The New York State Department of Labor has examined the economics of air recirculation in detail *

General Ventilation

Contaminant control by dilution

Although local exhaust systems have several inherent advantages, as compared with general ventilation—for example, removal of contaminant before it spreads throughout the room, economy of air flow, less heat loss, etc—there are some operations where local exhaust systems are impracticable With such operations the contaminant is usually a solvent vapor, but occasionally it is a fume or dust Local exhausts may be unsuited because there is a multitude of sources of vapor, or the source may be extensive as in a large coating process, or the amount of ductwork to connect all the necessary hoods may be forbidding

Such operations can sometimes be controlled by diluting the general room atmosphere with outdoor air fast enough to keep the concentration of toxic vapor in the room air within safe limits

Solvents appear in synthetic varnishes and lacquers, in cements and adhesives, in liquid coatings for fabrics and other materials, in cleaning operations, and in many other processes The basic purpose of solvents in these applications is to evaporate into the atmosphere, leaving behind some physically changed substance, which is the desired end product Thus, the very heart of the process involves polluting the air with vapor. The aim of the engineer is to keep this vapor concentration as low as possible, certainly below the toxic limit.

The rate of solvent evaporation can easily be ascertained as can the chemical nature of the solvent It is known that a weight of a given volume of vapor from a liquid when it evaporates is proportional to its molecular weight. It is possible, then, to calculate how much air must be mixed with this vapor to hold the concentration down to safe limits. Hemeon,** using not the maximum acceptable concentration for the compound, but what he calls the ventilation design concentration which has incorporated in it a safety factor based on toxicity, odor, and experience, has published a table from which general ventilation can be calculated (see Table 28-Q).

This table is based on this formula

$$\text{Cfm required} = \frac{\text{lb solvent evap}}{\text{min}} \times \frac{400}{\text{mw solvent}} \times \frac{10^6}{\text{VDC}}$$

where VDC is the Ventilation Design Concentration, and mw stands for molecular weight

Neither the maximum allowable concentration (MAC) nor the threshold limit value (TLV) should be used for calculating VDC not only because vapor dilution in the working space is bound to be uneven, but also because concentrations must always be maintained *below* the MAC or TLV in order to provide a factor of safety In turn, this factor of safety depends on whether the solvent vapor is to be controlled because of its inherent toxicity or its disagreeable odor.

For example, suppose one gallon of methyl ethyl ketone is evaporated per hour One pint of methyl ethyl ketone requires a ventilation rate amounting to 31,000 cu ft of air. One gallon would then require (31,000)8, or 248,000 cu ft of air If this is needed per hour, the ventilation rate would be 4,133 cfm

It is important to note that this example assumes there is perfect mixing of the clean air with the solvent vapor, but in practice this does not occur The ventilation rate calculated is therefore a minimum and should be increased depending upon other factors involved such as type and location of air diffusers, location of people in the room, and relative toxicity of the vapor

The size of the room where the work is done does not enter the calculation This is at variance with the common practice of specifying ventilation requirements in terms of "number of room air changes per minute" which, of course, directly involves

---

*Stern, Arthur C and Donald P O'Neil "Recirculation from Industrial Exhaust Systems." *Monthly Review*, vol. 30 (May, June, July 1951) New York State Department of Labor

**Hemeon, W. C. L. *Plant and Process Ventilation*, 2nd ed New York City, The Industrial Press, 1963