

Column E.—Samples of air are next taken at each station, and later analyzed for carbon dioxide, and results of this analysis plotted in **Column E** in parts in 10,000.

Column F.—Distribution of the air in the room is determined from the CO₂ analysis taken at the various stations.

The following example illustrates the method of making the calculation:

Stations	CO ₂	Stations	Variations from the Average
1.....	11.1	1.....	11.1 - 10.2 = 0.9
2.....	9.4	2.....	10.2 - 9.4 = 0.8
3.....	10.4	3.....	10.4 - 10.2 = 0.2
4.....	9.9	4.....	10.2 - 9.9 = 0.3
Total 40.8		Total 2.2	
Average 10.2		Average 0.55	

$$\frac{0.55 \times 100}{10.2} = 5.4 = \text{per cent of variation.}$$

$$100 - 5.4 = 94.6 = \text{final per cent of distribution.}$$

After the tests have been made as described, the observer completes his test by a study of air motion and air currents. This is done by liberated puffs of ammonium chloride in different locations in the room with a suitable apparatus. Observations of the velocity and direction of travel of these small artificial smoke clouds add materially in obtaining a true conception of the velocity and general behavior of the air currents in the room.

Plotting the Test Data

The results of the tests are plotted in each column as previously described. The following data from the test illustrated on the chart on page 105 will make the entire procedure clear:

Average Dry-Bulb temp. 75 deg.—Wet Bulb temp. 59.7 deg.—Effective temp. 67.4 deg.

Effective temp. Dif. 3.4 deg.—Plot in **Column A**.

Aver. Dust Count for 4 Stations—7,000 particles per cu. ft.—Plot in **Column B**.

Aver. Bacteria for 4 Stations — 3.5 —Plot in **Column C**.

Aver. Odors Percentage — 90 per cent —Plot in **Column D**.

Aver. CO₂ — 10.2 —Plot in **Column E**.

Distribution Per Cent — 94.2 per cent —Plot in **Column F**.

Adding the penalization for these factors found at the right of each column and subtracting the sum from 100 gives a final percentage of perfect of 84.7, which is plotted in the last column.

REFERENCES

- Modus Operandi of the Synthetic Air Chart*, By John R. Allen (TRANSACTIONS, A. S. H. V. E., Vol. 26, 1920, p. 545).
- Modern Trend in Science of Ventilation*, By Perry West (JOURNAL, A. S. H. V. E., June, 1924, p. 421).
- Instruments for the Measurement of Air Velocity*, By J. H. Parkin (JOURNAL, A. S. H. V. E., June, 1929, p. 149).
- Determining the Quantity of Dust in Air by Impingement*, By F. B. Rowley and John Beal (JOURNAL, A. S. H. V. E., July, 1929, p. 233).
- Determining Lines of Equal Comfort*, By F. C. Houghten and C. P. Yagloglou. (TRANSACTIONS, A. S. H. V. E., Vol. 29, 1923, p. 361).
- Cooling Effect on Human Beings Produced by Various Air Velocities*, By F. C. Houghten and C. P. Yagloglou (TRANSACTIONS, A. S. H. V. E., Vol. 30, 1924, p. 193).
- Practical Application of Temperature, Humidity and Air Motion Data to Air Conditioning Problems*, By F. C. Houghten, W. W. Teague, W. E. Miller (JOURNAL, A. S. H. V. E., November, 1926).
- Some Physiological Reactions to High Temperatures and Humidities*, By W. J. McConnell and F. C. Houghten (TRANSACTIONS, A. S. H. V. E., Vol. 29, 1923, p. 122).
- Air Motion, High Temperatures and Various Humidities-Reactions on Human Beings*, By W. J. McConnell, F. C. Houghten (TRANSACTIONS, Vol. 30, 1924, p. 167).
- Heat and Moisture Loss from the Human Body and Its Relation to Air Conditioning Problems*, By F. C. Houghten, W. W. Teague, W. E. Miller and W. P. Yant (TRANSACTIONS, A. S. H. V. E., 1929, when published).
- Low Humidity Psychrometric Charts*, By M. C. W. Tomlinson (JOURNAL, A. S. H. V. E., February, 1929).

CHAPTER 4

SYSTEMS OF VENTILATION

Natural, Gravity and Mechanical Systems of Ventilation; Distribution of Ventilation; Design of Ventilating Systems; Equipment for Attaining Synthetic Air Chart Percentage.

VENTILATING systems roughly may be classified as natural, gravity and mechanical systems, although frequently various combinations of these systems are used. Each type has certain favorable qualities and may be especially adapted to particular kinds of buildings.

NATURAL VENTILATING SYSTEMS

Natural ventilating systems are those which utilize the wind and the temperature difference between the inside and outside air of a building to displace the air. These two forces may either cooperate or oppose each other at any given ventilating opening. If possible, therefore, openings should be arranged so that the two forces always act cooperatively, or the control should be such that only groups of openings at which cooperative action occurs will be in use. Such openings may be doors or windows for inlets and outlets, or openings in the roof to permit egress of heated air.

These systems are not nearly as amenable to control as are ventilating systems which are provided with ducts and which use heat or mechanical force to compel the movement of air.

Natural ventilation is perhaps applied most frequently to factory and industrial buildings and the openings commonly consist of windows in side walls or monitors. These openings usually provide for a large air flow, even with wind forces of slight intensity.

Natural ventilation is used in many schools, especially in the smaller sized buildings. It is used on most railway coaches and street cars, where advantage is taken of the air movement due to car motion. Where natural ventilation is used in buildings designed for human occupancy some intelligent means of heating the incoming air and of controlling the ventilation always must be provided.

The Wind

The wind operates to produce regions of pressure or suction about the exterior of a building as compared with the conditions that would exist in these regions if the air were still. The action of the wind is described in a paper by W. C. Randall, *Airation of Industrial Buildings*, A. S. H. V. E. JOURNAL, January, 1928. The principal effects of the wind when blowing directly against one face of a building are illustrated in Fig. 1. The