Corrosion Guide

Buyers, metallurgists and engineers alike are continually faced with the question: "What material shall I use for this application?" This "Guide" is a helpful source of information in dealing with such questions.

It must be emphasized that while this guide provides useful basic information, it should not be regarded as the final word in choosing the best material for any given application. All environmental conditions should be carefully taken into account.

The input of most of the leading primary metal and plastic producers is reflected in this compilation. Where conflicting opinions were encountered, the lower corrosion rating has in each case been listed.

	Brass and Naval Bronze	Silicon Bronze	Monel Metal	Stainless Types 410, 416 and 430 (Magnetic)	Stainless Types 302, 303, 304 and 305 18-8 (A2)	Stainless Type 316 (A4)	Copper	Aluminum	Nylon
Acetate Solvents, Crude	Fair	Good	Good	Good	Excel	Excel	Good	Excel	Good
Acetate Solvents, Pure	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel
Acetate Acid, Crude	Fair[1]	Good	Good	Poor[2]	Good	Excel	Good	Good	Poor
Acetate Acid, Pure	Fair[1]	Good	Good	Poor[2]	Good	Excel	Good	Excel	Poor
Acetic Acid Vapors	Poor	Good	Fair	Poor	Good	Excel	Good	Good	Poor
Acetic Anhydride	Poor	Good	Good	Poor	Good	Excel	Good	Excel	Poor
Acetone	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel
Acetylene	[3]	Poor	Good	Excel	Excel	Excel	Poor	Excel	
Alcohols	Good	Excel	Excel	Excel	Excel	Excel	Excel	Good	Good
Aluminum Sulfate	Fair[1]	Good	Good	Poor	Fair	Good	Good	Fair	Poor
Alums	Fair[1]	Good	Good	Poor	Fair	Good	Good	Excel	Fair
Amonia Gas[4]	Poor[5,6]	[6]	[6]	Excel	Excel	Excel	[6]	Excel	Good[36]
Ammonium Chloride	Fair[1]	Good	Excel	Fair	Fair	Excel	Good	Poor	Fair
Ammonium Hydroxide	Poor	Poor	Fair	Excel	Excel	Excel	Poor	Good	Good[36]
Ammonium Nitrate	Poor	Fair	Fair	Excel	Excel	Excel	Fair	Excel	Fair
Ammonium Phosphate (Ammoniacal)	Poor	Poor	Good	Excel	Excel	Excel	Poor	Poor	Good
Ammonium Phosphate (Neutral)	Fair	Fair	Good	Good	Excel	Excel	Fair	Fair	Excel
Ammonium Phosphate (Acid)	Fair[1]	Fair	Good	Fair	Good	Excel	Fair	Fair	Fair
Ammonium Sulfate	Fair[1]	Fair	Good	Good	Excel	Excel	Fair	Good[35]	Fair
Asphalt	Good	Excel	Excel	Good	Excel	Excel	Excel	Excel	Excel
Beer	Good	Good	Excel	[7]	Excel	Excel	Good	Excel	Excel
Beet Sugar Liquors	Good	Excel	Excel	Good	Excel	Excel	Excel	Excel	Good
Benzene or Benzol[8]	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel
Benzine[8]	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel
Borax	Good	Good	Excel	Excel	Excel	Excel	Good	Good	Good
Boric Acid	Fair[1]	Good	Excel	Fair	Good	Excel	Good	Excel	Good
Butane, Butylene, Butadiene[9]	Excel[34]	Excel[34]	Excel	Excel[10]	Excel[10]	Excel[10]	Excel[34]	Excel	Excel
Calcium Bisulfite	Poor	Good	Poor	Poor	Good	Excel	Good	Poor	Good
Calcium Hypochlorite	Fair	Fair	Fair	Poor	Fair	Good	Fair	Poor	Fair
Cane Sugar Liquors	Good	Excel	Excel	Good	Excel	Excel	Excel	Excel	Good
Carbon Dioxide (Dry)	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel

Numerals refer to notes on page R18.

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Carbon Dioxide (Wet & Aqueous)	Fair[11]	Good[11]	Good[11]	Excel[11]	Excel	Excel	Good[11]	Excel	Excel
Carbon Disulfide	Fair	Poor	Fair	Good	Excel	Excel	Poor	Excel	Excel
Carbon Tetrachloride[12]	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Good	Excel
Chlorine (Dry)	Good	Good	Excel	Good	Good	Good	Good	Poor	Poor
Chlorine (Wet)	Poor	Fair	Fair	Poor	Poor	Fair	Fair	Poor	Poor
Chromic Acid	Poor	Poor	Fair	Fair	Good	Excel	Poor	Poor	Poor
Citric Acid	Fair[1]	Good	Good	Fair	Good	Excel	Good	Good	Good
Coke Oven Gas	Fair	Fair	Good	Excel	Excel	Excel	Fair	Good	Fair
Sulfate	Poor	Fair	Fair	Excel	Excel	Excel	Fair	Poor	Fair
Core Oils	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel
Cottonseed Oil	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel
Creosote	Fair	Good	Excel	Excel	Excel	Excel	Good	Good	
Ethers	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel
Ethylene Glycol	Good	Excel	Excel	Excel	Excel	Excel	Excel	Good	Good
Ferric Chloride	Poor	Poor	Poor	Poor	Poor	Poor	Poor	Poor	Poor
Ferric Sulfate	Poor	Fair	Fair	Excel	Excel	Excel	Fair	Good	Poor
Formaldehyde	Good	Good	Excel	Excel	Excel	Excel	Good	Good	Good
Formic Acid	Fair[1]	Good	Good	Poor	Good	Excel	Good	Poor	Poor
Freon	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Good	Excel
Furfural	Good	Good	Excel	Excel	Excel	Excel	Good	Excel	Excel
Gasoline (Sour)	Fair	Poor	Poor	Fair	Excel	Excel	Poor	Poor	Excel
Gasoline (Refined)	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel
Gelatin	Fair[13]	Excel[13]	Excel	Fair[13]	Excel	Excel	Excel[13]	Excel	Excel
Glucose	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel
Glue	Fair	Excel	Excel	Excel	Excel	Excel	Excel	Fair	Excel
Glycerine or Glycerol	Good	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Good
Hydrochloric Acid	Poor	Fair[14]	Fair[14]	Poor	Poor	Poor	Fair[14]	Poor	Poor
Hydrocyanic Acid (Hydrogen Cyanide)	Poor	Poor	Good	Fair	Excel	Excel	Poor	Excel	Excel
Hydrofluoric Acid	Poor	Fair	Excel	Poor	Poor	Poor	Fair	Poor	Poor
Hydrogen Fluoride	Fair	Good	Excel	Fair	Good	Good	Good	Poor	Poor
Hydrogen[9]	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel
Hydrogen Peroxide	Poor	Fair	Good	Excel	Excel	Excel	Fair	Good	Fair
Hydrogen Sulfide (Dry)	Fair[6]	Poor[6]	Fair[6]	Good	Excel	Excel	Poor[6]	Excel	Good[37]
Hydrogen Sulfide (Wet & Aqueous)	Fair	Poor	Fair	Fair[15]	Good	Excel	Poor	Excel	Good[37]
Lacquers and Lacquer Solvents	Fair	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel
Lime-Sulfur	Poor	Fair	Good	Good	Excel	Excel	Fair	Poor	Good
Magnesium Chloride	Fair	Good	Excel	Fair	Good	Excel	Good	Poor	Excel
Magnesium Hydroxide	Good	Excel	Excel	Excel	Excel	Excel	Excel	Fair	Good
Magnesium Sulfate	Good	Excel	Excel	Excel	Excel	Excel	Excel	Good	Excel
Mercuric Chloride	Poor	Poor	Poor	Poor	Poor	Fair[16]	Poor	Poor	
Mercury	Poor	Poor	Good	Excel	Excel	Excel	Poor	Poor	Excel
Milk	Fair	Fair	Fair	Good	Excel	Excel	Fair	Excel	Excel
Molasses	Good	Excel	Excel	Good	Excel	Excel	Excel	Excel	Excel

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Natural Gas	Good	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel
Nickel Chloride[17]	Poor	Fair	Good	Poor	Fair	Good	Fair	Poor	Poor
Nickel Sulfate[17]	Fair	Good	Excel	Fair	Good	Excel	Good	Poor	Poor
Nitric Acid	Poor	Poor	Poor	Good[18]	Good	Good	Poor	Fair	Poor
Oleic Acid	Fair[19]	Good[24]	Excel	Good[20]	Good[20]	Excel	Good[24]	Excel	Excel
Oxalic Acid	Fair	Good	Excel	Fair	Good	Excel	Good	Poor	Poor
Oxygen[9]	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Good
Palmitic Acid	Fair[19]	Good[24]	Excel	Good[20]	Good[20]	Excel	Good[24]	Excel	Excel
Petroleum Oils (Sour)	Fair	Poor	Poor	Fair	Excel	Excel	Poor	Poor	Excel
Petroleum Oils (Refined)	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel
Phosphoric Acid 25%	Poor	Good[21]	Good[22]	Poor	Fair[23]	Excel	Good[21]	Poor	Poor
Phosphoric Acid 25%, 50%	Poor	Good[21]	Good[22]	Poor	Poor	Good	Good[21]	Poor	Poor
Phosphoric Acid 50%, 85%	Poor	Good[21]	Good[22]	Poor	Poor	Good	Good[21]	Excel	Excel
Picric Acid	Poor	Poor	Poor	Good	Excel	Excel	Poor	Fair	Poor
Potassium Chloride	Fair	Good	Excel	Fair	Good	Excel	Good	Poor	Excel
Potassium Hydroxide	Poor	Fair	Excel	Excel	Excel	Excel	Fair	Poor	Good[38]
Potassium Sulfate	Good	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel
Propane[9]	Excel	Excel	Excel	Excel[10]	Excel[10]	Excel[10]	Excel	Excel	Excel
Rosin (Dark)	Good	Good	Excel	Excel	Excel	Excel	Good	Excel	Excel
Rosin (Light)	Poor	Poor	Good	Excel	Excel	Excel	Poor	Good	Excel
Shellac	Good	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel
Soda Ash (Sodium Carbonate)	Good	Good	Excel	Excel	Excel	Excel	Excel	Poor	Excel
Sodium Bicarbonate	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Good	Excel
Sodium Bisulfate	Fair[1]	Good	Excel	Poor	Poor	Excel	Good	Fair	Fair
Sodium Chloride	Fair	Good	Excel	Fair	Good	Excel	Good	Good	Excel
Sodium Cyanide	Poor	Poor	Good	Excel	Excel	Excel	Poor	Poor	Good
Sodium Hydroxide	Poor	Fair	Excel	Excel	Excel	Excel	Fair	Excel	Good[38]
Sodium Hypochlorite	Excel	Fair	Fair	Excel	Fair	Good	Fair	Excel	Fair
Sodium Metaphosphate	Fair	Good	Excel	Good	Excel	Excel	Good	Fair	Excel
Sodium Nitrate	Fair	Good	Excel	Excel	Excel	Excel	Good	Excel	Excel
Sodium Perborate	Fair	Good	Excel	Excel	Excel	Excel	Good	Fair	
Sodium Peroxide	Fair	Good	Excel	Excel	Excel	Excel	Good	Fair	Fair
Sodium Phosphate (Alkaline)	Fair	Good	Excel	Excel	Excel	Excel	Good	Poor	Good
Sodium Phosphate (Neutral)	Good	Excel	Excel	Excel	Excel	Excel	Excel	Poor	Excel
Sodium Phosphate (Acid)	Fair	Good	Excel	Poor	Good	Excel	Good	Poor	Fair
Sodium Silicate	Fair	Good	Excel	Excel	Excel	Excel	Good	Good	Good
Sodium Sulfate	Good	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel
Sodium Sulfide	Poor	Poor	Good	Excel	Excel	Excel	Poor	Poor	Good
Sodium Thiosulfate (Hypo)	Poor	Poor	Good	Excel	Excel	Excel	Poor	Excel	Good[39]
Sludge Acid	Poor	Good	Good	Poor	Poor	Fair	Good	Poor	
Stearic Acid	Fair[19]	Good[24]	Excel	Good[20]	Good[20]	Excel	Good[24]	Excel	Excel
Sulfate Liquors	Poor	Poor	Good	Poor	Poor	Poor	Excel	Excel	Good

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Sulfur	Fair	Fair	Fair	Excel	Excel	Excel	Fair	Excel	Good
Sulfur Chloride	Poor	Poor	Good	Poor	Fair	Good	Poor	Poor	Poor
Sulfur Dioxide (Dry)[9]	Fair	Excel	Excel	Excel	Excel	Excel	Excel	Good	Good
Sulfur Dioxide (Wet)	Poor	Good	Poor	Poor	Good	Excel	Good	Fair	Fair
Sulfuric Acid 10%	Poor	Good[25]	Good[25]	Poor	Poor	Good[25]	Good	Poor	Poor
Sulfuric Acid 10%, 75%	Poor	Fair	Good	Poor	Poor	Poor	Fair	Poor	Poor
Sulfuric Acid 75%, 95%	Poor	Fair[26]	Fair[26]	Fair[27]	Fair[27]	Good[27]	Fair[26]	Poor	Poor
Sulfuric Acid 95%	Poor	Fair	Poor	Good	Good	Good	Poor	Fair	Poor
Sulfurous Acid	Poor	Good	Poor	Poor	Fair	Good	Good	Poor	Fair
Tar	Good	Excel	Excel	Good	Excel	Excel	Excel	Excel	Excel
Tartaric Acid	Fair[1]	Good	Good	Fair	Good	Excel	Good	Good	Fair
Toluene or Toluol[8]	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel
Trichloroethylene[12]	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Good
Turpentine	Fair[28]	Excel	Excel	Good[28]	Excel	Excel	Excel	Excel	Excel
Varnish[29]	Good	Good	Excel	Excel	Excel	Excel	Good	Excel	Excel
Vegetable Oils[29]	Good	Good	Excel	Excel	Excel	Excel	Good	Excel	Excel
Vinegar[25]	Poor	Good	Good	Fair	Good	Excel	Good	Excel	Fair
Water (Acid Mine Water)	Poor	[30]	[30]	[31]	[31]	[31]	[30]	Fair	Good
Water (Fresh)	Fair[32]	Good	Excel	Excel	Excel	Excel	Good	Excel	Excel
Water (Salt)	Fair[32]	Good	Excel	Fair[33]	Good[33]	Good[33]	Good	Good	Excel
Whiskey	Good	Good	Good	Fair	Excel	Excel	Good	Fair	Excel
Wines	Good	Good	Good	Fair	Excel	Excel	Good	Fair	Excel
Xylene or Xylol[8]	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel
Zinc Chloride	Poor	Good	Excel	Poor	Poor	Good	Good	Poor	Good[39]
Zinc Sulfate	Fair	Good	Excel	Fair	Good	Excel	Good	Good	Good[39]

NOTES

1. Subject to dezincification and/or stress corrosion; especially at elevated temperatures and with concentrated solutions.
2. May be useful with cold dilute acid.
3. Alloys containing up to 60% copper acceptable; high copper alloys not acceptable.
4. Temperature assumed to be below that at which gas cracks and liberates nascent nitrogen.
5. Subject to stress corrosion with low concentrations.
6. Apparently resistant to dry gas at ordinary temperatures; attacked rapidly by moist gas and by hot gas.
7. Not recommended for use with beverage grade.
8. Chemicals used for treating in manufacture assumed to be absent.
9. Temperature assumed to be no higher than that normally encountered in compression, storage, and distribution.
10. Useful at elevated temperatures.
11. Not recommmended for use with carbonated beverages.
12. Water assumed to be absent.
13. Not recommended for use with edible grades.
14. Only with dilute or unaerated solutions.
15. Subject to stress corrosion by moist gas; and to severe general corrosion by saturated aqueous solution.
16. Subject to stress corrosion.
17. None of these materials recommended for use with nickel plating solutions.
18. Higher chromium alloys (over 18%) preferred.
19. Not recommended for temperature over 100° C (212°F).
20. Alloys with less that 18% Cr. not recommended for temperatures over 100° C (212° F). Others not recommended for temperatures over 200° C (390° F).
21. Up to 60° C (140° F).
22. Up to 90° C (200° F).
23. At room temperature.
24. Not recommended for temperatures over 200° C (390° F.)
25. Non-ferrous alloys preferred when unaerated and at temperatures above normal. Stainless Steel best when aerated and at normal to moderate temperatures.
26. With cold acid only.
27. In the absence of exposure to moist air.
28. Crude produce may contain acids which corrode these materials.
29. Some of these ratings may not apply when handling light colored products at elevated temperatures (200° C) (390° F).
30. Good with water containing no oxidizing salts; fair with water containing oxidizing salts.
31. Excellent with water containing oxidizing salts; not good with water containing no oxidizing salts.
32. Subject to dezincification with hot and/or aerated waters.
33. Subject to pitting attack.
34. Copper may act as a catalyst for undesirable reactions.
35. Free sulphuric acid absent.
36. Good at concentrations under 10% and below 38° C (100° F).
37. Suitable for limited service at concentrations under 50% and below 38° C (100° F).
38. Good only at concentrations under 10% and below 38° C (100° F).
39. Good only at concentrations under 20% and below 38° C (100° F).