Ventilation Fan Principles, Classification and Selection

1.Introduction

- Ventilation fan supplies fresh air or extracts used air with required flow rate over coming duct resistant

Selection parameters

- Volume flow rate in m3/h or liters/s (lps)ps
- Static pressure in pa or mm Wc

Fan Major Types

- Axial Fan

- Centrifugal Fan

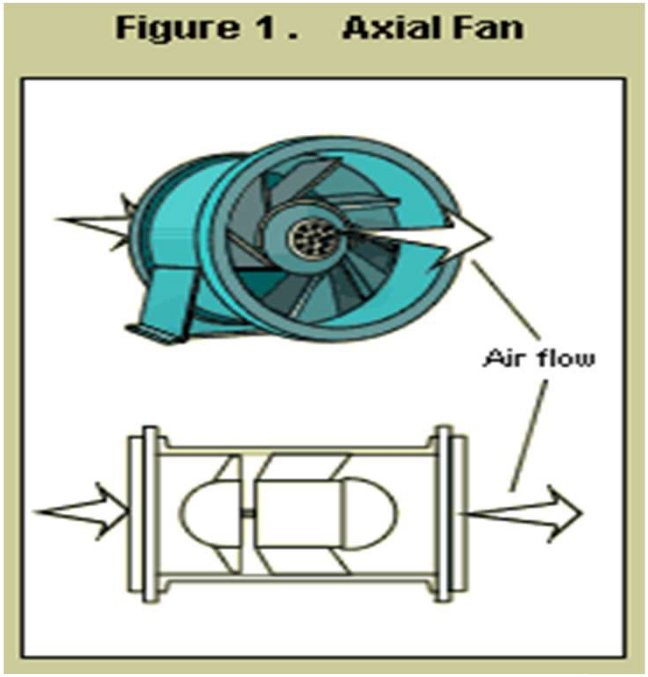
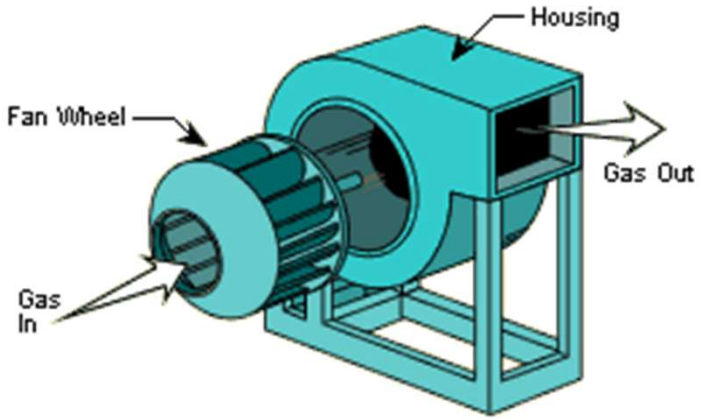
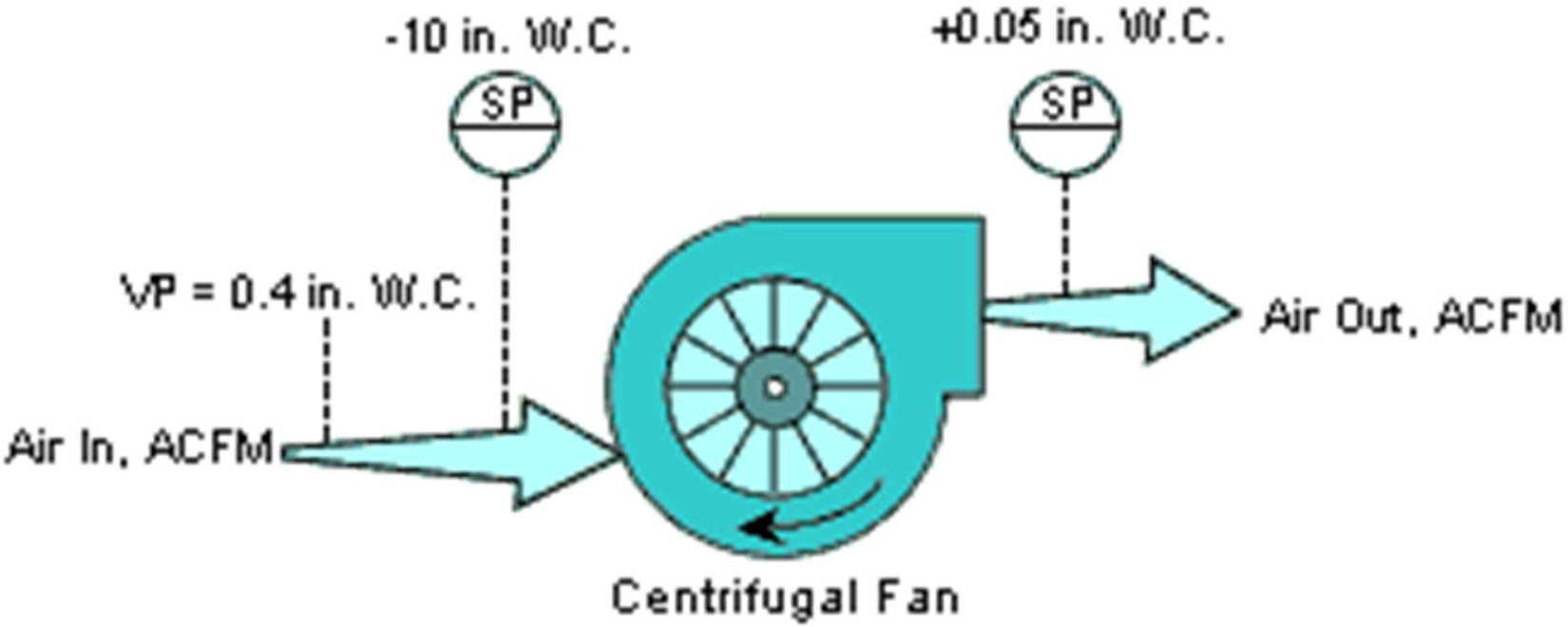


Figure 2. Centrifugal Fan Components



Fan Working Principle

Figure 1. Static Pressure Rise (ΔSP) Across a Fan



Fan ΔSP = [0.05 - (-10) - 0.4] in. W.C.
= 9.65 in. W.C.

Fan Components

The major components of a typical centrifugal fan include the fan wheel, fan housing, drive mechanism, and inlet dampers and/or outlet dampers. A wide variety of fan designs serve different applications. The fan drive determines the speed of the fan wheel and the extent to which this speed can be varied. The types of fan drives can be grouped into three basic categories:

- Direct drive
- Belt drive
- Variable drive

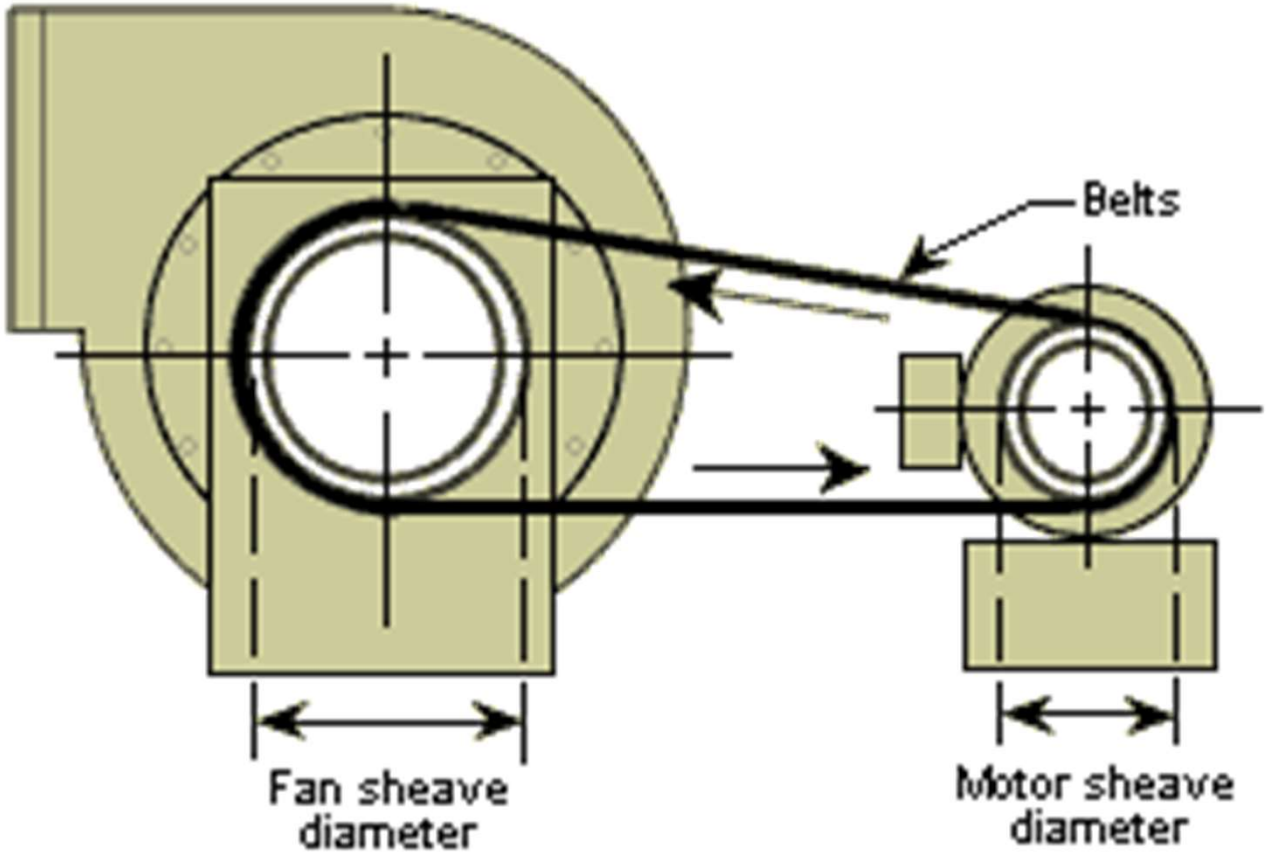
FAN DRIVE

In a **direct drive** arrangement, the fan wheel is linked directly to the shaft of the motor. This means that the fan wheel speed is identical to the motor rotational speed. With this type of fan drive, the fan speed cannot be varied.

Belt driven fans use multiple belts that rotate in a set of sheaves mounted on the motor shaft and the fan wheel shaft.

Belt Driven Centrifugal fan

Figure 3. Centrifugal Fan and Motor Sheaves



FAN DRIVE

Variable drive fans the fan wheel speed cab be varied by varying the motor speed using variable frequency drive. The fan speed controls are often integrated into automated systems to maintain the desired fan performance over a variety of process operating conditions.

2. Flow Parmeters
Velocity in Duct

$$V = \frac{Q}{A * 3600}$$

where:

V = *fluid average speed in m/s*

Q = *flow rate in* m^3/h

A = *duct cross section area in* m^2

Static Pressure

Static pressure (ps)

It is defined as the pressure applied by the fluid to the wall of the duct or of the container in which it's hold. It expresses the potential energy suitable to overcome the resistance given by the system to the fluid transit.

Dynamic Pressure

$$pd = 1/2 * \rho * V^2$$

where:
pd = dynamic pressure in Pa
ρ = fluid density in kg/m^3
V = fluid speed in m/s

Total Pressure

Total pressure (pt)
It is defined as the algebraic sum of static pressure (ps) and dynamic pressure (pd):

$$pt = ps + pd \qquad (1.3)$$

Mechanical Power

This mechanical power depends also from the aeraulic efficiency of the fan and is given by the following formula:

$$Pw = \frac{Q * pf * 100}{\eta} \qquad (1.4)$$

where:
Pw = mechanical power in W
Q = flow rate in m3/s
pf = total pressure in Pa
η = fan aeraulic efficiency in %

Electrical Power

Mechanical power is given by an electric motor, that also ab sorb a certain electrical power from power supply network. Following formulas are commonly used:

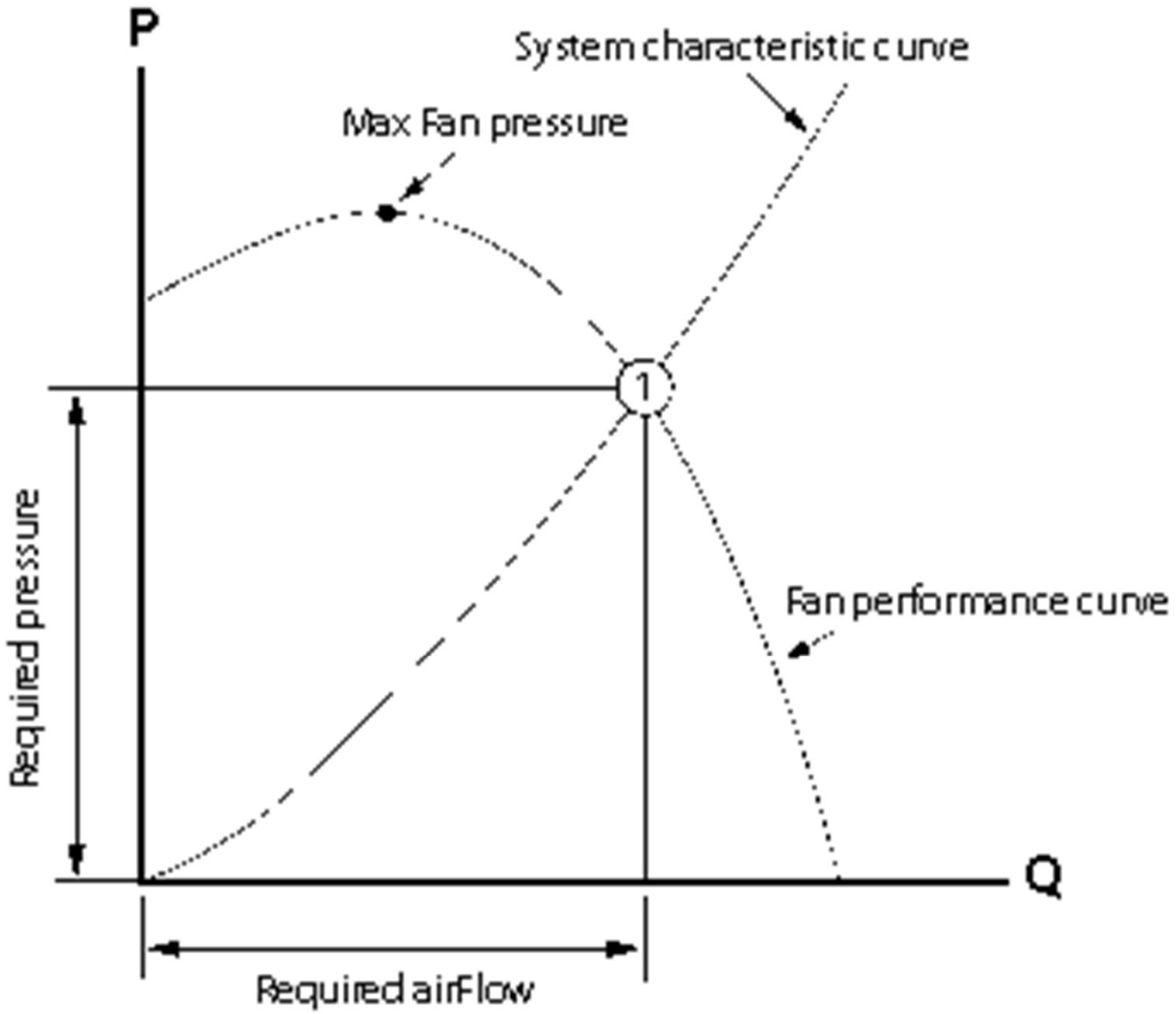
- *three-phase motor*

$$Pe = V * I * \sqrt{3} * \cos\varphi = \frac{Pw}{\eta_{mot}} \qquad (1.5)$$

- *mono-phase motor*

$$Pe = V * I * \cos\varphi = \frac{Pw}{\eta_{mot}} \qquad (1.6)$$

Fan Wroking


P
System characteristic curve
Max Fan pressure
1
Required pressure
Fan performance curve
Q
Required airFlow

Pressure Correction

$$p_0 = p_i * \frac{\rho_0}{\rho_i} \qquad (1.8)$$

where:

p_0 = pressure adjusted to standard density

p_i = pressure required in real working conditions

ρ_i = air density in real working conditions

ρ_0 = standard air density (1,225 kg/m3)

Effect of Speed Change on Fan

3.1 Given a certain impellor diameter and air density and changing the rotational speed (rpm):

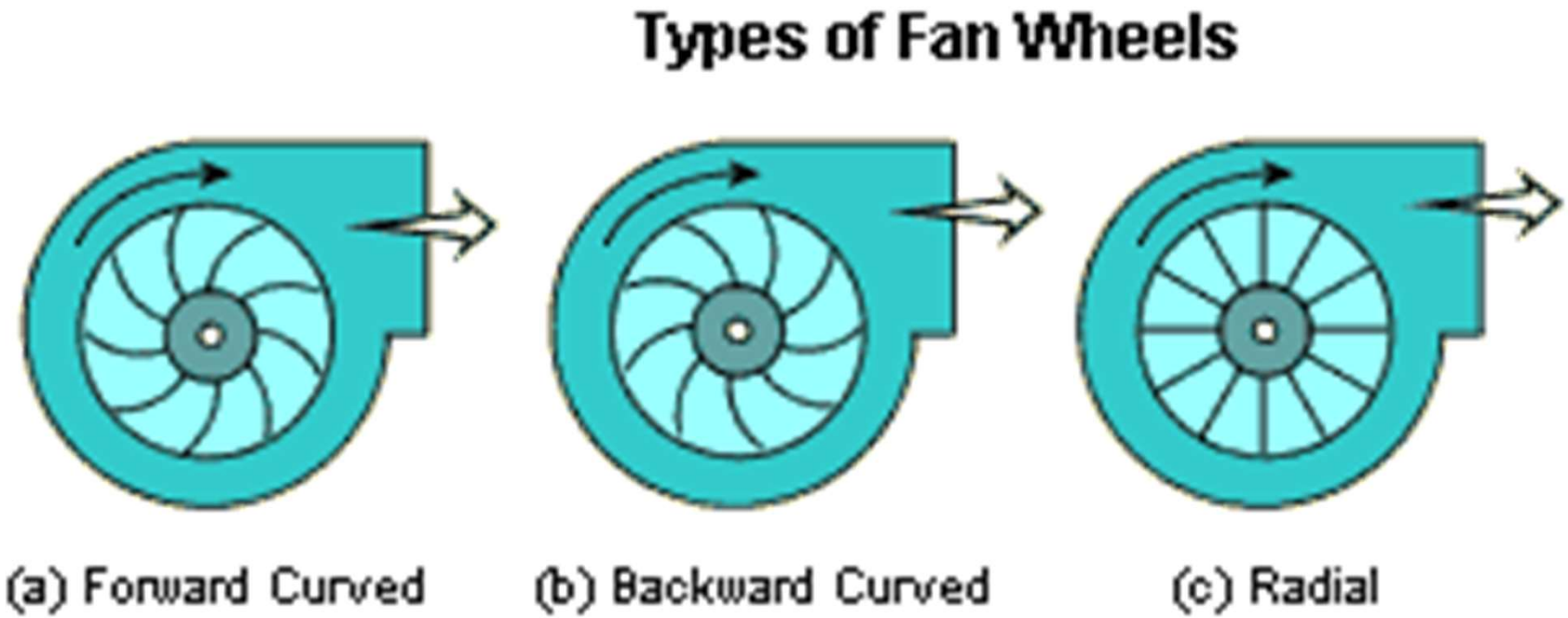
$$Q_2 = Q_1 * \left[\frac{rpm_2}{rpm_1}\right] \quad p_2 = p_1 * \left[\frac{rpm_2}{rpm_1}\right]^2 \quad Pw_2 = Pw_1 * \left[\frac{rpm_2}{rpm_1}\right]^3 \quad (3.1)$$

Centrifugal Fans

The fan wheel consists of a hub and a number of fan blades. The fan blades on the hub can be arranged in three different ways:

Forward
Backward
Radial

3. Centrifugal fan Classification



Centrifugal Fan Classification

Forward-curved use blades that curve toward the direction of rotation of the fan wheel. These are especially sensitive to particulate and are not used extensively in air pollution control systems.

Backward-curved fan blades use curved bladel. These types of fan wheels are used in fans designed to handle gas streams with relatively low particulate loadings. Backward-curved fans are more energy efficient than radial blade fans.

Centrifugal Fan Classification

Radial blades are fan wheel blades that extend straight out from the hub. A radial blade fan wheel is often used on particulate-laden gas streams because it is the least sensitive to solids build-up on the blades.

Gude for slection Fan Based on Fan position

1. End of duct at wall

- **Axial fan**
- **Inline fan**

2. Window

Window fan

3. Roof

- **Roof Fan or twin fan for toilette extraction**
- **Roof fan for kitchen extraction**
- **Box fan for ventilation**

4. When mechanical romm is vailable very floor

- **Box Fan**

Centrifugal fan for Fresh air supply

Centrifugal fan for Large capcity and pressure drop (Dynair PRL)

Box Fan (Dyn air Box D)

The fans of the BOX-D series are particularly designed for air extraction, supply or filtration. Their main characteristic is the low noise level which makes them ideal for urban environments (apartments, houses, bar, restaurants,

Mini Box Fan (Dynair)

Main features of this range are: modularity, extremely quit operation, reduced dimensions and ease of installation (thanks to included support bracket) and maintenance (thanks to accessible motor/impellor).

The ultra-slim shape of these fans make them ideal for false ceiling installation in houses, offices, public premises...

They are suitable to convey clean air up to a maximum temperature to 60°C.

Inline Box Fan (Dyn air) AxB

The AxB series represents and easy and not expensive solution for the installation of centrifugal fans in ducted systems. It is designed for a practical and quick installation into rectangular section ducted systems. The series foresees

Belt Driven Box Fan (Dyn air BOX-T) for large capcaities

The fans of the BOX-T series are particularly designed for air extraction, supply or filtration. Their main characteristic is the low noise level which makes them ideal for urban environments (apartments, houses, bar, restaurants,

Inline fan

Roof Fan (Dynair FC)

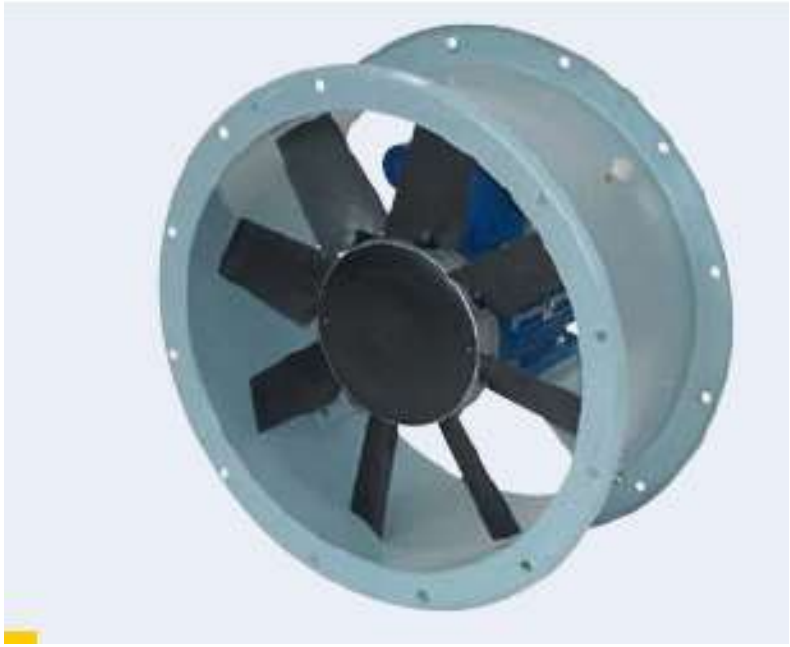
These fans are designed for direct or ducted ventilation in residential, commercial and industrial buildings.
They are designed for easy installation, high efficiency low noise level.

2. Axial Flow Fans

Axial wall Fan (Dynair Basic,Compact,QC)

The fans of the BASIC series are suitable, by wall or panel mounting, for ventilation of premises, offices, laboratories, shops, etc.

Axial inline Fan



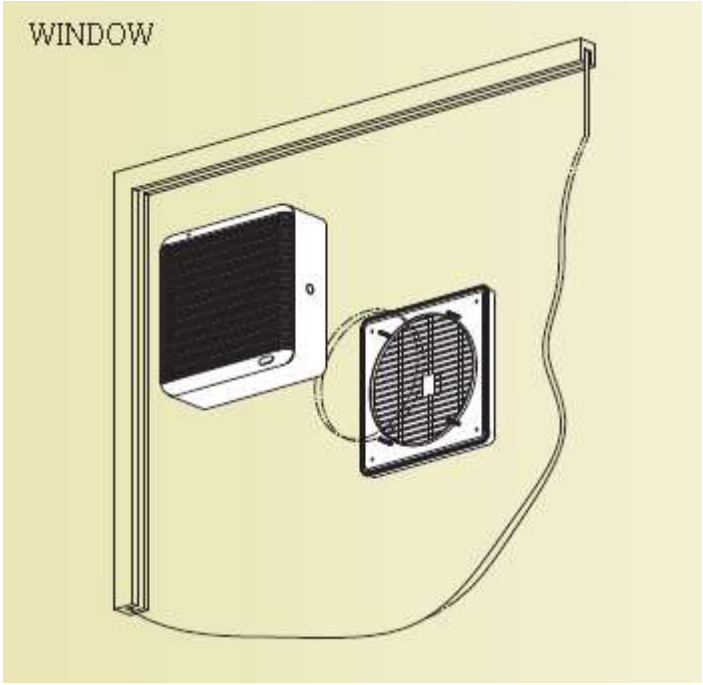
The tube axial fans of CC series are used for ducted installations requiring large airflow with relatively low pressure drop, like ventilation and cooling systems in industrial, naval, commercial, civil, energetic fields. This series has compared to centrifugal

Axial inline Fan (with external Motor)

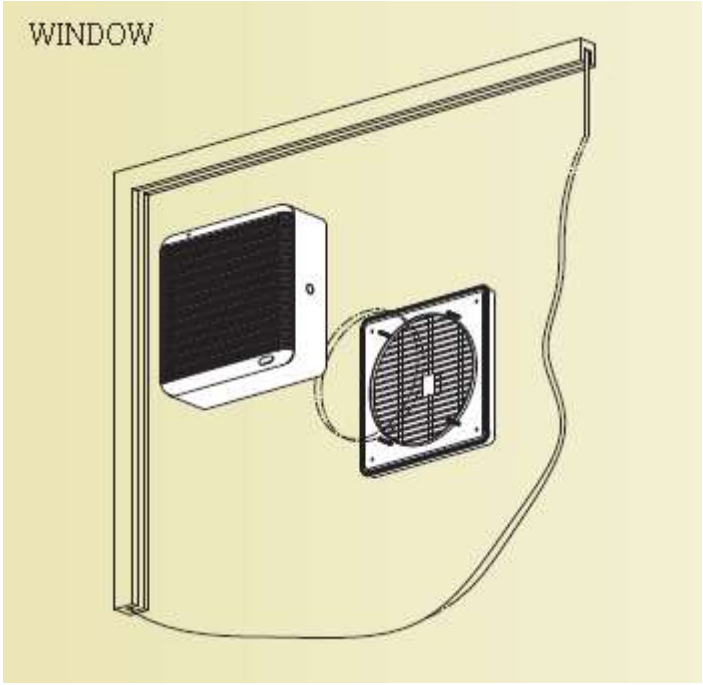
The CCT series is ideal for drying or painting plants, for ventilation (supply or exhaust) of air rich of smoke, dust and humidity and for all the applications where it is necessary to keep the motor not inside the air flow. The working tem-

Wall / Window Extraction Fan

Window Extraction Fan

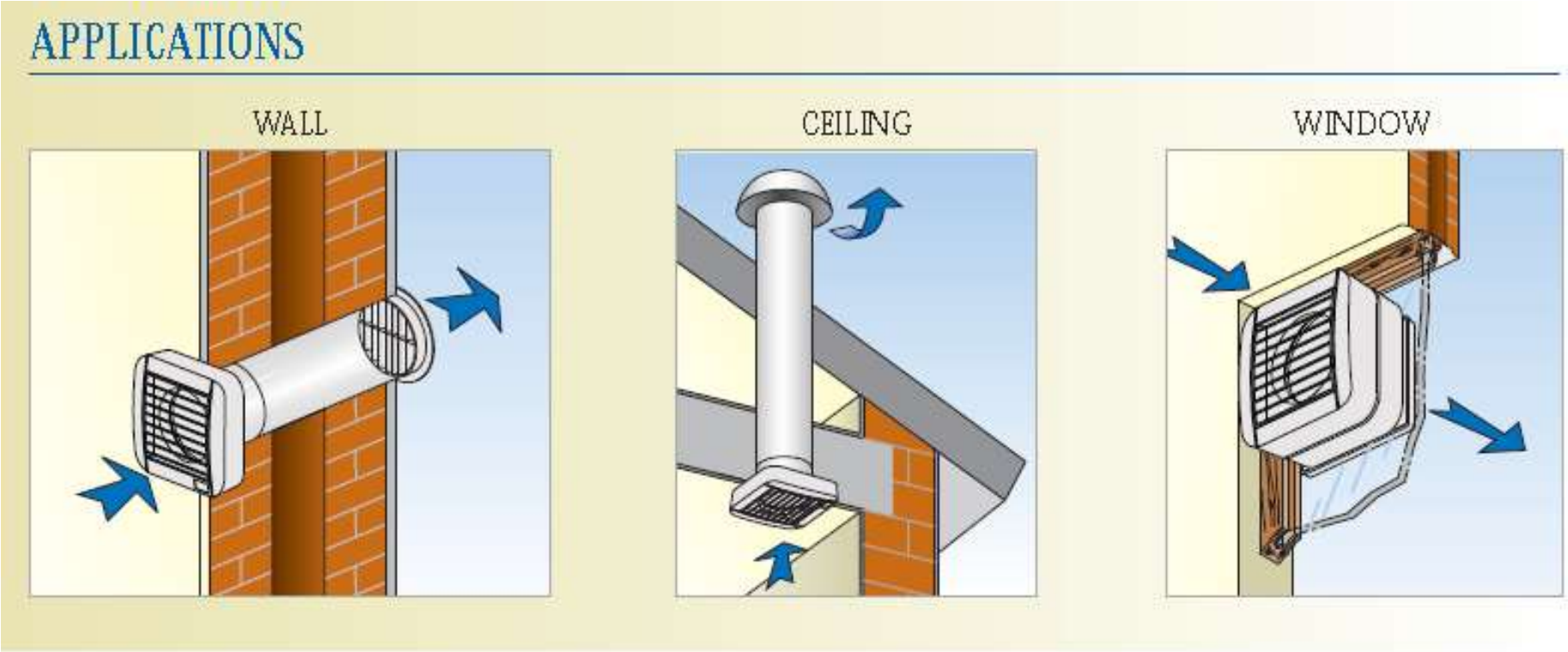


Window Extraction Fan



Small Wall Type Extraction Fan

Small Extraction Fan



Window Extraction Fan Chracteristics

SPECIFICATION

model	m^3/h	Pa	W	dB (A) @ 3m
VITRO 6/150 Manual low capacity	200	37	24	40
VITRO 6/150 Automatic low capacity	200	37	28	40
VITRO 6/150 Potentiated and Manual	300	75	41	48
VITRO 6/150 Potentiated and Automatic	300	75	45	48
VITRO 9/230 Manual	700	56	43	50
VITRO 9/230 Reversible and Automatic	700/400	56	46	50
VITRO 12/300 Reversible and Automatic	1400/800	85	106	59

Window Extraction Fan

SPECIFICATION

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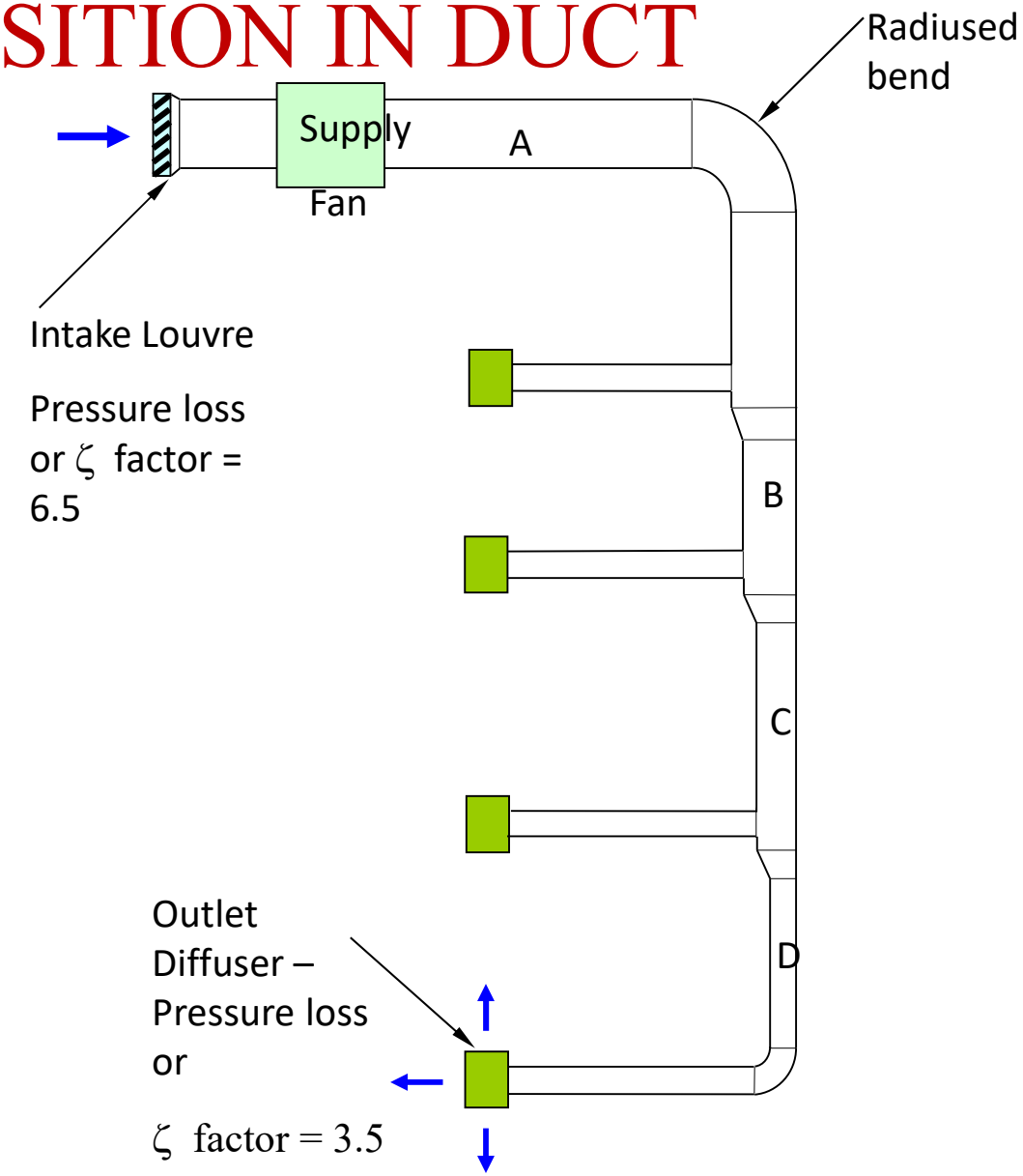
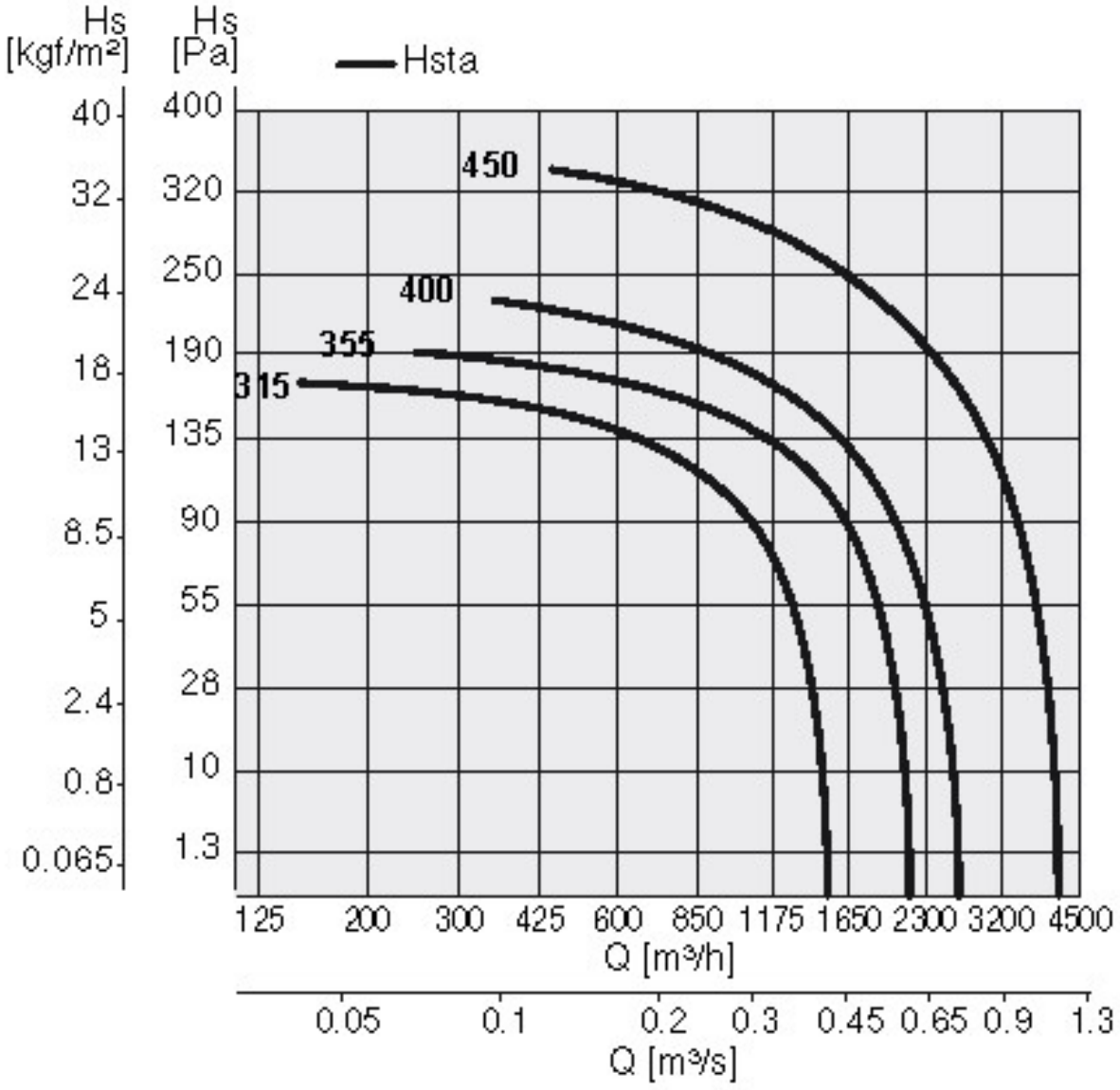
VITRO 9/230 Manual	700	56	43	50
VITRO 9/230 Reversible and Automatic	700/400	56	46	50
VITRO 12/300 Reversible and Automatic	1400/800	85	106	59

FAN POSITION IN DUCT



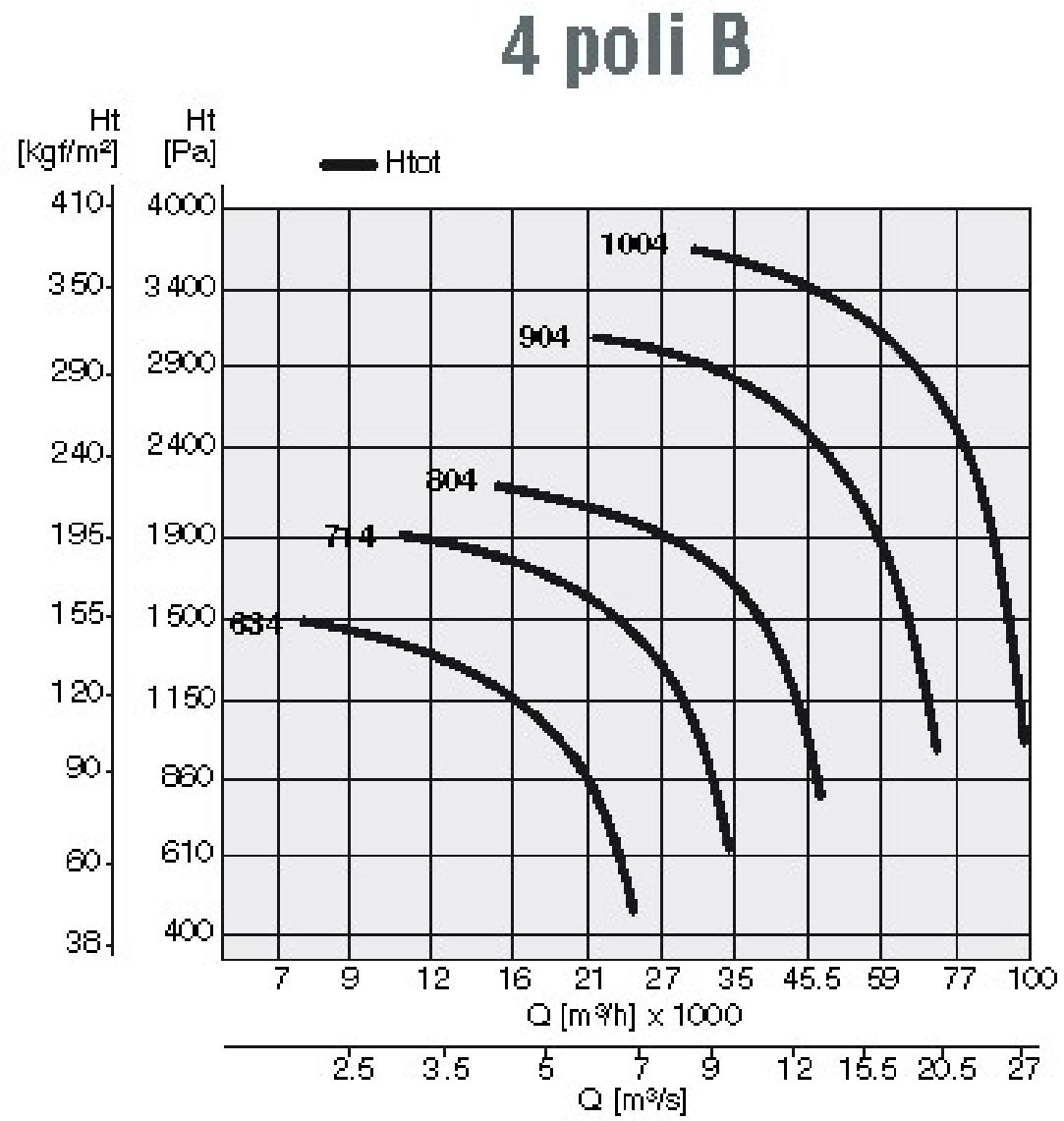
Fan Characteristics (small capacity)



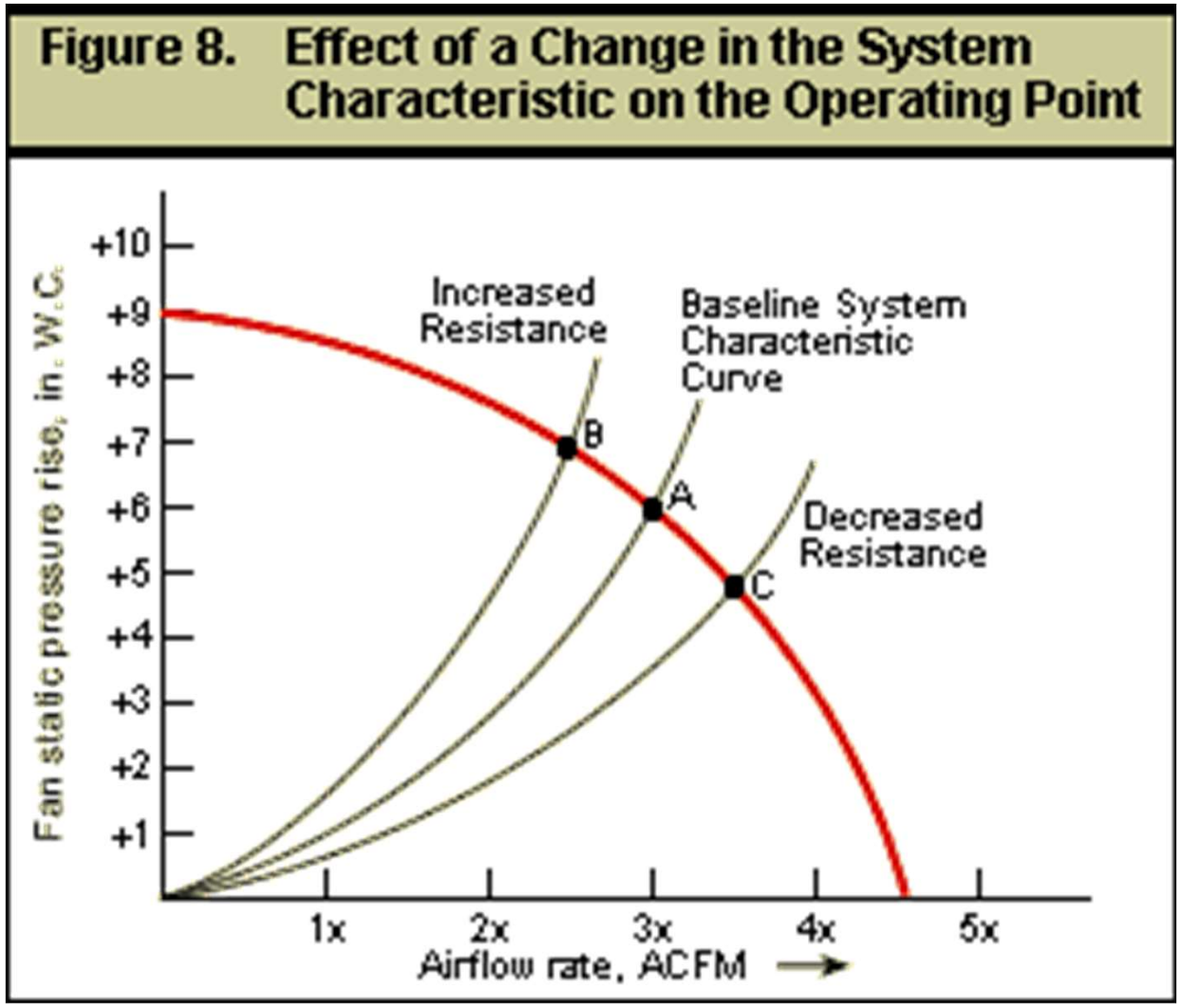
Fan Characteristics

Tipo Type	Modello Model	U	P	rpm	Pm (kW)	In (A)	IP/CL	REG.
SS-BOX	125 M	M	2	2544	0,070	0,40	44/F	RVN o RVS
SS-BOX	160 M	M	2	2730	0,110	0,52	44/F	RVN o RVS
SS-BOX	200 M	M	2	2580	0,180	0,90	44/F	RVM
SS-BOX	250 M	M	2	2538	0,300	1,40	44/F	RVM
SS-BOX	315 M	M	4	1360	0,140	1,70	20/F	RV-1 o RVM-2
SS-BOX	355 M	M	6	900	0,240	2,20	20/F	RV-1 o RVM-2
SS-BOX	400 M	M	6	900	0,240	3,00	20/F	RV-1 o RVM-2
SS-BOX	450 M	M	6	920	0,550	5,60	20/F	RV-2 o RVM-3

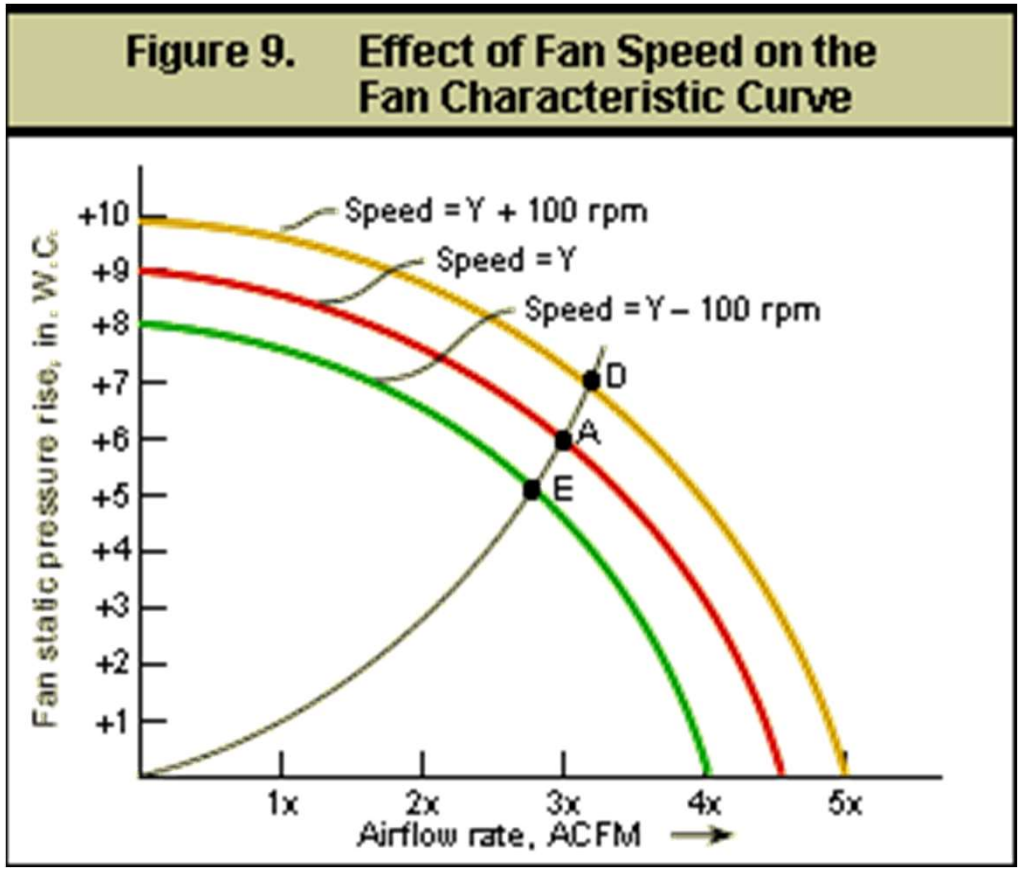
Fan Characteristics (large capacity)



Fan Characteristics (Duct resistance changes)



Fan Characteristics (Speed Chnages)



Fan Characteristics (damper opens and closes)