

PHILIPPINE NATIONAL STANDARD

PNS/PAES 240:2010
(PAES published 2010)
ICS 65.060.01

Agricultural machinery – Fans and Blowers – Specifications



BUREAU OF PRODUCT STANDARDS

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National Foreword

This Philippine Agricultural Engineering Standards PAES 240:2010, Agricultural machinery – Fans and Blowers – Specifications was approved for adoption as Philippine National Standard by the Bureau of Product Standards upon the recommendation of the Agricultural Machinery Testing and Evaluation Center (AMTEC) and the Philippine Council for Agriculture, Forestry and Natural Resources Research and Development of the Department of Science and Technology (PCARRD-DOST).

Foreword

The formulation of this national standard was initiated by the Agricultural Machinery Testing and Evaluation Center (AMTEC) through the project “Development of Standards for Agricultural Production and Postharvest Machinery” funded by the Philippine Council for Agriculture, Forestry and Natural Resources Research and Development – Department of Science and Technology (PCARRD – DOST)

This standard has been technically prepared in accordance with BPS Directives Part 3:2003 – Rules for the Structure and Drafting of International Standards.

The word “shall” is used to indicate mandatory requirements to conform to the standard.

The word “should” is used to indicate that among several possibilities one is recommended as particularly suitable without mentioning or excluding others.

In the preparation of this standard, the following documents/publications were considered:

PAES 318:2002 Engineering Materials – Clutches, Couplings and Splines for
Agricultural Machines – Specifications and Applications

Bleier, Frank P. 1998. *Fan handbook selection, application and design*. McGraw – Hill, Inc.

Baumeister, Theodore III and Avallone, Eugene A. *Marks’ handbook for mechanical engineers*. McGraw Hill. New York. Tenth Edition. 1997.

Carmichael, Colin. *Kent’s mechanical engineers’ handbook, design and production volume*. John Wiley and Sons, Inc., New York. Twelfth Edition. 1950.

Henderson, S.M., M.S. and Perry, R.L., M.E. *Agricultural processing engineering*. The AVI Publishing Company, Inc. Westport, Connecticut. Third Edition. 1976.

Industrial fans and blowers. http://process-equipment.globalspec.com/LearnMore/Processing_Equipment/Heat_Transfer_Equipment/Industrial_Fans_Blowers. <accessed May 12, 2009>

Mechanical engineering-propeller fan design. <http://en.allexperts.com/q/Mechanical-Engineering-667/propeller-fan-design.htm>. <accessed May 13, 2009>

Comair fans and blowers. <http://www.cstarwin.com/West/Comair.html>. <accessed May 07, 2009>

1 Scope

This standard specifies the manufacturing, installation and performance requirements for fans and blowers.

2 References

The following normative documents contain provisions, which, through reference in this text, constitute provisions of this National Standard:

AWS D1.1:2000	Structural Welding Code - Steel
PAES 102:2000	Agricultural Machinery – Operator’s Manual – Content and Presentation
PAES 103:2000	Agricultural Machinery – Method of Sampling
PAES 301:2000	Engineering Materials – V-belts and Pulleys for Agricultural Machines Specifications and Applications
PAES 116:2001	Agricultural Machinery – Small Engine – Specifications
PAES 301:2000	Engineering Materials – V-belts and Pulleys for Agricultural Machines Specifications and Applications
PAES 311:2001	Engineering Materials – Screws for Agricultural Machines – Specifications and Applications
PAES 313:2001	Engineering Materials – Bolts and Nuts for Agricultural Machines – Specifications and Applications
PAES 241:2010	Agricultural Machinery: Fans and Blowers – Methods of Test

3 Definitions

For the purpose of this standard the following definitions shall apply:

3.1

airfoil

shape of a wing or blade of a propeller, rotor, or turbine or sails as seen in cross section (see Figure 1)

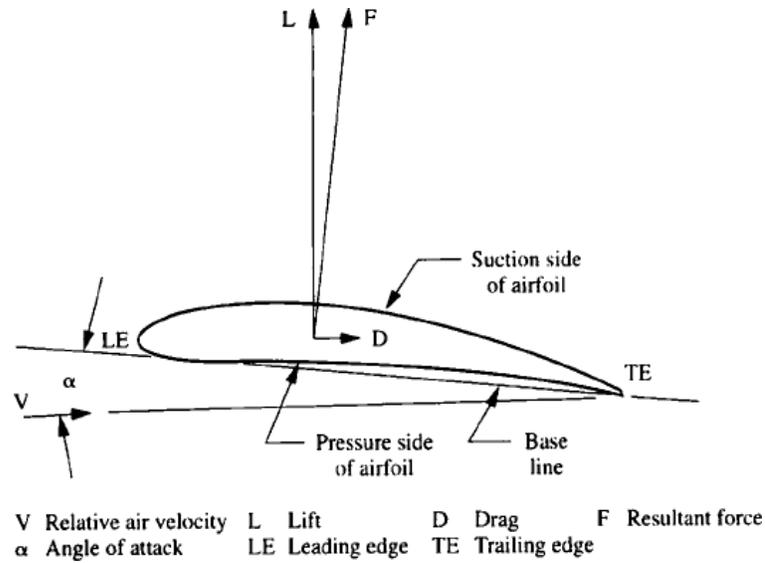


Figure 1. Free Body Diagram of Airfoil Blade (Fan Handbook Selection, Application and Design by Frank P. Bleier)

**3.2
camber**

asymmetry between the top and the bottom curves of an airfoil in cross-section

**3.3
drag, D**

force cause by friction which slows down the movement of an object (see Figure 2)

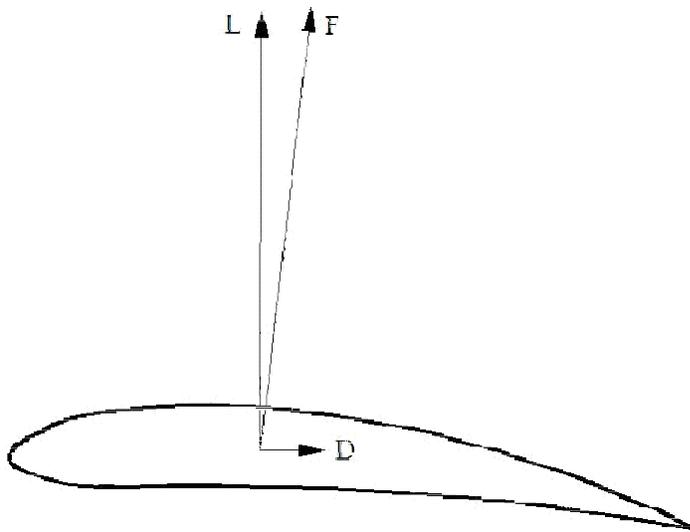


Figure 2. Lift and drag on fan/blower blade. (Fan Handbook Selection, Application and Design by Frank P. Bleier)

3.4

fan

blower

device for moving air which utilizes a power-driven rotating impeller

3.5

fan/blower guard

structure mounted on the inlet and/or outlet part of fan/blower for safety purpose

3.6

angle of attack, α

angle measured between the air inlet and lower camber of the fan/blower

(see Figure 1)

3.7

lift, L

sum of all the forces on a body that force it to move perpendicular to the direction of flow

(see Figure 2)

3.8

lift-drag ratio

ratio between the lift force and the drag force on fan/blower blades during operation (see

Figure 2)

3.9

leading edge, LE

side of the fan/blower blade where the air comes in contact with at entry

(see Figures 8 and 9)

3.10

trailing edge, TE

side of the fan/blower blade that is usually pointed and where the deflection of air occurs (see

Figures 8 and 9)

3.11

hub-tip ratio

ratio between the hub diameter and the fan/blower wheel diameter

3.12

rotor

rotating device with blades projecting from a hub

3.13

fan/blower wheel

any revolving vane or vanes used for producing currents of air

4 Classification

The classification of fans and blowers shall be based on:

4.1 Driving Mechanism

4.1.1 Belt-Drive Fan/Blower

Type of driving mechanism that can obtain any fan/blower speed by controlling the pulley ratio. (see Figure 3)

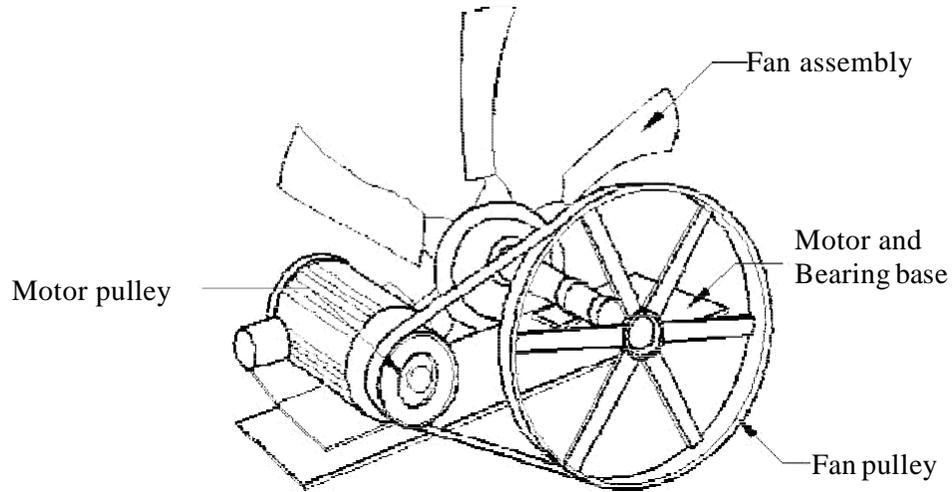


Figure 3. Parts of belt-driven propeller fan/blower (Fan Handbook Selection, Application and Design by Frank P. Bleier)

4.1.2 Direct-Drive Fan/Blower

Type of driving mechanism that directly transfers energy or power from engine crankshaft or motor shaft to the fan/blower. This enables better fan/blower efficiency and has less fan/blower components. (see Figure 4)

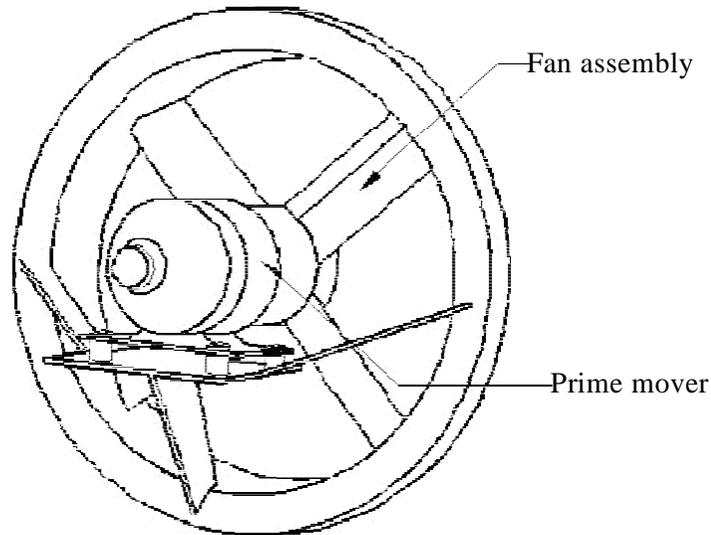


Figure 4. Parts of direct-drive propeller fan/blower (Fan Handbook Selection, Application and Design by Frank P. Bleier)

Different types of coupling used in direct-drive fan/blower shall be the following:

4.1.2.1 Rigid Coupling

Type of coupling that is used when the shafts are virtually collinear and when they remain in fixed angular relation with respect to each other (except for angular deflection). (see Figure 5)

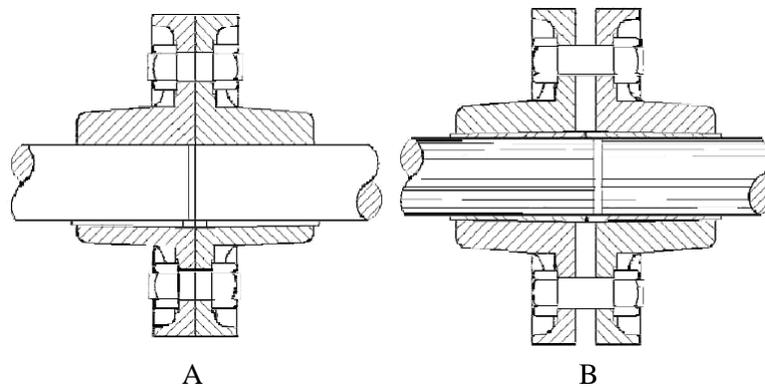


Figure 5. Rigid Coupling: (A) Flanged Face Coupling and (B) Keyless Compression Coupling. (Mark's Standard Handbook for Mechanical Engineers by Avallone and Baumeister III)

4.1.2.2 Flexible Coupling

Type of coupling that is designed to connect shafts which are misaligned either laterally or angularly. A secondary benefit is the absorption of impacts due to fluctuations in shaft torque or angular speed (see Figure 6)

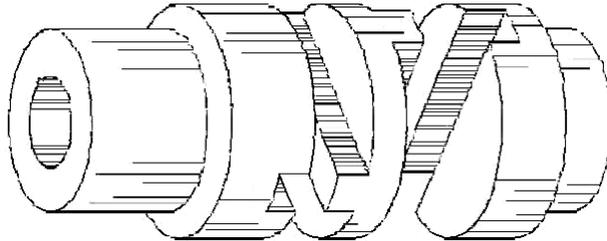


Figure 6. Flexible coupling. (Mark's Standard Handbook for Mechanical Engineers by Avallone and Baumeister III)

4.1.3 Variable Drive Fan/Blower

Type of driving mechanism that uses hydraulic or magnetic couplings between fan/blower wheel shaft and motor shaft which allows control of fan/blower wheel speed independent of the motor speed.

4.2 Cross-sectional Shape of Blade

4.2.1 Asymmetrical Airfoil Blade

Blade that has a blunt leading edge and a pointed trailing edge. It has a streamline cross-sectional shape. (see Figure 7)

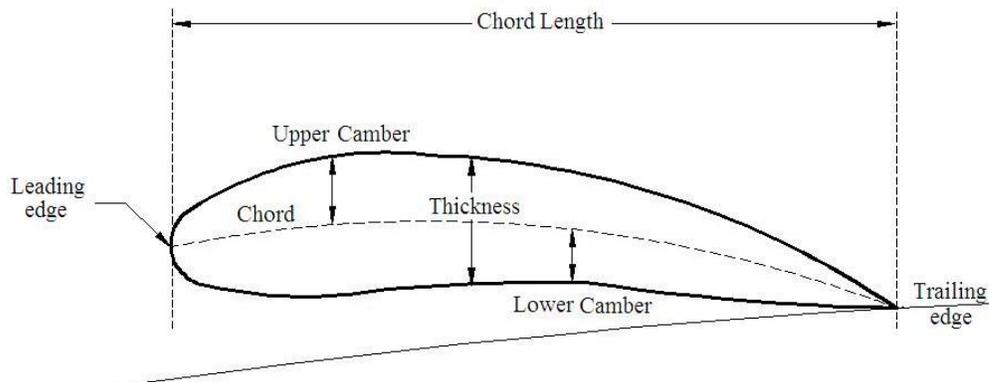


Figure 7. Parts of asymmetric airfoil blade. (Wikipedia, Airfoil)

4.2.2 Single-Thickness Sheet Metal Blade

Blade type that has pointed leading and trailing edge. (see Figure 8)

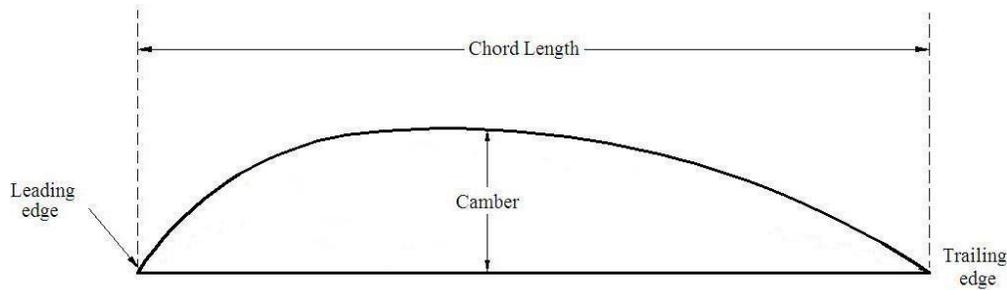


Figure 8. Parts of single-thickness metal blade (Fan Handbook Selection, Application and Design by Frank P. Bleier)

4.3 Air Flow Movement

4.3.1 Axial-Flow Fans/Blowers

Fans that force the air to move parallel to the shaft on which the fan blades rotate. (Fan Handbook Selection, Application and Design by Frank P. Bleier)

Classifications of axial-flow fan are the following:

4.3.1.1 Propeller Fan

Fans that are commonly used for supplying cool air to certain processes and exhausting hot or contaminated air and corrosive gases in buildings. (see Figures 3 and 4)

4.3.1.2 Tube-Axial Fan (see Figure 9)

Fan that serves as exhausting material from an inlet duct. (Fan Handbook Selection, Application and Design by Frank P. Bleier)

Fan that consists of an axial-flow wheel within a cylinder and includes driving-mechanism supports either for belt drive or direct connection. (Agricultural Process Engineering by Henderson and Perry)

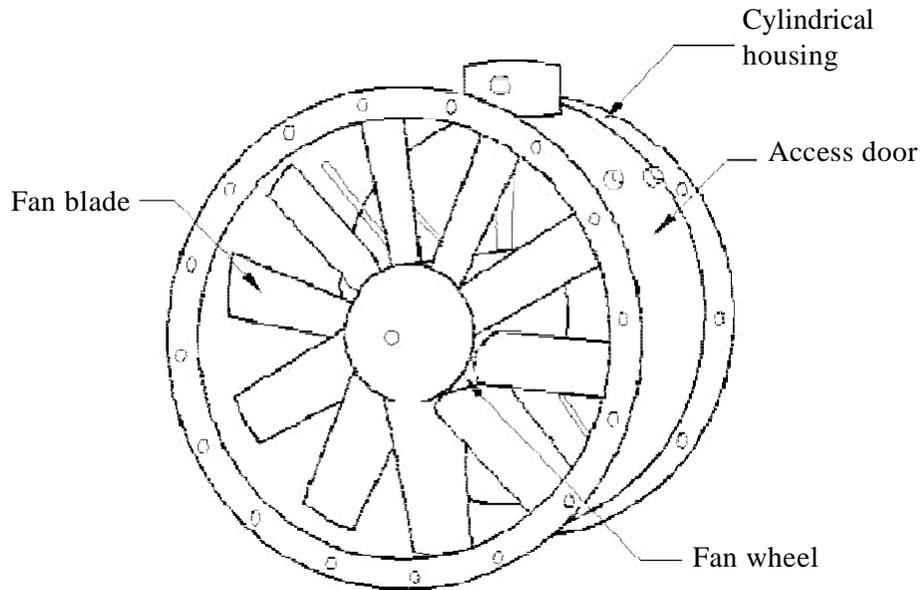


Figure 9. Parts of tube-axial fan with cylindrical housing. (Fan Handbook Selection, Application and Design by Frank P. Bleier)

4.3.1.3 Vane-Axial Fan (see Figure 10 and 11)

Fan that neutralizes air spin for it to be used as blower in outlet duct and exhaust in inlet duct. (Fan Handbook Selection, Application and Design by Frank P. Bleier)

Fan that consists of an axial-flow wheel within a cylinder, a set of guide located either before or after the wheel, and including driving-mechanism supports for either belt drive or direct connection. (Agricultural Process Engineering by Henderson and Perry)

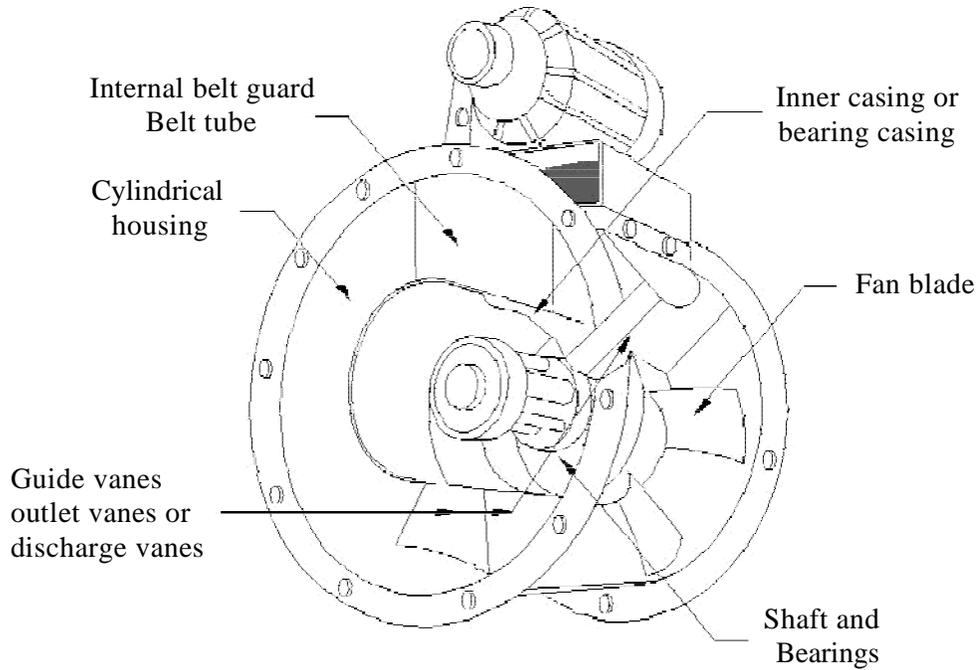


Figure 10. Parts of vane-axial fan. (Fan Handbook Selection, Application and Design by Frank P. Bleier)

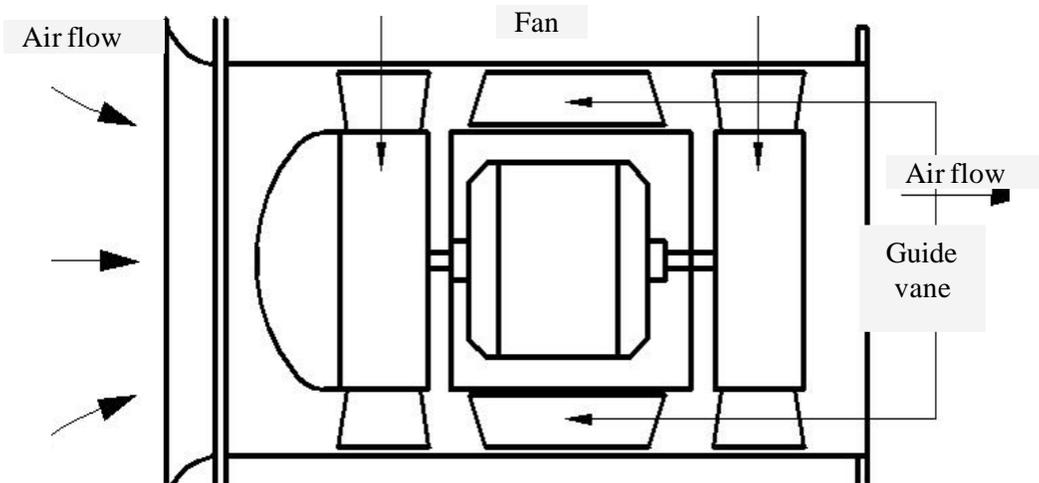


Figure 11a. Two-stage axial-flow fan rotating at the same direction. (Fan Handbook Selection, Application and Design by Frank P. Bleier)

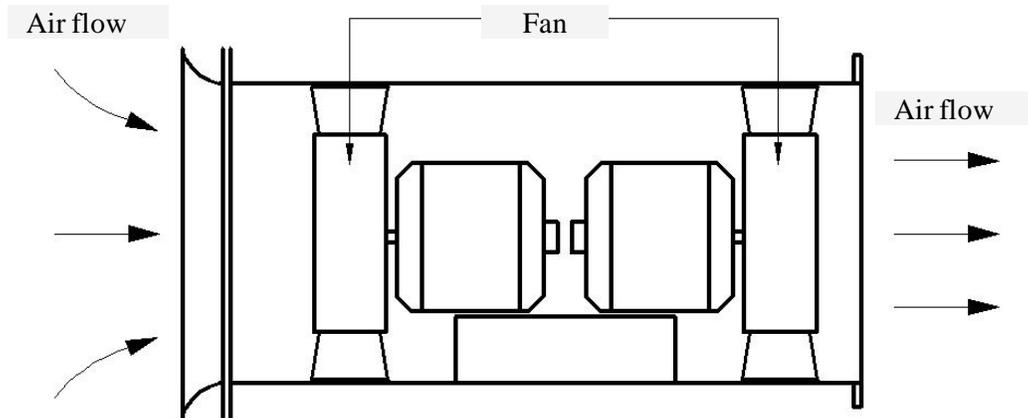


Figure 11b. Two-stage axial-flow fan rotating at opposite direction. (Fan Handbook Selection, Application and Design by Frank P. Bleier)

4.3.2 Centrifugal Fans

This fan causes the air/gas to enter from the side fan wheel, deflected 90 degrees and accelerates due to centrifugal force as it flows over the fan blades and exits the fan housing. (Fan Handbook Selection, Application and Design by Frank P. Bleier)

Type of fan that usually employ a volute or scroll-type casing. In this fan, the air inflow move axially and the air outflow move tangentially. (Mark's Standard Handbook for Mechanical Engineers by Avallone and Baumeister III)

Type of fan that consists of a wheel or rotor within a scroll spiral type housing. In this fan, the air enters parallel to the shaft, makes 90 degrees turn in the fan wheel, and is discharged from the wheel (and housing) in a radial manner. (Agricultural Process Engineering by Henderson and Perry)

Types of centrifugal fans shall be classified as follows:

4.3.2.1 Centrifugal Fans with Airfoil Blades (see Figure 12)

This type of fan has the best mechanical efficiency and the lowest noise level among the centrifugal fans. Used primarily for clean air, gas application and for general ventilation. (Fan Handbook Selection, Application and Design by Frank P. Bleier)

In this type of fan, blades have backward-curved chord lines so that the leading edge of the airfoil is at heel pointing forward and the trailing edge at the tip pointing backward with respect to rotation. (Mark's Standard Handbook for Mechanical Engineers by Avallone and Baumeister III)

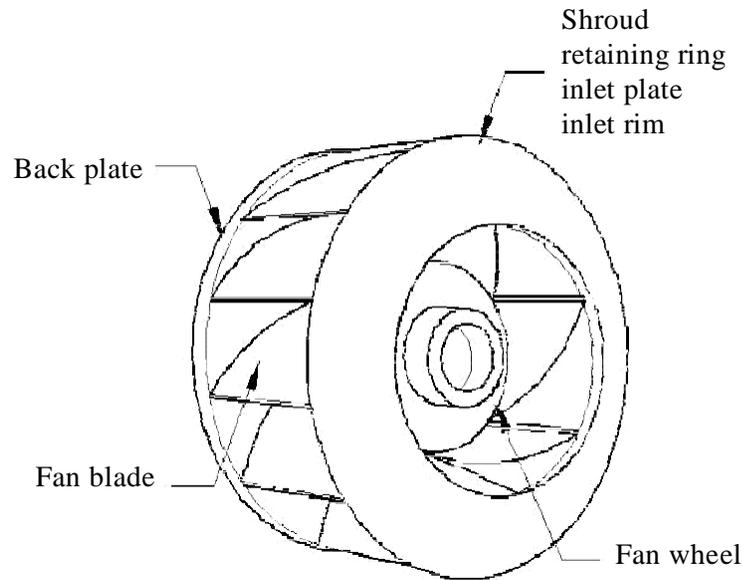


Figure 12. Parts of centrifugal fan with airfoil blades. (Fan Handbook Selection, Application and Design by Frank P. Bleier)

4.3.2.2 Centrifugal Fans with Backward Blades

4.3.2.2.1 Backward-Curved Blades (see Figure 12)

Type of centrifugal fan that has single-thickness steel fan blade and can handle contaminated air streams. (Fan Handbook Selection, Application and Design by Frank P. Bleier).

This type of fan has blades that point to the direction opposite to the rotation at the tip and in the direction of rotation at the heel. This fan has single thickness type of blade and is designed for radial flow. (Mark's Standard Handbook for Mechanical Engineers by Avallone and Baumeister III)

This type of fan has about 12 blades, essentially flat and tilted backward from the direction of fan wheel rotation. It is inherently a high speed type of fan with a self-limiting horsepower characteristic. (Agricultural Process Engineering by Henderson and Perry)

4.3.2.2.2 Backward-Inclined Blades (see Figure 13)

Type of centrifugal fan that is more economical in production and has low structural strength and efficiency. In this type, the direction of the outflow air is opposite to the inclination of the blades. (Fan Handbook Selection, Application and Design by Frank P. Bleier).

This type of fan has blades that point to the direction opposite to the rotation at the tip and in the direction of rotation at the heel. This fan has single thickness type of blade and is designed for radial flow. (Mark's Standard Handbook for Mechanical Engineers by Avallone and Baumeister III)

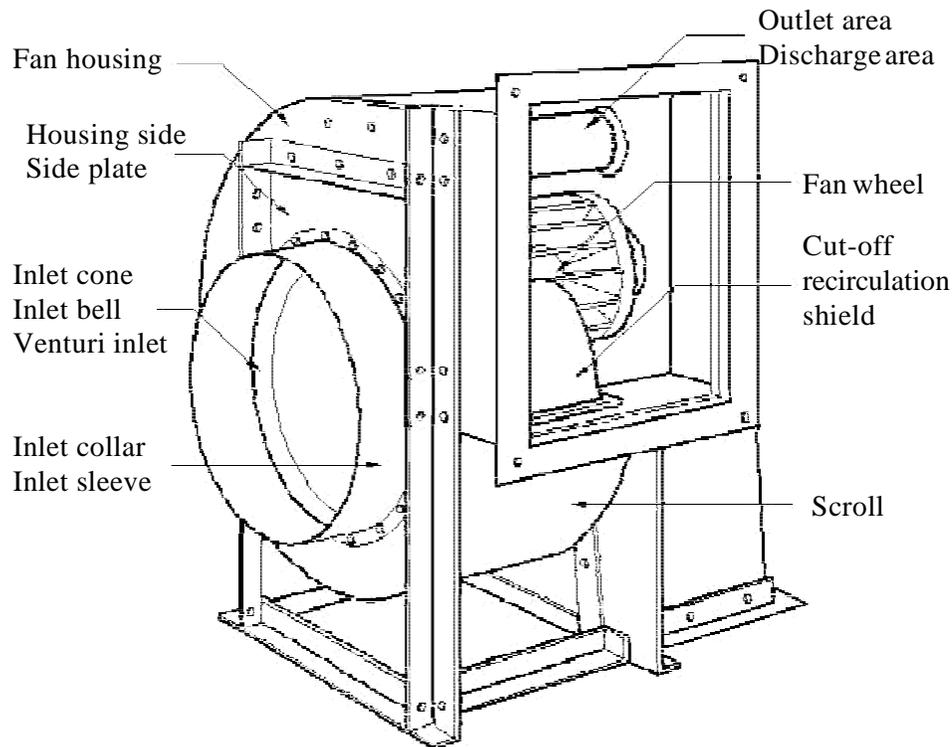


Figure 13. Parts of centrifugal fan with backward-inclined blades. (Fan Handbook Selection, Application and Design by Frank P. Bleier)

4.3.2.3 Centrifugal Fans with Forward-Curved Blades (see Figure 14)

Type of centrifugal fan that have blades which are curved forward to the direction of the rotation and have larger flow rate when compared to other centrifugal fans of the same size and speed. (Fan Handbook Selection, Application and Design by Frank P. Bleier).

This type of fan have blades that are shallow and curved so that both the tip and the heel point at the direction of rotation. This fan has single thickness type of blade and is designed for radial flow. (Mark's Standard Handbook for Mechanical Engineers by Avallone and Baumeister III)

This type has a rotor similar to a squirrel cage and a large number of blades up to 60, narrow in the radial dimension but wide parallel to the shaft and facing forward in the direction of rotation like a scoop. It is a low speed fan, capable of operating at several inches pressure under most conditions but is limited to handling clean air. (Agricultural Process Engineering by Henderson and Perry)

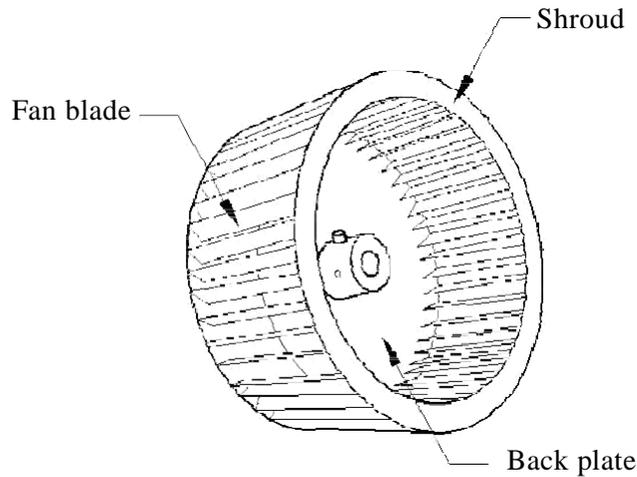


Figure 14. Parts of a centrifugal fan with forward-curved blades. (Fan Handbook Selection, Application and Design by Frank P. Bleier)

4.3.2.4 Centrifugal Fans with Radial blades (see Figure 15)

Type of centrifugal fan that are rugged and self cleaning and have non-tangential flow at the leading edge. This type can handle corrosive fumes and abrasive materials from grinding operations. (Fan Handbook Selection, Application and Design by Frank P. Bleier).

In this type of fan the blades are radial from tip to heel. This fan has single thickness type of blade and is designed for radial flow. (Mark's Standard Handbook for Mechanical Engineers by Avallone and Baumeister III)

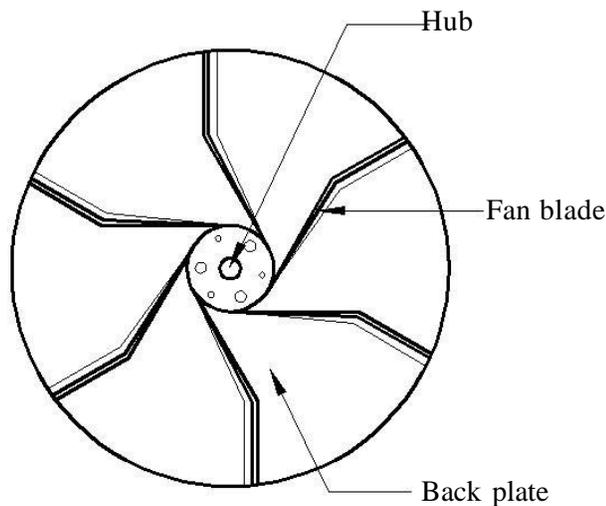


Figure 15. Parts of a centrifugal fan with radial blades. (Fan Handbook Selection, Application and Design by Frank P. Bleier)

Centrifugal Fans with Radial Tip Blades (see Figure 16)

Type of centrifugal fan that is curved, with good flow condition at the leading edge and blade tips are radial. (Fan Handbook Selection, Application and Design by Frank P. Bleier).

In this type of fan the blades are radial from tip and curved at the heel to point in the direction of rotation. This fan has single thickness type of blade and is designed for radial flow. (Mark's Standard Handbook for Mechanical Engineers by Avallone and Baumeister III)

This type has a smaller number of blades (from 6 to 20) and the blades are essentially in a plane radiating from the shaft. The blades are normally about two to three times as long radially as they are wide. (Agricultural Process Engineering by Henderson and Perry)

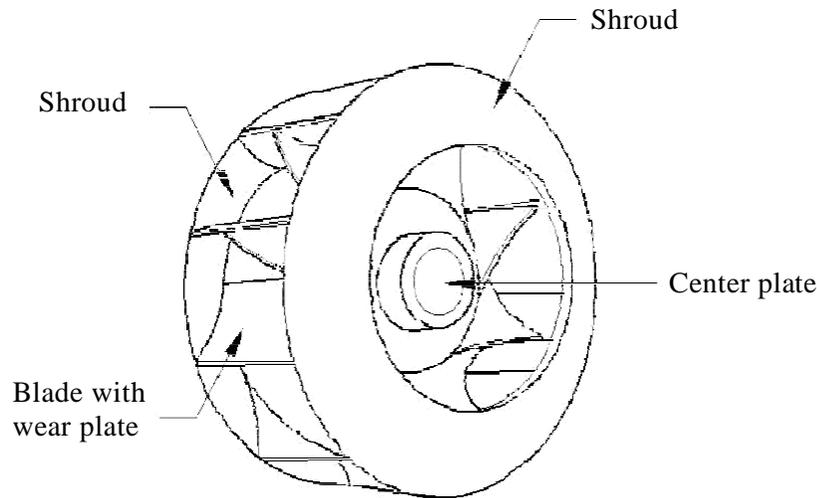


Figure 16. Parts of centrifugal fan with radial tip blades. (Fan Handbook Selection, Application and Design by Frank P. Bleier)

4.3.3 Axial-Centrifugal Fans (see Figure 17)

This type of fan is also known as tubular centrifugal fan, in-line centrifugal fan or mixed flow fan. (Fan Handbook Selection, Application and Design by Frank P. Bleier).

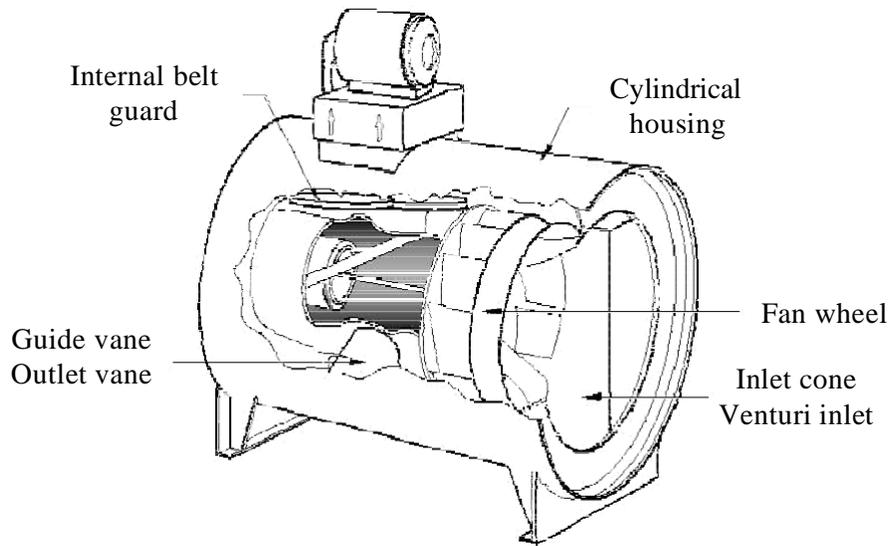


Figure 17. Parts of axial-centrifugal fan. (Fan Handbook Selection, Application and Design by Frank P. Bleier)

Classification of axial-centrifugal fans:

4.3.3.1 Fan Wheel with Flat Back Plate

In this type of fan, the air stream has to make two 90 degrees turns before exiting the fan housing. (see Figure 15 and 16)

4.3.3.2 Fan Wheel with Conical Back Plate

In this type of fan, the air stream has to make two 45 degrees turns before exiting the fan housing. (see Figure 18)

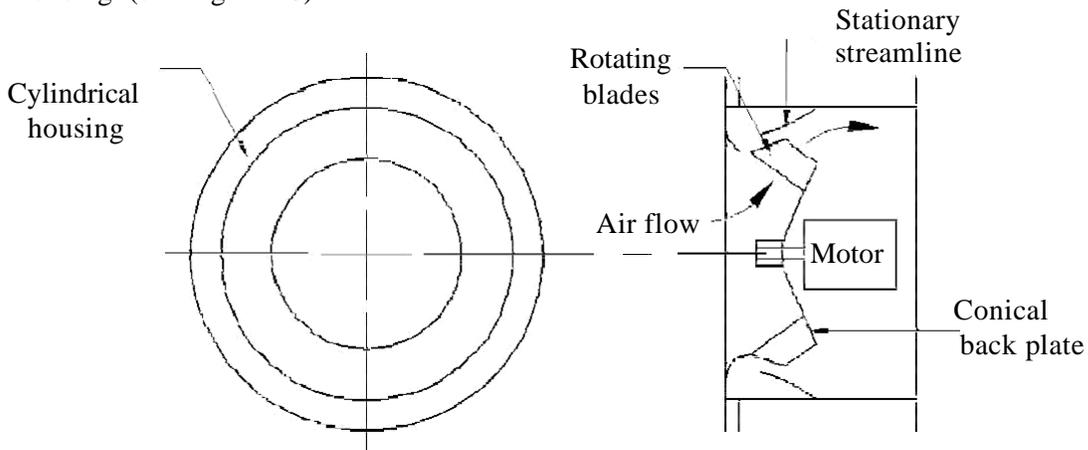


Figure 18. Fan wheel with conical back plate. (Fan Handbook Selection, Application and Design by Frank P. Bleier)

4.3.4 Roof Ventilators

These types of fan have up blast, down flow and radial discharge of air. This is mainly use for exhausting and supplying air from and into the building. (see Figure 19)

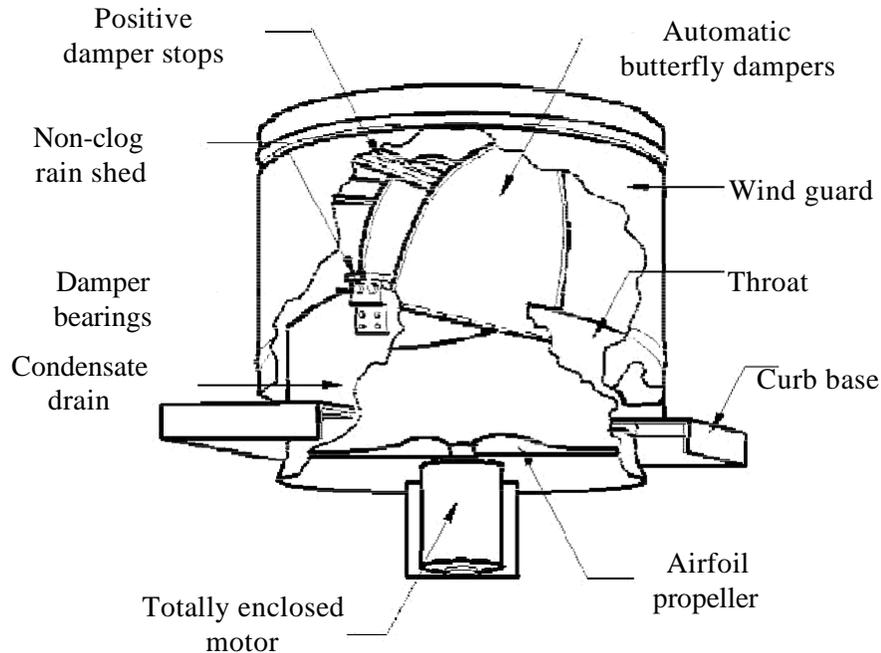


Figure 19. Parts of a roof ventilator. (Fan Handbook Selection, Application and Design by Frank P. Bleier)

4.3.5 Cross-Flow Blowers

In this type of fan, the airflow passes twice through a fan wheel with forward-curved blades. This type is mainly used as air curtains, long and narrow heating or cooling coils and dry blowers. (see Figure 20)

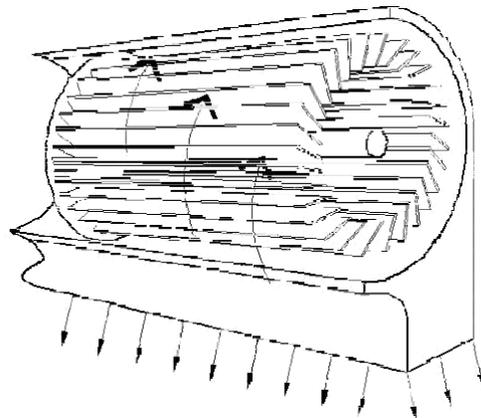


Figure 20. Direction of air flow in cross-flow blower. (Fan Handbook Selection, Application and Design by Frank P. Bleier)

4.3.6 Vortex or Regenerative Blowers

This type of fan causes the airflow to circle around in an annular, torus-shaped space. (see Figure 21) The rotating fan blades, which are located on one side of the torus, are throwing the air outward, and then airflow is guided back by the other side of the torus for it to reenter the inner portion of the rotating blade

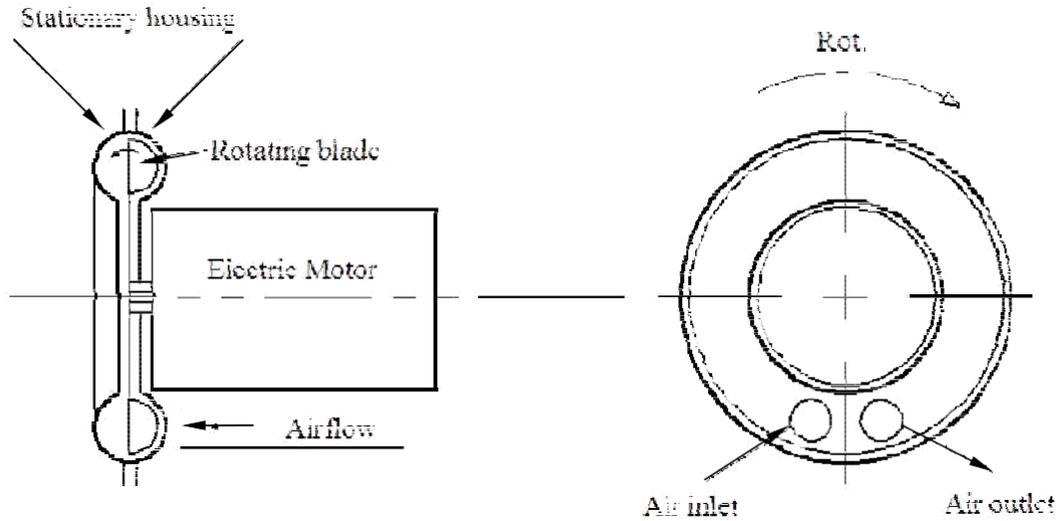


Figure 21a. Vortex blower rotating in right half of the torus-shaped housing. (Fan Handbook Selection, Application and Design by Frank P. Bleier)

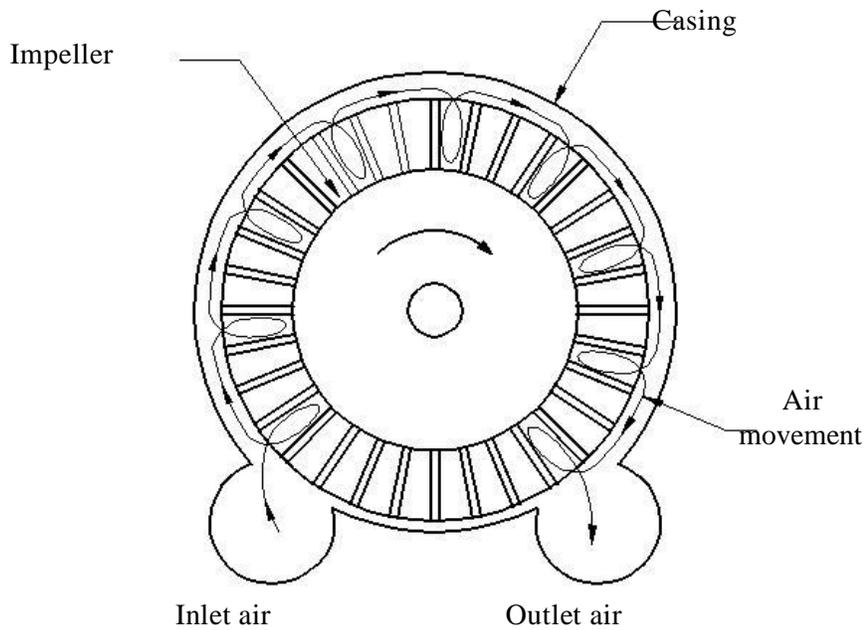


Figure 21b. Direction of air flow in vortex blower. (Spencer Blowers and Vacuum Systems with an Engineering Edge, www.images.google.com.ph)

5 Manufacturing Requirements

- 5.1** The fan guard shall be made of steel or cast aluminum or other appropriate materials within safety standards. It should be meshed to minimize the interference with the air stream
- 5.2** The fan wheel or fan blades shall be made of steel, cast aluminum materials or high grade industrial plastic molds.
- 5.3** For airfoil type of blade, the upper camber shall be at most 13.3% of the total chord and shall be located at about 36% of the chord from the leading edge. The lower camber shall be at most 2.4% of the total chord and shall be located at about 64% of the chord from the leading edge. (Fan Handbook Selection, Application and Design by Frank P. Bleier)
- 5.4** The leading edge of the airfoil type of fan blade shall have a blunt shape for structural purposes and to avoid turbulence and to decrease the drag. It shall have a pointed trailing edge.
- 5.5** Single-thickness metal type of blade shall have the maximum camber of 8% of the total chord. It shall be located at about 38% of the chord from the leading edge. (Fan Handbook Selection, Application and Design by Frank P. Bleier)
- 5.6** The range for angle of attack for each fan blade shall be between one (1) degree to ten (10) degrees to ensure high lift drag ratio and good performance of the fan. (Fan Handbook Selection, Application and Design by Frank P. Bleier)
- 5.7** For radial tip centrifugal fans that are being used for industrial purposes, range of 76.2 cm to 152.4 cm (30 inches to 60 inches) wheel shall be used to endure severe conditions of high temperature and high concentrations of solids.
- 5.8** The back plate shall be made of steel or cast aluminum. It shall be flat or conical in shape.
- 5.9** The fan frame shall be made of steel, cast aluminum and high grade industrial plastic mold and shall have rubber damper incorporated on it to minimize vibration.
- 5.10** The fan housing/casing shall be made of steel or cast aluminum. It shall be cylindrical, square or barrel shaped.
- 5.11** For propeller fan that is being used as exhaust on buildings, automatic or motorized shutter shall be provided to minimize heat losses and to serve as protection for the fan.
- 5.12** For large size propeller fan (3-phase), belt-drive shall be used. For small size (single phase) propeller fan, direct and belt-drive shall be used.
- 5.13** Bolts and screws to be used shall conform to the requirements of PAES 311 and 313.
- 5.14** The number of blades, size range and hub-tip ratio of each type of fan are listed on Table 1.

Table 1. Number of blades, size range and hub-tip ratio of different fans. (Fan Handbook Selection, Application and Design by Frank P. Bleier)

FAN TYPE	NO. OF BLADES	SIZE RANGE, (in)	HUB-TIP RATIO, %
<i>Axial-Flow Fans (with direct drive)</i>			
Propeller fan	---	---	40
Tube-axial fan	---	---	30 to 50
Vane-axial fan	---	---	45 to 80
Two-stage axial fan	---	---	50 to 80
<i>Centrifugal Fans</i>			
with Airfoil blade	9 to 12	12 to 132	65 to 80
with Backward-curved blade	9 to 12	12 to 132	60 to 80
with Backward-inclined blade	9 to 12	12 to 132	60 to 80
with Radial-tip blade	12 to 24	25 to 110	50 to 80
with Forward-curved blade	24 to 64	2 to 73	75 to 90
with Radial blade	6 to 10	12 to 122	30 to 60
<i>Cross-Flow Blowers</i>			
	---	---	70 to 80
<i>Vortex Blowers</i>			
	18 to 42	---	22 to 30

5.15 For large fans, 3-phase asynchronous motors should be used, placed near the fan and driving it by belt and pulley. Smaller fans should be powered by shaded pole AC motors or brushed or brushless DC motors. AC-powered fans usually use mains voltage, while DC-powered fans use low voltage, typically 24 V, 12 V or 6 V. Types of motors to be used for fan/blower shall be seen in Table 2 and 3. (Wikipedia, Fan (Mechanical))

Table 2. Types, characteristics and applications of single-phase motors (PAES 129:2002)

Type	Power Ranges		Load Starting Ability	Starting Current	Characteristics	Typical Uses
	kW	hp				
SQUIRREL CAGE:						
Split-phase	0.04 to 0.37	1/20 to 1/2	-Easy starting loads -Develops 150% of full-load torque	High; five to seven times full-load current	-Nearly constant speed with varying load -Electrically reversible	Fans, centrifugal pumps, loads that increase as speed increases
Capacitor start	0.09 to 7.46	1/8 to 10	-Hard starting loads -Develops 350 to 400% of full-load torque	Medium; three to six times full-load current	-Nearly constant speed with varying load -Electrically reversible	Compressors, grain augers, conveyors, pumps, silo unloader and barn cleaners
Two-value capacitor	1.49 to	2 to 20	-Hard starting	Medium; Three to	-Nearly constant	Conveyors, barn

	14.92		loads -Develops 350 to 400% of full-load torque	five times full-load current	speed with varying load -Electrically reversible	cleaners, elevators, silo unloaders
Permanent-split capacitor	0.04 to 0.75	1/20 to 1	-Easy starting loads -Develops 150% of full-load torque	Low; two to four times full-load current	-Electrically reversible	Fans and blowers
Shaded-pole	0.003 to 0.37	1/250 to 1/2	-Easy starting load	Medium	-Not electrically reversible	Small blowers, fans and small appliances
WOUND-ROTOR (repulsion)	0.12 to 7.46	1/6 to 10	-Very hard starting loads -Develops 350 to 400% of full-load torque	Low; two to four times full-load current	-Not electrically reversible -Reversed by brush ring readjustment	Conveyors, drag burr mills, deep-well pumps, hoists, silo unloaders, bucket elevators

Table 3. Type, characteristics and application of three-phase motors. (PAES 129:2002)

Type	Description	Starting Torque	Maximum Running Torque	Characteristics	Typical Uses
Squirrel Cage	NEMA Design B: Energy efficient; Normal starting current; can be used with variable frequency or variable-voltage inverters; higher efficiency than standard-design B motors	100-150% of full-load torque	200-250% of full-load torque	Continuous operation, constant speed, high speed (over 720 rpm), easy starting, subject to short time overloads, good speed regulation	Pumps, compressors, conveyors, process machinery
	NEMA Design B: Normal torques; Normal starting current; can be used with variable-frequency or	100-150% of full load torque	200-250% of full-load torque	Variable load conditions, constant speed, subjects to short time overloads, good speed regulation	Centrifugal pumps, blowers, fans, drilling machines, grinders, lathes,

	variable-voltage inverters				compressors, conveyors
	NEMA Design C: High torque; Normal starting current; not recommended for use with variable-frequency inverters	200-300% of full load torque	Not more than full-load torque	High starting torque; not subject to severe overload; good speed regulation	Reciprocating fans, stokers, compressors, crushers, ball and rod mills
	NEMA Design D: High torque; High slip; standard types have slip characteristics of 5-8% or 8-13% slip	Up to 300% of full-load torque	200-300% of full-load torque; loss of speed during peak loads required	Intermittent loads; poor speed regulation to smooth power peaks	Punch presses, cranes, hoists, press brakes, shears, centrifugals
	Multispeed: Normal torque on dominant winding or speed; consequent pole windings for each speed: based on load requirement, can be constant horsepower, constant torque, variable torque	Some require low torque; others require several times full-load torque	200% of full-load torque at each speed	Low starting torque and variable torque on blowers; High starting torque and constant torque on conveyors	Blowers, fans, machine tools, mixing machines, conveyors, pumps
Wound-rotor	Requires rotor control system to provide desired characteristics; control may be resistors or reactors or fixed frequency inverters in the secondary (rotor) circuit; actual load speed depends on the setting of rotor control	Can provide torque up to maximum torque at standstill	200-300% of full-load torque	Very high starting torque with low starting current; limited range of speed adjustments; controlled acceleration	Crushers, conveyors, bending rolls, ball and rod mills, pumps, centrifugal blowers, cranes and hoists, centrifugals

5.16 Fan/blower shall have air-cooled for direct cooling system or water-cooled for indirect cooling system engine. (PAES 116:2001)

- 5.17 Fan/blower shall have air cooled (direct cooling system) electric motor.
- 5.18 Lift-drag ratio for airfoil type of blade shall have range value of 40 to 63.
- 5.19 Lift-drag ratio for single-thickness sheet metal type of blade shall have range value of 20 to 57.

6 Installation Requirements

- 6.1 Fan guard shall be provided at the exposed fan inlets and/or outlets when the fan is being installed less than 2.13 m (7 ft) from the ground to avoid accidents
- 6.2 For large ventilator fans, more substantial foundations are required.
 - 6.2.1 The foundations shall be leveled, rigid and of sufficient mass for the equipment.
 - 6.2.2 The mass of concrete foundation shall be three to four times the weight of the fan assembly.
- 6.3 When the fan is mounted on the foundation, the fan shaft shall be leveled, and shims shall be used at the support points before the foundation bolts are tightened. This shall prevent distortion or twisting of the equipment and any possible rubbing of the rotating part.
- 6.4 The fan when installed shall have a clearance at the top of twice as much as the clearance at the bottom to obtain an even radial clearance all around when the fan handles hot air.
- 6.5 For V-belt driven fan, careful alignment of the sheaves and proper adjustment of the belt tension shall be observed. (see Figures 22 and 23) The belt shall have only a slight bow (refer to PAES 301:2000) on the slack side of the drive while operating under load. (see Figure 24) Types and designations of V-pulleys to be used shall be seen in Figure 25.

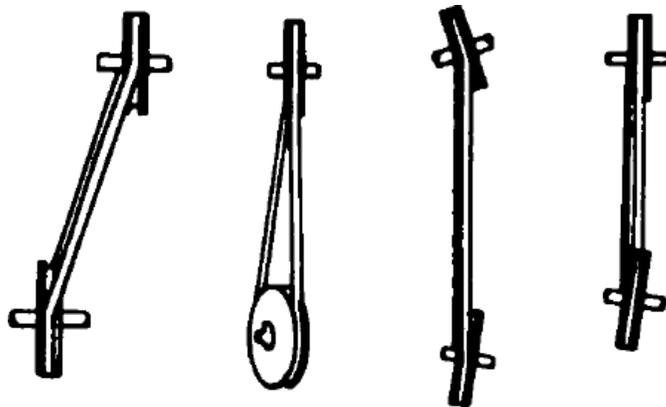


Figure 22. Fan belt misalignment to be avoided. (Fan Handbook Selection, Application and Design by Frank P. Bleier) (refer to PAES 301:2000 for V-belt selection)

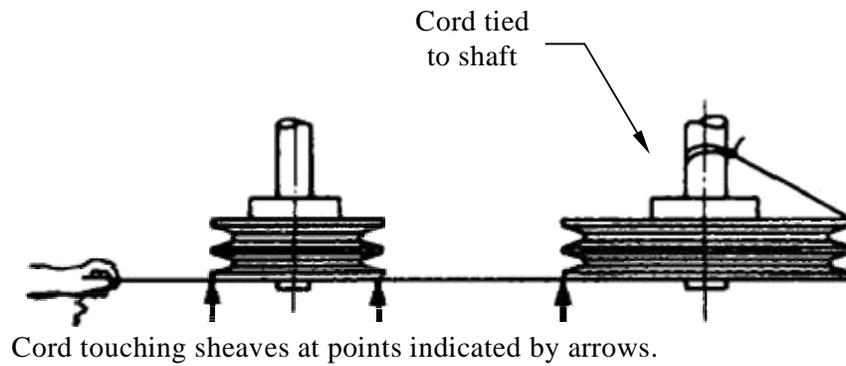


Figure 23. Use of a chord to check the alignment of the sheaves. (Fan Handbook Selection, Application and Design by Frank P. Bleier)

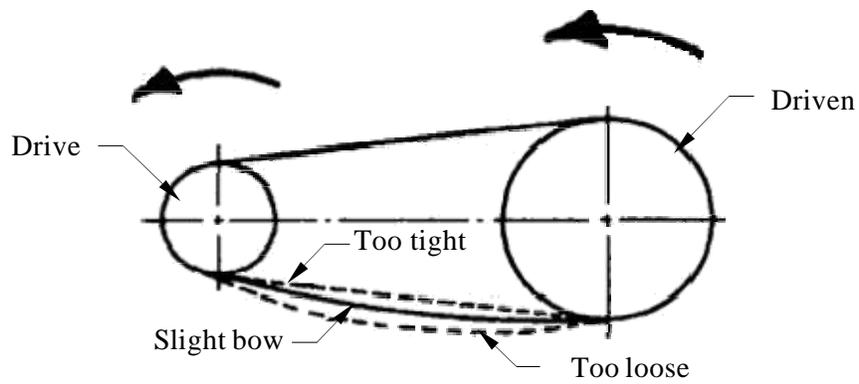
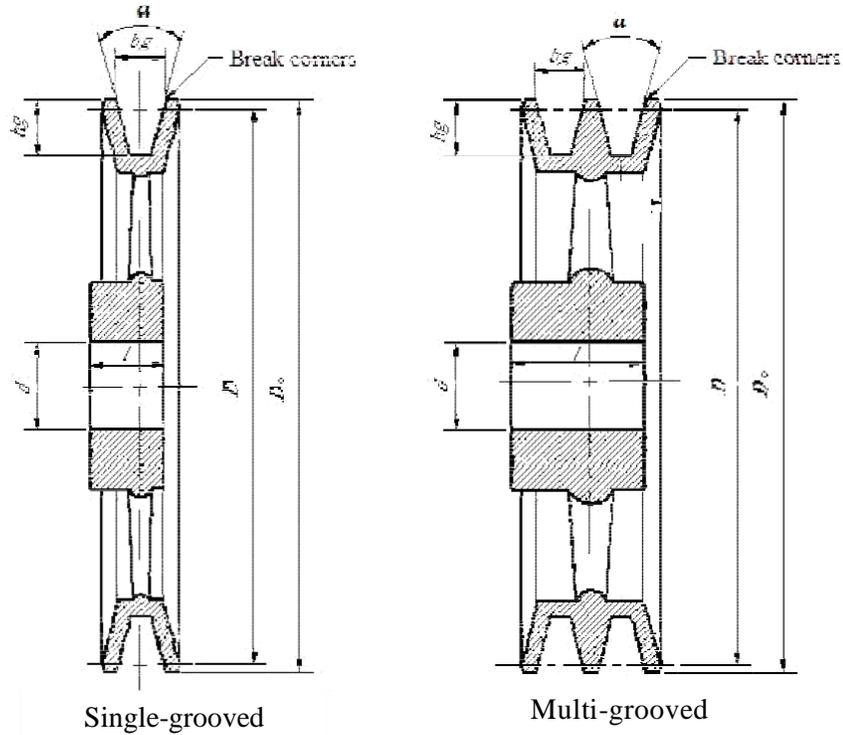


Figure 24. Shape of a fan belt during adjustment. (Fan Handbook Selection, Application and Design by Frank P. Bleier)



Where b_g is the top width of the pulley groove
 D is the pulley pitch diameter
 D_o is the pulley outside diameter
 d is the bore diameter
 l is the hub length
 h_g is the height of the pulley groove
 α is the groove angle
 x is one-half the difference between the outside diameter and pitch diameter

Figure 25. Types and designation of dimensions of V-pulleys

7 Performance Requirements

7.1 The minimum mechanical efficiency and the range of static pressure for each type of fan shall be the following: (see Table 4)

Table 4. Static pressure and mechanical efficiency of the different fan type. (Fan Handbook Selection, Application and Design by Frank P. Bleier)

FAN TYPE	STATIC PRESSURE (in WC)	MECHANICAL EFFICIENCY, %
<i>Axial-Flow Fans (with direct drive)</i>		
Propeller fan	0 to 1	70
Tube-axial fan	½ to 2 ½	75
Vane-axial fan	1 to 9	90
Two-stage axial fan	4 to 18	70
<i>Centrifugal Fans</i>		
with Airfoil blade	5 to 35	92
with Backward-curved blade	5 to 60	85
with Backward-inclined blade	5 to 30	80
with Radial-tip blade	10 to 40	71
with Forward-curved blade	1 to 10	65
with Radial blade	20 to 40	60
<i>Cross-Flow Blowers</i>	0 to 1.55	35 to 45
<i>Vortex Blowers</i>	0 to 54	30

7.2 Performance curve, which shows the input power (kW), overall efficiency (%) and static pressure (mmH₂O) plotted against air flow rate (m³/min) shall be provided.

8 Safety, Workmanship and Finish

8.1 All fan components attached to the main shaft shall be statically and dynamically balanced for stable operation.

8.2 The noise emitted by the fans/blowers measured one meter away shall not be more than 96 db (A).

NOTE: Allowable noise level for four (4) hours of continuous exposure based on Occupational Safety and Health Hazards, Ministry of Labor, Philippines. 1983

8.3 The fans and blowers shall be free from manufacturing defects that may significantly affect its performance.

8.4 All machine surfaces shall be coated with a suitable paint material.

8.5 Sealed type bearings should be used.

8.6 Provision for grease points for mechanical parts and non-sealed type bearings shall be integrated.

- 8.7 All welded parts shall be water-tight and smoothly polished and it shall pass visual inspection criteria (AWS D1.1:2000) for discontinuity of materials.
- 8.8 Welded joints shall not be less than 4 mm (1/8 inch) side fillet welded. Undercut shall not exceed 2 mm (1/16 inch) for any length of weld.
- 8.9 Mechanism for immediate disengagement of power transmission should be provided.

9 Warranty

- 9.1 Warranty against defective materials and workmanship shall be provided for parts and services except for normal wear and tear of consumable maintenance parts such as belts within six (6) months from the date of purchase of the fans and blowers.
- 9.2 The construction shall be rigid and durable without breakdown of its major components for at least one year from the date of purchase of end-user.

10 Maintenance and Operation

- 10.1 An operator's manual, which conforms to PAES 102, shall be provided by the manufacturer.
- 10.2 Standard tools and standard extra parts shall be provided as indicated in operator's manual.
- 10.3 The fans and blowers shall be easy to disassemble and reassemble to facilitate cleaning.

11 Testing

Fans and blowers shall be tested in accordance with PAES 241.

12 Markings

- 12.1 Each fan/blower shall be marked in English with the following information using a stencil or by directly punching it on a plate and shall be positioned at a most conspicuous place:
 - 12.1.1 Registered trademark of the manufacturer
 - 12.1.2 Brand
 - 12.1.3 Model

12.1.4 Serial number

12.1.5 Rotational speed, rpm

12.1.6 Power requirement, kW

12.1.7 Name and address of the manufacturer

12.1.8 Name and address of the distributor

12.1.9 Country of manufacture (if imported) / “Made in the Philippines” (if manufactured in the Philippines)

12.2 Safety/precautionary markings shall be provided when appropriate. Marking shall be stated in English and Filipino and shall be printed in red color with a white background.

12.3 The markings shall have a durable bond with the base surface material.

12.4 The markings shall be all weather resistant and under normal cleaning procedures, it shall not fade, discolor, crack or blister and shall remain legible.

Philippine Agricultural Engineering Standards

AMTEC-UPLB – PCARRD Project: “Development of Standards for Agricultural Production and Postharvest Machinery”

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