10.70 OPEN SURFACE TANKS

Ventilation rates for plating, cleaning, and other open surface tank operations will depend on a number of parameters that include materials, tank configuration and location, and type of ventilation system. This section describes four hood/ventilation types: enclosing and canopy hoods, lateral exhaust, and push–pull.

Enclosing hoods usually consist of a lateral hood with one end panel (two sides open) or panels at both tank ends (one side open). This hood configuration can provide increased efficiency by reducing the effects of cross drafts and by directing more of the hood air flow over the tank open surface.

Canopy hoods may be open on four sides (free standing) or on three sides (such as against a wall). Control is achieved by air flow into the hood. It is, however, difficult in many cases to achieve sufficient control velocity without excessive air flow rates. Canopy hoods should not be used with highly toxic materials, in locations where high cross drafts are unavoidable, or where the worker must bend over the tank.

Lateral exhaust consists of a slot hood that controls emissions by pulling air across the tank. A single slot may be used on one side of the tank where the tank width is 36 inches or less. For widths greater than 36 inches and where the process configuration will allow, two slot hoods on opposite sides of the tank or a slot hood along the tank centerline may be used. A single slot may be used up to a tank width of 48 inches but only if the material's hazard class is low and if cross drafts are not present (see paragraph 10.70.1).

The air flow required will be that necessary to achieve a minimum control velocity determined by the hazard class of the material used for operation and the particular tank/ventilation system configuration. The procedure for determining the class and minimum control velocity for the three preceding hood types is provided in Tables 10.70.1 through 10.70.7 and the accompanying text. Exhaust flow for a canopy hood is determined from VS-99-03 and for a booth hood from Figure 3-11 where W is the total opening width. The exhaust flow for a lateral hood is determined from Table 10.70.4.

Air and/or mechanical agitation of the tank solution may be used as an aid to the plating or cleaning process. Mechanical agitation creates a rolling motion and usually will not affect tank emissions. However, air agitation creates a boiling-like condition and may significantly increase tank emissions, thus creating need for increased exhaust flow to provide effective control.

Push–pull ventilation consists of a push jet located on one side of a tank with a lateral exhaust hood on the other side. Tank emissions are controlled by the jet formed over the tank surface. The jet captures the emissions and carries them into the hood. As the jet velocity, at all locations across the tank, is higher than the maximum control velocities specified for canopy, enclosing, or lateral exhaust hoods (Table 10.70.3), the push–pull exhaust flow is determined on the basis of that necessary to capture the jet flow and is independent of the hazard classification. Push–pull design criteria are provided in VS-70-10, -11, and -12.

10.70.1 Tank Design Considerations:

1. Duct velocity = any desired velocity (see Chapter 3).
2. Entry loss = 1.78 slot VP plus duct entry loss for slot hoods. For canopy or enclosure hoods, entry loss = duct entry loss.
3. Maximum slot hood plenum velocity = 1/2 slot velocity (see Chapter 3).
4. Slot velocity = 2000 fpm unless distribution is provided by well-designed, tapered take-off.
5. Provide ample area at the small end of the plenum.
6. If L = 6′ or greater, multiple take-offs are desirable. If L = 10′ or greater, multiple take-offs are necessary.
7. Tank width (W) means the effective width over which the hood must pull air to operate (e.g., where the hood face is set back from the edge of the tank, this setback must be added in measuring tank width).

   If W = 20″, slot on one side is suitable.

   If W = 20–36″, slots on both sides are desirable.

   If W = 36–48″, use slots on both sides or along tank centerline or use push–pull. A single slot along one side should not be used unless all other conditions are optimum.

   If W = 48″ or greater, local exhaust usually is not practical. Consider using push–pull.

   Enclosure can be used for any width tank if process will permit.

   It is not practicable to ventilate across the long dimension of a tank whose ratio W/L exceeds 2.0. It is undesirable to do so when W/L exceeds 1.0.
8. Liquid level should be 6″ to 8″ below top of tank with parts immersed.
9. Lateral hood types A, C, D, and E (VS-70-01 and -02) are preferred. Plenum acts as baffle to room air currents.
10. Provide removable covers on tank if possible.
11. Provide duct with clean outs, drains, and corrosion-resistant coating if necessary. Use flexible connection at fan inlet.
12. Install flanges to reduce cross drafts. If the exhaust hood is on the side of the tank against a building wall or close to it, it is well flanged.
13. Replacement air to the tank area must be supplied evenly and directed toward the tank from above or in front of the tank so that cross drafts do not occur.

Flow Rate Calculation for Good Conditions: (No cross drafts; adequate and well-distributed replacement air.)

1. Establish process class by determining hazard potential from Tables 10.70.1 and 10.70.2; information from Threshold Limit Values, Solvent Flash Point, Solvent Drying Time Tables in Appendices A and B; and from Tables 10.70.5–10.70.8.
2. Process class can also be established directly from Tables 10.70.5–10.70.8 if process parameters are known.
3. From Table 10.70.3, choose minimum control velocity according to hazard potential, evolution rate (process class), and hood design (see Table 10.70.5 for typical processes).
4. From Table 10.70.4, select the cfm/ft^2 for tank dimensions and tank location.
5. Multiply tank area by value obtained from Table 10.70.4 to calculate required air volume.

EXAMPLE

Given: Chrome Plating Tank 6′ × 2.5′
High production decorative chrome.
Free standing in room.
No cross-drafts.

a. Tank Hood. See VS-70-01. Use hood "A" long 6′ side. Hood acts as baffle.

b. Component — Chromic Acid.
Hazard potential: A (from Table 10.70.1; from Appendix A, TLV = 0.05 mg/m^3; from Appendix B, Flash point = Negligible)
Rate of Evolution: 1 (from Table 10.70.2; from Table 10.70.6, Gassing rate = *high)*
Control Velocity = 150 fpm (from Table 10.70.3)
Minimum Exhaust Rate = 225 cfm/ft^2 (from Table 10.70.4; Baffled tank, W/L = 0.42)
Minimum Exhaust Flow Rate = 225 × 15 = 3375 cfm

c. Hood Design
Design slot velocity = 2000 fpm
Slot area = Q/V = 3375 cfm/2000 fpm = 1.69 ft^2
Slot width = A/L = 1.69 ft^2/6 ft = 0.281 ft = 3.375 in.
Plenum depth = (2)(slot width) = (2)(3.375) = 6.75 in.
Duct area = Q/V = 3375 cfm/2500 fpm = 1.35 ft^2
Use 16″ duct, area = 1.396 ft^2
Final duct velocity = Q/A = 3375/1.396 = 2420 fpm
Hood Sp = Entry loss + Acceleration
= 1.78 VP_s + 0.25 VP_d + 1.0 VP_d (see Chapter 3)
= (1.78 × 0.25″) + (0.25 × 0.37″) + 0.37″
= 0.45 + 0.09 + 0.37
Hood SP = 0.91″

REFERENCES

10.70.1 D.J. Huebener and R.T. Hughes: "Development of Push–Pull Ventilation," *Am. Ind. Hyg. Assoc. J.* 46: 262–267 (1985).

10.70.2 R.T. Hughes: "Design Criteria for Plating Tank Push–Pull Ventilation," *Ventilation '85*, Elsiever Press, Amsterdam, 1986.

10.70.3 V. Sciola: Private Communication, Hamilton Standard.

TABLE 10.70.1. Determination of Hazard Potential

Hazard Potential	HYGIENIC STANDARDS		Flash Point (see Appendix B)
	Gas and Vapor (see Appendix A)	Mist (see Appendix A)	
A	0–10 ppm	0–0.1 mg/m^3	—
B	11–100 ppm	0.11–1.0 mg/m^3	Under 100 F
C	101–500 ppm	1.1–10 mg/m^3	100–200 F
D	Over 500 ppm	Over 10 mg/m^3	Over 200 F

TABLE 10.70.2. Determination of Rate of Gas, Vapor, or Mist Evolution

Rate	Liquid Temperature (F)	Degrees Below Boiling Point (F)	Relative Evaporation* (Time for 100% Evaporation)	Gassing**
1	Over 200	0–20	Fast (0–3 hours)	High
2	150–200	21–50	Medium (3–12 hours)	Medium
3	94–149	51–100	Slow (12–50 hours)	Low
4	Under 94	Over 100	Nil (Over 50 hours)	Nil

*Dry Time Relation (see Appendix B). Below 5 — Fast; 5–15 — Medium, 15–75 — Slow; 75–over — Nil.
**Rate of gassing depends on rate of chemical or electrochemical action and therefore depends on the material treated and the solution used in the tank and tends to increase with, 1) amount of work in the tank at any one time, 2) strength of the solution in the tank, 3) temperature of the solution in the tank, and 4) current density applied to the work in electrochemical tanks.

TABLE 10.70.3. Minimum Control Velocity (FPM) for Undisturbed Locations

Class (see Tables 10.70.1 & 10.70.2)	Enclosing Hood		Lateral Exhaust (see VS-70-01 & 70-02) (Note 1)	Canopy Hoods (see Figure 3-8 & VS-99-03)	
	One Open Side	Two Open Sides		Three Open Sides	Four Open Sides
A-1 and A-2 (Note 2)	100	150	150	Do not use	Do not use
A-3 (Note 2), B-1, B-2, and C-1	75	100	100	125	175
B-3, C-2, and D-1 (Note 3)	65	90	75	100	150
A-4 (Note 2) C-3, and D-2 (Note 3)	50	75	50	75	125
B-4, C-4, D-3 (Note 3), and D-4 — Adequate General Room Ventilation Required (see Chap. 2).					

Notes: 1. Use aspect ratio to determine air volume; see Table 10.70.4 for computation.
2. Do not use canopy hood for Hazard Potential A processes.
3. Where complete control of hot water is desired, design as next highest class.

TABLE 10.70.4. Minimum Rate, cfm/ft² of Tank Area for Lateral Exhaust

Required Minimum Control Velocity, fpm (from Table 10.70.3)	cfm/ft² to maintain required minimum control velocities at following $\frac{\text{tank width}}{\text{tank length}}\left(\frac{W}{L}\right)$ ratios				
	0.0 – 0.09	0.1 – 0.24	0.25 – 0.49	0.5 – 0.99	1.0 – 2.0 Note 2
Hood against wall or flanged (see Note 1 below and Section 10.70.1, Note 12. See VS-70-01 A and VS-70-02 D and E.					
50	50	60	75	90	100
75	75	90	110	130	150
100	100	125	150	175	200
150	150	190	225	[250] Note 3	[250] Note 3
Hood on free standing tank (see Note 1). See VS-70-01 B and VS-70-02 F.					
50	75	90	100	110	125
75	110	130	150	170	190
100	150	175	200	225	250
150	225	[250] Note 3	[250] Note 3	[250] Note 3	[250] Note 3

Notes: 1. Use W/2 as tank width in computing W/L ratio for hood along centerline or two parallel sides of tank. See VS-70-01 B and C and VS-70-02 F.
2. See Section 10.70.1, Notes 6 and 7.
3. While bracketed values may not produce 150 fpm control velocity at all aspect ratios, the 250 cfm/ft² is considered adequate for control.

TABLE 10.70.5. Typical Processes Minimum Control Velocity (fpm) for Undisturbed Locations

Operation	Contaminant	Hazard	Contaminant Evolution	Lateral Exhaust Control Velocity (See VS-70-01 & VS-70-02)	Collector Recommended
Anodizing Aluminum	Chromic-Sulfuric Acids	A	1	150	X
Aluminum Bright Dip	Nitric + Sulfuric Acids	A	1	150	X
	Nitric + Phosphoric Acids	A	1	150	X
Plating — Chromium	Chromic Acid	A	1	150	X
Copper Strike	Cyanide Mist	C	2	75	X
Metal Cleaning (Boiling)	Alkaline Mist	C	1	100	X
Hot Water (If vent desired)					
Not Boiling	Water Vapor	D	2	50*	
Boiling		D	1	75*	
Stripping — Copper	Alkaline-Cyanide Mists	C	2	75	X
Nickel	Nitrogen Oxide Gases	A	1	150	X
Pickling — Steel	Hydrochloric Acid	A	2	150	X
	Sulfuric Acid	B	1	100	X
Salt Solution					
(Bonderizing & Parkerizing)	Water Vapor	D	2	50*	
Not Boiling	Water Vapor	D	2	50*	
Boiling		D	1	75*	
Salt Baths (Molten)	Alkaline Mist	C	1	100	X

*Where complete control of water vapor is desired, design as next highest class.

TABLE 10.70.6. Airborne Contaminants Released by Metallic Surfaced Treatment, Etching, Pickling, Acid Dipping and Metal Cleaning Operations

Process	Type	Notes	Component of Bath Which May be Released to Atmosphere (13)	Physical and Chemical Nature of Major Atmospheric Contaminant	Class (12)	Usual Temp. Range F
Surface Treatment	Anodizing Aluminum		Chromic-Sulfuric Acids	Chromic Acid Mist	A-1	95
	Anodizing Aluminum		Sulfuric Acid	Sulfuric Acid Mist	B-1	60–80
	Black Magic		Conc. Sol. Alkaline Oxidizing Agents	Alkaline Mist, Steam	C-1	260–350
	Bonderizing	1	Boiling Water	Steam	D-2,1 (14, 15)	140–212
	Chemical Coloring		None	None	D-4	70–90
	Descaling	2	Nitric-Sulfuric, Hydrofluoric Acids	Acid Mist, Hydrogen Fluoride Gas, Steam	B-2,1 (15)	70–150
	Ebonol		Conc. Sol. Alkaline Oxidizing Agents	Alkaline Mist, Steam	C-1	260–350
	Galvanic-Anodize	3	Ammonium Hydroxide	Ammonia Gas, Steam	B-3	140
	Hard-Coating Aluminum		Chromic-Sulfuric Acids	Chromic Acid Mist	A-1	120–180
	Hard-Coating Aluminum		Sulfuric Acid	Sulfuric Acid Mist	B-1	120–180
	Jetal		Conc. Sol. Alkaline Oxidizing Agents	Alkaline Mist, Steam	C-1	260–350
	Magcote	4	Sodium Hydroxide	Alkaline Mist, Steam	C-3,2 (15)	105–212
	Magnesium Pre-Dye Dip		Ammonium Hydroxide-Ammonium Acetate	Ammonia Gas, Steam	B-3	90–180
	Parkerizing	1	Boiling Water	Steam	D-2,1 (14,15)	140–212
	Zincete Immersion	5	None	None	D-4	70–90
Etching	Aluminum		Sodium Hydroxide-Soda Ash-Trisodium Phosphate	Alkaline Mist, Steam	C-1	160–180
	Copper	6	Hydrochloric Acid	Hydrogen Chloride Gas	A-2	70–90
	Copper	7	None	None	D-4	70
Pickling	Aluminum		Nitric Acid	Nitrogen Oxide Gases	A-2	70–90
	Aluminum		Chromic, Sulfuric Acids	Acid Mists	A-3	140
	Aluminum		Sodium Hydroxide	Alkaline Mist	C-1	140
	Cast Iron		Hydrofluoric-Nitric Acids	Hydrogen Fluoride-Nitrogen Oxide Gases	A-2,1 (15)	70–90
	Copper		Sulfuric Acid	Acid Mist, Steam	B-3,2 (15)	125–175
	Copper	8	None	None	D-4	70–175
	Duralumin		Sodium Flouride, Sulfuric Acid	Hydrogen Fluoride Gas, Acid Mist	A-3	70
	Inconel		Nitric, Hydrofluoric Acids	Nitrogen Oxide, HF Gases, Steam	A-1	150–165
	Inconel		Sulfuric Acid	Sulfuric Acid Mist, Steam	B-2	160–180
	Iron and Steel		Hydrochloric Acid	Hydrogen Chloride Gas	A-2	70
	Iron and Steel		Sulfuric Acid	Sulfuric Acid Mist, Steam	B-1	70–175
	Magnesium		Chromic-Sulfuric, Nitric Acids	Nitrogen Oxide Gases, Acid Mist, Steam	A-2	70–160
	Monel and Nickel		Hydrochloric Acid	Hydrogen Chloride Gas, Steam	A-2	180
	Monel and Nickel		Sulfuric Acid	Sulfuric Acid Mist, Steam	B-1	160–190
	Nickel Silver		Sulfuric Acid	Acid Mist, Steam	B-3,2 (15)	70–140
	Silver		Sodium Cyanide	Cyanide Mist, Steam	C-3	70–210
	Stainless Steel	9	Nitric, Hydrofluoric Acids	Nitrogen Oxide, Hydrogen Fluoride Gases	A-2	125–180
	Stainless Steel	9,10	Hydrochloric Acid	Hydrogen Chloride Gas	A-2	130–140
	Stainless Steel	9,10	Sulfuric Acid	Sulfuric Acid Mist, Steam	B-1	180
	Stainless Steel Immunization		Nitric Acid	Nitrogen Oxide Gases	A-2	70–120
	Stainless Steel Passivation		Nitric Acid	Nitrogen Oxide Gases	A-2	70–120

TABLE 10.70.6. Airborne Contaminants Released by Metallic Surfaced Treatment, Etching, Pickling, Acid Dipping and Metal Cleaning Operations (con't)

Process	Type	Notes	Component of Bath Which May be Released to Atmosphere (13)	Physical and Chemical Nature of Major Atmospheric Contaminant	Class (12)	Usual Temp. Range F
Acid Dipping	Aluminum Bright Dip		Phosphoric, Nitric Acids	Nitrogen Oxide Gases	A-1	200
	Aluminum Bright Dip		Nitric, Sulfuric Acids	Nitrogen Oxide Gases, Acid Mist	A-2,1 (15)	70–90
	Cadmium Bright Dip		None	None	D-4	70
	Copper Bright Dip		Nitric, Sulfuric Acids	Nitrogen Oxide Gases, Acid Mist	A-2,1 (15)	70–90
	Copper Semi-Bright Dip		Sulfuric Acid	Acid Mist	B-2	70
	Copper Alloys Bright Dip		Nitric, Sulfuric Acids	Nitrogen Oxide Gases, Acid Mist	A-2,1 (15)	70–90
	Copper Matte Dip		Nitric, Sulfuric Acids	Nitrogen Oxide Gases, Acid Mist	A-2,1 (15)	70–90
	Magnesium Dip		Chromic Acid	Acid Mist, Steam	A-2	190–212
	Magnesium Dip		Nitric, Sulfuric Acids	Nitrogen Oxide Gases, Acid Mist	A-2,1 (15)	70–90
	Monel Dip		Nitric, Sulfuric Acids	Nitrogen Oxide Gases, Acid Mist	A-2,1 (15)	70–90
	Nickel and Nickel Alloys Dip		Nitric, Sulfuric Acids	Nitrogen Oxide Gases, Acid Mist	A-2,1 (15)	70–90
	Silver Dip		Nitric Acid	Nitrogen Oxide Gases	A-1	70–90
	Silver Dip		Sulfuric Acid	Sulfuric Acid Mist	B-2	70–90
	Zinc and Zinc Alloys Dip		Chromic, Hydrochloric Acids	Hydrogen Chloride Gas (If HCl attacks Zn)	A-4,3 (15)	70–90
Metal Cleaning	Alkaline Cleaning	11	Alkaline Sodium Salts	Alkaline Mist, Steam	C-2,1 (15)	160–210
	Degreasing		Trichloroethylene-Perchloroethylene	Trichloroethylene-Perchloroethylene Vapors	B (16)	188–250
	Emulsion Cleaning		Petroleum-Coal Tar Solvents	Petroleum-Coal Tar Vapors	B-3,2 (15) (17)	70–140 70–140
	Emulsion Cleaning		Chlorinated Hydrocarbons	Chlorinated Hydrocarbon Vapors	(17)	70–140

Notes:
1 Also Aluminum Seal, Magnesium Seal, Magnesium Dye Set, Dyeing Anodized Magnesium, Magnesium Alkaline Dichromate Soak, Coloring Anodized Aluminum.
2 Stainless Steel before Electropolishing.
3 On Magnesium.
4 Also Manodyz, Dow-12.
5 On Aluminum.
6 Dull Finish.
7 Ferric Chloride Bath.
8 Sodium Dichromate, Sulfuric Acid Bath and Ferrous Sulfate, Sulfuric Acid Bath.
9 Scale Removal.
10 Scale Loosening.
11 Soak and Electrocleaning.
12 Class as described in Chapter 2 for use in Table 10.70.3 based on hazard potential (Table 10.70.1) and rate of evolution (Table 10.70.2) for usual operating conditions. Higher temperatures, agitation or other conditions may result in a higher rate of evolution.
13 Hydrogen gas also released by many of these operations.
14 Rate where essentially complete control of steam is required. Otherwise, adequate dilution ventilation may be sufficient.
15 The higher rate is associated with the higher value in the temperature range.
16 For vapor degreasers, rate is determined by operating procedure. See VS-70-20.
17 Class of operation is determined by nature of the hydrocarbon. Refer to Appendix A.

TABLE 10.70.7. Airborne Contaminants Released by Electropolishing, Electroplating and Electroless Plating Operations

Process	Type	Notes	Component of Bath Which May be Released to Atmosphere (19)	Physical and Chemical Nature of Major Atmospheric Contaminant	Class (18)	Usual Temp. Range F
Electropolishing	Aluminum	1	Sulfuric, Hydrofluoric Acids	Acid Mist, Hydrogen Flouride Gas, Steam	A-2	140–200
	Brass, Bronze	1	Phosphoric Acid	Acid Mist	B-3	68
	Copper	1	Phosphoric Acid	Acid Mist	B-3	68
	Iron	1	Sulfuric, Hydrochloric, Perchloric Acids	Acid Mist, Hydrogen Chloride Gas, Steam	A-2	68–175
	Monel	1	Sulfuric Acid	Acid Mist, Steam	B-2	86–160
	Nickel	1	Sulfuric Acid	Acid Mist, Steam	B-2	86–160
	Stainless Steel	1	Sulfuric, Hydrofluoric, Chromic Acids	Acid Mist, Hydrogen Flouride Gas, Steam	A-2,1 (20)	70–300
	Steel	1	Sulfuric, Hydrochloric, Perchloric Acids	Acid Mist, Hydrogen Chloride Gas, Steam	A-2	68–175
Strike Solutions	Copper		Cyanide Salts	Cyanide Mist	C-2	70–90
	Silver		Cyanide Salts	Cyanide Mists	C-2	70–90
	Wood's Nickel		Nickel Chloride, Hydrochloric Acid	Hydrogen Chloride Gas, Chloride Mist	A-2	70–90
Electroless Plating	Copper		Formaldehyde	Formaldehyde Gas	A-1	75
	Nickel	2	Ammonium Hydroxide	Ammonia Gas	B-1	190
Electroplating Alkaline	Platium		Ammonium Phosphate, Ammonia Gas	Ammonia Gas	B-2	158–203
	Tin		Sodium Stannate	Tin Salt Mist, Steam	C-3	140–170
	Zinc	3	None	None	D-4	170–180
Electroplating Fluoborate	Cadmium		Fluoborate Salts	Fluoborate Mist, Steam	C-3,2 (20)	70–170
	Copper		Copper Fluoborate	Fluoborate Mist, Steam	C-3,2 (20)	70–170
	Indium		Fluoborate Salts	Fluoborate Mist, Steam	C-3,2 (20)	70–170
	Lead		Lead Fluoborate-Fluoboric Acid	Fluoborate Mist, Hydrogen Fluoride Gas	A-3	70–90
	Lead-Tin Alloy		Lead Fluoborate-Fluoboric Acid	Fluoborate Mist	C-3,2 (20)	70–100
	Nickel		Nickel Fluoborate	Fluoborate Mist	C-3,2 (20)	100–170
	Tin		Stannous Fluoborate, Fluoboric Acid	Fluoborate Mist	C-3,2 (20)	70–100
	Zinc		Fluoborate Salts	Fluoborate Mist, Steam	C-3,2 (20)	70–170
Electroplating Cyanide	Brass, Bronze	4,5	Cyanide Salts, Ammonium Hydroxide	Cyanide Mist, Ammonia Gas	B-4,3 (20)	60–100
	Bright Zinc	5	Cyanide Salts, Sodium Hydroxide	Cyanide, Akaline Mists	C-3	70–120
	Cadmium	5	None	None	D-4	70–100
	Copper	5,6	None	None	D-4	70–160
	Copper	5,7	Cyanide Salts, Sodium Hydroxide	Cyanide, Alkaline Mists, Steam	C-2	110–160
	Indium	5	Cyanide Salts, Sodium Hydroxide	Cyanide, Alkaline Mists	C-3	70–120
	Silver	5	None	None	D-4	72–120
	Tin-Zinc Alloy	5	Cyanide Salts, Potassium Hydroxide	Cyanide, Alkaline Mists, Steam	C-3,2 (20)	120–140
	White Alloy	5,8	Cyanide Salts, Sodium Stannate	Cyanide, Alkaline Mists	C-3	120–150
	Zinc	5,9	Cyanide Salts, Sodium Hydroxide	Cyanide, Alkaline Mists	C-3,2 (7)	70–120

TABLE 10.70.7. Airborne Contaminants Released by Electropolishing, Electroplating and Electroless Plating Operations (con't)

Process	Type	Notes	Component of Bath Which May be Released to Atmosphere (19)	Physical and Chemical Nature of Major Atmospheric Contaminant	Class (18)	Usual Temp. Range F
Electroplating Acid	Chromium		Chromic Acid	Chromic Acid Mists	A-1	90–140
	Copper	10	Copper Sulfate, Sulfuric Acid	Sulfuric Acid Mist	B-4,3 (20,21)	75–120
	Indium	12	None	None	D-4	70–120
	Indium	13,14	Sulfamic Acid, Sulfamate Salts	Sulfamate Mist	C-3	70–90
	Iron		Chloride Salts, Hydrochloric Acid	Hydrochloric Acid Mist, Steam	A-2	190–210
	Iron	12	None	None	D-4	70–120
	Nickel	3	Ammonium Fluoride, Hydrofluoric Acid	Hydrofluoric Acid Mist	A-3	102
	Nickel and Black Nickel	12,15	None	None	C-4 (22)	70–150
	Nickel	9,12	Nickel Sulfate	Nickel Sulfate Mist	B-2	70–90
	Nickel	13,14	Nickel Sulfamate	Sulfamate Mist	C-3	75–160
	Palladium	15	None	None	D-4	70–120
	Rhodium	12,17	None	None	D-4	70–120
	Tin		Tin Halide	Halide Mist	C-2	70–90
	Tin	12	None	None	D-4	70–120
	Zinc		Zinc Chloride	Zinc Chloride Mist	B-3	75–120
	Zinc	12	None	None	D-4	70–120

Notes:
1 Arsine may be produced due to the presence of arsenic in the metal or polishing bath.
2 Alkaline Bath
3 On Magnesium
4 Also Copper-Cadmium Bronze
5 HCN gas may be evolved due to the acidic action of CO_2 in the air at the surface of the bath
6 Conventional Cyanide Bath
7 Except Conventional Cyanide Bath
8 Albaloy, Spekwhite, Bonwhite (Alloys of Copper, Tin, Zinc)
9 Using Insoluble Anodes
10 Over 90 F
11 Mild Organic Acid Bath
12 Sulfate Bath
13 Sulfamate Bath
14 Air Agitated
15 Chloride Bath
16 Nitrite Bath
17 Phosphate Bath
18 Class as described in Chapter 2 for use in Table 10.70.3 based on hazard potential (Table 10.70.1) and rate of evolution (Table 10.70.2) for usual operating conditions. Higher temperatures, agitation, high current density or other conditions may result in a higher rate of evolution.
19 Hydrogen gas also released by many of these operations.
20 The higher rate is associated with the higher value in the temperature range.
21 Baths operated at a temperature of over 140 F with a current density of over 45 amps/ft^2 and with air agitation will have a higher rate of evolution.
22 Local exhaust ventilation may be desired to control steam and water vapor.

TABLE 10.70.8. Airborne Contaminants Released by Stripping Operations

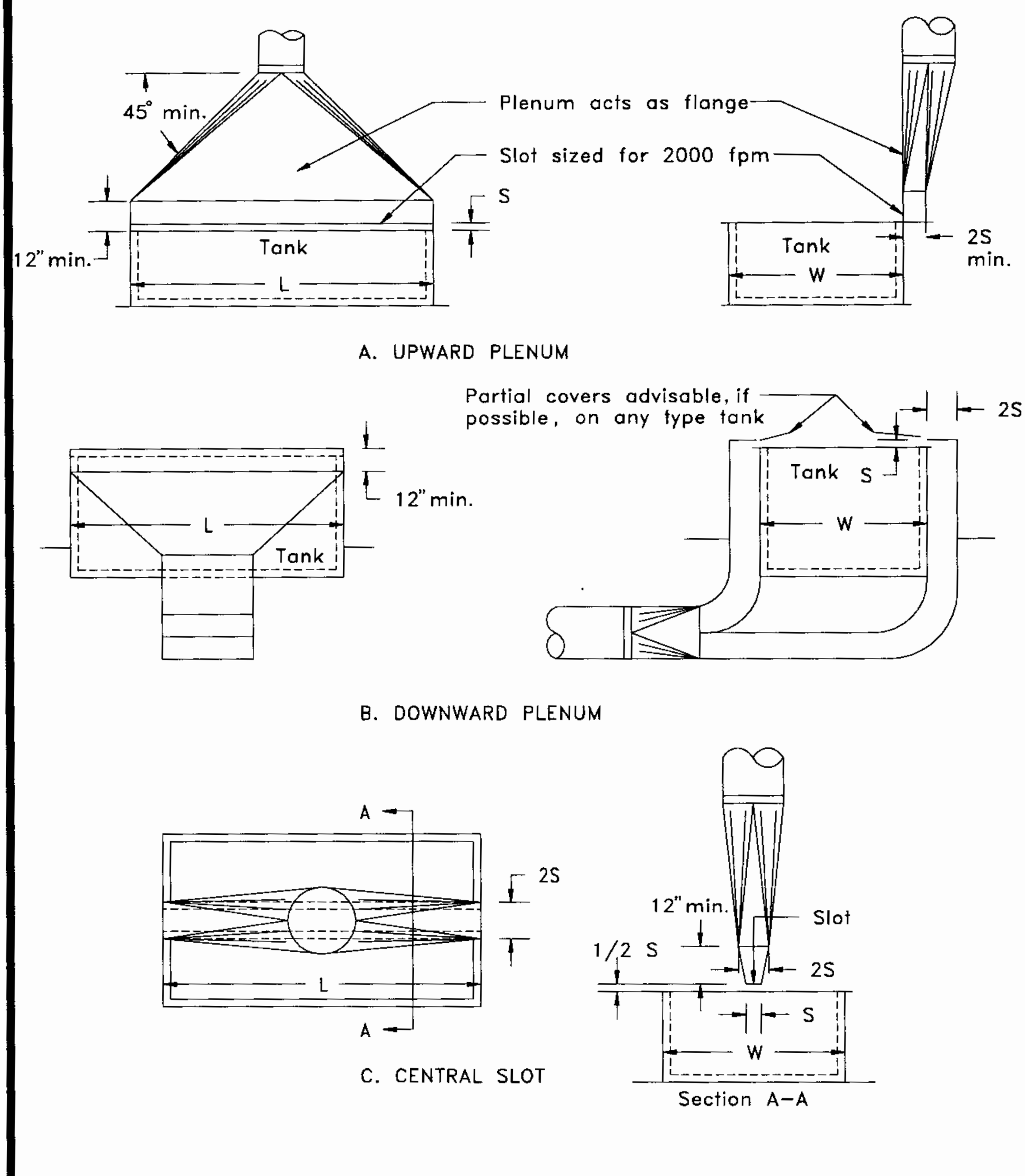
Coating to be Stripped	Base Metal (Footnote)	Component of Batch Which May be Released to Atmosphere (f)	Physical and Chemical Nature of Major Atmospheric Contaminant	Class (e)	Usual Temp. Range F
Anodized Coatings	1,7	Chromic Acid	Acid Mist, Steam	A-2	120–200
Black Oxide Coatings	14	Hydrochloric Acid	Hydrogen Chloride Gas	A-3,2 (g)	70–125
Brass and Bronze	8,14 (a)	Sodium Hydroxide, Sodium Cyanide	Alkaline, Cyanide Mists	C-3,2 (g)	70–90
Cadmium	8,14 (a)	Sodium Hydroxide, Sodium Cyanide	Alkaline, Cyanide Mists	C-3,2 (g)	70–90
	2,4,14	Hydrochloric Acid	Acid Mist, Hydrogen Chloride Gas	A-3,2 (g)	70–90
Chromium	7,8,14 (a)	Sodium Hydroxide	Alkaline Mist, Steam	C-3	70–150
	2,4,8,14	Hydrochloric Acid	Hydrogen Chloride Gas	A-2	70–125
	2,4,8,18 (a)	Sulfuric Acid	Acid Mist	B-2	70–90
Copper	8,14	Sodium Hydroxide, Sodium Cyanide	Alkaline, Cyanide Mists	C-3,2 (g)	70–90
	7,12,14 (b)	None	None	D-4	70–90
	14 (a)	Alkaline Cyanide	Cyanide Mist	C-3,2 (g)	70–160
	1	Nitric Acid	Nitrogen Oxide Gases	A-1	70–120
	18 (a)	Sodium Hydroxide-Sodium Sulfide	Alkaline Mist, Steam	C-2	185–195
Gold	4,5,6,8,9,14 (a)	Sodium Hydroxide, Sodium Cyanide	Alkaline, Cyanide Mists	C-3,2 (g)	70–90
	4,5,18 (a)	Sulfuric Acid	Acid Mist	B-3,2 (g)	70–100
Lead	13 (c)	Acetic Acid, Hydrogen Peroxide	Oxygen Mist	D-3	70–90
	14 (a),(c)	Sodium Hydroxide	Alakaline Mist, Steam	C-3,2 (g)	70–140
Nickel	2,4	Sulfuric, Nitric Acids	Nitrogen Oxide Gases	A-2,1 (g)	70–90
	2,4 (a)	Hydrochloric Acid	Hydrogen Chloride Gas	A-3	70–90
	2,4,14 (a)	Sulfuric Acid	Acid Mist	B-3	70–90
	7	Hydrofluoric Acid	Hydrogen Fluoride Gas	A-3,2 (g)	70–90
	14	Fuming Nitric Acid	Nitrogen Oxide Gases	A-1	70–90
	(a),(d)	Hot Water	Steam	D-2 (h)	200
	1,18,19 (a)	Sulfuric Acid	Acid Mist, Steam	B-3,2 (g)	70–150
Phosphate Coatings	15	Chromic Acid	Acid Mist, Steam	A-3	165
	16	Ammonium Hydroxide	Ammonia Gas	B-3,2 (g)	70–90
Rhodium	10	Sulfuric, Hydrochloric Acids	Acid Mist, Hydrogen Chloride Gas	A-3,2 (g)	70–100
Silver	1	Nitric Acid	Nitrogen Oxide Gases	A-1	70–90
	2,11	Sulfuric, Nitric Acids	Nitrogen Oxide Gases, Steam	A-1	180
	8,14 (a)	Sodium Hydroxide, Sodium Cyanide	Alkaline, Cyanide Mists	C-3	70–90
	17 (a)	Sodium Cyanide	Cyanide Mist	C-3	70–90
Tin	2,3,4	Ferric Chloride, Copper Sulfate Acetic Acid	Acid Mist	B-4,3 (g)	70–90
	(a)	Sodium Hydroxide	Alkaline Mist	C-3	70–90
	2,14	Hydrochloric Acid	Hydrogen Chloride Gas	A-3,2 (g)	70–90
	14 (a)	Sodium Hydroxide	Alkaline Mist, Steam	C-2	70–200

TABLE 10.70.8. Airborne Contaminants Released by Stripping Operations (con't)

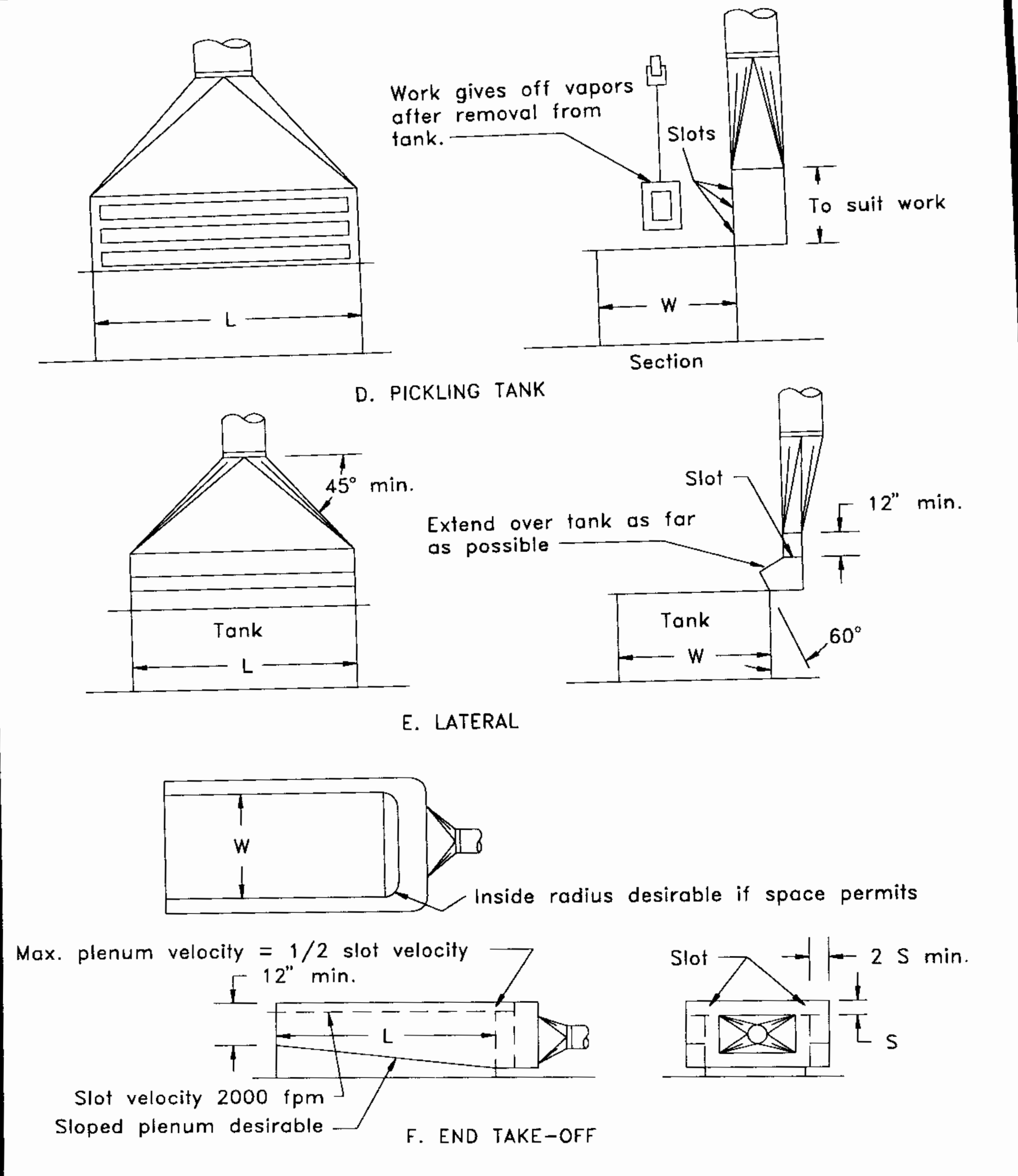
Coating to be Stripped	Base Metal (Footnote)	Component of Batch Which May be Released to Atmosphere (f)	Physical and Chemical Nature of Major Atmospheric Contaminant	Class (e)	Usual Temp. Range F
Zinc	1	Nitric Acid	Nitrogen Oxide Gases	A-1	70–90
	8,14	Sodium Hydroxide, Sodium	Alkaline, Cyanide Mists	C-3	70–90

Base Metal:
1. Aluminum
2. Brass
3. Bronze
4. Copper
5. Copper Alloys
6. Ferrous Metals
7. Magnesium
8. Nickel
9. Nickel Alloys
10. Nickel Plated Brass
11. Nickel Silver
12. Non-Ferrous Metals
13. Silver
14. Steel
15. Steel (Manganese Type Coatings)
16. Steel (Zinc Type Coatings)
17. White Metal
18. Zinc
19. Zinc Base Die Castings

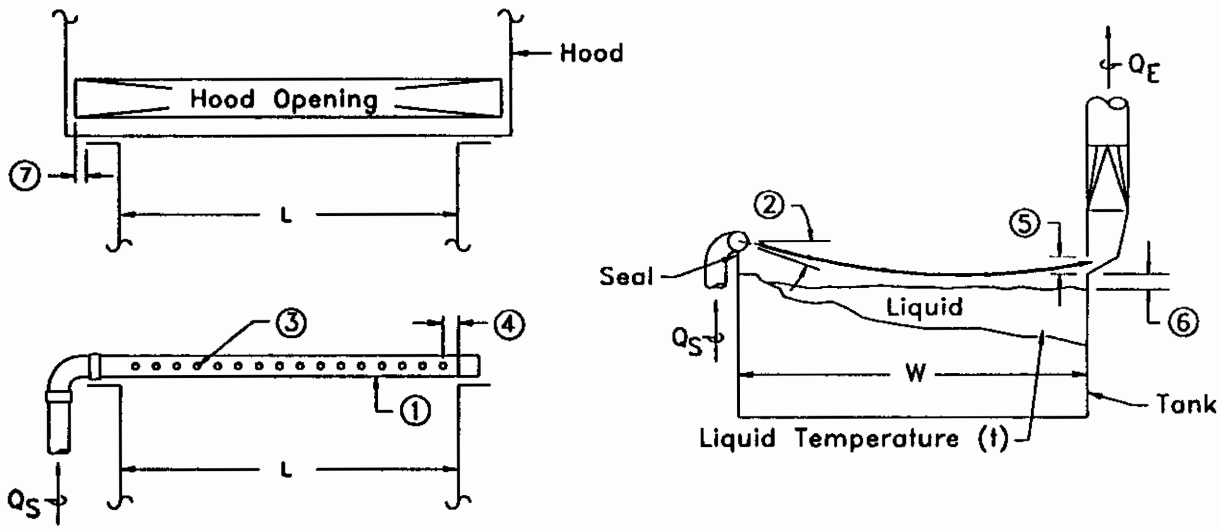
Notes:
(a) Electrolytic Process
(b) Refers only to steel (14) when Chromic, Sulfuric Acids Bath is used.
(c) Also Lead Alloys
(d) Sodium Nitrate Bath
(e) Class as described in Chapter 2 for use in Table 10.70.3 based on hazard potential (Table 10.70.1) and rate of evolution (Table 10.70.2) for usual operating conditions. Higher temperatures, agitation or other conditions may result in a higher rate of evolution.
(f) Hydrogen gas also released by some of these operations.
(g) The higher rate is associated with the higher value in the temperature range.
(h) Rate where essentially complete control of steam is required. Otherwise, adequate dilution ventilation may be sufficient.



AMERICAN CONFERENCE OF GOVERNMENTAL INDUSTRIAL HYGIENISTS	*OPEN SURFACE TANKS*			
	DATE	*12–90*	FIGURE	*VS–70–01*



AMERICAN CONFERENCE OF GOVERNMENTAL INDUSTRIAL HYGIENISTS	*OPEN SURFACE TANKS*	
	DATE *12-90*	FIGURE *VS-70-02*



Push nozzle manifold (1)–Circular, rectangular or square. Manifold cross-sectional area should be at least 2.5 times the total nozzle flow area.

Push nozzle angle (2) – 0° to 20° down.

Nozzle openings (3) – 1/8" to 1/4" slot or 5/32" to 1/4" dia. holes with 3 to 8 dia. spacing. Outer holes or slot ends (4) must be 1/2" to 1" inside tank inner edges.

Exhaust opening (5) – Size to achieve 2000 fpm slot velocity. Outer edges of opening (7) must extend to edge of tank including flanges.

Liquid surface (6) – Tank freeboard must not exceed 8" with parts removed.

Push nozzle supply $Q_j = 243 \sqrt{A_j}$

where Q_j = push nozzle supply, cfm/ft manifold length

A_j = total nozzle opening per foot of manifold length

Total push supply $Q_s = Q_j \times L$ cfm

Exhaust flow $Q_E = 75$ cfm/ft^2 tank surface area for $t \leq 150$ F

$Q_E = 0.4\ T + 15$ cfm/ft^2 tank surface area for $t > 150$ F.

Tank surface area = L (length of tank) x W (width of tank)

Design Procedure: Select nozzle opening within above limits and calculate push supply and exhaust air flow. See VS-70-11 and VS-70-12.

Reference 10.70.1, 10.70.2, & 10.70.3

AMERICAN CONFERENCE OF GOVERNMENTAL INDUSTRIAL HYGIENISTS	*PUSH-PULL HOOD DESIGN DATA FOR WIDTHS UP TO 10'*	
	DATE 4-94	FIGURE VS-70-10