Corrosion Resistance of Copper and Copper Alloys

CDA Publication No 106

(Data supplied by Copper Development Association for publication elsewhere as part of a table covering a wide range of materials)

An R indicates that the material is resistant to the named chemical up to the temperature shown, subject to limitations indicated by the footnotes. An 'X' indicates that the material is not recommended.

	Aluminium Bronze			**Brass (a)**			**Copper**			**Copper-Nickel 90/10 alloys (b)**			**Gunmetal and Bronze (c)**		
Temperature, Celsius	**20°**	**60°**	**100°**	**20°**	**60°**	**100°**	**20°**	**60°**	**100°**	**20°**	**60°**	**100°**	**20°**	**60°**	**100°**
Acetaldehyde	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
Acetic acid (10%)	R	R	R	X	X	X	R	R	R	R	R	R	R	R	R
Acetic acid (glac./anh.)	R	R	R	X	X	X	R	R	R	R	R	X	R	R	R
Acetic anhydride	R	R	R	X	X	X	R	R	R	R	R	R	R	R	X
Aceto-acetic ester	R	R	R	R(82)	X	X	R	R	R	R	R	R	R	R	R
Acetone	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
Other ketones	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
Acetonitrile	R(36)	X	X	X	X	X	R(36)	X	X	R(36)	X	X	R(36)	X	X
Acetylene	X	X	X	R	R	R(82)	X	X	X	X	X	X	X	X	X
Acetyl salicylic acid	R	R	R	No data	No data	No data	R(36)	X	X	R	R	R	R	R	R
Acid fumes	R(2)	R(2)	R(2)	X	X	X	R(2)	R(2)	R(2)	R(2)	R(2)	R(2)	X	X	X
Alcohols (mostly fatty)	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
Aliphatic esters	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
Alkyl chlorides	No data	No data	No data	X	X	X	R	R	R	R	R	R	R	R	R
Alum	R	R	R	X	X	X	R	R	R	R	R	R	R	R	R
Aluminium chloride	R (20)	R(20)	X	X	X	X	R	R	R	R	R	X	R	R	R
Aluminium sulphate	R	R	R	R (119)	R (119)	X	R(119)	R(20, 119)	R(20, 119)	R	R	R	R(119)	R(119)	R(119)
Ammonia, anhydrous	R	R	R	X	X	X	R	R	R(83)	R	R	R	R	R	R
Ammonia, aqueous	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Ammonium chloride	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Amyl acetate	R	R	R	X	X	X	R	R	R	R	R	R	R	R	R
Aniline	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Antimony trichloride	No data	No data	No data	X	X	X	No data	No data	No data	No data	No data	No data	R	X	X
Aqua regia	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Aromatic solvents	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
Ascorbic acid	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Beer	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
Benzaldehyde	R	R	R	No data	No data	No data	R	R	R	R	R	R	R	R	R
Benzene, pure	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
Benzoic acid	R	R	R	R	R	R	X	X	X	R	R	R	X	X	X
Benzoyl peroxide	No data	No data	No data	No data	No data	No data	No data	No data	No data	No data	No data	No data	No data	No data	No data
Boric acid	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
Brines, saturated	R	R	R	X	X	X	R	R	R(20)	R	R	R	R	R	X
Bromide (K) solution	R	R	R	X	X	X	R	R	X	R	R	R	R	R	X
Bromine	R(20)	X	X	X	X	X	X	X	X	R(11)	R(11)	R(11)	X	X	X
Bromine liquid, tech.	R	X	X	R	X	X	R	X	X	R	X	X	R	X	X
Bromine water, sat.aq.	R	X	X	R	X	X	X	X	X	X	X	X	X	X	X
Butyl acetate	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R

	Aluminium Bronze			Brass (a)			Copper			Copper-Nickel 90/10 alloys (b)			Gunmetal and Bronze (c)		
Temperature, Celsius	**20°**	**60°**	**100°**	**20°**	**60°**	**100°**	**20°**	**60°**	**100°**	**20°**	**60°**	**100°**	**20°**	**60°**	**100°**
Calcium chloride	R	R	R	X	X	X	R	R	R	R	R	R	R	R	R
Carbon disulphate	R	X	X	R	R	R	R	R	R	R	R	X	R	R	R
Carbonic acid	R	R	R	X	X	X	X	X	X	R	R	R	X	X	X
Carbon tetrachloride	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
Caustic soda & potash	R	X	X	X	X	X	R	R	R	R	R	X	R	R	R
Cellulose paint	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
Chlorates of Na, K, Ba	R	R	R	X	X	X	R	R	R	R	R	X	R	R	R
Chlorine, dry	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
Chlorine, wet	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Chlorides of Na, K, Mg	R	R	R	X	X	X	R	R	R(20)	R	R	R	R	R	R
Chloroacetic acids	No data	No data	No data	X	X	X	No data	No data	No data	No data	No data	No data	No data	No data	No data
Chlorobenzene	R	R	R	No data	No data	No data	No data	No data	No data	R	R	R	R	R	R
Chloroform	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
Chlorosulphonic acid	R(20)	R(20)	X	No data	No data	No data	X	X	X	R	R	R	X	X	X
Chromic acid (80%)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Citric acid	R	R	R	X	X	X	R	R	R	R	R	R	R	R	R
Copper salts (most)	R	R	R	X	X	X	X	X	X	R	X	X	R	R	R
Cresylic acids (50%)	R	R	R	X	X	X	R	R	R	R	R	X	R	R	R
Cyclohexane	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
Detergents, synthetic	No data	No data	No data	R	R	R	R	R	R	R	R	R	R	R	R
Emulsifiers (all conc.)	R	R	R	No data	No data	No data	R	R	R	R	R	R	No data	No data	No data
Esters	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
Ether	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
Fatty acids (>C6)	R	R	R	X	X	X	R	R	R	R	R	R	R	R	R
Ferric chloride	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Ferrous sulphate	R(20)	R(20)	R(20)	X	X	X	X	X	X	R	X	X	X	X	X
Fluorinated refrigerants	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
Fluorine, dry	R	R	R(11)	X	X	X	R	R	R	R	R	R	R	R	R
Fluorine, wet	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Fluorosilic acid	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Formaldehyde (40%)	R	R	R	R	X	X	R	R	R	R	R	R	R	R	R
Formic acid	R	R	R	No data	No data	No data	R	R	R	R	R	R	R	R	R
Fruit juices	R	R	R	X	X	X	R	R	R	R	R	R	R	R	R
Gelatine	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
Glycerine	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
Glycols	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
Glycol, ethylene	R	X	X	R	X	X	R	R	R	R (175)	R (175)	R (175)	R	R	R
Glycollic acid	R(36)	X	X	R(36)	X	X	R(36)	X	X	R(36)	X	X	R(36)	X	X
Hexamethylene diamine	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Hexamine	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Hydrazine	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Hydrobromic acid (50%)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Hydrochloric acid (10%)	R	X	X	X	X	X	X	X	X	R	X	X	X	X	X
Hydrochloric acid (conc.)	R(62)	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Hydrocyanic acid	R(20)	R(20)	R(20)	X	X	X	X	X	X	X	X	X	X	X	X

	Aluminium Bronze			Brass (a)			Copper			Copper-Nickel 90/10 alloys (b)			Gunmetal and Bronze (c)		
Temperature, Celcius	**20°**	**60°**	**100°**	**20°**	**60°**	**100°**	**20°**	**60°**	**100°**	**20°**	**60°**	**100°**	**20°**	**60°**	**100°**
Hydrofluoric acid (40%)	R(62)	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Hydrofluoric acid (75%)	R(62)	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Hydrogen peroxide (30%)	X	X	X	X	X	X	X	X	X	R	X	X	X	X	X
Hydrogen peroxide (3090%)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Hydrogen sulphide	R(11)	R	R	R(11)	R	R	R(11)	R	R	R(11)	R(11)	R(11)	R(11)	R	R
Hypochlorites	R	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Hypochlorite (Na 12-14%)	X	X	X	X	X	X	X	X	X	No data	No data	No data	R	R	R
Iso-butyl acetate	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
Lactic acid (90%)	R	R	X	X	X	X	R	R	X	R	R	X	R(4)	R(4)	X
Lead acetate	No data	No data	No data	X	X	X	X	X	X	R	R	X	X	X	X
Lead perchlorate	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Lime (CaO)	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
Maleic acid	No data	No data	No data	No data	No data	No data	R	R	R	R	R	X	No data	No data	No data
Manganate, pot (K)	R	X	X	R	X	X	R(60)	R(60)	X	X	X	X	R(60)	R(60)	X
Meat juices	R	R	R	X	X	X	X	X	X	No data	No data	No data	X	X	X
Mercuric chloride	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Mercury	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Methanol	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
Methylene chloride	R	R	R	R(82)	R(82)	R(82)	R	R	R	R	R	R	R	R	R
Milk & milk products	R	R	X	X	X	X	X	X	X	R	R	X	R	R	R
Moist air	R	R	R	X	X	X	R	R	R	R	R	R	R	R	R
Molasses	R(30)	R(30)	R(30)	R(30)	R	X	R(30)	R	R	R	R	R	R(30)	R	R
Monoethanolamine	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Naphtha	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
Naphthalene	No data	No data	No data	No data	No data	No data	R	R	R	R	R	R	No data	No data	No data
Nickel salts	No data	No data	No data	X	X	X	X	X	X	R	R	R	R	R	R
Nitrates of Na, K, NH3	R(73)	R(73)	R(73)	X	X	X	X	X	X	R(73)	R(73)	X	X	X	X
Nitric acid (<25%)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Nitric acid (50%)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Nitric acid (90%)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Nitric acid, fuming	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Nitrite (Na)	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
Nitrobenzine	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
Oil, diesel	R	X	X	R	X	X	R	X	X	R	X	X	R	X	X
Oils, essential	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
Oils, lube + aromatic ads.	R	R	X	R	R	X	R	R	X	R	R	X	R	R	X
Oils, mineral	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
Oils, vegetable & animal	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
Oxalic acid	R	R	R	No data	No data	No data	R	R	R	R	R	R	R	R	R
Ozone	No data	No data	No data	No data	No data	No data	No data	No ata	No data	No data	No data	No data	No data	No data	No data
Paraffin wax	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
Perchloric acid	X	X	X	No data	No data	No data	X	X	X	X	X	X	X	X	X
Petroleum spirits	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R

Phenol	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R

	Aluminium Bronze			Brass (a)			Copper			Copper-Nickel 90/10 alloys (b)			Gunmetal and Bronze (c)		
Temperature, Celsius	**20°**	**60°**	**100°**	**20°**	**60°**	**100°**	**20°**	**60°**	**100°**	**20°**	**60°**	**100°**	**20°**	**60°**	**100°**
Phosphoric acid (20%)	R	R	R	X	X	X	R	R	R	R	R	X	X	X	X
Phosphoric acid (50%)	R	R	R	X	X	X	X	X	X	R	R	X	X	X	X
Phosphoric acid (95%)	R	R	R	X	X	X	X	X	X	R	X	X	X	X	X
Phosphorus chlorides	R(11)	R(11)	R(11)	X	X	X	X	X	X	R	X	X	X	X	X
Phosphorous pentoxide	No data	No data	No data	X	X	X	X	X	X	No data	No data	No data	X	X	X
Phthalic acid	R	R	R	No data	No data	No data	R	R	R	R	R	R	R	R	R
Picric acid	X	X	X	X	X	X	X	X	X	R	R	R	R	R	R
Pyridine	No data	No data	No data	X	X	X	X	X	X	No data	No data	No data	X	X	X
Salicyl aldehyde	No data	No data	No data	No data	No data	No data	No data	No data	No data	No data	No data	No data	No data	No data	No data
Sea water	R	R	R	R(62)	R	R	R	R	R	R	R	R	R	R	R
Silicic acid	R	R	R	No data	No data	No data	R	R	R	X	X	X	No data	No data	No data
Silicone fluids	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
Silver nitrate	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Sodium carbonate	R	R	R(4)	R	R	R	R	R	R	R	R	R	R	R	R
Sodium peroxide	X	X	X	X	X	X	X	X	X	R	X	X	X	X	X
Sodium silicate	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
Sodium sulphide	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Stannic chloride	R(11)	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Starch	R	R	X	No data	No data	No data	R	R	R	R	R	R	R	R	R
Sugar soln, syrups, jams	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
Sulphamic acid	No data	No data	No data	X	X	X	X	X	X	No data	No data	No data	X	X	X
Sulphates (Na, K, Mg, Ca)	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
Suphites	R	R	R	X	X	X	R	R	R	R	R	R	R	R	R
Sulphonic acids	No data	No data	No data	No data	No data	No data	X	X	X	No data	No data	No data	No data	No data	No data
Sulphur	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Sulphur dioxide, dry	R	R	R	R	R	R	R	R	R	R	R	X	R	R	R
Sulphur dioxide, wet	R	R	R	X	X	X	X	X	X	X	X	X	X	X	X
Sulphur dioxide, (96%)	R	R	R	X	X	X	R(20)	R(20)	X	R	R(20)	X	R(20)	R(20)	R(20)
Sulphur trioxide	R(11)b	R	R	R(11)	R	R	R(11)	R	R	R(11)	R	X	R(11)	R	R
Sulphuric acid (<50%)	R	R	R	X	X	X	R	R	R	R	X	X	X	X	X
Sulphuric acid (70%)	R	R(62)	X	X	X	X	X	X	X	R	X	X	X	X	X
Sulphuric acid (95%)	R(62)	X	X	X	X	X	X	X	X	R	X	X	X	X	X
Sulphuric acid, fuming	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Sulphur chlorides	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Tallow	R	R	R	No data	No data	No data	R	R	R	R	R	R	No data	No data	No data
Tannic acid (10%)	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
Tartaric acid	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
Trichlorethylene	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
Urea (30%)	R	R	X	R	R	X	R	R	X	R	R	X	R	R	No data
Vinegar	R	R	R	X	X	X	X	X	X	R	R	R	X	X	X

	Aluminium Bronze			Brass (a)			Copper			Copper-Nickel 90/10 alloys (b)			Gunmetal and Bronze (c)		
Temperature, Celsius	**20°**	**60°**	**100°**	**20°**	**60°**	**100°**	**20°**	**60°**	**100°**	**20°**	**60°**	**100°**	**20°**	**60°**	**100°**
Water, distilled	R(53)	R	X	X	X	X	R(53)	R	X	R	R	R	R(53)	R	R
Water, soft	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
Water, hard	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
Wetting agents (to 5%)	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
Yeast	No data	No data	No data	No data	No data	No data	R	R	R	No data	No data	No data	R	R	R
Zinc chloride	R	R	R	X	X	X	X	X	X	X	X	X	X	X	X

Footnotes:

(a) Brass: Some types of brass have less corrosion resistance than is shown on the chart, others have more, e.g. Aluminium brass

(b) Copper-nickel alloys: Based on behaviour of Cu/Ni 90/10; 70/30 may be generally more resistant

(c) Gunmetal: The data refer only to high tin gunmetals

(2) Depending on the acid

(4) Fair resistance

(11) Anhydrous

(20) Not aerated solutions

(30) Depending on composition

(36) Over 85%

(53) In absence of dissolved O_2 and CO_2

(60) May discolour liquid/ product

(62) Depending on type

(73) Not ammonium

(82) Provided more than 70% copper

(83) Water less than 150ppm

(119) Pure solution

(175) With stabiliser

Copper Development Association
5 Grovelands Business Centre
Boundary Way
Hemel Hempstead HP2 7TE

Website: www.copperinfo.co.uk
Email: helpline@copperdev.co.uk
Fax: 01442 275716