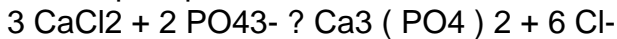


= Calcium chloride =

Calcium chloride are inorganic compounds with the chemical formula  $\text{CaCl}_2 (\text{H}_2\text{O})_x$ , where  $x = 0, 1, 2, 4$ , and  $6$ . All of these salts are highly soluble in water. They are mainly used for deicing and dust control. Because the anhydrous salt is hygroscopic, it is used as a desiccant.

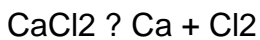
= = Properties = =

Calcium chloride dissolves in water to afford chloride and the aquo complex  $[\text{Ca}(\text{H}_2\text{O})_6]^{2+}$ . In this way, these solutions are sources of "free" calcium and free chloride ions. This description is illustrated by the fact that these solutions react with phosphate sources to give solid precipitate of calcium phosphate:



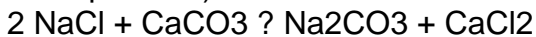
Calcium chloride has a very high enthalpy change of solution, indicated by considerable temperature rise accompanying dissolution of the anhydrous salt in water. This property is the basis for its largest scale application.

Molten calcium chloride can be electrolysed to give calcium metal and chlorine gas.



= = Preparation = =

In much of the world, calcium chloride is derived from limestone as a by-product of the Solvay process: North American consumption in 2002 was 1 @, @ 687 @, @ 000 tons (3 @. @ 7 billion pounds).



In the US, most of calcium chloride is obtained by purification from brine. A Dow Chemical Company manufacturing facility in Michigan houses about 35 % of the total U.S. production capacity for calcium chloride.

= = = Occurrence = = =

Calcium chloride occurs as the rare evaporite minerals sinjarite (dihydrate) and antarcticite (hexahydrate). The related minerals chlorocalcite (potassium calcium chloride,  $\text{KCaCl}_3$ ) and tachyhydrite (calcium magnesium chloride,  $\text{CaMg}_2\text{Cl}_6 \cdot 12\text{H}_2\text{O}$ ) are also very rare.

= = Uses = =

= = = Deicing and freezing point depression = = =

By depressing the freezing point of water, calcium chloride is used to prevent ice formation and to deice. This application consumes the greatest amount of calcium chloride. Calcium chloride is relatively harmless to plants and soil. As a deicing agent, it is more effective at lower temperatures than sodium chloride. When distributed for this use, it usually takes the form of small, white spheres a few millimeters in diameter, called prills. Solutions of calcium chloride can prevent freezing at temperature as low as  $-52^\circ \text{C}$  ( $-62^\circ \text{F}$ ), making it ideal for filling agricultural implement tires as a liquid ballast, aiding traction in cold climates.

Also used in salt / chemical @-@ based dehumidifiers in domestic and other environments to adsorb dampness / moisture from the air.

= = = Road surfacing = = =

The second largest application of calcium chloride exploits its hygroscopic properties and the

tackiness of its hydrates . A concentrated solution keep a liquid layer on the surface of dirt roads , which suppresses formation of dust . It keeps the finer dust particles on the road , providing a cushioning layer . If these are allowed to blow away , the larger aggregate begins to shift around and the road breaks down . Using calcium chloride reduces the need for grading by as much as 50 % and the need for fill @-@ in materials as much as 80 %

= = = Water treatment = = =

Calcium chloride is used to increase the water hardness in swimming pools . This process reduces the erosion of the concrete in the pool . By Le Chatelier 's principle and the common ion effect , increasing the concentration of calcium in the water will reduce the dissolution of calcium compounds essential to the structure of concrete .

= = = Food = = =

As an ingredient , it is listed as a permitted food additive in the European Union for use as a sequestrant and firming agent with the E number E509 . It is considered as generally recognized as safe ( GRAS ) by the U.S. Food and Drug Administration . Its use in organic crop production is generally prohibited under US National Organic Program 's National List of Allowed and Prohibited Substances . The average intake of calcium chloride as food additives has been estimated to be 160 ? 345 mg / day for individuals . In marine aquariums , calcium chloride is added to introduce bioavailable calcium for calcium carbonate @-@ shelled animals such as mollusks and some cnidarians . Calcium hydroxide ( kalkwasser mix ) or a calcium reactor can also be used to introduce calcium ; however , calcium chloride addition is the fastest method and has minimal impact on pH .

As a firming agent , calcium chloride is used in canned vegetables , in firming soybean curds into tofu and in producing a caviar substitute from vegetable or fruit juices . It is commonly used as an electrolyte in sports drinks and other beverages , including bottled water . The extremely salty taste of calcium chloride is used to flavor pickles while not increasing the food 's sodium content . Calcium chloride 's freezing @-@ point depression properties are used to slow the freezing of the caramel in caramel @-@ filled chocolate bars .

In brewing beer , calcium chloride is sometimes used to correct mineral deficiencies in the brewing water . It affects flavor and chemical reactions during the brewing process , and can also affect yeast function during fermentation .

In cheesemaking , calcium chloride is sometimes added to processed ( pasteurized / homogenized ) milk to restore the natural balance between calcium and protein in casein for the purposes of making cheeses , such as brie , Pélardon and Stilton . By adding calcium chloride to the milk before adding the coagulant , calcium levels are restored . Also , it is frequently added to sliced apples to maintain texture .

= = = Laboratory and related drying operations = = =

Drying tubes are frequently packed with calcium chloride . Kelp is dried with calcium chloride for use in producing sodium carbonate . Anhydrous calcium chloride has been approved by the FDA as a packaging aid to ensure dryness ( CPG 7117 @.@ 02 ) .

= = = Medicine = = =

It is injected to treat internal hydrofluoric acid burns . It can be used to treat magnesium intoxication . Calcium chloride injection may antagonize cardiac toxicity as measured by electrocardiogram . It can help to protect the myocardium from dangerously high levels of serum potassium in hyperkalemia . Calcium chloride can be used to quickly treat calcium channel blocker toxicity , from the side effects of drugs such as diltiazem ( Cardizem ) ? helping avoid potential heart attacks .

Aqueous calcium chloride is used in genetic transformation of cells by increasing the cell membrane

permeability , inducing competence for DNA uptake ( allowing DNA fragments to enter the cell more readily ) .

= = = Miscellaneous applications = = =

Calcium chloride is used in concrete mixes to accelerate ( speed up ) the initial setting , but chloride ions lead to corrosion of steel rebar , so it should not be used in reinforced concrete . The anhydrous form of calcium chloride may also be used for this purpose and can provide a measure of the moisture in concrete .

Calcium chloride is included as an additive in plastics and in fire extinguishers , in wastewater treatment as a drainage aid , in blast furnaces as an additive to control scaffolding ( clumping and adhesion of materials that prevent the furnace charge from descending ) , and in fabric softener as a thinner .

The exothermic dissolution of calcium chloride is used in self @-@ heating cans and heating pads .

In the oil industry , calcium chloride is used to increase the density of solids @-@ free brines . It is also used to provide inhibition of swelling clays in the water phase of invert emulsion drilling fluids .

$\text{CaCl}_2$  acts as flux material ( decreasing melting point ) in the Davy process for the industrial production of sodium metal , through the electrolysis of molten  $\text{NaCl}$  .

Calcium chloride is also an ingredient used in ceramic slipware . It suspends clay particles so that they float within the solution making it easier to use in a variety of slipcasting techniques .

= = = = Animal sterilization = = = =

Calcium chloride dihydrate ( 20 % by weight ) dissolved in ethanol ( 95 % ABV ) has been used as a sterilant for male animals . The non surgical procedure consists of the injection of the solution into the testes of the animal . Within 1 month , necrosis of testicular tissue results in sterilization .

= = Hazards = =

Calcium chloride can act as an irritant by desiccating moist skin . Solid calcium chloride dissolves exothermically , and burns can result in the mouth and esophagus if it is ingested . Ingestion of concentrated solutions or solid products may cause gastrointestinal irritation or ulceration .

Consumption of calcium chloride can lead to hypercalcemia .