

the machine; and where a heavy vapor, or dust-laden air at ordinary temperature is to be removed, horizontal or floor connections are sometimes preferable. In many cases there are convection currents and other atmospheric disturbances in the work room which should be given consideration. These disturbances diminish the tendency of dusts and fumes to settle from the room air because of their density.

In another class of operation the main objective is to prevent the escape of dust into the surrounding atmosphere, the removal of some dust from the machine or enclosure being merely incidental. The dust-creating apparatus is enclosed within a housing which is made as tight as practicable, and sufficient suction is applied to the enclosure to maintain an inward air leakage, thus preventing escape of the dust. While the exhaust system is required to handle only the air which leaks in through the crevices and openings in the enclosure, yet in many installations leakages are very high and great care is required to obtain satisfactory results with a system of this kind. The inward-leakage principle is utilized for controlling dust in the operating of tumbling barrels, grinding, screening, elevating, and similar processes.

Certain dust and fume producing operations are best carried on by isolating the process in a separate compartment or room and then applying general ventilation to this space. The compartment or room in which the work is performed should be as small as is consistent with convenience in handling the work. The ventilating system should be designed so that a current of clean air is drawn across the work in such a manner as to carry the dust or fume away from the operator and out of the work space. Another method of accomplishing the control of this type of installation is the dilution method. In this case sufficient clean air is introduced generally into the work space to dilute the contamination to a safe level.

HOOD DESIGN PRINCIPLES

The first step in the design of an exhaust system is to determine the number and size of the hoods and their connections. No general rules, however, can be given since hood and duct dimensions are determined by the characteristics of the operations to which they are applied. When a tentative decision regarding the set-up has been made, it is then necessary to obtain the suction and air velocities required to effect control. At this point the designer must rely upon the prevailing practice and on such physical data relating to hoods, duct systems and collectors as are available. The fan speed must be sufficient to maintain the estimated suction and air velocities in the system. In general, the most important requirements of an efficient exhaust and collecting system are¹:

1. Hoods, ducts, fans, motors and collectors should be of adequate size and type.
2. The air velocities should be sufficient to control and convey the materials collected.
3. The hoods and ducts should be placed so as not to interfere with the operation of a machine or any working part.
4. The system should do the required work with a minimum power consumption.

¹For more detailed requirements refer to Fundamentals Relating to the Design and Operation of Exhaust Systems, Z9-1936 (American Standards Association). Industrial Code Bulletin Nos. 10 and 12 (New York State Labor Department). Principles of Exhaust Hood Design, by J. M. DallaValle (U. S. Public Health Service, 1939).

5. When inflammable dusts and fumes are conveyed, the piping should be provided with an automatic damper in passing through a fire-wall.

6. Ducts and all metal parts should be grounded to reduce the danger of dust explosions by static electricity.

7. The design of an exhaust system should afford easy access to parts for inspection and care.

REQUIREMENTS FOR SUCTION AND VELOCITY

The removal of dust or waste by means of an exhaust hood requires a movement of air at the point of origin sufficient to carry it into a collecting system. The air velocities necessary to accomplish this depend upon the physical properties of the material to be eliminated and the direction and speed with which it is thrown off. If the dust to be removed is already in motion, as is the case with high-speed grinding wheels, the hood must be installed in the path of the particles so that a minimum air volume may be used effectively. It is always desirable to design and locate a hood so that the volume of air necessary to produce results is as small as possible. This will reduce the size of equipment and power required by the system and also the heating load requirements in the winter.

Air Flow from Static Readings

The static suction at the throat of a hood is frequently used in practice as a measure of the effectiveness of control. Where the hood coefficient is known the volume of air flow through any hood may be determined from the equation:

$$Q = 4005 f A \sqrt{h_t} \quad (1)$$

where

Q = volume of air flow, cubic feet per minute.

A = area of connecting duct, square feet.

h_t = static suction measured 3 diameters from throat of hood, inches of water.

f = orifice or restriction coefficient which varies from 0.6 to 0.9 depending on the shape of the hood.

An average value of f is 0.71, although for a well-shaped opening a value of 0.8 may be used. The factor f is determined from the equation:

$$f = \sqrt{\frac{h_v}{h_t}} \quad (2)$$

where h_v is the velocity head in the connecting duct.

The *static suction* is not a good measure of the effectiveness of a hood unless the area of the opening and the location of the operation with respect to the hood are known. This is clearly indicated by Equation 3 which shows that the velocity at any point along the axis varies approximately inversely as the square of the distance. However, this formula coupled with Equation 1 should serve to indicate the velocity conditions to be expected when operations are conducted external to the hood opening.

Design Based on Total Air Flow

Where the foregoing factors are not known, the usual method of designing an exhaust system is to base the air flow through the system on