

Corrosion Resistance Tables

Metals, Nonmetals, Coatings, Mortars,
Plastics, Elastomers and Linings, and Fabrics

Fourth Edition, Revised and Expanded

Part B, E-O

Philip A. Schweitzer, P.E.

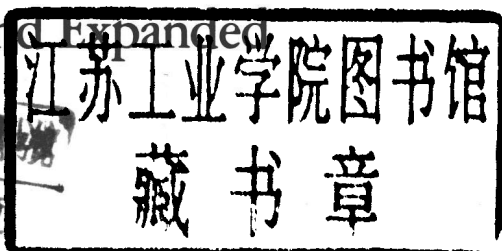


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Fallston, Maryland

Marcel Dekker, Inc.

New York • Basel • Hong Kong

30018786

Library of Congress Cataloging-in-Publication Data

Schweitzer, Philip A.

Corrosion resistance tables: metals, nonmetals, coatings, mortars, plastics, elastomers and linings, and fabrics / Philip A. Schweitzer. — 4th ed., rev. and expanded.
p. cm.

ISBN 0-8247-9590-3 (v. 1: alk. paper). — ISBN 0-8247-9591-1 (v. 2: alk. paper). — ISBN 0-8247-9641-1 (v. 3: alk. paper).

1. Corrosion and anti-corrosives — Tables. I. Title.

TA418.74.S38 1995

620.1'1223 — dc20

95-10260

CIP

The publisher offers discounts on this book when ordered in bulk quantities. For more information, write to Special Sales/Professional Marketing at the address below.

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Marcel Dekker, Inc.

270 Madison Avenue, New York, New York 10016

Current printing (last digit):

10 9 8 7 6 5 4 3 2 1

PRINTED IN THE UNITED STATES OF AMERICA

CORROSION TECHNOLOGY

Editor

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1. *Corrosion Protection Handbook: Second Edition, Revised and Expanded*, edited by Philip A. Schweitzer
2. *Corrosion Resistant Coatings Technology*, Ichiro Suzuki
3. *Corrosion Resistance of Elastomers*, Philip A. Schweitzer
4. *Corrosion Resistance Tables: Metals, Nonmetals, Coatings, Mortars, Plastics, Elastomers and Linings, and Fabrics: Third Edition, Revised and Expanded (Parts A and B)*, Philip A. Schweitzer
5. *Corrosion-Resistant Piping Systems*, Philip A. Schweitzer
6. *Corrosion Resistance of Zinc and Zinc Alloys: Fundamentals and Applications*, Frank Porter
7. *Corrosion of Ceramics*, Ronald A. McCauley
8. *Corrosion Mechanisms in Theory and Practice*, edited by P. Marcus and J. Oudar
9. *Corrosion Resistance of Stainless Steels*, C. P. Dillon
10. *Corrosion Resistance Tables: Metals, Nonmetals, Coatings, Mortars, Plastics, Elastomers and Linings, and Fabrics: Fourth Edition, Revised and Expanded (Parts A, B, and C)*, Philip A. Schweitzer

ADDITIONAL VOLUMES IN PREPARATION

Preface

The field of corrosion resistance is one of constant change. Research and development is constantly underway, involving both new materials and expanding the uses of known materials. These advances are particularly important for such areas as chemical processing and pollution control. Increased knowledge of corrosion resistance and the mechanisms of corrosion is a vital factor in this work.

This fourth edition of the corrosion resistance tables has been prepared in an attempt to provide the most current information available. Data on the corrosion resistance for the materials and corrodents covered in the previous editions have been greatly expanded, and data for 96 additional corrodents have been incorporated in this edition.

Philip A. Schweitzer, P.E.

Introduction

For years the chemical engineer has been faced with the problem of selecting the proper material to be used for the construction of processing vessels, storage tanks, valves, piping systems, and whatever else comes into contact with potentially corrosive chemicals. During the early days of the chemical engineering profession, the list of materials from which to choose was relatively small, consisting primarily of various metals and their alloys.

As technology made advances, new alloys were developed as well as synthetic materials such as plastics. Simultaneously, new chemicals came into being, many of which required the newly developed materials of construction for safe handling.

However, the problem of material selection is not limited to the chemical engineer. Many industries that use chemicals in their everyday operations cannot be classified as members of the chemical processing industry, yet they have the same problems of selecting the proper materials of construction to handle these products. This is particularly true in the area of pollution control. Many processes for the elimination of air and/or water pollution involve chemical changes in the pollutants that result in problems of corrosion that were not present before.

The dictionary defines corrosion as "the eating or wearing away by slow degrees," a definition that is rather broad and does not restrict the application of the word to the destruction of metals. This is as it should be because of the availability of so many nonmetallic materials of construction.

Most reference sources for the selection of proper materials of construction are devoted to either a specific group of metals or alloys, plastics, rubbers (synthetic and natural), gasketing materials, or packing materials. An individual with the problem of selecting materials of construction usually must make a selection in more than one of the preceding categories, which necessitates going to several sources for the information. It is the purpose of this book to provide one source from which all the components of a system may be selected, including processing vessels, tanks, pumps, piping, valves, gaskets, packing, etc.

These corrosion tables have been prepared with the intention of assisting not only the practicing engineer, but whoever may be charged with the responsibility of selecting the proper materials of construction for a specific application. Any table of this type should be used only as a guide since it is extremely difficult, and at times impossible, to duplicate actual operating conditions. To fully guarantee the suitability of a particular material of construction, corrosion tests should be conducted under actual operating conditions.

In the tables, all the chemicals are assumed to be in the pure state or in concentrated or saturated aqueous solutions, unless otherwise indicated. Concentration percentages used are by weight.

Two types of notation have been employed to indicate the suitability of a specific material of construction—one for metallic materials and one for nonmetallic materials. This is necessary because their mechanisms of corrosion differ.

CORROSION OF METALLICS

The four most common forms of corrosion of metals are

1. General corrosion
2. Galvanic corrosion
3. Stress corrosion cracking
4. Intergranular corrosion

General Corrosion

Metals resist corrosion by the formation of a passive film on the surface, which in a sense is also corrosion but once formed prevents further degradation of the base metal. Most metals form this film after a period of time of exposure to the air. *Passivation* is the name applied to the chemical treatment procedure that helps to form the film more rapidly. For example, exposure of austenitic stainless steels to nitric acid will produce this protective film.

As long as these films remain intact, they protect the base metal from further attack. Certain chemicals attack various films at varying rates. When this occurs, the metal is said to corrode. Such interaction between a chemical and a metal can be determined from the corrosion tables. This type of corrosion is known as general corrosion.

Galvanic Corrosion

Galvanic corrosion occurs when two or more dissimilar metals are in contact, or when metals having the same analysis have different surface conditions and an electrolyte is present.

Under these conditions an electrolytic cell is formed. All metals and alloys have certain "built-in" properties that cause them to react as an anode or a cathode when in contact with dissimilar metals or alloys. Whether a particular material will react as a cathode or an anode can be determined from the relative positions of the materials in the galvanic series. The farther apart two materials are from each other in the galvanic

series, with all other factors being equal, the greater the rate of corrosion. The material closest to the anodic end will be the one to corrode. For example, if tin and zinc were in contact, the zinc would corrode, whereas if tin and copper were in contact, the tin would corrode.

The rate of attack is also affected by the relative size of the materials and the specific electrolyte present. A small anode area in contact with a large cathode area will result in a rapid severe attack. Conversely, a large anode area in contact with a small cathode area will lessen the rate of galvanic attack since the same total electromagnetic driving force of corrosion will be spread out over a larger area. The higher the degree of ionization of the electrolyte, the greater the rate of attack.

Galvanic corrosion can be prevented by judicious use of dissimilar metals.

Galvanic Series

Anodic (corroded) end

Magnesium
Magnesium alloys
Zinc
Aluminum 5052
Aluminum 6061
Cadmium
Aluminum AA 2017
Iron and carbon steel
Copper steel
4-6% Chromium steel
Ferritic stainless (active) 400 series
Austenitic stainless (active) 18-8 series
Lead-tin solder
Lead
Tin
Nickel (active)
Inconel (active)

Hastelloy C (active)
Brasses
Copper
Bronzes
Cupro-nickel alloys
Monel
Silver solder
Nickel (passive)
Inconel (passive)
Ferritic stainless (passive)
Austenitic stainless (passive)
Titanium
Hastelloy C (passive)
Silver
Graphite
Gold
Platinum
Cathodic (protected) end

Stress Corrosion Cracking

All metals are subject to stress corrosion cracking, which results from residual or applied stress in the metal. Residual stresses can occur as a result of cold forming or quenching after heat treating. Annealing after fabrication will minimize these stresses. Applied stresses can result from faulty design, vibrations, flexing, and excessive expansion and contraction due to thermal changes.

The particular corrodent will determine the degree of effect. Halogen salts are among the materials that will attack metals most vigorously when stresses are present.

Intergranular Corrosion

Corrosive attack involving intergranular corrosion occurs only at the grain boundaries of austenitic stainless steels. All austenitic stainless steels contain carbon in small amounts.

When this material is heated to the sensitizing range (850 to 1650°F), such as in welding, carbon is precipitated out at the grain boundaries in the form of chromium carbide. The chromium has been taken from the grain boundaries, changing the composition and making this area even more susceptible to corrosive attack.

This effect can be minimized by annealing the stainless steel after it has been sensitized. This is done by heating the alloy to 1800°F or higher, depending on the specific alloy, and then quickly cooling it through the sensitizing range to prevent the carbon from precipitating out. Another way to reduce this effect is to limit the carbon content to less than 0.03%. This extra-low-carbon (ELC) stainless steel can be welded without the danger of carbide precipitation.

CORROSION OF NONMETALLICS

Plastic materials are attacked by solvation and chemical reactions. Solvation is the penetration of the plastic by corrosive elements that cause softening, swelling, and ultimate failure. Plastics, in contrast to metals, do not exhibit a useful corrosion rate; they usually either completely resist attack or deteriorate rapidly. Because of this difference in corrosion mechanism, the two types of notation used in the tables were established.

Plastic and elastomeric materials are compounded by the manufacturer. Properties of the materials produced can vary from manufacturer to manufacturer. By compounding, it is possible to improve specific mechanical/physical properties, but usually at the expense of another property. Consequently, materials that have been produced to improve a mechanical property may have had their ability to resist corrosion reduced. Since all plastic or elastomeric materials produced may not have the corrosion resistance indicated in the charts, the manufacturer of the material to be used should be consulted. The same reasoning applies to the physical/mechanical properties required for the application.

A word of caution should also be given regarding temperatures. The table shows only the resistivity to corrosive attack at various temperatures. Although the material may be corrosion-resistant at a specific temperature, this does not mean that the physical/mechanical properties would be satisfactory at these temperatures. These must be investigated at the operating temperature to ensure that the material has the proper mechanical strength for the application.

Using the Tables

The tables are arranged alphabetically according to corrodent. Unless otherwise noted, the corrodent is considered pure in the case of liquids, or a saturated aqueous solution in the case of solids. All percentages shown are by weight.

There are four pages for each corrodent: one for the resistance to metals; one for the resistance to nonmetallic materials, coatings, and mortars; one for the resistance to plastics; and one for the resistance to elastomers, linings, and fabrics.

TABLE NOTATION

Since corrosion is a function of temperature, the tables indicate the suitability of each material at varying temperatures. Symbols used to designate specific corrosion rates are shown on the bottom of the metals pages. The use of the temperature scale is explained by the following example.

		ACETIC ACID 80%																											
		°C	15	26	38	49	60	71	82	93	104	116	127	138	149	160	171	182	193	204	216	227	238	249	260	271	282	293	
		°F	60	80	100	120	140	160	180	200	220	240	260	280	300	320	340	360	380	400	420	440	460	480	500	520	540	560	
METALS																													
MONEL		E			G																								
STAINLESS STEELS																													
Type 316		E	G						S			U																	

From the sample table, it is seen that in the presence of an 80% solution of acetic acid, monel has a corrosion rate varying with temperature rated as follows:

- From 60 to 120°F, excellent (E): < 2 mils penetration/year.
- From 120 to 210°F, good (G): < 20 mils penetration/year.
- There are no data for temperatures beyond 210°F.

Type 316 stainless steel has a corrosion rate for the same corrodent varying with temperature rated as follows:

- From 60 to 100°F, excellent (E): < 2 mils penetration/year.
- From 100 to 180°F, good (G): < 20 mils penetration/year.
- From 180 to 240°F, satisfactory (S): < 50 mils penetration/year.
- Above 240°F, unsatisfactory (U): > 50 mils penetration/year.

Nonmetallics are only rated as resistant (R) or unsatisfactory (U), because they do not exhibit a useful corrosion rate, as explained previously.

Other Notation

Further information regarding the corrosion of specific materials by certain corrodents is provided by the following symbols. In the tables, the symbols follow the applicable material or corrodent name.

Symbol	Meaning
1	Material is subject to pitting.
2	Material is subject to stress cracking.
3	Material is subject to crevice attack.
4	Not for use with carbonated beverages.
5	Material should be passivated.
6	Alkaline.
7	Acid free.
8	Acid free and passivated.
9	Material is subject to intergranular corrosion.
10	Synthetic veil or surfacing mat should be used.
11	Material will cause stress cracking in many polyethylenes. A stress crack-resistant, high molecular weight polyethylene must be used.
12	Material is subject to stress cracking when wet.
ALL	Data applies to all concentrations.
ELC	Material is low-carbon grade.
SAT	Solution is saturated.

General Notes

- Incolloy category is applicable to grades 800 and 825 only, unless otherwise specified.

- Inconel category is applicable to grade 600, unless otherwise specified.
- The mortars specified are for use fully immersed or subject to constant flow.
- The coatings specified are for use fully immersed or for wet spills or wet fumes.
- There are many epoxy formulations. Where epoxy is shown as being a satisfactory material of construction, it indicates that there is a suitable formulation. Manufacturers should be consulted for the suitability of their specific formulation.
- See Appendix 3 for plating solution compositions.

READING THE TEMPERATURE SCALE

When using the tables, note that the vertical lines refer to temperatures midway between the temperatures cited (see the sample table below). Thus, aluminum is corroded by pyridine at a rate less than 20 mils/year between 60 and 350°F. Brass, carbon steel, and copper have the same corrosion rate between the temperatures of 60 and 210°F, 120°F, and 80°F, respectively.

When a material is indicated to be unsatisfactory at a specific temperature, it is also unsatisfactory at all temperatures above the one shown. A blank in the chart indicates that no data are available.

		PYRIDINE																											
		°C	15	26	38	49	60	71	82	93	104	116	127	138	149	160	171	182	193	204	216	227	238	249	260	271	282	293	
		°F	60	80	100	120	140	160	180	200	220	240	260	280	300	320	340	360	380	400	420	440	460	480	500	520	540	560	
METALS	ADMIRALTY BRASS																												
	ALUMINUM	G																											
	ALUMINUM BRONZE																												
	BRASS	G																											
	BRONZE																												
	CARBON STEEL	G																											
	COLUMBIUM (NIOBIUM)																												
	COPPER	G																											
	HASTELLOY B/B-2																												
	HASTELLOY C/C-276																												

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Part A, A-D

A	1
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Acetaldehyde / Acetamide / Acetate Solvents, Crude / Acetate Solvents, Pure / Acetic Acid 10% / Acetic Acid 20% / Acetic Acid 50% / Acetic Acid 80% / Acetic Acid, Glacial / Acetic Acid Vapors / Acetic Anhydride / Acetone / Acetone, 50% Water / Acetonitrile / Acetophenone / Acetyl Chloride / Acetylene / Acetylene Tetrabromide / Acrylic Acid / Acrylonitrile / Adipic Acid / Allyl Alcohol / Allyl Chloride / Alum (Aluminum Potassium Sulfate) / Alum Ammonium / Alum Ammonium Sulfate / Alum Chrome / Alum Potassium / Aluminum Acetate (Sat.) / Aluminum Bromide / Aluminum Chloride Aqueous / Aluminum Chloride Dry / Aluminum Fluoride (Sat.) / Aluminum Hydroxide / Aluminum Nitrate (Sat.) / Aluminum Oxalate / Aluminum Oxychloride / Aluminum Phosphate / Aluminum Potassium Sulfate / Aluminum Sulfate (Sat.) / Ammonia (Anhydrous) / Ammonia Gas / Ammonium Acetate / Ammonium Bicarbonate / Ammonium Bifluoride / Ammonium Bromide 5% / Ammonium Carbonate (Sat.) / Ammonium Chloride 10% / Ammonium Chloride 28% / Ammonium Chloride 50% / Ammonium Chloride (Sat.) / Ammonium Citrate / Ammonium Dichromate / Ammonium Fluoride 10% / Ammonium Fluoride 25% / Ammonium Hydroxide 10% / Ammonium Hydroxide 25% / Ammonium Hydroxide (Sat.) / Ammonium Metaphosphate / Ammonium Nitrate / Ammonium Oxalate 10% / Ammonium Oxalate 20-30% / Ammonium Persulfate / Ammonium Phosphate / Ammonium Sulfate 10-40% / Ammonium Sulfate (Sat.) / Ammonium Sulfide / Ammonium Sulfite / Ammonium Thiocyanate / Amyl Acetate / Amyl Alcohol / Amyl Chloride / Aniline / Aniline Chlorohydrate / Aniline Hydrochloride / Anthraquinone / Anthraquinone Sulfonic Acid / Antimony Trichloride / Aqua Regia 3:1 / Argon / Aroclor / Arsenic Acid / Asphalt / Asphalt Emulsion

Barium Acetate / Barium Carbonate (Sat.) / Barium Chloride (Sat.) / Barium Cyanide / Barium Hydroxide (Sat.) / Barium Nitrate / Barium Sulfate / Barium Sulfide / Beer / Beet Sugar Liquors / Benzaldehyde / Benzene, Benzol / Benzene Sulfonic Acid 10% / Benzene Sulfonic Acid 100% / Benzoic Acid / Benzonitrile / Benzoyl Chloride / Benzyl Acetate / Benzyl Alcohol / Benzyl Chloride / Bismuth Carbonate / Black Liquor / Bleach, 12.5% Active Chlorine / Blood / Borax / Borax Liquors / Bordeaux Mixtures / Boric Acid / Brine Acid / Bromic Acid / Bromine Gas Dry / Bromine Gas Moist / Bromine Liquid / Bromine Water Dilute / Bromine Water (Sat.) / Bromobenzene / Butadiene (Butylene) / Butane / Butyl Acetate / Butyl Alcohol / Butyl Alcohol Primary / Butyl Alcohol Secondary / Butyl Alcohol Tertiary / *n*-Butylamine / Butyl Bromide / Butyl Cellosolve / Butyl Chloride / Butylene (Butadiene) / Butyl Ether / *n*-Butyl Mercaptan / Butyl Phenol / Butyl Phthalate / Butyl Stearate / Butyne Diol / Butyraldehyde / Butyric Acid

C

561

Cadmium Chloride / Cadmium Cyanide / Cadmium Sulfate 10% / Calcium Acetate / Calcium Bicarbonate / Calcium Bisulfate / Calcium Bisulfide / Calcium Bisulfite / Calcium Bromide 38% / Calcium Carbonate / Calcium Chlorate / Calcium Chloride Dilute / Calcium Chloride (Sat.) / Calcium Fluoride / Calcium Hydroxide 10% / Calcium Hydroxide 20% / Calcium Hydroxide 30% / Calcium Hydroxide (Sat.) / Calcium Hypochlorite 30% / Calcium Hypochlorite (Sat.) / Calcium Nitrate / Calcium Oxide / Calcium Sulfate / Calcium Sulfide / Camphor / Cane Sugar Liquors / Caprylic Acid / Carbitol / Carbon Bisulfide (Disulfide) / Carbon Dioxide Dry / Carbon Dioxide Wet / Carbon Disulfide (Bisulfide) / Carbon Monoxide / Carbon Tetrachloride / Carbonic Acid / Castor Oil / Caustic Potash (Potassium Hydroxide) / Cellosolve / Cellulose Acetate / Chloral Hydrate / Chloramine Dilute / Chloric Acid 10% / Chloric Acid 20% / Chlorine Dioxide 15% / Chlorine Gas Dry / Chlorine Gas Wet / Chlorine Liquid / Chlorine Water (Sat.) / Chloroacetic Acid / Chloroacetic Acid, 50% Water / Chloroacetyl Chloride / Chlorobenzene (Phenylchloride) / Chlorobenzyl Chloride / Chloroform / Chlorophenol, 5% Aqueous / Chloropicrin / Chlorosulfonic Acid 100% / Chrome Alum / Chromic Acid 10% / Chromic Acid 30% / Chromic Acid 40% / Chromic Acid 50% / Chromium Potassium Sulfate / Chromyl Chloride / Citric Acid 5% / Citric Acid 10% / Citric Acid 15% / Citric Acid (Conc.) / Clorox Bleach Solution, 5.5% Chlorine / Coal Gas / Coconut Oil / Coffee / Coke Oven Gas / Copper Acetate / Copper Carbonate / Copper Chloride / Copper Cyanide / Copper Fluoride / Copper Nitrate / Copper Sulfate / Corn Oil / Cottonseed Oil / Creosote / Cresol / Cresylic Acid 50% / Cresylic Acid (Conc.) / Croton Aldehyde / Crude Oil / Cumene / Cupric Chloride 5% / Cupric Chloride 50% / Cupric Cyanide / Cupric Fluoride / Cupric Nitrate / Cupric Sulfate / Cuprous Chloride / Cyanoacetic Acid / Cyanogen Gas / Cyclohexane / Cyclohexanol / Cyclohexanone

D

965

Detergents / Detergent Solution, Heavy Duty / Dextrin / Dextrose / Diacetone Alcohol / Diammonium Phosphate / Diazo Salts / Dibenzyl Ether / Dibutyl Ether / Dibutyl Phthal-

ate / Dichloroacetic Acid / Dichlorobenzene / Dichloroethane (Ethylene Dichloride) / Dichloroethylene / Diesel Fuels / Diethanolamine / Diethylamine / Diethyl Benzene / Diethyl Cellosolve / Diethyl Ether / Diethylene Glycol / Diethylene Triamine / Diglycolic Acid / Dimethylamine / Dimethylamine Aqueous / Dimethyl Aniline / Dimethyl Ether / Dimethyl Formamide / Dimethyl Phthalate / Dimethyl Sulfoxide / Dioctyl Phthalate / Dioctyl Sebacate / Dioxane / Dipentene / Diphenyl (Dowtherm) / Diphenyl Oxide / Disodium Phosphate

Part B, E–O

E

1113

Epichlorhydrin / Esters, General / Ethane / Ethanolamine / Ethers, General / Ethyl Acetate / Ethyl Acetoacetate / Ethyl Acrylate / Ethyl Alcohol / Ethyl Benzene / Ethyl Chloride / Ethyl Chloroacetate / Ethyl Ether / Ethyl Formate / 2-Ethyl Hexanol / Ethyl Mercaptan / Ethyl Oxalate / Ethylene Bromide / Ethylene Chloride / Ethylene Chlorohydrin / Ethylene Diamine / Ethylene Dibromide / Ethylene Dichloride (Dichloroethane) / Ethylene Glycol / Ethylene Oxide

F

1213

Fatty Acids / Ferric Acetate / Ferric Chloride / Ferric Chloride 50% in Water / Ferric Hydroxide / Ferric Nitrate 10–50% / Ferric Nitrate (Sat.) / Ferric Sulfate / Ferrous Ammonium Citrate / Ferrous Chloride (Sat.) / Ferrous Hydroxide / Ferrous Nitrate / Ferrous Sulfate / Fish Oil / Fish Solubles / Flue Gas / Fluoboric Acid / Fluorine Gas Dry / Fluorine Gas Moist / Fluorosilicic Acid 50% / Fluosilicic Acid / Formaldehyde Dilute / Formaldehyde 35% Solution / Formaldehyde 37% Solution / Formaldehyde 50% Solution / Formic Acid 5% / Formic Acid 10–85% / Formic Acid Anhydrous / Freon F–11 / Freon F–12 / Freon F–21 / Freon F–22 / Freon F–113 / Fructose / Fruit Juices, Pulp / Fuel Oil / Furfural

G

1361

Gallic Acid / Gas, Manufactured / Gas, Natural / Gasohol / Gasoline, Leaded / Gasoline, Refined / Gasoline, Sour / Gasoline, Unleaded / Gelatin / Gin / Glauber's Salt / Glucose (Corn Syrup) / Glue / Glycerine (Glycerol) / Glycolic Acid / Glycols / Green Liquor

H

1429

Heptane / Hexamethylene Tetramine / Hexamine / Hexane / Hexanol, Tertiary / Hydrazine / Hydrobromic Acid Dilute / Hydrobromic Acid 20% / Hydrobromic Acid 50% / Hydrochloric Acid Dilute / Hydrochloric Acid 20% / Hydrochloric Acid 35% / Hydrochloric Acid 38% / Hydrochloric Acid 50% / Hydrochloric Acid Fumes / Hydrocyanic Acid 10% / Hydrocyanic Acid (Conc.) / Hydrofluoric Acid Dilute / Hydrofluoric Acid

30% / Hydrofluoric Acid 40% / Hydrofluoric Acid 50% / Hydrofluoric Acid 70% / Hydrofluoric Acid 100% / Hydrofluoric Acid Vapors / Hydrofluosilicic Acid 10-50% / Hydrogen / Hydrogen Chloride Gas Dry / Hydrogen Chloride Gas Moist / Hydrogen Cyanide / Hydrogen Fluoride / Hydrogen Iodide / Hydrogen Peroxide Dilute / Hydrogen Peroxide 30% / Hydrogen Peroxide 50% / Hydrogen Peroxide 90% / Hydrogen Phosphide / Hydrogen Sulfide Aqueous Solution / Hydrogen Sulfide Dry / Hydrogen Sulfide Wet / Hydrogen Sulfite / Hydroiodic Acid (49% + 12% Iodine) / Hydroquinone / Hypochlorous Acid

I

1601

Iodine / Iodine Solution 10% / Iodine Solution (Sat.) / Iodine in Alcohol / Iodoform / Isobutane / Isobutyl Alcohol / Isooctane / Isopropyl Acetate / Isopropyl Alcohol / Isopropyl Ether

J

1645

Jet Fuel JP-4 / Jet Fuel JP-5

K

1653

Kerosene / Ketchup / Ketones, General / Kraft Liquor

L

1669

Lactic Acid 5% / Lactic Acid 10% / Lactic Acid 25% / Lactic Acid 80% / Lactic Acid (Conc.) / Lard Oil / Lauric Acid / Lauryl Chloride / Lead Acetate / Lead Chloride / Lead Nitrate / Lead Sulfate / Lime Slurry / Lime Sulfur / Linoleic Acid / Linseed Oil / Liqueurs / Lithium Bromide / Lithium Chloride 30% / Lithium Hydroxide 10% / Lubricating Oil

M

1753

Machine Oil / Magnesium Carbonate / Magnesium Chloride / Magnesium Citrate / Magnesium Hydroxide / Magnesium Nitrate / Magnesium Sulfate / Maleic Acid / Maleic Anhydride / Malic Acid / Manganese Carbonate / Manganese Chloride / Mercuric Chloride / Mercuric Cyanide / Mercuric Nitrate / Mercurous Nitrate / Mercury / Methane / Methane Sulfonic Acid 50% / Methyl Acetate / Methyl Acetone / Methyl Alcohol / Methyl Amine / Methyl Bromide / Methyl Cellosolve / Methyl Chloride / Methyl Chloroform / Methyl Ethyl Ketone / Methyl Formate / Methyl Isobutyl Carbinol / Methyl Isobutyl Ketone / Methyl Methacrylate / Methyl Salicylate / Methyl Sulfate / Methyl Sulfuric Acid / Methylene Chloride / Methylene Chlorobromide / Milk / Mineral Oil / Mixed Acids / Molasses / Molybdic Acid 5% / Monochlorobenzene / Monochlorodifluoromethane / Monoethanolamine / Morpholine / Motor Oil / Muriatic Acid

N**1945**

Naphtha / Naphthalene / Naphthalenic Acid / Nickel Acetate / Nickel Chloride / Nickel Nitrate / Nickel Salt / Nickel Sulfate / Nicotine / Nicotinic Acid / Nitric Acid 5% / Nitric Acid 10% / Nitric Acid 20% / Nitric Acid 30% / Nitric Acid 40% / Nitric Acid 50% / Nitric Acid 70% / Nitric Acid 100% (Anhydrous) / Nitric Acid Fuming (Red) / Nitric Acid:Sulfuric Acid 50:50 / Nitrobenzene / Nitrogen / Nitrogen Dioxide / Nitromethane / Nitrous Acid 5% / Nitrous Acid 10% / Nitrous Acid (Conc.) / Nitrous Oxide

O**2057**

Ocenol / Octane / Oil and Fats / Oils, Vegetable / Oleic Acid / Oleum / Olive Oil / Oxalic Acid 5% / Oxalic Acid 10% / Oxalic Acid 50% / Oxalic Acid (Sat.) / Oxygen / Oxygen Gas / Ozone

Part C, P-Z**P****2113**

Palmitic Acid 10% / Palmitic Acid 70% / Palmitic Acid (Conc.) / Paraffin / Peanut Oil / Pentane / Peracetic Acid 40% / Perchloric Acid 10% / Perchloric Acid 70% / Perchloroethylene / Petrolatum / Petroleum Ether / Petroleum Oils, Refined / Petroleum Oils, Sour / Phenol (Carbolic Acid) / Phenol 10% / Phenylhydrazine / Phenylhydrazine Hydrochloride / Phosgene Gas / Phosgene Liquid / Phosphoric Acid 5% / Phosphoric Acid 10% / Phosphoric Acid 25-50% / Phosphoric Acid 50-85% / Phosphoric Anhydride (Dry or Moist) / Phosphorus / Phosphorus Oxychloride / Phosphorus Pentoxide / Phosphorus Red / Phosphorus Trichloride / Phosphorus Yellow / Photographic Solutions / Phthalic Acid / Phthalic Anhydride / Picric Acid / Picric Acid 10% / Plating Solutions, Brass / Plating Solutions, Cadmium / Plating Solutions, Chrome 25% / Plating Solutions, Chrome 40% / Plating Solutions, Copper (Cyanide) / Plating Solutions, Gold / Plating Solutions, Iron / Plating Solutions, Lead / Plating Solutions, Nickel / Plating Solutions, Rhodium / Plating Solutions, Silver / Plating Solutions, Tin / Plating Solutions, Zinc / Polysulfide Liquor / Polyvinyl Acetate / Potassium Acetate / Potassium Aluminum Sulfate / Potassium Bicarbonate 30% / Potassium Bicarbonate (Sat.) / Potassium Bichromate / Potassium Bisulfate / Potassium Borate / Potassium Bromate / Potassium Bromide 30% / Potassium Bromide (Sat.) / Potassium Carbonate 50% / Potassium Chlorate, Aqueous 30% / Potassium Chloride 30% / Potassium Chromate 30% / Potassium Cyanide 30% / Potassium Dichromate 30% / Potassium Dichromate (Sat.) / Potassium Ferricyanide 30% / Potassium Ferrocyanide 30% / Potassium Fluoride / Potassium Hydroxide 5% / Potassium Hydroxide 27% / Potassium Hydroxide 50% / Potassium Hydroxide 90% / Potassium Hypochlorite / Potassium Iodide 70% / Potassium Nitrate 1-5% / Potassium Nitrate 80% / Potassium Nitrite / Potassium Oxalate 20% / Potassium Perborate / Potassium Perchlorate / Potassium Permanganate 10% / Potassium Permanga-