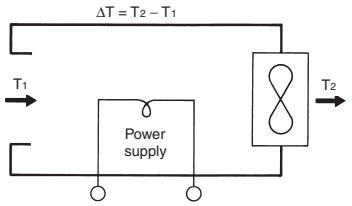


Selecting a Fan

Procedure

(1) Estimate the amount of heat generated (W) inside the Unit.

(2) Set the maximum permitted temperature rise limit (ΔT) inside the Unit.



T1: Temperature of the inlet air (°C).
T2: Temperature of the outlet air (°C).

(3) Calculate the required flow rate.

$$Q = \frac{50\ W}{\Delta T}\ m^3/min$$

Q = flow rate (m^3/min.)
ΔT = permitted temperature rise limit (°C)
(Normally between 8 to 10°C.)
W = amount of heat generated (kW)

(4) Estimate the system impedance from the air flow through the Unit or from previous data.

$$\Delta P = KQ^n$$

ΔP: Pressure drop (Pa)
K: Unit constant
n: Coefficient determined by air flow
n=1: laminar flow
n=2: turbulent flow
(n=2 is the normal value.)

(5) Select the Fan according to the P - Q characteristics.

(6) Measure the temperature rise in an installed Unit.

(7) Reappraise the Fan if the measured cooling effect is insufficient.

The procedure to select a Fan is described above. It is difficult, however, to obtain the actual system impedance. In general, therefore, select a Fan with a maximum flow rate of from 1.3 to 2 times the flow rate required.

As a rough guide, 1.3 times for a small system impedance, 1.5 times for medium, and 2 times for large.

Reconsider the Fan if the cooling effect is insufficient after the selected fan has been installed in the Unit and the temperature rise has been measured.

Explanation of Terms

Nominal Value

The average value of data based on actual measurements. Nominal values cannot be treated as rated values. Ask your OMRON representative for details on rated values.

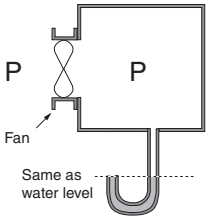
Flow Rate: Q (m^3/min.)

The volume of air discharged by the Fan in a unit of time.

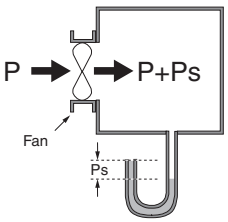
Static Pressure: Ps (Pa)

The pressure difference across the front to the back of the Fan generated by the discharged air, which is unaffected by air flow speed.

(1) The air pressure across the front to the back of the Fan does not change when the Fan is stopped.



(2) Static pressure (Ps) is generated at the front of the Fan when it rotates.

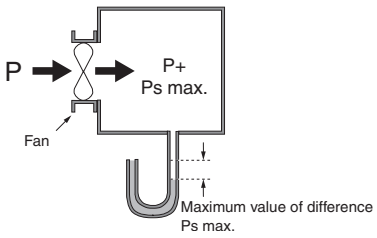


Maximum Flow Rate: Q max. (m^3/min.)

The volume of air discharged by the Fan when the static pressure is adjusted to zero (Pa) at the flow measurement unit.

Maximum Static Pressure: Ps max. (Pa)

The pressure difference inside and outside the Unit when the flow rate is adjusted to zero (0 m^3/min.) at the flow measurement unit. This would be the pressure in front of the Unit when the front of the fan was completely sealed.



System Impedance

The flow resistance inside a mounted Axial Fan caused by the density of parts and shape of the flow path.

Impedance Protection

A method of preventing burning damage when the motor is restricted from rotating by setting the motor winding impedance (AC resistance) to a value giving a temperature rise in the windings below the temperature at which burning occurs.

Thermal Protection

A method of preventing burning damage when the motor is restricted from rotating by setting a thermal element to interrupt operation before the motor reaches a temperature at which burning occurs.

Further Information

Flow Rate and Static Pressure

The characteristic graphs provided for each of the models represent the average of actual measurement data obtained under the measurement conditions given below. They are provided as reference for determining the Fan most suitable for the type of cooling required; the actual characteristics may differ from the values represented in the graphs. The graphs are not intended to guarantee these characteristic values.

A simple explanation of the flow rate/static pressure characteristics and the methods of measuring them is given below.

Note: The following symbols are used in the graph below for the flow rate/static pressure characteristics model: ◎ ○ ◉

◎Maximum Static Pressure, Ps max. (flow rate = 0):
Fully close the damper. Take the pressure difference between chamber B and ambient pressure (Ps). The maximum value of the pressure difference (Ps) is the maximum static pressure (Ps max).

○Intermediate Region, (Q, Ps):
Adjust the auxiliary blower to change the static pressure (Ps). Measure the pressure difference between chamber A and chamber B (Pd). Calculate the flow rate (Q).

◉ Maximum Flow Rate, Q max. (static pressure = 0):
Fully open the damper and adjust the auxiliary blower to set the static pressure to zero (0). Measure the pressure difference between chamber A and chamber B (Pd). Take the flow rate (Q) calculated at this point as the maximum flow rate (Q max.).

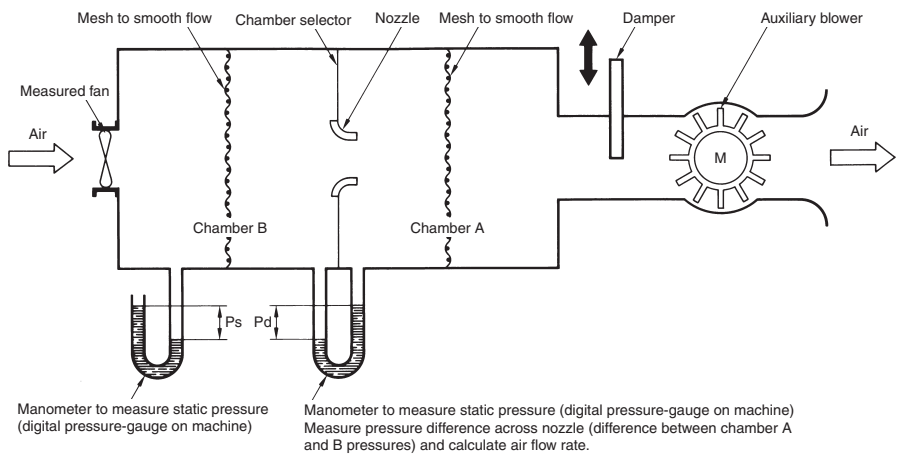
Fan Operating Point:
A Fan installed in equipment operates near the point where the Fan characteristic curve crosses the system impedance curve.

Note: The maximum flow rate and maximum static pressure do not indicate the Fan operating point when it is installed in equipment. However, these characteristics are important for comparing Fan performances and for selecting Fans.

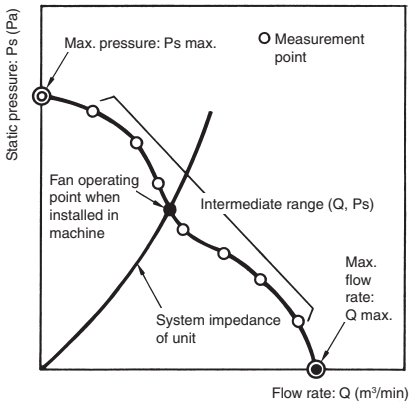
Measurement Conditions

Number of Fans tested	Ambient conditions	Measurement device
5	Temperature: 23 ±2°C Humidity: 65% ±5%	Measurement was performed using the multi-nozzle double chamber method based on AMCA (Air Moving Condition Association, U.S.A.) Standards 270 to 274.

Flow Rate Measurement Device



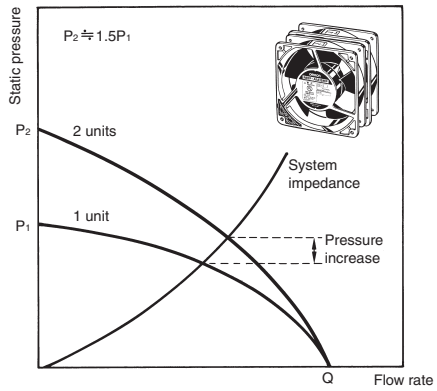
Flow Rate/Static Pressure Characteristic Model



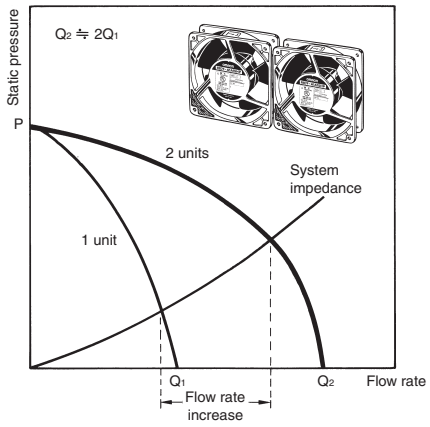
Serial and Parallel Fan Operation

The characteristics of two identical Fans operated in series or parallel are determined as shown in the following diagrams.

Serial Operation:



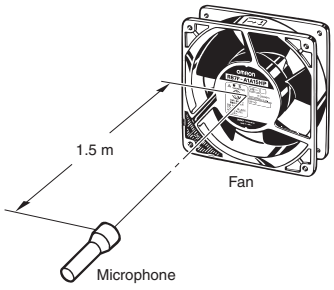
Parallel Operation:



Noise Measurements

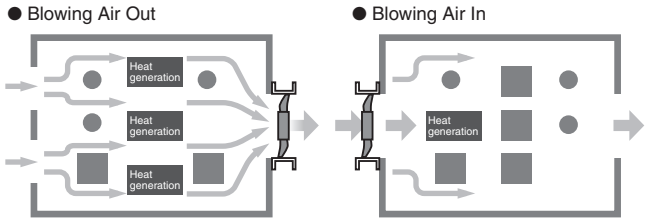
Measurements are performed according to JIS B 8346 (Noise Level Measurement Method for Blowers and Compressors).

Axial fan: Measurement is performed at a position 1.5 m above the center line from the air inlet.



Cooling Effect

Use the location and number of heat-generating elements to determine which is more efficient, blowing air out or blowing air in.



Many Heat-generating Elements in Various Locations	Heat-generating Elements in One Location
The pressure inside the box decreases, so dust can easily enter through other openings.	The pressure inside the box increases, preventing dust from easily enter through other openings.

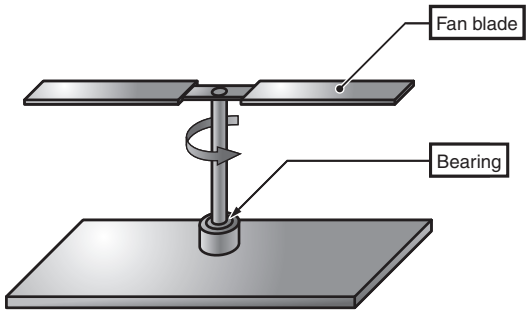
Service Life

The service life of an Axial Fan is generally determined by the bearings.

The following diagram is a simple, mechanical illustration of the Fan structure.

The Fan blade will turn smoothly if the bearings are in normal condition. When there is an abnormality in the bearings, however, the friction between the shaft and the bearings will increase until the blade eventually stops turning.

This is the definition of a Fan's service life.



A mechanical illustration of the Axial Fan structure