# ALUMINIUM WITH CHEMICALS.

## Table of corrosive chemicals and how they perform with aluminium

**Alkaline Solutions:** are variable in their action on aluminium. The pH of alkaline solutions is not a reliable indicator of the performance of aluminium in these solutions. Although bases such as sodium hydroxide and potassium hydroxide attack aluminium, many others, such as ammonium hydroxide and hexamine, are handled in aluminium equipment.

**Aluminium Sulphate:** (alum, Peral alum, pickle alum) is handled in aluminium cooling trays to avoid product contamination. The rate of attack is low at room temperature and varies directly with concentration and temperature. Aluminium piping for aluminium sulphate solutions is in use in the paper industry.

**Ammonia:** gas (dry) has no action on aluminium, even at elevated temperatures. When ammonia is moist or in solution, the rate of attack also is low for all concentrations at temperatures up to at least 1200F. Aluminium handling and process equipment are widely used.

**Ammonium Carbonate:** has negligible corrosive action on aluminium. Aluminium tankage, piping and subliming equipment are in use. The product is not discoloured by contact with aluminium.

**Ammonium Chloride:** solutions cause moderate pitting on unprotected aluminium.

**Ammonium Nitrate:** and its solutions are handled extensively in aluminium. Aluminium does not render the nitrate unstable.

**Ammonium Nitrate, Ammoniated:** does not attack aluminium. Aluminium pressure vessels, storage tanks, piping and tank cars are excellent for handling these nitrogen fertilizer solutions.

**Aniline:** vapours and liquid at room temperature do not attack aluminium. Aluminium resists corrosion even at elevated temperatures, provided a trace of moisture is present. Aluminium equipment is used in process handling aniline at elevated temperatures.

**Asphalt:** has no action on aluminium.

**Benzene:** has no action on aluminium. Aluminium containers, tankage, heat exchangers, distillation columns and piping are in service.

**Boraz:** in dilute solutions at temperatures up to 1750F, is without action on aluminium. Aluminium equipment is in service in contact with borax solutions in the emulsification of waxes and gums.

**Boric Acid:** has little action on aluminium. Aluminium drying kilns, trays, bucket conveyors and hoods for bottom closings for centrifuges are in service in boric acid plants.

**Butane:** has no action on aluminium.

**Butter:** (containing up to 8% salt) is handled satisfactorily in aluminium. Aluminium butter churns and foil wrappers are in service.

**Buttermilk:** is bottled in containers with unlined aluminium foil hoods.

**Butyl Alcohol:** pure or in solution, has no action on aluminium at room temperature. Even at the boiling point, aluminium may be used, provided a trace of moisture is present in the alcohol. Aluminium decanters and heat exchangers are used for butanol-water mixtures. Aluminium storage tanks are used for the pure alcohol.

**Calcium Carbonate:** solutions cause only negligible action on aluminium.

**Calcium Chloride:** solutions at room temperatures have a slight action on aluminium. Aluminium equipment is used with chromate-inhibited calcium chloride brines. Molten calcium chloride is corrosive to aluminium.

**Calcium Gluconate:** is processed in aluminium tanks to avoid discoloration.

**Calcium Propionate:** is stored in aluminium tanks.

**Calcium Silicate:** is dried in aluminium rotary dryers.

**Calcium Sulphate:** in saturated solution, has negligible action on aluminium at room temperature.

**Calcium Sulphide:** has negligible action on aluminium. Horticultural spray formulations containing up to about 20% calcium sulphide have been handled in aluminium equipment.

**Cane Sugar Liquors:** are handled in aluminium piping, crystallizers and heating equipment.

**Carbon Dioxide:** has no action on aluminium at room or elevated temperatures, even when moisture is present.

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**Carbon Disulphide:** has no action on aluminium even at the boiling point. Aluminium absorbers, distillation columns, condensers and piping are used in carbon disulphide recovery systems.

**Carbonic Acid:** has negligible action on aluminium. Aluminium equipment is in use handling carbonated beverages. Aluminium steam condensate lines have replaced steel in installations where carbon dioxide is associated with the steam.

**Cellulose Acetate:** has no action on aluminium. Aluminium tankage, piping, trays, rotary dryers, fume ducts, hoods and conveyors are used in the production of cellulose acetate.

**Cellulose Nitrate:** plants employ aluminium fume ducts, ventilating hoods, washing tanks and centrifugal extractors.

**Cement:** after hardening, has no appreciable action on aluminium. During the setting-up period, minor action occurs which may be prevented by the use of a coating. Galvanic action in presence of highly conductive cements, such as magnesium oxychloride cement, can be inhibited by the addition of chromate. Aluminium strips are used in terrazzo floors.

**Cereals:** may be handled in aluminium equipment. A variety of industrial cooking utensils are in general use.

**Cheese:** is handled in aluminium cheese moulds and vats. Aluminium foil wrappings, both plain and lacquered, are widely used.

**Chocolate:** does not attack aluminium. It is processed in aluminium steam-jacketed kettles, moulds and tanks and packaged in foil.

Chromic Acid: solutions have a moderate action on aluminium which varies directly with concentration and temperature.

**Citric Acid:** is produced in aluminium fermentation pans, crystallizers and storage tanks. Aluminium is non-toxic, has a minimum effect on fermentation processes, and does not discolour the product.

**Clay:** slurries are handled in aluminium piping, fittings and valves because of low friction losses, portability and the elimination of iron oxide contamination in the clay.

**Coal:** has been handled for many years in aluminium mining equipment such as trucks, hopper cars, chutes, skips, cages, trolleys, pip props and hand tools. Despite some corrosion, aluminium pipe has been found to be the most economical material for handling acid mine water.

**Coal Gas:** does not attack aluminium.

**Coal Tar Bases:** do not attack aluminium. Their colour is unaffected by contact with aluminium.

**Corn Products:** plants are taking increasing advantage of the high resistance to corrosion of aluminium roofing, siding, handrails and architectural trim. In the process, aluminium hoods, ducts, piping and screw-type starch conveyors are in service.

**Corn Syrup:** has no action on aluminium. Aluminium piping, tankage and shipping drums are in service.

**Cottonseed Oil:** is processed, stored and shipped in aluminium.

**Cream of Tartar:** (Potassium Bitartrate) is handled in aluminium equipment because aluminium does not discolour the product.

**Creosote:** vapours have been handled in aluminium coils and heat exchanger tube bundles for more than 15 years in a tar distillation plant. Aluminium storage tanks and shipping drums are in use.

**Dextrose:** solutions have no action on aluminium at room or elevated temperatures.

**Dextro-Lactic Acid:** is produced from glucose in aluminium fermentation equipment.

**Dyes:** must be considered individually. Aluminium can be used to handle neutral dyes for cotton, linen, vegetable and other natural and synthetic fibres. Many acid dyes and direct dyes also are suitable with aluminium. Aluminium drying pans, dye kettles and dye sticks are in service. Lithopone, ultramarine and chrome dyes can be handled in aluminium. Vat dyeing solutions, however, because of their high alkalinity, should not be handled in aluminium equipment.

**Ethyl Alcohol:** and its solutions do not attack aluminium up to the boiling point. Commercial absolute alcohol is not corrosive at the boiling point.

**Ethyl Benzene:** has been handled in aluminium heat exchanger tubes form more than five years. Ethyl benzene contacts the tube side, and a mixture of steam and carbon dioxide contacts the shell side.

**Ethylene Glycol:** has negligible action on aluminium at room or boiling temperatures. Contaminated solutions may be inhibited effectively in many cases. Certain plastics containing ethylene glycol are formulated in aluminium vessels to avoid discoloration.

**Fermentation:** process equipment often is designed in aluminium because aluminium is nontoxic to organisms used in these operations.

**Flue Gases:** have a variety of actions on aluminium. Aluminium chimney liners and vents for domestic gas-fired appliances are used extensively. Under condensing conditions, some attack occurs when high sulphur fuels are burned.

**Fruit Juices:** usually can be processed and handled in aluminium equipment. Orange squeezers of aluminium have been used for many years. Frozen juices are packed in aluminium foil wrappers or aluminium impact-extruded tubes.

**Gasoline:** does not attack aluminium. Where substantial amounts of "sump water" collect in the bottom of the tank, alclad materials are preferred. Aluminium tanks for high octane gasoline are standard for aircraft.

**Glucose:** and its solutions do not attack aluminium.

**Glue:** is processed in aluminium tubs, pans, drying screens, drying tunnels and dehumidifying systems.

**Glycerine:** and its solutions have no action on aluminium. Aluminium stills, condensers, heat exchangers, receivers, storage tanks and tank cars are in service with natural and synthetic glycerine.

**Hydrochloric Acid:** solutions are corrosive to aluminium, but the attack in dilute solutions can be reduced by inhibitors.

**Hydrogen:** has no effect on aluminium. Aluminium equipment is used to produce liquid hydrogen in a heavy water plant.

**Hydrogen Peroxide:** is processed, stored and shipped in aluminium distillation towers, heat exchangers, storage tanks, piping, tank cars and shipping drums. Aluminium is the preferred material for producing and shipping hydrogen peroxide in all commercial concentrations.

**Hydrogen Sulphide:** has negligible action on aluminium. Aluminium storage tank roofs for sour crude oils, bubble caps in petroleum distillation towers and heat exchanger tubes are in service.

**Ice Cream:** is handled in aluminium trays, moulds, pans, insulated storage tanks and freezer parts.

**Kerosene:** has no action on aluminium.

**Ketones:** generally are without action on aluminium, even at their boiling points.

**Lacquers:** and their solvents are handled in aluminium tanks and piping to avoid discoloration.

**Lactic Acid:** solutions, at room temperature, have negligible action on aluminium. The anhydrous acid is stored in aluminium tanks.

**Lactose:** (Milk Sugar), when pure has no action on aluminium.

**Lard Oil:** has no action on aluminium and is used as a forming or rolling lubricant in the fabrication of aluminium parts.

**Linseed Oil:** is handled in aluminium equipment at elevated temperatures. Drying agents, such as lead and manganese compounds do not cause difficulty. Local overheating should be avoided since decomposition products may cause some attack.

**Magnesium Carbonate:** solutions have no action on aluminium.

**Magnesium Chloride:** solutions, below 1% in concentrations, cause only staining of aluminium at room temperature. Dilute solutions above 1% by weight cause moderate pitting on aluminium.

**Magnesium Sulphate:** solutions have virtually no action on aluminium. Oxygen-saturated 50% solutions at 1500F, used in the weighting of silk, are handled in aluminium to avoid product discoloration.

**Meats:** are processed in aluminium. Aluminium is an approved material for utensils and equipment used in the meat packing industry.

**Milk:** when fresh, at temperatures up to the boiling point, has no action on aluminium, and aluminium imparts no taste to the milk. Aluminium milker pails, coolers, tanks, piping and cans are used with whole milk and sweetened or unsweetened condensed milk. Powdered milk is dried in aluminium towers. Aluminium foil milk hoods are in service for sealing bottles. Sour milk may cause a slight action because of its acidity.

**Mine Waters:** cause attack of aluminium which varies with the nature and concentration of salts present in solution. Coal mine waters usually contain sulfuric acid. Nonetheless, aluminium piping is used because the life of aluminium pipe is several times as long as the life of steel pipe and more than compensates for the difference in initial cost.

**Molasses:** has negligible action on aluminium.

**Naphthalene:** is processed in aluminium stills, reactors, fractionators, heat exchangers, piping, receivers and storage tanks at temperatures above 3000F.

**Naval Stores:** such as turpentine, rosin, copal, pentene, dipentene and pinene are widely handled in aluminium equipment.

**Nitric Acid:** in concentrations over 82% by weight, (including red fuming nitric acid) has a negligible action on aluminium.

**Nitrous Gases:** when dry, have only a slight action on aluminium at room temperature. Some etching occurs in the presence of moisture.

**Orange Juice:** is handled in aluminium equipment. Aluminium does not affect the flavour of the juice.

**Ozone:** when dry, does not attack aluminium. A superficial attack may occur in the presence of moist ozone, but it is not enough to discourage the use of aluminium in the construction of ozonisers.

**Pickle Liquor:** a solution of acetic acid and sodium chloride, causes pitting of aluminium.

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| **Potassium Chloride:** solutions have only slight action on aluminium and are similar to solutions of sodium chloride. |
| **Potassium Nitrate:** solutions have negligible action on aluminium, even at elevated temperatures. Aluminium tankage is in service handling solutions of potassium nitrate. |
| **Sauerkraut Juice:** is similar to pickle liquor in its actions on aluminium, causing a pitting type of attack |
| **Soaps:** of many kinds are handled in aluminium, depending on pH. Alkaline soaps that cause some action on aluminium may be inhibited by the addition of silicates. |
| **Sodium Bicarbonate:** solutions have a negligible action on aluminium at room temperature. |
| **Sodium Carbonate:** solutions cause some attack on aluminium, the rate varying directly with concentration and temperature. |
| **Sodium Chloride:** both in solid form and in solution, is handled extensively in aluminium equipment |
| **Sodium Hydroxide:** solutions dissolve aluminium readily. |
| **Sodium Nitrate:** solutions have a negligible action on aluminium. |
| **Sodium Sulphate:** solutions have negligible action on aluminium at room or elevated temperature. |
| **Spirits:** such as whiskies, brandies and gins, may be handled in aluminium for short-time exposure, but undergo slight changes in flavour and clarity if stored or left in prolonged contact with aluminium. Corrosive attack on the aluminium is slight. |
| **Steam:** even when containing carbon dioxide, does not corrode aluminium at temperatures up to 4800F. Aluminium surface condensers, condensate lines and condensate tanks are being used in power plants. |
| **Sulphur:** has no corrosive action on aluminium. |
| **Sulfuric Acid:** varies in its action on aluminium depending on concentration and temperature. Very dilute solutions of sulfuric acid are handled in aluminium equipment at room temperature. |
| **Turpentine:** is handled extensively in aluminium equipment. |
| **Vapours and Fumes:** of many varieties are handled in aluminium equipment. Aluminium ventilating canopies, hoods and ducts are widely used for removing fumes from nitrating processes. Aluminium ducts have given excellent service in applications for venting fumes containing considerable H2S, SO2, SO3, CO2, or NH3. |
| **Waters:** vary in their action on aluminium. Distilled water regularly is stored and piped in aluminium equipment. High quality deionized water has no action on aluminium. Unpolluted rain water does not corrode aluminium. Fresh and salt waters in the pH range 4.5 - 8.5 cause only negligible attack of aluminium even at the boiling point, but certain of these waters cause pitting because they contain traces of heavy metal salts. Alclad alloys prevent premature perforation under these circumstances and are recommended for equipment handling salt water. A number of aluminium heat exchangers are in service employing salt water cooling. Aluminium may be used with practically all recirculated waters. |
| **Wines:** have various actions on aluminium. Light wines have little effect on aluminium, but the heavy and white wines, which contain some free sulphurous acid, tend to become turbid when in contact with aluminium. |