

Chapter 26, and the number of the renewals of air contents per hour is given in Chapter 4.

To obtain effective, uniform ventilation and avoid local drafts, the ventilators should not be placed more than 30 ft. apart; 20 ft. apart is a good average. It is best, although not absolutely necessary, to locate the ventilator at the ridge of the roof, unless the building exceeds 40 ft. in width, in which case two rows of smaller ventilators should be used. Where the building to be ventilated is surrounded by higher buildings which obstruct air currents, it is desirable to extend the ventilators above the buildings by mounting them on stacks.

Example.—A foundry building is 40 ft. wide, 200 ft. long, with an average height of 40 ft.; the ventilators are to be mounted at the ridge of the roof, at a height of 55 ft. above the floor. What number and size of ventilators are required?

Answer.—In this case, ventilation is especially necessary in summer. The air in the building should not be over 10 deg. Fahr. warmer than the outside air. The wind velocity may be as low as 4 miles per hour. Spacing the ventilators, tentatively, 25 ft. apart, 8 ventilators would be required. Under average conditions, 10 air renewals per hour are sufficient. If the foundry is small and cramped, and pouring takes place over a large section of the floor space, 15 or more air renewals per hour may be needed. On the basis of 10 renewals per hour, the capacity of each ventilator must be:

$$Q = \frac{10 \times (200 \text{ ft.} \times 40 \text{ ft.} \times 40 \text{ ft.})}{8} = 400,000 \text{ cu. ft. per hour}$$

The discharge per square inch of throat area under these conditions is;

$$\left[\frac{36 \times \sqrt{55 \times 10 \text{ deg.}}}{6 + 4 \text{ mi. per hr.}} + 20 \times 4 \text{ mi. per hr.} \right] = 165 \text{ cu. ft. of air per hour.}$$

The required throat area per ventilator is

$$\frac{400,000}{165} = 2420 \text{ sq. in.}$$

if there is no resistance and no wind pressure.

The diameter is $\sqrt{\frac{2420}{0.7854}} = 55.5 \text{ in.}$ Standard sizes are 54 in. and 60 in.

Either eight—54-in. or else seven—60-in. ventilators could be used, spaced respectively 25 ft. or 28 ft. apart.

The foregoing is based on the use of high class ventilators. If ventilators of lower efficiency are used, or if the air flow into the building is restricted (as in winter) larger ventilators may be required.

General Rules for Natural Ventilation Systems

Although it is almost out of the question to attempt to predetermine accurately the pressure difference from fundamental data of wind velocity, wind direction, temperature difference, building dimensions and disposition of openings, in most cases merely a general knowledge of how the forces of wind and temperature difference act, what their maximum magnitudes are, and how they are disposed in and about a building, will be helpful in planning ventilation. On this basis, the following simple rules are suggested:

CHAPTER 27—VENTILATION SYSTEMS

1. In an industrial building where furnaces, that give off heat and fumes, are to be installed, it is better to locate them in the end of the building exposed to the prevailing wind. The strong suction effect of the wind at the roof near the windward end will then cooperate with temperature difference, to provide for the most active and satisfactory removal of the heat and gas laden air.

2. In case it is impossible to locate furnaces in the windward end, that part of the building in which they are to be located should be built higher than the rest, so that the wind, in splashing therefrom will create a suction. The additional height also increases the effect of temperature difference to cooperate with the wind.

3. In the use of monitors, windows on the windward side should usually be kept closed, since, if they are open, the inflow tendency of the wind counteracts the outflow tendency of temperature difference. Openings on the leeward side of the monitor result in cooperation of wind and temperature difference.

4. In order that the force of temperature difference may operate to maximum advantage, the vertical distance between inlet and outlet openings should be as great as possible. Openings in the vicinity of the neutral zone are less effective for ventilation.

5. In order that temperature difference may produce a motive force, there must be vertical distance between openings. That is, if there are a number of openings available in a building, but all are at the same level, there will be no motive head produced by temperature difference, no matter how great that difference might be.

6. In the design of window ventilated buildings, where the direction of the wind is quite constant and dependable, the orientation of the building together with amount and grouping of ventilation opening can be readily arranged to take full advantage of the force of the wind. On the other hand, where the direction of the wind is quite variable, it may be stated as a general principle that windows should be arranged in sidewalls and monitors so that there will be approximately equal area on all sides. Thus, no matter what the wind's direction, there will always be some openings directly exposed to the pressure force of the wind, and others opposed to a suction force, and effective movement through the building will be assured.

MECHANICAL VENTILATION SYSTEMS

The principal advantages of mechanical systems of ventilation are:

1. Positive circulation of air at any desired temperature and volume to all parts of the building.
2. Practical uniformity of ventilation regardless of indoor and outdoor temperatures and atmospheric conditions, inasmuch as a positive movement of the air is possible through all ducts, flues and registers at any desired pressure.

COMBINED AND SPLIT SYSTEMS

Central supply systems of mechanical ventilation may operate independently, or in conjunction with the heating of the building. In some cities, for instance, the schools for many years have been heated and ventilated satisfactorily with *combined* heating and ventilating, no heaters being placed in the classrooms. Temperature is controlled by the automatic varying in proportions of the cool air and of the warm air. The heating, ventilation and cooling of many large banks and theaters is accomplished with combined heating and ventilating systems.

With this system it is necessary to operate the fans in order to warm the building and to control the conditions. There are obvious advantages in such an arrangement for certain buildings. It tends to insure proper maintenance and intelligent operation.

When the heating is accomplished with radiators, heat conductors or local heaters, separate from the ventilation, the scheme is called a *split* system. This type of mechanical ventilation is used for many schools.