Chemical Guidelines

The Following section has been derived from the Aluminum Association's Guidelines for the Use of Aluminum with Food & Chemicals - Sixth Edition

This Section provides a concise and up-to-date guide to the behavior of aluminum alloys with a wide variety of foods & chemicals. Unless otherwise specified, the entries in this book describe the action of aluminum alloys in direct contact with the pure material in its normal state (solid, liquid, or gas); aqueous or other solutions are specified.

Corrosion Rate Units

- Used Extensively - indicates extensive historic usage
- Resistant = less than 1 mpy attack
- Mild Action = 1-5 mpy attack
- Moderate Action = 5-20 mpy attack
- Corrosive = greater than 20 mpy

Other Sources of Information

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Chemical Reactions Table

Chemical or Compound	Used Extensively	Resistant	Mild Action	Moderate Action	Corrosive	Mixed Reaction	Additional Notes
Abietic Acid							
Acetaldehyde							
Acetanilide							
Acetic Acid							Very Corrosive at the boiling point
Acetic Anhydride							Moderate Attack at 100 Degrees Celsius
Acetone							Resistant at all Temperatures
Acetonitrile							Resistant at 100 Degrees Celsius
Acetophenone, Orthohydroxy							Mildly corrosive under refluxing or boiling conditions
Acetylsalicylic Acid							
Aconitic Acid							Moderate attack by solutions of 0.25-50% at 100 Degrees Celsius
Acrolein							
Acrylic Acid							
Acrylonitrile							
Adipic Acid							Mild attack by concentrations of 20-50%
Aerosols							
Aldol							Resistant at 100 Degrees Celsius, Mild attack at the boiling point
Alkaline Solutions							Individual Bases have different reactions, check the individual base
Alkyl Sodium Sulfate							
Allyl Alcohol							Resistant under refluxing conditions
Allyl Isothiocyanate							
Alumina							
Aluminum Acetate							Mild attack by aqueous solutions of 0.25-25%
Aluminum Ammonium Sulfate							Resistant under conditions of 100% relative humidity at ambient temp
Aluminum Borate							Resistant under conditions of 100% relative humidity at ambient temp
Aluminum Chloride Solution							
Aluminum Fluoride							Resistant to Solids, Solutions are corrosive
Aluminum Formate							Solutions of 1% & 10% cause highly localized attack
Aluminum Nitrate							Laboratory tests have indicated material to be corrosive under conditions of 100% relative humidity at ambient temperature.
Aluminum Oxalate							Resistant under conditions of 100% relative humidity at ambient temp
Aluminum Stearate							Resistant under conditions of 100% relative humidity at ambient temp
Aluminum Sulfate							Resistant to solids under conditions of 100% relative humidity at ambient temp. Mild action by solutions.
Aluminum Tartrate							Resistant, under conditions of 100% relative humidity at ambient temp
Aminoethylethanolamine							Resistant at temperatures from ambient 204 degrees C under refluxing conditions. Very corrosive.
Ammonia							Resistant to dry, gaseous ammonia even at elevated temperatures.
Ammonium Acetate							Mild attack in laboratory tests under conditions of 100% relative humidity at ambient temperatures.
Ammonium Bicarbonate							
Ammonium Carbonate							Mild attack on 5154 alloy while 3003 alloy was resistant in laboratory tests conducted under conditions of 100% relative humidity at ambient temperature.
Ammonium Chloride							Aqueous solutions caused mild attack with localized pitting occurring at all concentrations. Solid ammonium chloride resulted in moderate attack under conditions of 100% relative humidity at ambient temperature. Concentrated solutions of ammonium chloride at the boiling point are very corrosive.
Ammonium Dichromate							Resistant in laboratory tests under conditions of 100% relative humidity at ambient temperatures.
Ammonium Fluoride							Solid ammonium fluoride caused mild attack under conditions of 100% relative humidity at ambient temperatures. 50% solutions were very corrosive at 93 degrees C.
Ammonium Hydroxide							Solutions have a rapid initial reaction on aluminum alloys, which decreased dramatically as concentration and pH increase.
Ammonium Iodide							Mild attack in laboratory tests conducted under conditions of 100% relative humidity at ambient temperature.
Ammonium Lactate							At ambient temperature aqueous solutions caused mild attack. At boiling temperature solutions were very corrosive.
Ammonium Molybdate							Resistant in laboratory tests conducted under conditions of 100% relative humidity at ambient temperature.
Ammonium Nitrate							Resistant at ambient temperature.
Ammonium Nitrate (Ammoniated)							
Ammonium Oxalate							Solid ammonium oxalate caused mild attack in laboratory tests conducted under conditions of 100% relative humidity at ambient temperature. 4% solution was found to be corrosive at the boiling temperature, 1% solution was very corrosive.
Ammonium Perchlorate							
Ammonium Persulfate							Resistant in laboratory tests conducted under conditions of 100% relative humidity at ambient temperature.
Ammonium Phosphate							Solutions of the monobasic salt up to 28% caused moderate attack. Solutions of the diammonium salt are corrosive.

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Chemical or Compound	Used Extensively	Resistant	Mild Action	Moderate Action	Corrosive	Mixed Reaction	Additional Notes
Anhydrous Aluminum Chloride							
Orthohydroxy							
p-Acetotoluidide							
Ammonium Sulfamate							Resistant at ambient temperatures.
Ammonium Sulfate							Resistant under conditions of 100% relative humidity at ambient temperature.
Ammonium Sulfide							Resistant at ambient temperature.
Ammonium Thiocyanate							Resistant in laboratory tests conducted under conditions of 100% relative humidity at ambient temperature.
Ammonium Thioglycolate							
Ammonium Thiosulfate							Resistant at ambient temperature.
Amyl Acetate							Resistant at temperatures up to 204 degree C, condensing amyl acetate caused mild attack.
Amyl Alcohol							Resistant at 100 degree C, very corrosive to 204 degree C.
Amyl Mercaptan							
Amyl Valerate							Resistant to concentrated amyl valerate at ambient temperature.
Aniline							Resistant at ambient and 75 degree C temperatures. Concentrated solutions were corrosive at the boiling point 184 degree C.
Anise Oil							
Antifreeze Solutions							
Antipesticides, Insecticides							In laboratory tests most insecticides were corrosive to aluminum alloys.
Apple Brine							Limited laboratory tests indicated resistant to apple brine at 100 degree C.
Aqua Regia							
Argon							
Arsenic Acid							
Arsenic Trioxide							Resistant in laboratory tests conducted under conditions of 100% relative humidity at ambient temperature.
Asbestos							Wet asbestos will cause corrosion when in intimate contact with all aluminum alloys.
Aspartic Acid							In limited laboratory tests was found to be resistant to aspartic acid a t 204 degree C.
Asphalt							
Aspirin							
Atmospheres							
Barium Carbonate							Resistant in laboratory tests conducted under conditions of 100% relative humidity at ambient temperature.
Barium Chloride							Resistant in laboratory tests conducted under conditions of 100% relative humidity at ambient temperature.
Barium Hydroxide							
Barium Nitrate							Resistant in laboratory tests under conditions of 100% relative humidity at ambient temperature.
Barium Sulfide							
Bauxite							
Beans							
Beer							
Beeswax							
Benzaldehyde							Resistant to benzaldehyde at 50 degree C and 204 degree C. Under boiling and condensing conditions, caused moderate attack with localized pitting. The addition of water caused moderate corrosion.
Benzene							Resistant at ambient and 50 degree C temperatures. The addition of moisture increases the corrosivity.
Benzene Hexachloride							
Benzil							Resistant at 204 degree C.
Benzoic Acid							Resistant under conditions of 100% relative humidity at ambient temperature.
Benzoyl Chloride							Corrosive at boiling temperature.
Benzyl Acetate							Resistant to benzyl acetate at 100 degree C but was corroded under boiling and condensing conditions.
Benzyl Alcohol							
Benzyl Chloride							High purity aluminum was resistant to benzyl chloride in laboratory tests at ambient temperature. Caused corrosion of other alloys, increasing as temperature increased.
Beryllium Chloride							
Bismuth Nitrate							Resistant under conditions of 100% relative humidity at ambient temperature.
Bituminous Paint							
Blackberry Juice							In laboratory tests was found to be corrosive at 100 degree C.
Bordeaux Mixture							
Boric Acid							Resistant under conditions of 100% relative humidity at ambient temperature.
Boron Trifluoride							
Borosilicates							Resistant under conditions of 100% relative humidity at 52 degree C.
Bromoform							Corrosive with the attack being accelerated as the temperature increased.
Bromomethane							Very corrosive at 50 degree C.
Bulk (Dry) Materials							
Butadiene 1,3							

Chemical Reactions Table

Chemical or Compound	Used Extensively	Resistant	Mild Action	Moderate Action	Corrosive	Mixed Reaction	Additional Notes
Butane							
Butter							
Butyl Acetate							Resistant at ambient temperature and at the boiling point. Under refluxing conditions caused a mild attack.
Butyl Alcohols							
Butyl Cellosolve							
Butyl Cellosolve Acetyl Recinoleate							
Butyl Lactate							
n-Butyraldehyde							Resistant at ambient temperature. Corrosion increased at elevated temperatures.
Butyric Acid							The effect is similar to that of acetic acid and propionic acid.
Butric Anhydride							Temperatures from ambient to boiling caused moderate attack. A mixture of dehydrated butyric acid and commercial strength anhydride was corrosive.
Cadmium Chloride							Very corrosive.
Cadmium Sulfate							Resistant to solid cadium sulfate under conditions of 100% relative humidity at ambient temperature. Aqueous solution mild attack at ambient temperature.
Calcium Carbide							Mild attack of alloy 5154, while alloy 3003 was resistant.
Calcium Carbonate							Saturated solutions caused mild attack at ambient temperature. The rate decreased with time. Dry calcium carbonate had no effect.
Calcium Chloride							Solid calcium chloride caused moderate attack under conditions of 100% relative humidity at ambient temperature. Aqueous solutions caused mild attack at ambient temperature with pitting in evidence.
Calcium Chromate							
Calcium Gluconate							
Calcium Hydroxide							Solutions have rapid etching action on aluminum alloys, which quickly subsides as the result of the formation of protective films on the aluminum surface.
Calcium Hypochlorite							Solid calcium hypochlorite was corrosive to alloy 3003 and caused moderate attack of alloy 5154 aqueous solutions. Were corrosive to 3003 alloy at ambient temperature.
Calcium Nitrate							
Calcium Oxide							
Calcium Propionate							
Calcium Silicate							
Camphor							
Cane Sugar Liquors							
n-Caproic Acid							Resistant at 50 degree C and at the boiling point. Under refluxing conditions was corrosive to aluminum alloys.
Caprolactam							Discolored by contact with aluminum alloys.
n-Caprylic Acid							Resistant at ambient temperature.
Carbolic Acid							See **PHENOL.**
Carbon							Resistant to carbon when dry. When wet, carbon acts as a cathode to contacting aluminum and causes corrosion as a result of galvanic action.
Carbon Dioxide							
Carbon Disulfide							Resistant at ambient temperature and at the boiling point.
Carbonic Acid							
Carbon Tetrachloride							Resistant at ambient temperature, whereas, boiling carbon tetrachloride was corrosive.
Cellulose							
Cellulose Acetate Butyrate							
Cellulose Acetates							
Cement, Portland							While in the fluid state, Portland cement causes etching of aluminum alloys. After the cement has set, no further corrosion occurs as a result of a protective film forming on the aluminum. Galvanic corrosion will develop if aluminum is coupled to dissimilar metals in cement or concrete to which chlorides have been added for high early strength.
Cereals							
Cheese							Cheeses vary in their action on aluminum alloys.
Cherries							
Cherry Juice							Sweet red cherry juice caused mild attack, while black cherry juice caused moderate attack.
Chlordane							Resistant to technical chlordane the addition of as little as 0.2% distilled water to these solutions increased their corrosivity greatly
Chlorine							Aqueous solutions caused moderate attack at ambient temperature. Dry chlorine gas does not attack aluminum alloys, but in the presence of water is corrosive.
Chloroacetic Acid							
Chlorobenzene							Resistant at 100 degree C and refluxing temperatures.
1-Chlorobutane							Resistant at ambient temperature and 50 degree C. At the reflux temperature was corrosive.
2-Chlorobutane							Resistant at ambient temperature and 50 degree C. At the reflux temperature was corrosive.
2-Chloroethanol							Resistant at ambient temperature. Corrosion increased significantly as temperatures increased.
Chloroform							Resistant at temperatures up to the boiling point. Anhydrous chloroform was corrosive.
Chloronitrobenzene							Resistant at ambient temperatures.

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Chemical or Compound	Used Extensively	Resistant	Mild Action	Moderate Action	Corrosive	Mixed Reaction	Additional Notes
Chocolate							
Chromic Acid							Resistant to aqueous chromic acid solutions in concentrations up to 0.1 N at ambient temperature.
Chromium							
Chromium Oxide							
Chromium Potassium Sulfate							Resistant under conditions of 100% relative humidity at ambient temperature.
Chromium Sulfate							Corrosive under conditions of 100% relative humidity in ambient temperature.
Chromium Trioxide							Moderate Attack under conditions of 100% relative humidity at ambient temperature.
Cider							Resistant at 38 degree C.
Citric Acid							Resistant to aqueous solutions at ambient temperature. Increasing temperature caused the corrosivity of the solutions to increase substantially.
Citrus Fruit Juices							Resistant at ambient and refrigerator temperatures.
Clay							
Coal							
Coal Gas							Resistant at ambient temperature.
Coal Tar							
Cobalt Compounds							Solid cobaltous chloride was very corrosive under conditions of 100% relative humidity at ambient temperature. Solid cobaltous nitrate caused mild attack in the same tests.
Coca Cola Syrup							
Coconut Oil							
Cod Liver Oil							
Coffee							
Coke							
Coke Oven Gas							Condensation of moisture can accelerate corrosion on aluminum alloys as the result of the formation of sulfurous acid.
Collodion							Resistant at ambient temperature.
Concrete							As shown by laboratory tests, some surface attack occurs during the first few hours while the concrete is still fluid. However, further attack is substantially retarded because of the formation of highly protective films on the aluminum.
Copal							
Copper Compounds							Aqueous solutions were corrosive causing localized pitting.
Cork							Corrosive under conditions of 100% relative humidity at 52 degree C, which caused wetting of the cork.
Corn Oil							
Corn Products							
Corn Syrup							
Cosmetics							
Cottonseed Oil							Resistant at ambient temperature.
Cream							
Cresol							Resistant at ambient temperature. Found to be very corrosive at the boiling point.
Cresylic Acid							Resistant at ambient temperature.
Cryolite							Resistant under conditions of 100% relative humidity at ambient temperature.
Cumen							Resistant under refluxing conditions
Currants (Black and Red)							Corrosive at 100 degree C.
Cyclohexane							Resistant under refluxing conditions.
Cymene							
2, 4-D							Mild attack at ambient temperature.
Dairy Products							
DDT							Resistant at ambient temperature.
Detergents							When in solution, some detergents stain and/or corrode aluminum. Detergents should be tested individually.
Diacetone Alcohol							
Dichloroacetic Acid							Corrosive at 204 degree C.
Dichlorobenzene							Resistant at 50 degree C.
Dicyclopentenyl Alcohol							Resistant at ambient temperature.
Diethanolamine							Resistant at ambient temperature. However at the boiling temperature and under refluxing conditions caused moderate attack.
Diethylamine							Resistant at elevated temperatures of 100 degree C.
Diethylene Glycol							Resistant under refluxing conditions.
n-Dimethyl Formamide							Resistant at ambient temperature and at the boiling point.
UNS-Dimethylhydrazine							Resistant at 30 degree C and 63 degree C.
Dimethyl Sulfate							
Dimethyl Terephthalate							
Dioctyl Phthalate							
Diphenyl							
Dyes							
Dynamite							
Eggs							
Essential Oils							
Ester Gums							

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Chemical or Compound	Used Extensively	Resistant	Mild Action	Moderate Action	Corrosive	Mixed Reaction	Additional Notes
Ethanolamine							Under refluxing conditions caused mild attack.
Ether							Resistant at both ambient and elevated temperatures.
Ethyl Acetate							
Ethyl Alcohol							Resistant to commercial ethyl alcohol and its aqueous solutions. Anhydrous ethyl alcohol was corrosive.
n-Ethylaniline							Resistant at the boiling temperature and under refluxing conditions.
Ethylbenzene							Resistant at the boiling temperature and at 204 degree C.
Ethylbutyl Acetylricinoleate							
Ethyl Butyrate							Mild attack under boiling and condensing conditions and under refluxing conditions.
Ethylene							
Ethylenediamine							Resistant at 100 degree C and 204 degree C.
Ethylene Dichloride							Resistant to dry ethylene dichloride vapor at the boiling point. The presence of water causes increased corrosion because of hydrochloric acid formed by hydrolysis
Ethylene Glycol							Resistant at ambient temperature and under refluxing and boiling and condensing conditions. Aluminum alloys should not be used in applications with stagnant ethylene glycol where very high temperatures are involved.
Ethylene Oxide							Violent reactions are possible if aluminum chloride and aluminum oxide are present.
Ethyl Formate							Resistant at ambient temperature and a t the boiling point.
Ethyl Lactate							Resistant at ambient temperature.
Ethyl Propionate							Resistant under boiling and condensing conditions.
Eucalyptus Oil							
Eugenol							
Fats							
Fatty Acids							Mild attack at ambient temperature. Anhydrous fatty acids were found to be very corrosive at the boiling point.
Ferric Chloride							Solid ferric chloride was very corrosive under conditions of 100% relative humidity at ambient temperature. Aqueous solutions were found to be very corrosive.
Ferric Oxide							Resistant under conditions of 100% relative humidity at ambient temperature.
Ferrous Sulfate							At elevated temperature, ferrous sulfate oxidizes to ferric sulfate, which is aggressive to aluminum alloys.
Fertilizers							Solid and liquid nitrogen fertilizers have been the least corrosive while the complete mix neutral fertilizers have been the most corrosive.
Fish							Resistant to most fish products at ambient temperature.
Flour							
Flue Gases							The corrosivity of the flue gases to aluminum alloys depends on the sulfur content of the fuel being burned and if condensation is present.
Fluophosphoric Acids							
Fluorinated Hydrocarbons							
Fluorine							Resistant at temperatures up to 450 degree C. In the presence of moisture, hydrofluoric acid is formed which corrodes aluminum alloys.
Fly Ash							Resistant to dry fly ash at ambient temperature. Wet fly ash caused variable results depending upon the composition of the fly ash.
Formaldehyde Gas							
Formalin							At ambient temperature and at 38 degree C resistant to 19% solution of fomalin. At boiling conditions, formalin (37%) solution caused substantial pitting corrosion. Chlorides and copper salts increase pitting in formalin solutions.
Formamide							Resistant to aqueous solutions of formamide at ambient temperature and at 50 degree C at the boiling point temperatures were very corrosive.
Formic Acid							Mild attack at ambient temperature at 50 degree C, the formic acid was corrosive and the boiling temperature, formic acid was very corrosive.
Freon							Resistant to most dry Freons at elevated temperature 200 degree C. The presence of moisture permitted hydrolysis of the Freons and subsequent corrosion of the aluminum.
Fruit							Some of the acids in fruits have been found to be corrosive to aluminum alloys in laboratory tests.
Fruit Juices							Fruit juices are generally less corrosive to aluminum alloys than are the corresponding fruit acids.
Fudge							Resistant at ambient temperature and 60 degree C.
Fuel Oil							
Fuels, Missile							United States Defense Research reports that aluminum is resistant to many oxidizers and fuels used as missile propellants.
Furfural							Resistant at ambient temperature and 200 degree C.
Gasoline							Resistant to gasoline at room temperature. Sump water in gasoline tanks can be corrosive because of the accumulation of halogen and lead compounds.
Gelatin							
Glass Wool							The binders used in glass wools may be corrosive to aluminum alloys in some cases.
Gluconic Acid							Resistant to 10% solutions of gluconic acid at ambient temperature. Increase temperature resulted in substantially increased corrosion.
Glucose							
Glue							

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Chemical or Compound	Used Extensively	Resistant	Mild Action	Moderate Action	Corrosive	Mixed Reaction	Additional Notes
Glycerin							Resistant to glycerin solutions at ambient and boiling temperatures.
Gylcerophosphate							
Glycolic Acid							Corrosive at 100 degree C
Grapefruit Juice							Resistant at ambient and refrigerated temperature.
Grape Juice							Unfermented grape juice caused mild attack at room temperature.
Graphite							Resistant under conditions of 100% relative humidity at ambient temperature and 54 degree C.
Gum Arabic							
Halogenated Hydrocarbons							Aluminum alloys are usually resistant to pure halogenated hydrocarbons and other organic chemicals containing halogens under most conditions particularly at room temperature or lower. Under certain conditions some of these hydrocarbons may produce a rapid rate of corrosion of aluminum or a violent reaction. Hence, the service conditions to insure safety should be recognized or established before aluminum alloys are used with halogenated hydrocarbon.
Helium							
Heptyl Aldehyde							
n-Hexane							
Honey							
Hydrazine							Mild attack at ambient temperature. The action of hydrazine on aluminum alloys increased by the presence of moisture resulting in hydrolysis.
Hydroabietyl Alcohol							
Hydrocarbons							
Hydrochloric Acid							Aluminum is corroded by hydrochloric acid. The rate at attack increases with acid concentration and temperature.
Hydrocyanic Acid							Resistant at ambient temperature.
Hydrofluoric Acid							Aluminum alloys are corroded by hydrofluoric acid.
Hydrogen							
Hydrogen Chloride Gas							Aluminum alloys are corroded by hydrogen chloride gas. The reaction becomes more rapid as temperature is increased.
Hydrogen Cyanide Gas							Resistant at ambient temperature.
Hydrogen Peroxide							Resistant at ambient temperature.
Hydrogen Sulfide							Mild attack at ambient temperature.
Ice							
Ice Cream							
Ink							Inks vary widely in their corrosivity to aluminum alloys. Generally, writing inks have been found to be corrosive, while marking inks are not.
Invert Sugar							
Iodine							In laboratory tests, alcohol solutions of iodine were corrosive to aluminum alloys.
Iodoform							Moderate attack under conditions of 100% relative humidity at ambient temperature.
Iron Oxides							Resistant to solid ferric oxide under conditions of 100% relative humidity at ambient temperature.
Iron Sulfide							Dry iron sulfide has been shipped in aluminum alloy containers. In laboratory tests, iron sulfide accelerated corrosion of contacting aluminum alloys as the result of galvanic action.
Isoamyl Acetate							Resistant at temperatures up to and including the boiling temperature.
Isoamyl Alcohol							Resistant at 93 degree C.
Isobutyl Acetate							
Isobutyl Alcohol							Resistant at ambient temperature, but is corrosive at elevated temperature 204 degree C.
Isobutyric Acid							
Isoeugenol							
Isooctanoic Acid							
Isopropyl Alcohol							Resistant at 100 degree C and 204 degree C.
Itaconic Acid							
Kerosene							
Kippers							
Lacquers							
di-Lactic Acid							Aqueous solutions caused mild attack at 100 degree C. Aqueous solution of lactic acid was very corrosive with the maximum attack occurring at about 5% concentration.
Lard Oil							
Latex							Mild attack at ambient temperature.
Lead Acetate							Mild attack at ambient temperature but was corrosive at 54 degree C under conditions of 100% relative humidity. In laboratory tests was resistant to 0.1% aqueous solution of lead acetate, while 1.0% and 10% solutions were corrosive at ambient temperature.
Lead Azide							
Lead Monoxide							Resistant under conditions of 100% relative humidity at ambient temperature.
Lead Nitrate							Very corrosive under conditions of 100% relative humidity at ambient temperature.
Lead Oxide							Resistant under conditions of 100% relative humidity at ambient temperature and at 54 degree C.
Lead Tetraethyl							Resistant at ambient temperature. In the presence of a separated water phase, some by-products of the lead tetraethyl accumulate in the water and cause corrosion.

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Chemical or Compound	Used Extensively	Resistant	Mild Action	Moderate Action	Corrosive	Mixed Reaction	Additional Notes
Leather							
Lemon Juice							Resistant at ambient and refrigerated temperatures.
Lime							Solid lime caused mild attack under conditions of 100% relative humidity at ambient temperature.
Lime Juice							Resistant at ambient and refrigerated temperatures.
Lime Mortar							During the period when mortar is liquid, aluminum alloys show etching, which ceases when the *mortar dries* because of the formation of a protective film.
Limestone							
Linseed Oil							Resistant to linseed oil at 300, 350, and 380 degree C, linseed oil vapors at these temperatures were corrosive.
Lithium Chloride							Resistant under conditions of 100% relative humidity and at ambient temperature. At 54 degree C caused mild attack. Aqueous solutions caused mild attack at ambient temperature and a t 50 degree C.
Lithopone							Mild attack under conditions of 100% relative humidity at ambient temperature.
Lubricating Oils							Resistant at ambient temperature and at 66 degree C.
Magnesium Chloride							Resistant to solid magnesium chloride under conditions of 100% relative humidity at ambient temperature. Resistant to aqueous solutions at ambient temperature.
Magnesium Hydroxide							Corrosive at ambient temperature and that the corrosion rate increases as the pH of the solution increases.
Magnesium Nitrate							Resistant at ambient temperature but suffered mild attack at 54 degree C, under conditions of 100% relative humidity. In other laboratory tests was found to be resistant to 1%, 5%, and 10% solutions at ambient temperature.
Magnesium Oxide							Resistant under conditions of 100% relative humidity at ambient temperature and at 54 degree C.
Magnesium Silicate							Resistant under conditions of 100% relative humidity at ambient temperature and at 54 degree C.
Magnesium Sulfate							Resistant to ambient temperature.
Maleic Acid							Resistant to solid maleic acid under conditions of 100% relative humidity and ambient temperature. In other laboratory tests, 30% aqueous solutions of maleic acid caused mild attack at 52 degree C. At 100 degree C maleic acid was corrosive.
Maleic Anhydride							Resistant to solid maleic anhydride under conditions of 100% relative humidity at ambient temperature.
1-Malic Acid							Aqueous solutions caused mild attack at ambient temperature. Corrosive at 100 degree C.
Malonic Acid							Resistant at ambient temperature.
Maple Syrup							Resistant at ambient temperature.
Margarine							Resistant at ambient and refrigerated temperatures.
Meat							
Mercury							Tends to amalgamate with *aluminum* to produce a surface that corrodes at an extraordinary rate in the presence of moisture with the production of voluminous columnar corrosion products, the rate of *corrosion* is dependent upon relative humidity.
Mercury Salts							In laboratory tests, aqueous solutions of mercury salts were corrosive to aluminum alloys.
Methane							
Methyl Alcohol							Resistant to commercial absolute methanol at ambient and boiling temperatures. Aqueous solutions of methanol varied in their corrosivity with concentration. Anhydrous methanol at the boiling point was corrosive.
Methylamine							
Methyl Chloride							Methyl chloride, under certain conditions, reacts with aluminum alloys to form metrallo-organic compounds, which are spontaneously explosive upon exposure to air. Aluminum is not recommended for the use with methyl chloride.
Methylene Chloride							Resistant at ambient temperature and at the boiling point.
Methyl Ethyl Ketone							In laboratory tests was resistant to condensing vapors of methyl ethyl keytone.
Methyl Formate							Resistant at ambient temperature.
Methyl Glycerol							
Methyl Isobutyl Ketone							Resistant under boiling and condensing conditions.
Methyl Methacrylate							
Methyl Salicylate							Resistant at ambient temperature.
Milk							Resistant at ambient and boiling temperatures.
Mineral Oils							Many mineral oils are protective to aluminum alloys.
Molasses							Resistant at ambient and 46 degree C.
Molybdenum Disulfide							Accelerated corrosion of aluminum alloys in the presence of a conductive electrolyte.
Monoethanolamine							Solutions containing up to 50% monoethanolamine have an initial rapid reaction, but the aluminum develops a protective film that inhibits further action. Medium strength solutions (~15%) cause more corrosion. In greater than 50% solutions, initial corrosion is slight. The effects can be accelerated by elevated temperature.
Mortar							While the mortar is liquid, etching of aluminum alloys occurs; but the reaction stops after the mortar sets.
Mustard							
Mustard Oil							
Naphtha							Resistant at ambient temperature.

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Chemical or Compound	Used Extensively	Resistant	Mild Action	Moderate Action	Corrosive	Mixed Reaction	Additional Notes
Naphthalene							
Naphthenic Acid							Resistant at ambient temperature and 82 degree C, boiling naphthenic acid was very corrosive in the same test.
Natural Gas							Natural gas has been handled in aluminum alloy equipment including processing equipment, distillation apparatus and pipe lines.
Naval Stores							These include turpentine, rosin, copal, pentene, dependence, and pinene.
Neoprene							In laboratory tests, various aluminum alloys were resistant to pure neoprene. However, the amount and type of filler materials were found to affect corrosion.
Nickel Compounds							Aqueous solutions of nickel salts at ambient temperature caused varying degrees of attack, depending upon the concentration and the specific compound. Most solutions of nickel compounds are inherently corrosive to aluminum alloys.
Nicotine Sulfate							Resistant to a 40% solution of nicotine sulfate at 204 degree C.
Nitric Acid							The action of nitric acid on aluminum alloys varies with concentration and temperature and is increased by agitation or the presence of nitrogen oxide.
Nitric Sulfuric Acids							In laboratory tests, mixed acids had varying corrosive effects on aluminum alloys which were dependent upon the composition of the mixed acids.
Nitrobenzene							Resistant at temperatures ranging from ambient to the boiling point.
2-Nitro-1-Butanol							
Nitrocellulose							
Nitroethane							Resistant at 114 degree C (237 degree F) and 204 degree C (400 degree F)
2-Nitro-2 Ethyl-1, 3 Propanediol							
Nitrogen							
Nitrogen Tetroxide							
Nitroglycerin							
Nitromethane							
Nitroparaffins							Controlled field service tests showed that nitroparaffins caused mild attack.
Nitrophenol							Resistant to solid p-nitrophenol in laboratory tests conducted under conditions of 100% relative humidity at ambient temperature.
Nitro Propanes							Resistant under refluxing conditions and suffered mild attack under boiling and condensing conditions.
Nitro Toluenes							Resistant at boiling and refluxing conditions.
Nitrous Oxide							
Nylon							
Ointments							
Oleic Acid							Resistant at ambient temperature.
Olive Oil							
Onion Juice							
Orange Juice							Resistant at ambient and refrigerated temperatures.
Ores							
Orlon							
Oxalic Acid							Solid oxalic acid was corrosive under conditions of 100% relative humidity at ambient temperature. Aqueous solutions were corrosive at ambient temperature.
Oxogluconic Acid							
Oxygen							
Ozone							
Paints							Paints containing mercury, lead or copper compound pigments were corrosive.
Palmitic Acid							
Palm Oil							
Paper							Laboratory tests indicated that the corrosive effects of paper on aluminum alloys vary with composition of the papers. Paper when wet can cause corrosion of aluminum alloys by poultice action.
Paraffin							
Paraformaldehyde							
Paraldehyde							
Peanut Oil							
Penicillin							
Pentachloroethane							Resistant at ambient temperature and at 50 degree C (122 degree F) At the boiling temperature, pentachloroethane was very corrosive to all alloys.
Pentachlorophenol							
Pentaerythritol							
Pentaerythrityl Tetranitrate							
Pentane							In laboratory tests was resistant under refluxing conditions.
Peppermint Oil							
Peracetic Acid							
Perchloric Acid							
Perchloroethylene							See TETRACHLOROETHYLENE.
Petroleum or Crude Oil							Sour crudes are more corrosive to metal than are sweet crudes. Aluminum alloys have found increased use in the petroleum industry as a result of their superior corrosion resistance compared to steel.
Petroleum Jelly							Laboratory tests showed that many petroleum jellies are protective to aluminum alloys.

Chemical Reactions Table

Chemical or Compound	Used Extensively	Resistant	Mild Action	Moderate Action	Corrosive	Mixed Reaction	Additional Notes
Phenethyl Alcohol							Resistant at the boiling point.
Phenol							Resistant to anhydrous phenol at temperatures up to 50 degree C (122 degree F). Above that temperature phenol was very corrosive to aluminum alloys. Aqueous solutions of phenol caused mild attack at temperatures from ambient to 50 degree C.
Phenyl Ether							Resistant at refluxing conditions and at 204 degree C.
Phosphate Rock							
Phosphoric Acid							In laboratory tests, aqueous solutions of phosphoric acid (5-85%) were corrosive, the corrosion increased with the concentration at ambient temperature.
Phosphor Suspensions							In limited laboratory tests was resistant to solid and liquid white phosphorus at ambient temperature.
Phosphorus							
Phosphorus Pentasulfide							
Phosphorus Sesquisulfide							
Phthalic Anhydride							
Pickles							In laboratory tests, pickles were corrosive to aluminum alloys. Sodium chloride and vinegar contribute to this corrosion.
Picolines							Corrosive at 66 degree C (150 degree F)
Pineapple Juice							Resistant at ambient temperature was corrosive at 100 degree C (212 degree F).
Pinene							
Piperazine							
Plaster							In laboratory tests, plaster caused an initial reaction of contracting aluminum alloys while the plaster was liquid after which corrosion did not continue.
Plasticizers							
Plums							In limited laboratory tests, blue plum pomace was corrosive at 38 degree C (100 degree F) while red plum pomace caused mild attack.
Polythylene							
Polypropylene							
Polystyrene							Resistant under conditions of 100 % relative humidity at ambient temperature.
Polyvinyl Acetate							
Polyvinyl Alcohol							
Polyvinyl Butyral Resins							
Potash Ore							
Potassium Bitartrate							Dilute aqueous solutions caused varied degrees of corrosion at ambient temperature . 0.25% solutions caused moderate attack while 1.8% solutions were corrosive.
Potassium Bromide							At ambient temperature have a action on aluminum alloys similar to that of sodium chloride.
Potassium Chlorate							
Potassium Chloride							Resistant under conditions of 100% relative humidity at ambient temperature.
Potassium Chromate							Resistant to aqueous solutions ambient temperature/
Potassium Cyante							
Potassium Dichromate							A well-accepted inhibitor for use with aluminum alloys in natural and salt waters.
Potassium Hydroxide							
Potassium Iodide							Action similar to that of sodium chloride.
Potassium Nitrate							Resistant at 100% relative humidity at ambient temperature. At 54 degree C very corrosive.
Potassium Permanganate							Corrosive under conditions of 100% relative humidity at ambient temperature.
Potassium Persulfate							
Potassium Pyrosulfate							
Potassium Sulfate							Resistant under conditions of 100% relative humidity at ambient temperature at 54 degree C caused mild attack.
Potassium Tartrate							Moderate corrosion under conditions of 100% relative humidity at ambient temperature.
Potassium Thiocyanate							Resistant under conditions of 100% relative humidity at ambient temperature.
Propane							
Propionic Acid							Resistant at ambient temperature. As the temperature increases, solutions of propionic acid becomes aggressive.
Propionic Aldehyde							Resistant at ambient temperature. At 50 degree C (122 degree F) and 100 degree C (212 degree F), these solutions caused moderate attack.
Propionic Anhydride							Resistant at ambient temperature and at 50 degree C (122 degree F). At the boiling point, very corrosive.
Propyl Acetate							Resistant at the boiling temperature. Condensing vapors caused mild attack.
n-Propyl Alcohol							Mild attack under boiling and condensing conditions.
Propylene Glycol							
Pyridine							Resistant at ambient temperature. Aqueous solutions caused mild attack at ambient temperature.
Quebracho Extract							Mild attack at 204 degree C (400 degree F)
Quinoline							
Raspberry Juice							Resistant at refrigerated temperatures. Moderate attack at 100 degree C (212 degree F).
Rayon Industry							
Resorcinol Formaldehyde							
Rhubarb							Corrosive at 100 degree C (212 degree F)

Chemical Reactions Table

Chemical or Compound	Used Extensively	Resistant	Mild Action	Moderate Action	Corrosive	Mixed Reaction	Additional Notes
Rice							
Ricinoleic Acid							Resistant at ambient temperature.
Rosin							
Rubber							
Rum							Corrosive usually in the form of localized pitting.
Salicylaldehyde							In laboratory tests, aluminum alloys caused discoloration of salicylaldehyde.
Salicylic Acid							Resistant under conditions of 100% relative humidity at ambient temperature.
Sardines							
Sauerkraut							In limited laboratory tests, sauerkraut caused localized pitting.
Seawater							Many aluminum alloys have been shown to resist seawater in both laboratory controlled field tests and in service. These include aluminum-magnesium alloys 5052, 5154, 5083, 5086 and 5456 and aluminum-magnesium-silicon alloys 6061 and 6061.
Sewage							
Shaving Cream							
Shellac							Resistant at ambient temperature.
Shoe Polish							
Silver Compounds							Corrosive causing localized pitting attack.
Soap							Many soaps cause less than 1 mpy attack while others, usually those more alkaline, are corrosive.
Soda Ash							
Soda Water							Resistant at ambient temperature.
Sodium							
Sodium Acetate							Resistant under conditions of 100% relative humidity at ambient temperature.
Sodium Aluminate							Very corrosive under conditions of 100% relative humidity at ambient temperature.
Sodium Arsenate							Moderate attack under conditions of 100% relative humidity at ambient temperature.
Sodium Arsenite							Resistant under conditions of 100% relative humidity at ambient temperature.
Sodium Benzenesulfonate							
Sodium Benzoate							Resistant under conditions of 100% relative humidity at ambient temperature.
Sodiium Bisulfite							Corrosive with evidence of localized pitting in laboratory tests conducted under conditions of 100% relative humidity at ambient temperature. Solutions of 10% or less caused mild attack while 25% solutions were slightly more corrosive.
Sodium Carbonate							Solid sodium carbonate very corrosive under conditions of 100% relative humidity at ambient temperature. Aqueous solutions of sodium carbonate were very corrosive at ambient temperature.
Sodium Chlorate							Resistant under conditions of 100% relative humidity at ambient temperature.
Sodium Chloride							Resistant to solid sodium chloride in laboratory tests conducted under conditions of 100% relative humidity at ambient temperature. Aqueous solutions of sodium chloride caused mild attack at ambient temperature with some localized pitting.
Sodium Chromate							Resistant under conditions of 100% relative humidity at ambient temperature.
Sodium Cyanide							Aqueous solutions at ambient temperature caused attack which increased with concentration. At 0.1%, the sodium cyanide solution caused mild attack, while at 20%, it was very corrosive.
Sodium Dichromate							Used as an inhibitor to retard corrosion of aluminum alloys.
Sodium Disilicate							Used as an inhibitor to retard corrosion of aluminum alloys.
Sodium Fluoride							Solid sodium fluoride was corrosive under conditions of 100% relative humidity at ambient temperature. Aqueous solutions of sodium fluoride caused moderate attack which varied with concentration.
Sodium Fluosilicate							Resistant under conditions of 100% relative humidity at ambient temperature.
Sodium Hydrogen Sulfate							Solid sodium hydrogen sulfate was very corrosive under conditions of 100% relative humidity at ambient temperature. Aqueous solutions caused attack at ambient temperature which increased with concentration. Resistant to a 1% solution, while a 25% solution caused mild attack.
Sodium Hydroxide							Very corrosive at all concentrations and temperatures.
Sodium Hypochlorite							Cause corrosion which varies with concentration.
Sodium Lactate							Corrosive at ambient temperature and at 100 degree C (212 degree F).
Sodium Lauryl Sulfate							
Sodium Mercaptobenzothiazole							Used as an inhibitor to retard corrosion of aluminum alloys.
Sodium Nitrate							Resistant at ambient temperature.
Sodium Nitrite							Resistant under conditions of 100% relative humidity at ambient temperature.
Sodium Oxalate							Resistant under conditions of 100% relative humidity at ambient temperature. Dilute solutions of sodium oxalate caused moderate attack at 100 degree C (212 degree F)
Sodium Perborate							Resistant under conditions of 100% relative humidity at ambient temperature.
Sodium Percarbonate							
Sodium Peroxide							Very corrosive under conditions of 100% relative humidity at ambient temperature.
Sodium Phosphate, Dibasic							Resistant under conditions of 100% relative humidity at ambient temperature.
Sodium Phosphate, Tribasic							
Sodium Propionate							
Sodium Silicates							In laboratory tests, sodium metasilicate with a weight ratio of 1 was very corrosive at ambient temperature.

Chemical Reactions Table

Chemical or Compound	Used Extensively	Resistant	Mild Action	Moderate Action	Corrosive	Mixed Reaction	Additional Notes
Sodium Sulfate	■	■	■				Resistant to solid sodium sulfate under conditions of 100% relative humidity at ambient temperature. Aqueous solutions caused mild attack at ambient temperature.
Sodium Sulfide					■		Very corrosive under conditions of 100% relative humidity at ambient temperature.
Sodium Sulfite		■					
Sodium Thiocyanate	■	■					Resistant under conditions of 100% relative humidity at ambient temperature.
Sodium Thiosulfate	■	■					Resistant under conditions of 100% relative humidity at ambient temperature.
Soils	■	■	■	■	■	■	Soils vary widely in their corrosivity towards aluminum alloys. Aluminum alloys buried in soil are usually protected by claddings, coatings or wrappings.
Sorbitol	■						
Sorbose	■						
Soya Oil	■						
Stannic Chloride					■		Very corrosive under conditions of 100% relative humidity at ambient temperature.
Stannous Chloride			■		■		Solid stannous chloride was very corrosive under conditions of 100% relative humidity at ambient temperature. Dilute solutions of stannous chloride caused mild attack at ambient temperature.
Starch	■		■				Resistant under conditions of 100% relative humidity at ambient temperature.
Steam	■	■					Resistant at temperatures up to 268 degree C, steam at 268 degree C was corrosive.
Stearic Acid	■	■					Resistant under conditions of 100% relative humidity at ambient temperature.
Strawberries					■		
Streptomycin	■						
Strobane		■					Resistant at ambient temperature.
Styrene	■						
Succinic Acid		■		■	■		Resistant to solid succinic acid under conditions of 100% relative humidity at ambient temperature. In other laboratory test, aqueous solutions of succinic acid caused attack that increased with concentration and temperature.
Sucrose	■		■				Mild attack under conditions of 100% relative humidity at ambient temperature.
Sugar	■						
Sulfamic Acid				■	■		At ambient temperature, the attack was moderate, while at 50 degree C and 100 degree C, sulfamic acid solutions were very corrosive.
Sulfite Waste Liquor	■						
Sulfur	■	■					Resistant at 135-154 degree C (275-310 degree F).
Sulfur Chloride					■		
Sulfur Dioxide	■				■		In laboratory tests, sulfur dioxide saturated with water was corrosive to all aluminum alloys at ambient temperature.
Sulfuric Acid	■	■	■	■	■		The corrosion varies with concentration of sulfuric acid. The corrosion reaches a maximum at about 80% acid concentration.
Sulfurous Acid			■	■			At 0.1% sulfurous acid, that attack was mild, while at 8%, the attack was moderate.
Sulfur Trioxide	■						
Tall Oil	■						
Tannic Acid			■	■	■		Solid tannic acid caused mild attack under conditions of 100% relative humidity at ambient temperature. 0.01% to 20% aqueous solutions caused mild attack at ambient temperature and moderate attack at 50 degree C (122 degree F). These solutions were corrosive at 100 degree C (212 degree F)
Tar	■						
Tartaric Acid	■	■			■		Resistant under conditions of 100% relative humidity at ambient temperature. Aqueous solutions were corrosive at 50 degree C (122 degree F) and very corrosive at 100 degree C (212 degree F).
Tea	■						
Terpenes	■						
Tetrachloroethane		■			■		Resistant at ambient temperature but at boiling temperature was very corrosive.
Tetrachloroethylene	■	■	■				Mild attack under refluxing conditions.
Thiocarbanilide	■		■				Mild attack at 204 degree C (400 degree F)/
Thioglycolic Acid	■	■			■		Resistant to 7.2 aqueous solutions of thioglycolic acid at ambient temperature. Aqueous solutions of 45% concentration were corrosive.
Thiophene		■					Resistant at 204 degree C (400 degree F).
Titanium	■				■		In laboratory tests, titanium was found to cause corrosion of contacting aluminum alloys in high chloride containing environments by galvanic acid.
Titanium Dioxide	■						
Titanium Tetrachloride			■				Mild attack under refluxing conditions.
Tobacco	■				■		Moist tobacco caused localized pitting at ambient temperature.
Toluene	■	■					Resistant at ambient temperature and the boiling temperature.
Toluidines	■						
Tomatoes and Tomato Juice	■	■			■		Resistant at ambient temperature. Cooking and storage of tomatoes in *aluminum alloy vessels* has caused pitting on the metal.
Toothpaste	■	■					Those containing fluorides are corrosive to aluminum alloys.
Toxaphene	■				■		In limited laboratory tests at ambient temperature and 52 degree C toxaphene solutions caused localized pitting.
Triacetin	■	■					Resistant at ambient temperature.
Trichlorobenzene	■	■					Resistant at ambient temperature and under refluxing conditions.
1,1,1-Trichloroethane		■					Resistant at ambient temperature and under refluxing conditions.

Chemical Reactions Table

Chemical or Compound	Used Extensively	Resistant	Mild Action	Moderate Action	Corrosive	Mixed Reaction	Additional Notes
Trichloroethane							Resistant to trichloroethylene in the dry condition at ambient temperature, 50 degree C (122 degree F) and under refluxing conditions. The presence of water accelerates the corrosive effects of trichloroethylene.
Triethanolamine							Corrosive at 204 degree C (400 degree F) and under refluxing conditions. Aqueous solutions were very corrosive to aluminum alloys at ambient temperature.
Triethylamine							Resistant at 100 degree C (212 degree F) and 204 degree C (400 degree F).
Triethylenediamine							
1,2,4-Trimethylbenzene (Pseudocumene)							
2,4,6-Trinitrotoluene							
Tri-o-Cresyl Phosphate							Resistant at 204 degree C (400 degree F). Under refluxing conditions tri-o-cresyl phosphate was corrosive.
Tuna Fish							Resistant at ambient temperature.
Tung Oil							Resistant at ambient temperature.
Turpentine							Resistant at ambient temperature and at the boiling temperature.
Undecylenic Acid							
Urea							Mild attack under conditions of 100% relative humidity at ambient temperature.
Valeric Acid							Resistant at 100 degree C 9 212 degree F).
Vanillin							
Varnish							
Vegetables							
Vinegar							Resistant at ambient temperature. At 50 degree C (122 degree F), the corrosion was increased and the attack was moderate.
Vinyl Acetate							
Vinyl Chloride Monomer							
Vinyl Resins							
Vitamins							
Water							At elevated temperature, ~200 degree C (392 degree F) and above, both distilled and deionized water caused very severe corrosion of most aluminum alloys.
Wax							
Wetting Agents							
Whiskey							Resistant at ambient temperature but pronounced localized pitting occurred.
Whiting							
Wines							In laboratory tests, the corrosion effects of wines and aluminum alloys vary widely.
Wood							Wet wood has caused varying degrees of corrosion of contacting aluminum alloys in laboratory tests.
Wood Creosote							Wet wood treated with creosote did not accelerate corrosion, under conditions of 100% relative humidity at 52 degree C (125 degree F).
Wood Preservatives							In laboratory tests, wood preservatives were found to vary greatly in their corrosivity to aluminum alloys. Creosote, zinc napthanate and pentachlorophenol were found to be most compatible with aluminum alloys.
Xylene							Resistant at the boiling temperature.
Yeast							Resistant at ambient temperature and 32 degree C (90 degree F).
Zinc Acetate							Resistant under conditions of 100% relative humidity at ambient temperature.
Zinc Borate							Resistant under conditions of 100% relative humidity at ambient temperature.
Zinc Chloride							Solid zinc chloride was corrosive under conditions of 100% relative humidity at ambient temperature. Dilute (up to 10%) solutions of zinc chloride caused mild attack, with evidence of localized pitting at ambient temperature.
Zinc Chromate							Resistant under conditions of 100% relative humidity at ambient temperature.
Zinc Naphthanate							In laboratory tests, zinc naphthanate preservative treatment did not accelerate attack of aluminum alloys by contacting wet wood.
Zinc Nitrate							Resistant under conditions of 100% relative humidity at ambient temperature.
Zinc Oxide							Resistant under conditions of 100% relative humidity at ambient temperature.
Zinc Stearate							Resistant under conditions of 100% relative humidity at ambient temperature. Resistant under conditions of 100% relative humidity at ambient temperature.
Zinc Sulfate							