

# Corrosion Ratings of Continuous-Cast Copper Alloys in Various Media

Ratings: A = Recommended B = Acceptable C = Not recommended

| Corrosive Medium                   | Copper | Tin Bronze | Leaded Tin Bronze | High-Lead Tin Bronze | Leaded Red Brass | Leaded Semi-Red Brass | Leaded Yellow Brass | Leaded High-Strength Yellow Brass | High-Strength Yellow Brass | Aluminum Bronze | Leaded Nickel Brass | Leaded Nickel Bronze | Silicon Bronze | Silicon Brass |
|------------------------------------|--------|------------|-------------------|----------------------|------------------|-----------------------|---------------------|-----------------------------------|----------------------------|-----------------|---------------------|----------------------|----------------|---------------|
| Acetate solvents                   | B      | A          | A                 | A                    | A                | A                     | B                   | A                                 | A                          | A               | A                   | A                    | A              | B             |
| Acetic acid                        |        |            |                   |                      |                  |                       |                     |                                   |                            |                 |                     |                      |                |               |
| 20%                                | A      | C          | B                 | C                    | B                | C                     | C                   | C                                 | C                          | A               | C                   | A                    | A              | B             |
| 50%                                | A      | C          | B                 | C                    | B                | C                     | C                   | C                                 | C                          | A               | C                   | B                    | A              | B             |
| Glacial                            | A      | A          | A                 | C                    | A                | C                     | C                   | C                                 | C                          | A               | B                   | B                    | A              | A             |
| Acetone                            | A      | A          | A                 | A                    | A                | A                     | A                   | A                                 | A                          | A               | A                   | A                    | A              | A             |
| Acetylene <sup>1</sup>             | C      | C          | C                 | C                    | C                | C                     | C                   | C                                 | C                          | C               | C                   | C                    | C              | C             |
| Alcohols <sup>2</sup>              | A      | A          | A                 | A                    | A                | A                     | A                   | A                                 | A                          | A               | A                   | A                    | A              | A             |
| Aluminum chloride                  | C      | C          | C                 | C                    | C                | C                     | C                   | C                                 | C                          | B               | C                   | C                    | C              | C             |
| Aluminum sulfate                   | B      | B          | B                 | B                    | B                | C                     | C                   | C                                 | C                          | A               | C                   | C                    | A              | A             |
| Ammonia, moist gas                 | C      | C          | C                 | C                    | C                | C                     | C                   | C                                 | C                          | C               | C                   | C                    | C              | C             |
| Ammonia, moisture-free             | A      | A          | A                 | A                    | A                | A                     | A                   | A                                 | A                          | A               | A                   | A                    | A              | A             |
| Ammonium chloride                  | C      | C          | C                 | C                    | C                | C                     | C                   | C                                 | C                          | C               | C                   | C                    | C              | C             |
| Ammonium hydroxide                 | C      | C          | C                 | C                    | C                | C                     | C                   | C                                 | C                          | C               | C                   | C                    | C              | C             |
| Ammonium nitrate                   | C      | C          | C                 | C                    | C                | C                     | C                   | C                                 | C                          | C               | C                   | C                    | C              | C             |
| Ammonium sulfate                   | B      | B          | B                 | B                    | B                | C                     | C                   | C                                 | C                          | A               | C                   | C                    | A              | A             |
| Aniline and aniline dyes           | C      | C          | C                 | C                    | C                | C                     | C                   | C                                 | C                          | B               | C                   | C                    | C              | C             |
| Asphalt                            | A      | A          | A                 | A                    | A                | A                     | A                   | A                                 | A                          | A               | A                   | A                    | A              | A             |
| Barium chloride                    | A      | A          | A                 | A                    | A                | C                     | C                   | C                                 | C                          | A               | A                   | A                    | A              | C             |
| Barium sulfide                     | C      | C          | C                 | C                    | C                | C                     | C                   | C                                 | B                          | C               | C                   | C                    | C              | C             |
| Beer <sup>2</sup>                  | A      | A          | B                 | B                    | B                | C                     | C                   | C                                 | A                          | A               | C                   | A                    | A              | B             |
| Beet sugar syrup                   | A      | A          | B                 | B                    | B                | A                     | A                   | A                                 | B                          | A               | A                   | A                    | B              | B             |
| Benzene                            | A      | A          | A                 | A                    | A                | A                     | A                   | A                                 | A                          | A               | A                   | A                    | A              | A             |
| Benzol                             | A      | A          | A                 | A                    | A                | A                     | A                   | A                                 | A                          | A               | A                   | A                    | A              | A             |
| Boric acid                         | A      | A          | A                 | A                    | A                | A                     | B                   | A                                 | A                          | A               | A                   | A                    | A              | A             |
| Butane                             | A      | A          | A                 | A                    | A                | A                     | A                   | A                                 | A                          | A               | A                   | A                    | A              | A             |
| Calcium bisulfite                  | A      | A          | B                 | B                    | B                | C                     | C                   | C                                 | C                          | A               | B                   | A                    | A              | B             |
| Calcium chloride, acid             | B      | B          | B                 | B                    | B                | B                     | C                   | C                                 | C                          | A               | C                   | C                    | A              | C             |
| Calcium chloride, alkaline         | C      | C          | C                 | C                    | C                | C                     | C                   | C                                 | C                          | A               | C                   | A                    | C              | B             |
| Calcium hydroxide                  | C      | C          | C                 | C                    | C                | C                     | C                   | C                                 | C                          | B               | C                   | C                    | C              | C             |
| Calcium hypochlorite               | C      | C          | B                 | B                    | B                | C                     | C                   | C                                 | C                          | B               | C                   | C                    | C              | C             |
| Cane sugar syrups                  | A      | A          | B                 | A                    | B                | A                     | A                   | A                                 | A                          | A               | A                   | A                    | A              | B             |
| Carbonated beverages               | A      | C          | C                 | C                    | C                | C                     | C                   | C                                 | C                          | A               | C                   | C                    | A              | C             |
| Carbon dioxide, dry                | A      | A          | A                 | A                    | A                | A                     | A                   | A                                 | A                          | A               | A                   | A                    | A              | A             |
| Carbon dioxide, moist <sup>2</sup> | B      | B          | B                 | C                    | B                | C                     | C                   | C                                 | C                          | A               | C                   | A                    | A              | B             |
| Carbon tetrachloride, dry          | A      | A          | A                 | A                    | A                | A                     | A                   | A                                 | A                          | A               | A                   | A                    | A              | A             |
| Carbon tetrachloride, moist        | B      | B          | B                 | B                    | B                | B                     | B                   | B                                 | B                          | B               | B                   | A                    | A              | A             |
| Chlorine, dry                      | A      | A          | A                 | A                    | A                | A                     | A                   | A                                 | A                          | A               | A                   | A                    | A              | A             |
| Chlorine, moist                    | C      | C          | B                 | B                    | B                | C                     | C                   | C                                 | C                          | C               | C                   | C                    | C              | C             |
| Chromic, acid                      | C      | C          | C                 | C                    | C                | C                     | C                   | C                                 | C                          | C               | C                   | C                    | C              | C             |
| Citric, acid                       | A      | A          | A                 | A                    | A                | A                     | A                   | A                                 | A                          | A               | A                   | A                    | A              | A             |
| Copper sulfate                     | B      | A          | A                 | A                    | A                | C                     | C                   | C                                 | C                          | B               | B                   | B                    | A              | A             |

<sup>1</sup>Acetylene forms an explosive compound with copper when moist or when certain impurities are present and the gas is under pressure. Alloys containing less than 65% Cu are satisfactory under this use. When gas is not under pressure other copper alloys are satisfactory. <sup>2</sup>Copper and copper alloys resist corrosion by most food products. Traces may be dissolved and affect taste or color. In such cases, copper metals are often tin coated.

# Corrosion Ratings of Continuous-Cast Copper Alloys in Various Media (continued)

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| Corrosive Medium              | Copper | Tin Bronze | Leaded Tin Bronze | High-Lead Tin Bronze | Leaded Red Brass | Leaded Semi-Red Brass | Leaded Yellow Brass | Leaded High-Strength Yellow Brass | High-Strength Yellow Brass | Aluminum Bronze | Leaded Nickel Brass | Leaded Nickel Bronze | Silicon Bronze | Silicon Brass |
|-------------------------------|--------|------------|-------------------|----------------------|------------------|-----------------------|---------------------|-----------------------------------|----------------------------|-----------------|---------------------|----------------------|----------------|---------------|
| Cottonseed oil <sup>2</sup>   | A      | A          | A                 | A                    | A                | A                     | A                   | A                                 | A                          | A               | A                   | A                    | A              | A             |
| Creosole                      | B      | B          | B                 | B                    | B                | C                     | C                   | C                                 | C                          | A               | B                   | B                    | B              | B             |
| Ethers                        | A      | A          | A                 | A                    | A                | A                     | A                   | A                                 | A                          | A               | A                   | A                    | A              | A             |
| Ethylene glycol               | A      | A          | A                 | A                    | A                | A                     | A                   | A                                 | A                          | A               | A                   | A                    | A              | A             |
| Ferric chloride, sulfate      | C      | C          | C                 | C                    | C                | C                     | C                   | C                                 | C                          | C               | C                   | C                    | C              | C             |
| Ferrous chloride, sulfate     | C      | C          | C                 | C                    | C                | C                     | C                   | C                                 | C                          | C               | C                   | C                    | C              | C             |
| Formaldehyde                  | A      | A          | A                 | A                    | A                | A                     | A                   | A                                 | A                          | A               | A                   | A                    | A              | A             |
| Formic acid                   | A      | A          | A                 | A                    | A                | B                     | B                   | B                                 | B                          | A               | B                   | B                    | B              | C             |
| Freon                         | A      | A          | A                 | A                    | A                | A                     | A                   | A                                 | A                          | A               | A                   | A                    | A              | B             |
| Fuel oil                      | A      | A          | A                 | A                    | A                | A                     | A                   | A                                 | A                          | A               | A                   | A                    | A              | A             |
| Furfural                      | A      | A          | A                 | A                    | A                | A                     | A                   | A                                 | A                          | A               | A                   | A                    | A              | A             |
| Gasoline                      | A      | A          | A                 | A                    | A                | A                     | A                   | A                                 | A                          | A               | A                   | A                    | A              | A             |
| Gelatin <sup>2</sup>          | A      | A          | A                 | A                    | A                | A                     | A                   | A                                 | A                          | A               | A                   | A                    | A              | A             |
| Glucose                       | A      | A          | A                 | A                    | A                | A                     | A                   | A                                 | A                          | A               | A                   | A                    | A              | A             |
| Glue                          | A      | A          | A                 | A                    | A                | A                     | A                   | A                                 | A                          | A               | A                   | A                    | A              | A             |
| Glycerin                      | A      | A          | A                 | A                    | A                | A                     | A                   | A                                 | A                          | A               | A                   | A                    | A              | A             |
| Hydrochloric or muriatic acid | C      | C          | C                 | C                    | C                | C                     | C                   | C                                 | C                          | B               | C                   | C                    | C              | C             |
| Hydrofluoric acid             | B      | B          | B                 | B                    | B                | B                     | B                   | B                                 | B                          | B               | B                   | B                    | B              | B             |
| Hydrofluosilicic acid         | B      | B          | B                 | B                    | B                | C                     | C                   | C                                 | C                          | B               | C                   | C                    | B              | C             |
| Hydrogen                      | A      | A          | A                 | A                    | A                | A                     | A                   | A                                 | A                          | A               | A                   | A                    | A              | A             |
| Hydrogen peroxide             | C      | C          | C                 | C                    | C                | C                     | C                   | C                                 | C                          | C               | C                   | C                    | C              | C             |
| Hydrogen sulfide, dry         | C      | C          | C                 | C                    | C                | C                     | C                   | C                                 | C                          | B               | C                   | C                    | B              | C             |
| Hydrogen sulfide, moist       | C      | C          | C                 | C                    | C                | C                     | C                   | C                                 | C                          | B               | C                   | C                    | C              | C             |
| Lacquers                      | A      | A          | A                 | A                    | A                | A                     | A                   | A                                 | A                          | A               | A                   | A                    | A              | A             |
| Lacquer thinners              | A      | A          | A                 | A                    | A                | A                     | A                   | A                                 | A                          | A               | A                   | A                    | A              | A             |
| Lactic acid                   | A      | A          | A                 | A                    | A                | C                     | C                   | C                                 | C                          | A               | C                   | C                    | A              | C             |
| Linseed oil                   | A      | A          | A                 | A                    | A                | A                     | A                   | A                                 | A                          | A               | A                   | A                    | A              | A             |
| Liquors                       |        |            |                   |                      |                  |                       |                     |                                   |                            |                 |                     |                      |                |               |
| Black                         | B      | B          | B                 | B                    | B                | C                     | C                   | C                                 | C                          | B               | C                   | C                    | B              | B             |
| Green                         | C      | C          | C                 | C                    | C                | C                     | C                   | C                                 | C                          | B               | C                   | C                    | C              | B             |
| White                         | C      | C          | C                 | C                    | C                | C                     | C                   | C                                 | C                          | A               | C                   | C                    | C              | B             |
| Magnesium chloride            | A      | A          | A                 | A                    | A                | C                     | C                   | C                                 | C                          | A               | C                   | C                    | A              | B             |
| Magnesium hydroxide           | B      | B          | B                 | B                    | B                | B                     | B                   | B                                 | B                          | A               | B                   | B                    | B              | B             |
| Magnesium sulfate             | A      | A          | A                 | A                    | B                | C                     | C                   | C                                 | C                          | A               | C                   | B                    | A              | B             |
| Mercury and mercury salts     | C      | C          | C                 | C                    | C                | C                     | C                   | C                                 | C                          | C               | C                   | C                    | C              | C             |
| Milk <sup>2</sup>             | A      | A          | A                 | A                    | A                | A                     | A                   | A                                 | A                          | A               | A                   | A                    | A              | A             |
| Mosasses <sup>2</sup>         | A      | A          | A                 | A                    | A                | A                     | A                   | A                                 | A                          | A               | A                   | A                    | A              | A             |
| Natural gas                   | A      | A          | A                 | A                    | A                | A                     | A                   | A                                 | A                          | A               | A                   | A                    | A              | A             |
| Nickel chloride               | A      | A          | A                 | A                    | A                | C                     | C                   | C                                 | C                          | B               | C                   | C                    | A              | C             |
| Nickel sulfate                | A      | A          | A                 | A                    | A                | C                     | C                   | C                                 | C                          | A               | C                   | C                    | A              | C             |
| Nitric acid                   | C      | C          | C                 | C                    | C                | C                     | C                   | C                                 | C                          | C               | C                   | C                    | C              | C             |
| Oleic acid                    | A      | A          | B                 | B                    | B                | C                     | C                   | C                                 | C                          | A               | C                   | A                    | A              | B             |
| Oxalic acid                   | A      | A          | B                 | B                    | B                | C                     | C                   | C                                 | C                          | A               | C                   | A                    | A              | B             |
| Phosphoric acid               | A      | A          | A                 | A                    | A                | C                     | C                   | C                                 | C                          | A               | C                   | A                    | A              | A             |
| Picric acid                   | C      | C          | C                 | C                    | C                | C                     | C                   | C                                 | C                          | C               | C                   | C                    | C              | C             |

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|-----------------------------|--------|------------|-------------------|----------------------|------------------|-----------------------|---------------------|-----------------------------------|----------------------------|-----------------|---------------------|----------------------|----------------|---------------|
| Potassium chloride          | A      | A          | A                 | A                    | A                | C                     | C                   | C                                 | C                          | A               | C                   | C                    | A              | C             |
| Potassium cyanide           | C      | C          | C                 | C                    | C                | C                     | C                   | C                                 | C                          | C               | C                   | C                    | C              | C             |
| Potassium hydroxide         | C      | C          | C                 | C                    | C                | C                     | C                   | C                                 | C                          | C               | C                   | C                    | C              | C             |
| Potassium sulfate           | A      | A          | A                 | A                    | A                | C                     | C                   | C                                 | C                          | A               | C                   | C                    | A              | C             |
| Propane gas                 | A      | A          | A                 | A                    | A                | A                     | A                   | A                                 | A                          | A               | A                   | A                    | A              | A             |
| Sea water                   | A      | A          | A                 | A                    | A                | C                     | C                   | C                                 | C                          | A               | C                   | C                    | B              | B             |
| Soap solutions              | A      | A          | A                 | A                    | B                | C                     | C                   | C                                 | C                          | A               | C                   | C                    | A              | C             |
| Sodium bicarbonate          | A      | A          | A                 | A                    | A                | A                     | A                   | A                                 | A                          | A               | A                   | A                    | A              | B             |
| Sodium bisulfate            | C      | C          | C                 | C                    | C                | C                     | C                   | C                                 | C                          | A               | C                   | C                    | C              | C             |
| Sodium carbonate            | C      | A          | A                 | A                    | A                | C                     | C                   | C                                 | C                          | A               | C                   | C                    | C              | A             |
| Sodium chloride             | A      | A          | A                 | A                    | A                | B                     | C                   | C                                 | C                          | A               | C                   | C                    | A              | C             |
| Sodium cyanide              | C      | C          | C                 | C                    | C                | C                     | C                   | C                                 | C                          | B               | C                   | C                    | C              | C             |
| Sodium hydroxide            | C      | C          | C                 | C                    | C                | C                     | C                   | C                                 | C                          | A               | C                   | C                    | C              | C             |
| Sodium hypochlorite         | C      | C          | C                 | C                    | C                | C                     | C                   | C                                 | C                          | C               | C                   | C                    | C              | C             |
| Sodium nitrate              | B      | B          | B                 | B                    | B                | B                     | B                   | B                                 | B                          | A               | B                   | B                    | A              | A             |
| Sodium peroxide             | B      | B          | B                 | B                    | B                | B                     | B                   | B                                 | B                          | B               | B                   | B                    | B              | B             |
| Sodium phosphate            | A      | A          | A                 | A                    | A                | A                     | A                   | A                                 | A                          | A               | A                   | A                    | A              | A             |
| Sodium sulfate, silicate    | A      | A          | B                 | B                    | B                | B                     | C                   | C                                 | C                          | A               | C                   | C                    | A              | B             |
| Sodium sulfide, thiosulfate | C      | C          | C                 | C                    | C                | C                     | C                   | C                                 | C                          | C               | C                   | C                    | C              | C             |
| Stearic acid                | A      | A          | A                 | A                    | A                | A                     | A                   | A                                 | A                          | A               | A                   | A                    | A              | A             |
| Sulfur, solid               | C      | C          | C                 | C                    | C                | C                     | C                   | C                                 | C                          | A               | C                   | C                    | C              | C             |
| Sulfur chloride             | C      | C          | C                 | C                    | C                | C                     | C                   | C                                 | C                          | C               | C                   | C                    | C              | C             |
| Sulfur dioxide, dry         | A      | A          | A                 | A                    | A                | A                     | A                   | A                                 | A                          | A               | A                   | A                    | A              | A             |
| Sulfur dioxide, moist       | A      | A          | A                 | B                    | B                | C                     | C                   | C                                 | C                          | A               | C                   | C                    | A              | B             |
| Sulfur trioxide, dry        | A      | A          | A                 | A                    | A                | A                     | A                   | A                                 | A                          | A               | A                   | A                    | A              | A             |
| Sulfuric acid               |        |            |                   |                      |                  |                       |                     |                                   |                            |                 |                     |                      |                |               |
| 78% or less                 | B      | B          | B                 | B                    | B                | C                     | C                   | C                                 | C                          | A               | C                   | C                    | B              | B             |
| 78% to 90%                  | C      | C          | C                 | C                    | C                | C                     | C                   | C                                 | C                          | B               | C                   | C                    | C              | C             |
| 90% to 95%                  | C      | C          | C                 | C                    | C                | C                     | C                   | C                                 | C                          | B               | C                   | C                    | C              | C             |
| Fuming                      | C      | C          | C                 | C                    | C                | C                     | C                   | C                                 | C                          | A               | C                   | C                    | C              | C             |
| Tannic acid                 | A      | A          | A                 | A                    | A                | A                     | A                   | A                                 | A                          | A               | A                   | A                    | A              | A             |
| Tartaric acid               | B      | A          | A                 | A                    | A                | A                     | A                   | A                                 | A                          | A               | A                   | A                    | A              | A             |
| Toluene                     | B      | B          | A                 | A                    | A                | B                     | B                   | B                                 | B                          | B               | B                   | B                    | B              | A             |
| Trichlorethylene, dry       | A      | A          | A                 | A                    | A                | A                     | A                   | A                                 | A                          | A               | A                   | A                    | A              | A             |
| Trichlorethylene, moist     | A      | A          | A                 | A                    | A                | A                     | A                   | A                                 | A                          | A               | A                   | A                    | A              | A             |
| Turpentine                  | A      | A          | A                 | A                    | A                | A                     | A                   | A                                 | A                          | A               | A                   | A                    | A              | A             |
| Varnish                     | A      | A          | A                 | A                    | A                | A                     | A                   | A                                 | A                          | A               | A                   | A                    | A              | A             |
| Vinegar                     | A      | A          | B                 | B                    | B                | C                     | C                   | C                                 | C                          | B               | C                   | C                    | A              | B             |
| Water, acid mine            | C      | C          | C                 | C                    | C                | C                     | C                   | C                                 | C                          | C               | C                   | C                    | C              | C             |
| Water, condensate           | A      | A          | A                 | A                    | A                | A                     | A                   | A                                 | A                          | A               | A                   | A                    | A              | A             |
| Water, potable              | A      | A          | A                 | A                    | A                | A                     | B                   | B                                 | B                          | A               | A                   | A                    | A              | A             |
| Whiskey <sup>2</sup>        | A      | A          | C                 | C                    | C                | C                     | C                   | C                                 | C                          | A               | C                   | C                    | A              | C             |
| Zinc chloride               | C      | C          | C                 | C                    | C                | C                     | C                   | C                                 | C                          | B               | C                   | C                    | B              | C             |
| Zinc sulfate                | A      | A          | A                 | A                    | A                | C                     | C                   | C                                 | C                          | B               | C                   | A                    | A              | C             |

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