Often the service determines the type of fan. When operation occurs with little or no resistance, and particularly without a duct system, the propeller fan is indicated for convenience and low cost. When resistance is low the power required is low, and efficiency becomes of secondary importance. When a duct system is involved the choice is usually made between a centrifugal fan and a tubeaxial or vaneaxial. At times the capacity-pressure-speed relationship (specific speed)[9] dictates a choice. Usually, space, efficiency, sound, cost and serviceability must all be considered.[10] In general, centrifugal and axial fans are comparable in efficiency and sound, but the latter are lighter and require considerably less space, especially if arranged for straight-through operation. The comparison cannot be made on the cost of fans only, but the difference in cost of ductwork, mounting and servicing must be included. A vaneaxial is more efficient and quieter than a tubeaxial, but is more expensive, and frequently requires more space. While requiring less space than the centrifugal, the axial flow fan is inherently less accessible for service. When high-temperature air or air containing corrosive elements is being conveyed, motors and bearings should be located outside of the air stream. This requirement may determine the type of fan to be used. Where the system resistance is indefinite or variable, the pressure, horsepower and noise characteristics of centrifugal fans usually indicate their selection. Under such conditions, a steep and constantly rising pressure curve permits less variation in air delivery when the resistance varies. Likewise, a flat sound curve minimizes the chance of moving into a region of increased noise. A fan having a high efficiency over a wide range is more desirable than one which reaches an even higher maximum efficiency, but decreases more rapidly on either side of a narrow range. A self-limiting horsepower curve may permit more accurate selection of motor size.

Table 1. Good Operating Velocities and Tip Speeds for Ventilating Fans

Static Pressure Inches of Water	Forward Curved Blade Fans		Backward Tipped and Double Curved Blade Fans		Tubeaxial and Vaneaxial Fans
	Outlet Velocity Feet per Minute	Tip Speed Feet per Minute	Outlet Velocity Feet per Minute	Tip Speed Feet per Minute	Wheel Velocity[a] Feet per Minute
¼	1000–1100	1520–1700	800–1100	2600–3100	1100–1500
⅜	1000–1100	1760–1900	800–1150	3000–3500	1250–1700
½	1000–1200	1970–2150	900–1300	3400–4000	1400–1900
⅝	1200–1400	2225–2450	1000–1500	3800–4500	1500–2100
¾	1300–1500	2480–2700	1100–1650	4200–5000	1650–2350
⅞	1400–1700	2660–2910	1200–1750	4500–5300	1800–2500
1	1500–1800	2820–3120	1200–1900	4800–5750	1900–2700
1¼	1600–1900	3162–3450	1300–2100	5300–6350	2150–3000
1½	1800–2100	3480–3810	1400–2300	5750–6950	2350–3300
1¾	1900–2200	3760–4205	1500–2500	6200–7550	2500–3550
2	2000–2400	4000–4500	1600–2700	6650–8050	2700–3800
2¼	2200–2600	4250–4740	1700–2800	7050–8550	
2½	2300–2600	4475–4970	1800–2950	7450–9000	
3	2500–2800	4900–5365	2000–3200	8200–9850	

[a] Wheel velocity is the axial mean air velocity through the inside diameter of the housing cylinder at the point of wheel location.

The selection of size of fan usually involves balancing cost and space against sound and efficiency. Unless the pressure involved is so high that a smaller fan running at greater speed requires a higher class[2] of construction, the smallest fan is the cheapest in first cost of the fan only. However, as the cost of the driving equipment is also involved in the total installation

cost, fan efficiency must be considered for that reason as well as its bearing on the cost of operation. In some cases where large fans operate long hours per year, selection at absolute maximum efficiency is indicated. Generally, however, the power saving by selecting for optimum efficiency does not justify the extra cost, and a slightly smaller fan gives the best balance of cost and efficiency. Reference to Figs. 2 to 4 shows that all types tend to have a minimum sound near maximum efficiency so, when noise is a consideration, selection approaching maximum efficiency is indicated. Too large a fan may not only mean an unnecessary investment and an increased power consumption and sound, but may also give faulty performance if of a type having an unstable pressure characteristic at low capacity.

Table 1 shows the outlet velocities and impeller tip speeds recognized as good practice for various static pressures for centrifugal, tubeaxial and vaneaxial fans applied to average heating, ventilating and air conditioning applications. Fans for churches, schools, residences and other buildings having a low prevailing noise level should be selected for lower than average outlet velocities.

FAN INSTALLATION

In designing heating, ventilating and air conditioning systems, the characteristics of the fans available for use therewith should not be ignored. If double inlet fans or multiple fans in parallel are used, care must be taken that both inlets have the same free area and general approach conditions.

The dimensions of the ductwork and the size of the various devices whose individual resistances determine the static pressure, dictate the fan selection. Often a minor modification of the system may permit use of a smaller motor, and even a lower class[2] of fan, with considerable saving of cost. Invariably, the sound generated is affected, as fans operating at high pressure produce more noise than at lower pressure (see Chapter 40). Minimizing the resistance may be the best insurance against noise. On the other hand, sometimes the lowest overall cost results from selecting the minimum size of system equipment, and then installing adequate acoustical and vibration treatment.

All ducts should be connected to fan outlets and inlets by means of unpainted canvas or other flexible material. Access should be provided in the connections for periodic removal of any accumulations tending to unbalance the rotor. When operating against high resistance, or when ambient noise levels are low, it is preferable to locate the fan in a room removed from occupied areas or acoustically treated to prevent sound transmission. The lighter building constructions which are common today, make it desirable to mount fans and driving motors on resilient bases designed to prevent transmission of vibrations through floors to the building structure. Conduits, pipes and other rigid members should not be attached to fans. Noises due to high velocities, abrupt turns, grilles and other items not connected with the fan, may be present. Treatment of such problems, as well as the design of sound and vibration absorbents, are covered in Chapter 40.

FAN APPLICATIONS

Many fan applications and the corresponding types of fan commonly used are listed in the following paragraphs. Reference is also made to the chapters where the applications are discussed.

Central System Supply Fans (Chapter 29) are usually of the centrifugal