basis that the smaller the kitchen the more concentrated the heat will be, thus requiring a more rapid rate of air change. Standard size built-in kitchen ventilators are generally available in three sizes, namely, 350, 500 and 800 cfm. The proper size to use will depend on design conditions and available wall space.

DUCT SYSTEM DESIGN

In designing a duct system it is necessary to recognize a few fundamental principles (see also Chapter 31). Knowing the quantity of air required, the size of the duct may be computed from Equation 6:

$$A = \frac{Q}{V} \tag{6}$$

where

A = cross-section area of duct, square feet.
Q = air quantity to be exhausted by the duct, cubic feet per minute.
V = velocity of air, feet per minute.

Air Velocities in Ducts

Where it is necessary to transport the particulate material collected in an exhaust system, minimum carrying velocities must be maintained in the ducts preceding the collector. It has been found that good results are obtained when design air velocities in horizontal runs are not less than 2000 fpm, or not greater than 5000 fpm. When the dust being carried is organic and other than wood flour, or similar material, a velocity of 2500 fpm is adequate. Approximate required conveying velocities are given in Table 4.

For duct systems wherein the air has no dust or solid load, a lower velocity is desirable, which may range from 1500 to 2500 fpm. In view of the fact that the horsepower required by a system depends directly on the resistance, and the resistance is a function of the velocity, economical design requires velocities of this magnitude.

The equal friction method is generally used for designing a duct system, as this insures equal resistance to air flow in all branches throughout the system (see Chapter 31). Long main ducts do not generally provide the most economical layout. Where it is necessary to ventilate a large number of machines, or machines which are widely separated, it is desirable to locate the fan at approximately the center of the system. With this arrangement it is possible to choose a fan which will deliver the required air quantity against a lower resistance pressure, and this will generally result in a horsepower saving.

When a system carrying dust is designed with an oversize main duct to allow for future extension, the air velocity may be found to be too low to carry the dust, and serious plugging may occur. In this case it is desirable to install an orifice in the end of the pipe to allow for the lower air quantity.

Construction

The interior of all ducts should be smooth and free from obstructions at joints and soldered air-tight. Other sealing mediums are permissible where soldering is impracticable.

Ducts should be constructed of galvanized sheet metal, except when the presence of corrosive fumes or gases, temperatures above 400 F, or other factors would make galvanized material impracticable. For the usual exhaust systems, the metal thicknesses shown in Table 5 are recommended. Elbows and angles should be a minimum of two gages heavier than straight lengths of equal diameter. Hoods should be a minimum of two gages heavier than straight sections of a connecting branch.

TABLE 5. GAGES OF METALS FOR EXHAUST SYSTEMS[a]

DIAMETER OF ROUND PIPE OR GREATEST DIMENSION OF RECTANGULAR PIPE, INCHES	THICKNESS OF DUCT MATERIAL U. S. GAGE NUMBER	
	For Highly Abrasive Matter	For Other Matter
Up to 8 inclusive	20	22
Over 8 to 18 inclusive	18	20
Over 18 to 30 inclusive	16	18
Over 30	14	16

[a] *Fundamentals of Design, Construction, Operation and Maintenance of Exhaust Systems (American Foundrymen's Association,* p. 53).

Longitudinal joints of ducts should be lapped and riveted or spot-welded on 3-in. centers maximum. Girth joints or ducts should be made with lap in direction of air flow, with 1 in. lap for duct diameters through 19 in., and 1½ in. lap for diameters over 19 in. Elbows and angles should have an inside or throat radius of two pipe diameters whenever possible. Large radii are recommended for heavy concentrations of highly abrasive dusts. Elbows 6 in. or less in diameter should be constructed of at least 5 sections and, if over 6 in. in diameter, of 7 sections, with angles pieced proportionally. Hoods should be free of sharp edges or burrs and reinforced to provide necessary stiffness. Transitions in mains and submains should be tapered with a taper 5 in. long for each 1 in. change in diameter whenever possible. All branches should enter the main at the large end of the transition at an angle not to exceed 45 deg, or preferably 30 deg. Branches should be connected only to the top or sides of mains, with no two branches entering diametrically opposite to each other. Dead end caps should be provided within 6 in. from last branch of all mains and sub-mains. Cleanouts should be provided every 10 ft and near each elbow, angle, or duct junction in horizontal sections. Ducts should be supported sufficiently to place no loads on connected equipment, and to carry weight of a system plugged with material. The maximum distance between supports should be 12 ft for 8 in. or smaller ducts, and 20 ft for larger ducts. Six inches minimum clearance should be provided between ducts and the ceiling, wall or floor. Blast gates for adjustment of the system should be placed near the connection of a branch to the main, and means of locking gates after the adjustments have been made should be included. Rectangular ducts should be used only when clearances prevent the use of round construction. Rectangular ducts should be as nearly square as possible. The weight of metal and the lap, and other construction details, should be the equal of round duct construction having a diameter equal to the longest side. All pipes passing through roofs should be equipped with collars so arranged as to prevent water from leaking into the building.

The main trunks and branch pipes should be as short and straight as possible.

Cleanout openings having suitable covers should be placed in the main and branch pipes so that every part of the system can be easily reached in case the system clogs. Either a large cleanout door should be placed in the main suction pipe near the fan inlet, or a detachable section of pipe, held in place by lug bands, may be provided.