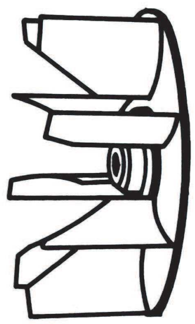
THEORETICAL AND PRACTICAL NOTICES

Centrifugal fans are essentially composed by a housing scroll in which an impeller has been put, this is designed with a determinate number of blades arranged according to their circumference. The housing has an axial sucking opening on the impellerer and a delivery point set out in the right angle compared to the axis. When the impellerer is turning, the blades lead the air by centrifugal force to the periphery of the impeller and push it in the same direction as its rotation. So, the air enters in axial direction, makes a right angle through the blades and is radially exhausted.
The housing works to convert the high dynamic pressure developed at the end of the blades into static pressure.
There are different kinds of fans depending on the form and the position of the blades, we can distinguish them as below :

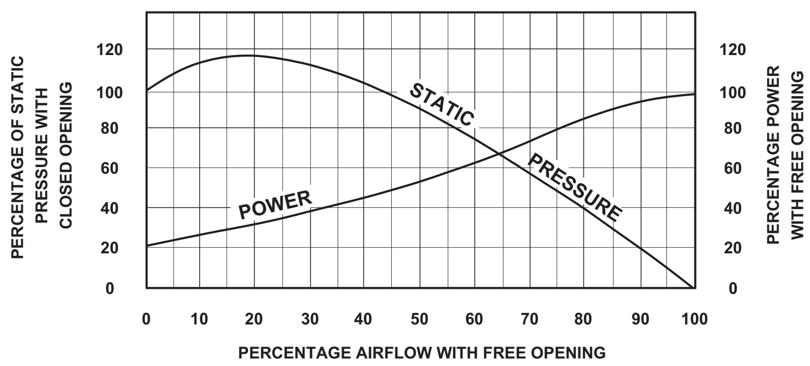
a) fans with straight radial blades :



The fans with straight radial blades are equipped with an impeller composed by a determinate number of blades that are radially carried or welded onto some arms departing from a central hub.

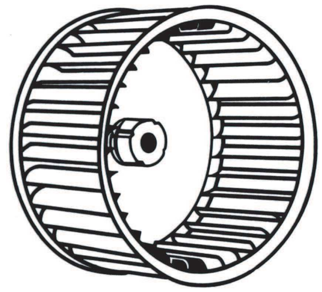
The performance and pressure of these fans is not high, their main characteristic is that they can transport filamentous material without sticking to the blades and consequently obstructing them.

The trend of the static pressure curve and the trend of the power-shaft, working according to the airflow is shown in the diagram below:

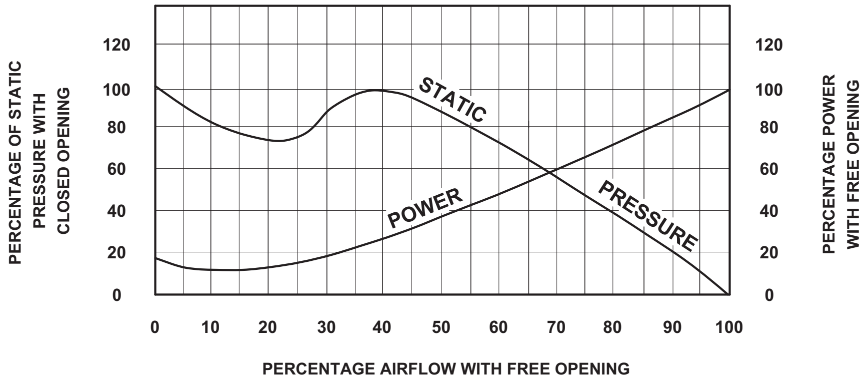


It is important to note that the maximum absorbed power is reached with the minimum prevalence.

b) Fans with forward curved blades:

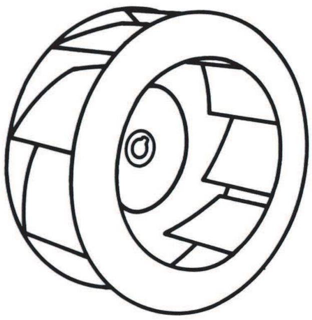


These fans are equipped with impellers composed by many little curved blades and their concavity is arranged in the same direction as the rotation. The blades are carried or welded perpendiculary onto two rings coaxial to the hub. Compared to fans with flat blades, these models achieve better performances, moreover this kind of impeller can reach the highest air speed, developing in this way in comparison to other kind of impellers, for the same rotational speed and diameter a higher airflow. The consequence is that this fan is smaller and works at a lower speed, for the same performaces requested. The trend of the static pressure curve and the trend of the power shaft, working accordingly to the airflow is shown in the diagram below:

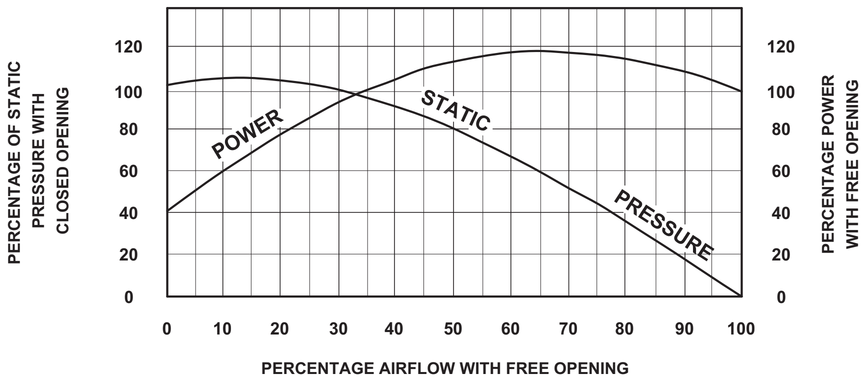


The power increases until the maximum point of absorption coinciding with the maximum capacity and the minimum prevalence. This is, as you can see, more marked compared to the previous model.

c) Fans with reversed curved blades:



The fans that are equipped with this kind of impeller obtain the best performances. They are composed by a determinate number of blades of a large section and their convex side meets the air flow, allowing an easier passage through the blades and therefore reducing the losses due to collision or whirl. Moreover, by changing the section of the blades, it is possible to obtain very high pressures.
On the other hand, the peripherical speed is higher compared to other kind of fans and consequently the weight of the blades, that is supported by a proportional shaft, increases. Here follows the trend of the static pressure and of the absorbed power.



It is important to note that the requested power from the shaft of the fans with this kind fanwheels is low with medium values of airflow and pressure.

d) Centrifugal fans with other kind of blades :

These three executions can also be modified to obtain a better performance by combining profiles of different blades; for example: you can have a forward curved blade at the entry with a radial blade at the exit; a forward curved blade at the entry and a backward one at the exit, which is one of the many possible modifications you can do to the basic models already described.
Finally it is necessary to mention "the double suction execution", in which a double centrifugal impeller together with a suction on two sides of the housing, guarantees an almost doubled airflow compared to other fans with the same speed and diameter.

The essential parameters to identify a centrifugal fan are :

a) airflow
b) pressure
c) speed of rotation
d) efficiency

A) AIRFLOW
The airflow is the value of the fluid that the fan sucks in a period of time, it is normally expressed in m^3/sec, m^3/min, m^3/h.

B) PRESSURE
This is normally expressed in mm H_2O or in Pascal. The pressure that generates from a fan is the sum of two pressures :

static pressure + dynamic pressure = total pressure

The static pressure (Ps) is the energy power that is necessary to overcome the resistance from the circuit when the fluid passes. The dynamic pressure (Pd) is the cinetic energy of the moving fluid and depends on the average air output speed through the outlet side of the fan. It can be calculated with the following formula:

$$Pd = \frac{V^2}{2g} 1{,}226 \quad ; \quad V = \frac{Q}{A}$$

in which:

Q = airflow in m^3/sec
A = outlet side surface in m^2
V = average air speed in m/sec
g = gravity acceleration (9,81 m/sec^2)
1.226 = specific air weight in kg/m^3 at 15° C and 760 Hg mm.

C) SPEED OF ROTATION
The speed of rotation expresses the number of turns per minute that the impeller is supposed to do to reach the requested characteristics. The requested characteristics reported by the performance tables and the curves of this catalogue are referred to fans working with a temperature of 15° C and with barometric pressure of 760 mm Hg with a specific weight of 1,226 kg/m^3 and according to the norms set up in the UNI 7179-73P specifications. If intermediate characteristics are required, which are different from those reported in the performance charts, or if the fan is working with a temperature different from 15°C and with a specific weight different from 1,226 it is necessary to choose :

- a belt-driven fan
- to keep the fundamental fan relations into account, such as :

a) The variation of the rotation speed at a constant air specific weight.

1) The airflow in m^3/sec Q is directly proportional to the number of turns per minute ratio.

$$Q_1 = Q \frac{n_1}{n}$$

2) The total pressure in mm H_2O "Pt" is directly proportional to the square of the number of turns per minute ratio.

$$Pt_1 = Pt\left(\frac{n_1}{n}\right)^2$$

3) The absorbed fan power in kw "W" is directly proportional to the cube of the number of turns per minute ratio.

$$W_1 = W\left(\frac{n_1}{n}\right)^3$$

b) Specific weight variation "y" with constant rotation speed.

1) The "Q" airflow remains constant.
2) The pressure "Pt" and the power "W" are directly proportional to the specific weights ratio :

$$Pt_1 = Pt \frac{y_1}{y} \qquad W_1 = W \frac{y_1}{y}$$

1) The specific air weight variation according to the temperature is calculated with the following formula :

$$y = 1{,}293 \frac{273}{273 + t}$$

in which :

y = specific air weight at t °C
1.293 = specific air weight at 0 °C
t = temperature of the air in °C
273 = absolute zero point

TRANSMISSION CALCULATION

GEAR RATIO: The gear ratio "K" necessary to determine the parameters for the transmission is is obtained with the following formula :

$$K = \frac{n}{N}$$

in which:

N = rounds per minute of the main driving pulley
n = rounds per minute of the small driving pulley

DIAMETER OF THE DRIVING PULLEYS : the pulleys dimensions are also related to gear ratio "K", they have to be calculated by using these formulae :

$$D = d \times K \qquad d = \frac{D}{K}$$

in which:

D = diameter of the main driving pulley.
d = diameter of the small driving pulley .

Warning : It is advisable to keep the peripherical speed within the values of 25 m/sec (max 30 m/sec), you can use the below formula to check this parameter :

$$V = \frac{0{,}052 \times d \times n}{1000}$$

AXLE SPACING: When the axle spacing is not clearly defined in the installation conditions, it may be found out with the following formulae :

1) If the gear ratio "K" is between 1 and 2, the axle spacing "i" will be greater than or equal to the value determined by the following formula :

$$i = \frac{(K + 1)\ d}{2} + d$$

2) If the gear ratio "K" is greater than 3, the axle spacing "i" will be greater than the main driving pulley.

SECTIONS AND NUMBER OF THE BELTS : The number of the belts and their section have to be found out according to the power to be transmitted, the operating conditions and the load type.

THE CHOICE OF A FAN

In order to choose correctly a fan for a closed environment, the volume of the rooms and the needed air exchanges per hour have to be taken into consideration. The quantity of needed air has to be determined by finding out how many times in an hour the air in a closed environment should be completely replaced with other fresh air. Therefore, the correct formula is :

$$Q = V \times R$$

in which:
Q = fan airflow in m^3/h
V = volume of the room to ventilate in m^3
R = number of air exchanges per hour

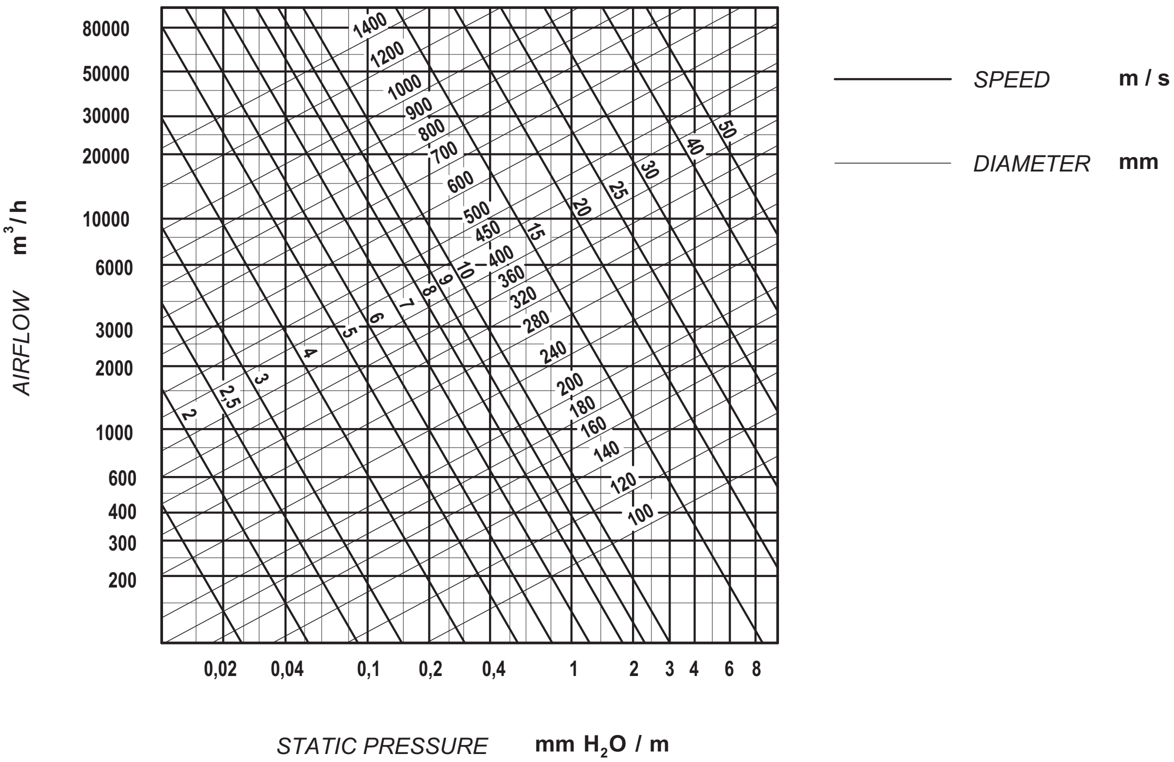
The following air exchanges per hour are advisable considering that :

- with 8 exchanges per hour, the pollution caused by people is eliminated.
- in case of smoking, the values should be doubled.
- in tropical climates the values should be increased to 2-4 times.

AIR EXCHANGES PER HOUR

Habitation	1-2	Darkrooms	10-15
Kitchens	10-15	Laboratories	4-6
Classrooms	2-3	Laundries	20-30
Industrial kitchens	15-20	Lavatories	10-15
Bread ovens	20-30	Swimming pools	20-30
Bar	10-15	Factories	6-10
Canteens	4-6	Foundries	20-30
Restaurants	6-10	Furnaces	30-60
Conference rooms	4-10	Spray booths and rooms	30-60
Dance halls	6-8	Boiler and engine rooms	20-30
Card rooms	6-8	Mushroom beds	10-20
Theatres	10-15	Hen-houses	6-10
Cinemas	10-15	Pigsties	6-10
Churches	1-2	Holds	6-10
Banks	2-4	Fruit holds	20-30
Hospitals	4-6	Egg, meat holds	10-20
Garages	6-8	Berths	10-20

If the fan is ducted (as many centrifugal fans are), it is important to know the disposition and the dimensions of the ducts network to calculate the pressure that the fan has to overcome. To meet this requirement, we provide you with the following diagram, which shows the pressure drops in mm of water gauge per meter of channel in straight circular ducts made in galvanized steel according to the airflow and to the air speed :



For the choice and for the dimensioning of the channels and for an initial general orientation, the the following aspects have to be taken into consideration :

1) In order to convoy a certain quantity of air in a wide duct, a lower pressure and a lower speed are needed in comparison to those which are necessary to convoy the same quantity of air in ducts having the same length, but a smaller width.
2) The right angle curves are overcome by the air with a bigger pressure drop in comparison to long radius elbows.
3) Any change of section, elbow or branch, when necessary, have to be planned as "gentle" as possible.

In case of dusts or fumes extraction, the air exchange technique normally proves to be not profitable and unsatisfactory. In such cases, the best solution is to eliminate the pollution origin by using suction hoods. The choice of the suction speed is very important in order to avoid any fumes or dust spread, it has to be faster than the deposition speed of the different particles.

For this reason the following speed values, in the diagram below, have to be kept into account :

Electrolysis hoods	0.75 (m/s)	at the hood inlet
Electrical welding hoods	0.75 (m/s)	at the hood inlet
Kitchen hoods	0.5 (m/s)	at the hood inlet
Spraybooths	0.75 (m/s)	at the level of the worker's breathing
Sandblasting rooms	2.5 (m/s)	at the inlet

Minimum recommended air speed in the absence of any different local specification.

To find out the air quantity (or airflow) that the fan has to guarantee in order to reach the selected speed, please take this formula into consideration :

$$Q = V \times S \times 3600 \ [m^3/h]$$

in which :
Q = airflow in m^3/h
V = recommended extraction speed in m/s
S = hood surface in m^2

In case of fans used for the transport of materials mixed with air, it is important to pay particular attention in choosing a fan, which has to be compatible with the transported material. For the transport speed, please take into account the following table as a first indication :

Material	Speed (m/sec)	Material	Speed (m/sec)
Textile waste	7,5	Metal powder	15
Fine coal	20	Rubber powder	10
Flour	15	Jute powder	10
Sawdust	15	Grain powder	10
Woods shavings or chips	18	Lead powder	25
Fine brass shavings	20	Marble powder	23

N.B.: In case of high concentration or great quantities of materials mixed with air, it is necessary to increase the indicated speeds.

AIR FILTERING

In case of materials suction, where the suspended particles can damage the production process or the human respiratory system, it is necessary to remove from the air each element contaminating it. Moreover in the cases where the suspended particles are particularly contaminated or of large dimensions it is indispensable to have an air filtering, because a direct discharge in the atmosphere will doubtlessly be destructive and forbidden. The machineries used for the air purification can be divided into five groups according to the dimensions and the types of particles that they have to separate :

1) Water and deposit spray rooms : they are suitable even for very heavy industrial particles and for the paint fumes abatement.

2) Cyclones : they are used both for industrial particles, as sawdust etc., and for moderately light dusts as flour, etc.

3) Filters : they are used for light dusts filtrations.

4) Electrostatic filters : they are used for very fine dusts and for light fumes.

5) Air sterilizers: they are mostly used to eliminate bacteria and in all the cases in which an air sterilization is required.

PERFORMANCE VARIATION ACCORDING TO DIFFERENT TEMPERATURES AND ALTITUDES

The performance tables and the diagrams are valid for an air density of 1,226 kg/m^3, with a pressure of 760 mmHg (corresponding to the sea level) and at a temperature at 15 °C. In different conditions of temperature and altitude, it is necessary to correct the requested pressure, multiplying it by the factor "k" before selecting the fan from the diagrams in the catalogue. The absorbed power at the effective working condition is calculated by dividing the number in the diagram by "k".

The values of the correction factor "k" at different altitudes and temperatures can be easily read in the following table.

	Temp. in °C	-40	-20	0	+20	+40	+60	+80	+100	+150	+200	+250	+300	+350	+400	+450	+500
Altitude - meters above sea level	0	0,79	0,86	0,93	1,00	1,07	1,14	1,20	1,27	1,44	1,61	1,78	1,96	2,13	2,30	2,47	2,64
	250	0,81	0,88	0,95	1,02	1,09	1,16	1,23	1,30	1,48	1,65	1,83	2,00	2,18	2,35	2,53	2,70
	500	0,83	0,91	0,98	1,05	1,12	1,19	1,27	1,34	1,52	1,70	1,88	2,05	2,23	2,41	2,59	2,77
	750	0,86	0,93	1,00	1,08	1,15	1,22	1,30	1,37	1,56	1,74	1,92	2,11	2,28	2,48	2,66	2,84
	1000	0,88	0,95	1,03	1,11	1,18	1,26	1,33	1,41	1,60	1,79	1,98	2,17	2,35	2,54	2,73	2,92
	1500	0,93	1,01	1,09	1,17	1,25	1,33	1,41	1,49	1,69	1,89	2,09	2,29	2,49	2,69	2,89	3,09
	2000	0,99	1,07	1,16	1,24	1,32	1,41	1,49	1,58	1,79	2,00	2,21	2,42	2,64	2,85	3,06	3,27
	2500	1,05	1,14	1,23	1,32	1,41	1,50	1,59	1,68	1,90	2,13	2,35	2,58	2,80	3,03	3,26	3,48
	3000	1,12	1,22	1,31	1,41	1,50	1,60	1,70	1,79	2,03	2,27	2,51	2,76	3,00	3,24	3,48	3,72

ORDER SPECIFICATIONS

In order to identify correctly the fan and to simplify the work of our commercial department, please keep the following points into consideration in case of order :

1) TYPE OF CHOSEN FAN, WITH THE FOLLOWING CHARACTERISTICS :

- Airflow
- Pressure
- Rounds per minute (rpm)
- Supply voltage
- Frequency

2) ORIENTATION
3) MANUFACTURING EXECUTION
4) MOTOR POSITION
5) ACCESSORIES ON REQUEST

- Discharge side counterflange.
- Sucking side counterflange.
- Complete transmission kit, made of pulleys and belts.
- Flame-proof (ADPE) execution, according to ATEX specifications.
- High temperature execution.