where

Q = quantity of air circulated, cubic feet per minute.
V = rate of generation of contaminant, cubic feet per minute.
MAC = maximum allowable concentration, ppm by volume.
SAC = concentration in supply air, ppm by volume.

The rate of generation of the contaminating vapor will often be available as a *weight* or *volume* of liquid evaporated into the space per unit time. These may be converted to the units of Equation 1 by applying the principle that a pound-mol of a gas or vapor will occupy approximately 359 cu ft at standard pressure and temperature. Thus,

$$\text{cfm (vapor)} = \frac{W}{M_w} \times 359 \times \frac{t + 460}{492} \qquad (2)$$

where

W = rate of generation of contaminant, pounds of liquid solvent per minute.
M_w = molecular weight.
t = air temperature, Fahrenheit.

A special case occurs where local concentrations of solvent vapors *at the breathing zone*, resulting from concentrated sources of contamination, are intolerably higher than the average design concentration when using dilution methods. Data are available for calculations, but involve many assumptions regarding boundary conditions, such as convection area and random air movement in the vicinity.

2. *Dusts and Fumes.* Maximum allowable concentration of various dusts, fumes and mists are also tabulated in Chapter 8. However, the dilution method as a means of treating particulate contaminating agents should be used with care, since the allowable air movement in spaces will ordinarily be lower than the capture velocity required for such particles. Exhausting at the source (see Chapter 45) will generally be the recommended treatment for these particulate contaminants.

3. *Sensible Heat.* Excessive sensible heat contamination is subject to treatment, similar to that for vapors, by the dilution method, the difference being that the rate of generation of the contaminant must be expressed in units of energy rather than volume or weight, and that the effect will be expressed as excessive temperature. In this case, the circulated air required will be:

$$Q = \frac{H}{(t_1 - t_o) \times d \times c} \qquad (3)$$

where

Q = quantity of air circulated, cubic feet per minute.
H = rate of generation of heat, Btu per minute.
t_1 = allowable temperature in the space, Fahrenheit.
t_o = temperature of supply air, Fahrenheit.
d = density of air in pounds per cubic foot.
c = specific heat of air.

In some cases, such as ventilation systems not employing refrigeration, unusually large and uneconomical air quantities may be required when the desired or tolerable temperature t_1 approaches too closely the temperature t_o of the dilution air. This condition may sometimes be corrected by a combination of treatment by dilution and central exhaust, large sources of heat load being eliminated by exhaust through hoods at the source.

Heat Storage in Structure

A special condition is sometimes encountered in large masonry structures when, due to the heat storage capacity and time lag of the structure, a prolonged period of hot weather may cause storage of such large quantities of heat in the structure that they continue to be a source of heat load after the outside weather has moderated.

In general, the solution to ventilation problems by the simple *dilution method* is limited to cases where a practical and economical equilibrium may be established between the maximum rate of generation of the contaminant distribution and cost of the air required for its removal.

Control of Radiant Heat

One of the most difficult problems of ventilation engineers is found in the so-called *hot industries* (steel mills, paper mills, foundries, etc.) where radiant heat from high temperature surfaces is a most important factor, the magnitude of which is not always appreciated. Since ventilation cannot remove radiant heat, it is worthwhile to consider using low emissivity materials and shielding to minimize conversion to sensible heat due to interaction with surfaces within sight of the radiant source.

Odors

There is little information available either on the rate of generation of common odors, or on the maximum concentration which would be tolerated by a majority of persons. Thus a quantitative specification covering systems for locker rooms and toilet rooms, or other applications where odors constitute the contaminant, is not now possible. Pending research in this important field, it is suggested that the data in Table 1, Chapter 6, showing the outside air supply required per person, at various socio-economic levels, be used.

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