

= Iron (III) chloride =

Iron (III) chloride , also called ferric chloride , is an industrial scale commodity chemical compound , with the formula FeCl_3 and with iron in the + 3 oxidation state . The colour of iron (III) chloride crystals depends on the viewing angle : by reflected light the crystals appear dark green , but by transmitted light they appear purple @-@ red . Anhydrous iron (III) chloride is deliquescent , forming hydrated hydrogen chloride mists in moist air . It is rarely observed in its natural form , mineral molysite , known mainly from some fumaroles .

When dissolved in water , iron (III) chloride undergoes hydrolysis and gives off heat in an exothermic reaction . The resulting brown , acidic , and corrosive solution is used as a flocculant in sewage treatment and drinking water production , and as an etchant for copper @-@ based metals in printed circuit boards . Anhydrous iron (III) chloride is a fairly strong Lewis acid , and it is used as a catalyst in organic synthesis .

= = Nomenclature = =

The descriptor hydrated or anhydrous is used when referring to iron (III) chloride , to distinguish between the two common forms . The hexahydrate is usually given as the simplified empirical formula $\text{FeCl}_3 \cdot 6\text{H}_2\text{O}$. It may also be given as trans- $[\text{Fe}(\text{H}_2\text{O})_4\text{Cl}_2]\text{Cl} \cdot 2\text{H}_2\text{O}$ and the systematic name tetraaquadichloroiron (III) chloride dihydrate , which more clearly represents its structure .

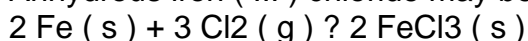
= = Structure and properties = =

Anhydrous iron (III) chloride adopts the BiI_3 structure , which features octahedral Fe (III) centres interconnected by two @-@ coordinate chloride ligands . Iron (III) chloride hexahydrate consists of trans- $[\text{Fe}(\text{H}_2\text{O})_4\text{Cl}_2]$ + cationic complexes and chloride anions , with the remaining two H_2O molecules embedded within the monoclinic crystal structure .

Iron (III) chloride has a relatively low melting point and boils at around 315°C . The vapour consists of the dimer Fe_2Cl_6 (c.f. aluminium chloride) which increasingly dissociates into the monomeric FeCl_3 (D_{3h} point group molecular symmetry) at higher temperature , in competition with its reversible decomposition to give iron (II) chloride and chlorine gas .

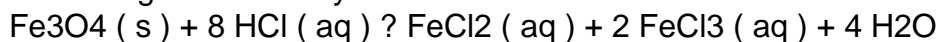
= = Preparation = =

Anhydrous iron (III) chloride may be prepared by union of the elements :

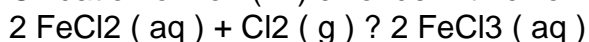


Solutions of iron (III) chloride are produced industrially both from iron and from ore , in a closed @-@ loop process .

Dissolving iron ore in hydrochloric acid



Oxidation of iron (II) chloride with chlorine



Oxidation of iron (II) chloride with oxygen



Reacting Iron with hydrochloric acid , then with hydrogen peroxide . The hydrogen peroxide is the oxidant in turning ferrous chloride into ferric chloride

Like many other hydrated metal chlorides , hydrated iron (III) chloride can be converted to the anhydrous salt by refluxing with thionyl chloride . Conversion of the hydrate to anhydrous iron (III) chloride is not accomplished by heating , as HCl and iron oxychlorides are produced .

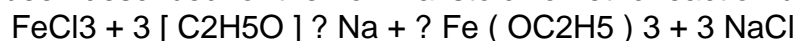
= = Reactions = =

Iron (III) chloride undergoes hydrolysis to give an acidic solution . When heated with iron (III) oxide at 350 ° C , iron (III) chloride gives iron oxychloride , a layered solid and intercalation host .



It is a moderately strong Lewis acid , forming adducts with Lewis bases such as triphenylphosphine oxide , e.g. $\text{FeCl}_3 \cdot (\text{OPPh}_3)_2$ where Ph = phenyl . It also reacts with other chloride salts to give the yellow tetrahedral FeCl_4^- ion . Salts of FeCl_4^- in hydrochloric acid can be extracted into diethyl ether .

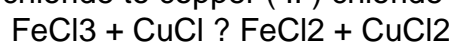
Alkali metal alkoxides react to give the metal alkoxide complexes of varying complexity . The compounds can be dimeric or trimeric . In the solid phase a variety of multinuclear complexes have been described for the nominal stoichiometric reaction between FeCl_3 and sodium ethoxide :



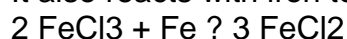
Oxalates react rapidly with aqueous iron (III) chloride to give $[\text{Fe}(\text{C}_2\text{O}_4)_3]^{3-}$. Other carboxylate salts form complexes , e.g. citrate and tartrate .

== Oxidation ==

Iron (III) chloride is a mild oxidising agent , for example , it is capable of oxidising copper (I) chloride to copper (II) chloride .



It also reacts with iron to form iron (II) chloride :

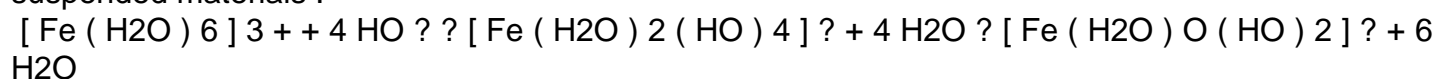


Reducing agents such as hydrazine convert iron (III) chloride to complexes of iron (II) .

== Uses ==

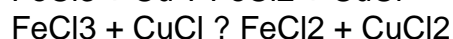
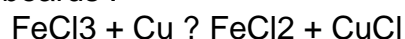
== Industrial ==

In industrial application , iron (III) chloride is used in sewage treatment and drinking water production . In this application , FeCl_3 in slightly basic water reacts with the hydroxide ion to form a floc of iron (III) hydroxide , or more precisely formulated as $\text{FeO}(\text{OH})$, that can remove suspended materials .

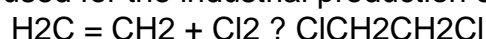


It is also used as a leaching agent in chloride hydrometallurgy , for example in the production of Si from FeSi . (Silgrain process)

Another important application of iron (III) chloride is etching copper in two @-@ step redox reaction to copper (I) chloride and then to copper (II) chloride in the production of printed circuit boards .



Iron (III) chloride is used as catalyst for the reaction of ethylene with chlorine , forming ethylene dichloride (1 @, @ 2 @-@ dichloroethane) , an important commodity chemical , which is mainly used for the industrial production of vinyl chloride , the monomer for making PVC .



== Laboratory use ==

In the laboratory iron (III) chloride is commonly employed as a Lewis acid for catalysing reactions such as chlorination of aromatic compounds and Friedel @-@ Crafts reaction of aromatics . It is less powerful than aluminium chloride , but in some cases this mildness leads to higher yields , for example in the alkylation of benzene :

The ferric chloride test is a traditional colorimetric test for phenols , which uses a 1 % iron (III)

chloride solution that has been neutralised with sodium hydroxide until a slight precipitate of $\text{FeO}(\text{OH})$ is formed . The mixture is filtered before use . The organic substance is dissolved in water , methanol or ethanol , then the neutralised iron (III) chloride solution is added ? a transient or permanent coloration (usually purple , green or blue) indicates the presence of a phenol or enol .

This reaction is exploited in the Trinder spot test , which is used to indicate the presence of salicylates , particularly salicylic acid , which contains a phenolic OH group .

This test can be used to detect the presence of gamma @-@ Hydroxybutyric acid and gamma @-@ butyrolactone , which cause it to turn red @-@ brown .

== Other uses ==

Used in anhydrous form as a drying reagent in certain reactions .

Used to detect the presence of phenol compounds in organic synthesis e.g. : examining purity of synthesised Aspirin .

Used in water and wastewater treatment to precipitate phosphate as iron (III) phosphate .

Used by American coin collectors to identify the dates of Buffalo nickels that are so badly worn that the date is no longer visible .

Used by Blade @-@ smiths and Artisans in Pattern welding to etch the metal , giving it a contrasting effect , to view metal layering or imperfections .

Used to etch the widmanstatten pattern in iron meteorites .

Necessary for the etching of photogravure plates for printing photographic and fine art images in intaglio and for etching rotogravure cylinders used in the printing industry .

Used to make printed circuit boards (PCBs) .

Used in veterinary practice to treat overcropping of an animal 's claws , particularly when the overcropping results in bleeding .

Reacts with cyclopentadienylmagnesium bromide in one preparation of ferrocene , a metal @-@ sandwich complex .

Sometimes used in a technique of Raku ware firing , the iron coloring a pottery piece shades of pink , brown , and orange .

Used to test the pitting and crevice corrosion resistance of stainless steels and other alloys .

Used in conjunction with NaI in acetonitrile to mildly reduce organic azides to primary amines .

Used in an animal thrombosis model .

Used in energy storage systems

Historically it was used to make direct positive blueprints ; U.S. patent 241 @,@ 713 , May 17 1881

== Safety ==

Iron (III) chloride is toxic , highly corrosive and acidic . The anhydrous material is a powerful dehydrating agent .

Although reports of poisoning in humans are rare , ingestion of ferric chloride can result in serious morbidity and mortality . Inappropriate labeling and storage lead to accidental swallowing or misdiagnosis . Early diagnosis is important , especially in seriously poisoned patients .