Table 6. Ventilation Rates for Open Surface Tanks[36,37]

Process	Minimum Ventilation Rate CFM per Sq Ft Hood Opening: Enclosing Hood, One Open Side	Enclosing Hood, Two Open Sides	Canopy Hood, Three Open Sides	Canopy Hood, Four Open Sides	Minimum Ventilation Rate CFM per Sq Ft Tank Area Lateral Exhaust (Note 1) $W/L = \frac{\text{Tank Width}}{\text{Tank Length}}$ Ratio: W/L 0–0.24, A	W/L 0–0.24, B	W/L 0.25–0.49, A	W/L 0.25–0.49, B	W/L 0.50–1.0, A	W/L 0.50–1.0, B
Plating										
Chromium (Chromic Acid Mist)	75	100	125	175	125	175	150	200	175	225
Arsenic (Arsine)	65	90	100	150	90	130	110	150	130	170
Hydrogen Cyanide	75	100	125	175	125	175	150	200	175	225
Cadmium	75	100	125	175	125	175	150	200	175	225
Anodizing	75	100	125	175	125	175	150	200	175	225
Metal Cleaning (Pickling)										
Cold Acid	65	90	100	150	90	130	110	150	130	170
Hot Acid	75	100	125	175	125	175	150	200	175	225
Nitric and Sulphuric Acid	75	100	125	175	125	175	150	200	175	225
Nitric and Hydrofluoric Acid	75	100	125	175	125	175	150	200	175	225
Metal Cleaning (Degreasing) See Note 2 and Ref. 38 and 39										
Metal Cleaning (Caustic or Electrolytic)										
Not Boiling	65	90	100	150	90	130	110	150	130	170
Boiling	75	100	125	175	125	175	150	200	175	225
Bright Dip (Nitric Acid)	75	100	125	175	125	175	150	200	175	225
Stripping										
Concentrated Nitric Acid	75	100	125	175	125	175	150	200	175	225
Conc. Nitric and Sulphuric Acid	75	100	125	175	125	175	150	200	175	225
Salt Baths (Molten Salt)	50	75	75	125	60	90	75	100	90	110
Salt Solution (Parkerize, Bonderize, etc.)										
Not Boiling	90	90	100	150	90	130	110	150	130	170
Boiling	75	100	125	175	125	175	150	200	175	225
Hot Water (if vent. desired)										
Not Boiling	50	75	75	125	60	90	75	100	90	110
Boiling	75	100	125	175	125	175	150	200	175	225

Note 1—Column A refers to tank with hood along one side or two parallel sides when one hood is against a wall or a baffle running length of tank and as high as tank is wide; also to tanks with exhaust manifold along center line with $\frac{W}{Z}$ becoming tank width in W/L Ratio.

Column B refers to free standing tank with hood along one side or two parallel sides.

Note 2—Complete control of the vapors and mist from degreasing operations requires the same ventilation rates as recommended for pickling. However, the solvents employed in degreasing operations are relatively volatile, and the solvent loss caused by evaporation increases rapidly as the exhaust rate at the tank increases. For this reason perfect control is usually sacrificed in favor of lower solvent evaporation rates. Where solvent loss does not present an important cost or operating problem, the exhaust rates given for pickling should be adhered to, but where solvent loss must be kept at a minimum, an exhaust rate of 50 cfm per sq ft of tank area is commonly employed. Where this rate is used, control will be adequate only if the tank is located in an area free of drafts and if the degreasing operations are carried out in accordance with a rigid schedule.[38]

and dilution have taken place may be approximated for low canopy hoods above horizontal surfaces and where no heat from steam is involved, as

$$q_s = 5.4\, A_s^{3}\, l_b\, (\Delta t)^{5/4} \tag{3}$$

where

A_s = surface area of hot body, square feet.
Δt = the temperature difference, hot body to room air, Fahrenheit degrees.

Similarly, where the heat is furnished by steam from a tank of hot water,

$$q_s = 290\, A_s\, \sqrt[3]{l_b\, G} \tag{4}$$

where

G = the rate of steam formation, pounds per (square foot water surface) (minute).

For high canopy hoods, Equation 5 may be used:

$$q_s = 7.4\, l_e^{3/2}\, H_c^{1/3} \tag{5}$$

where

l_e = effective height, feet.

The effective height l_e may be taken as the actual vertical distance from hood to hot surface plus twice the width of the hot surface.

Where it is necessary to have openings at the top of a hood that is filled with heated air, leakage of the hood contents through these openings may be prevented by using sufficient ventilation to obtain a face velocity V as calculated from the following equation:

$$V = C \sqrt[3]{\frac{l_a H_s}{A_t}} \tag{6}$$

where

l_a = height of the air column, feet.
A_t = area of the (sharp-edged) openings, square feet.
H_s = sensible heat released to air stream, Btu per minute.
C = a coefficient depending on the excess of temperature inside the hood above room temperature with values as follows:

Temperature excess (F deg)	0–200	200–400	400–600	600–800
Value of C	20	18	16	14

The American Society of Heating and Air-Conditioning Engineers has recognized the need for design criteria for determining exhaust ventilation requirements for hot processes in industry. Research studies on this subject have been in progress since 1952, and the results to date have recently been published.[42]

Induced Air Flow

Where quantities of individual particles are projected through an air space by gravity or by process forces, volumes of room air in proportion to the momentum of the particles are set in motion with resulting intermixing and flow in the same direction as the particles. Exhausted volumes from hoods or enclosures must be sufficient to include this induced air flow if control is to be effective. Induced air flow should be evaluated from high speed rotating machines including pulverizers, from material handling systems employing high speed belts or involving large tonnages of falling granular material, and from escaping compressed air jets from pneumatic tools. The energy represented by material of various particle sizes and falling heights has been computed by Hemeon[13] and the theoretical equivalent induced air flow resulting from unenclosed air streams is summarized in Table 4.

Where falling streams occur largely within an enclosure such as a storage bin, it should be recognized that much of the air set in motion is recirculated within the bin. Exhaust volumes from the enclosure need only include the extra air induced before the falling material enters the enclosure although the recirculating induced air can cause localized positive pressures and outward leakage if the enclosure is not of air tight construction.

The amount of air induced by falling material is much less if the space through which the material falls is enclosed effectively than if not enclosed,