

= Aluminium chloride =

Aluminium chloride (AlCl_3) is the main compound of aluminium and chlorine . It is white , but samples are often contaminated with iron trichloride , giving it a yellow colour . The solid has a low melting and boiling point . It is mainly produced and consumed in the production of aluminium metal , but large amounts are also used in other areas of chemical industry . The compound is often cited as a Lewis acid . It is an example of an inorganic compound that " cracks " at mild temperature , reversibly changing from a polymer to a monomer .

= = Structure = =

AlCl_3 adopts three different structures , depending on the temperature and the state (solid , liquid , gas) . Solid AlCl_3 is a sheet @-@ like layered cubic close packed layers . In this framework , the Al centres exhibit octahedral coordination geometry . In the melt , aluminium trichloride exists as the dimer Al_2Cl_6 , with tetracoordinate aluminium . This change in structure is related to the lower density of the liquid phase (1 @. @ 78 g / cm^3) vs solid aluminium trichloride (2 @. @ 48 g / cm^3) . Al_2Cl_6 dimers are also found in the vapour phase . At higher temperatures , the Al_2Cl_6 dimers dissociate into trigonal planar AlCl_3 , which is structurally analogous to BF_3 . The melt conducts electricity poorly , unlike more ionic halides such as sodium chloride .

= = Reactions = =

Anhydrous aluminium chloride is a powerful Lewis acid , capable of forming Lewis acid @-@ base adducts with even weak Lewis bases such as benzophenone and mesitylene . It forms tetrachloroaluminate AlCl_4^- in the presence of chloride ions .

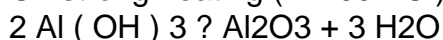
Aluminium chloride reacts with calcium and magnesium hydrides in tetrahydrofuran forming tetrahydroaluminates .

= = = Reactions with water = = =

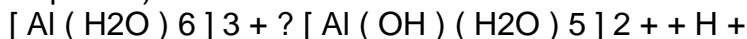
Aluminium chloride is hygroscopic , having a very pronounced affinity for water . It fumes in moist air and hisses when mixed with liquid water as the Cl^- ions are displaced with H_2O molecules in the lattice to form the hexahydrate $\text{AlCl}_3 \cdot 6\text{H}_2\text{O}$ (also white to yellowish in color) . The anhydrous phase cannot be regained on heating as HCl is lost leaving aluminium hydroxide or alumina (aluminium oxide) :



On strong heating ($\sim 400^\circ\text{C}$) , the aluminium oxide is formed from the aluminium hydroxide via :



Aqueous solutions of AlCl_3 are ionic and thus conduct electricity well . Such solutions are found to be acidic , indicative of partial hydrolysis of the Al^{3+} ion . The reactions can be described (simplified) as :

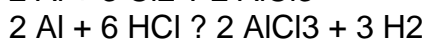


Aqueous solutions behave similarly to other aluminium salts containing hydrated Al^{3+} ions , giving a gelatinous precipitate of aluminium hydroxide upon reaction with dilute sodium hydroxide :

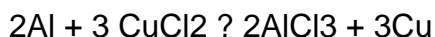


= = Synthesis = =

Aluminium chloride is manufactured on a large scale by the exothermic reaction of aluminium metal with chlorine or hydrogen chloride at temperatures between 650 to 750°C ($1 @, @ 202$ to $1 @, @ 382^\circ\text{F}$) .

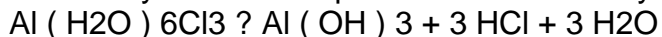


Aluminum chloride may be formed via a single displacement reaction between copper chloride and aluminum metal .



In the US in 1993 , approximately 21 @, @ 000 tons were produced , not counting the amounts consumed in the production of aluminium .

Hydrated aluminium trichloride is prepared by dissolving aluminium oxides in hydrochloric acid . Metallic aluminum also readily dissolves in hydrochloric acid ? releasing hydrogen gas and generating considerable heat . Heating this solid does not produce anhydrous aluminium trichloride , the hexahydrate decomposes to aluminium hydroxide when heated :



Aluminium also forms a lower chloride , aluminium (I) chloride (AlCl) , but this is very unstable and only known in the vapour phase .

= = Uses = =

= = = Anhydrous aluminium trichloride = = =

AlCl_3 is probably the most commonly used Lewis acid and also one of the most powerful . It finds application in the chemical industry as a catalyst for Friedel ? Crafts reactions , both acylations and alkylations . Important products are detergents and ethylbenzene . It also finds use in polymerization and isomerization reactions of hydrocarbons .

The Friedel ? Crafts reaction is the major use for aluminium chloride , for example in the preparation of anthraquinone (for the dyestuffs industry) from benzene and phosgene . In the general Friedel ? Crafts reaction , an acyl chloride or alkyl halide reacts with an aromatic system as shown :

The alkylation reaction is more widely used than the acylation reaction , although its practice is more technically demanding because the reaction is more sluggish . For both reactions , the aluminium chloride , as well as other materials and the equipment , should be dry , although a trace of moisture is necessary for the reaction to proceed . A general problem with the Friedel ? Crafts reaction is that the aluminium chloride catalyst sometimes is required in full stoichiometric quantities , because it complexes strongly with the products . This complication sometimes generates a large amount of corrosive waste . For these and similar reasons , more recyclable or environmentally benign catalysts have been sought . Thus , the use of aluminium trichloride in some applications is being displaced by zeolites .

Aluminium chloride can also be used to introduce aldehyde groups onto aromatic rings , for example via the Gattermann @-@ Koch reaction which uses carbon monoxide , hydrogen chloride and a copper (I) chloride co @-@ catalyst .

Aluminium chloride finds a wide variety of other applications in organic chemistry . For example , it can catalyse the " ene reaction " , such as the addition of 3 @-@ buten @-@ 2 @-@ one (methyl vinyl ketone) to carvone :

AlCl_3 is also widely used for polymerization and isomerization reactions of hydrocarbons . Important examples include the manufacture of ethylbenzene , which used to make styrene and thus polystyrene , and also production of dodecylbenzene , which is used for making detergents .

Aluminium chloride combined with aluminium in the presence of an arene can be used to synthesize bis (arene) metal complexes , e.g. bis (benzene) chromium , from certain metal halides via the so @-@ called Fischer @-@ Hafner synthesis .

= = = Hydrated aluminium chlorides = = =

The hexahydrate has few applications , but aluminium chlorohydrate is a common component in antiperspirants at low concentrations . Hyperhidrosis sufferers need a much higher concentration (12 % or higher) , sold under such brand names as Xeransis , Drysol , DryDerm , sunsola , Maxim ,

Odaban , CertainDri , B + Drier , Chlorhydrol , Anhydrol Forte and Driclor .

= = Symmetry and dipole moment = =

Aluminium chloride belongs to the point group D_{3h} in its monomeric form and D_{2h} in its dimeric form . Both forms of aluminium chloride , however , do not possess a dipole moment because the bond dipole moments cancel each other out .

= = Safety = =

Anhydrous $AlCl_3$ reacts vigorously with bases , so suitable precautions are required . It can cause irritation to the eyes , skin , and the respiratory system if inhaled or on contact .

Aluminum chloride has been established as a neurotoxin .