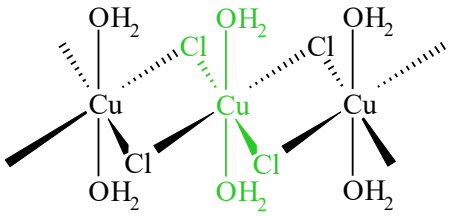
Preparation of copper(II) chloride dihydrate

Pure and dry copper(II) chloride dihydrate is a pale blue crystalline substance. Its structure consists of distorted octahedra connected to chains, therefore, it is a coordination compound with exact name *trans*-diaqua-dichloridocopper(II) complex, *trans*-$[CuCl_2(H_2O)_2]$. Often observed green colour of the substance originates from traces of captured water molecules from air humidity. It is very good soluble in water and ethanol. Aqueous solution acidified by hydrochloric acid have intensive grass-green colour as a result of presence of blue tetraaquacopper(II) cations $[Cu(H_2O)_4]^{2+}$ and yellow tetrachlorido-cuprate anions $[CuCl_4]^{2-}$.



Structure of $CuCl_2 \cdot 2\ H_2O$

Copper(II) chloride dihydrate can be prepared by the reaction of copper(II) salts of weak acids with hydrochloric acid.

In the first step of this two-step synthesis we will prepare insoluble dicopper(II) dihydroxide-carbonate (called also basic copper carbonate) and in the second step we let it react with hydrochloric acid.

$$\mathbf{2\ CuSO_4(aq) + 4\ NaHCO_3(aq) \longrightarrow Cu_2CO_3(OH)_2(s) + 2\ Na_2SO_4(aq) + 3\ CO_2(g) + H_2O(l)}$$

$$\mathbf{Cu_2CO_3(OH)_2(s) + 4\ HCl(aq) \longrightarrow 2\ CuCl_2(aq) + CO_2(g) + 3\ H_2O(l)}$$

Work

Prepare 0,030 moles of copper(II) chloride dihydrate.

Chemicals

- copper(II) sulphate pentahydrate, $CuSO_4 \cdot 5\ H_2O$, light blue crystalline,
- sodium hydrogen carbonate, $NaHCO_3$, white crystalline,
- hydrochloric acid, HCl, concentrated, w(HCl) = 0,36.

Procedure

Dissolve calculated amount of copper(II) sulphate pentahydrate in water to prepare 7% solution. Prepare 4% solution of stoichiometric amount of sodium hydrogen carbonate with 5% exceess. Heat the copper(II) sulphate solution almost to a boil and under continuous stirring add dropwise hydrogencarbonate solution. Light green precipitate of $Cu_2CO_3(OH)_2$ is immediately formed. Let settle the precipitate and decant it with 5% sodium hydrogen carbonate solution and then with clear water. After decantation add slowly calculated volume of hydrochloric acid diluted in volume ratio 1 : 1. Be careful to prevent the solution from bubbling up from the beaker. If the solution is not transparent and of grass-green colour, add little more hydrochloric acid. Filter the resulting solution under vacuum on a fritted glass. Connect safety bottle between a suction flask and a vacuum pump to protect filtrate from water from a pump. Pour the filtered solution to an evaporating dish over a water bath and heat it until the crystals of wait until crystals appear. It may take a long time because of very good slubility of copper(II) chloride. Pour the saturated solution into a crystallization dish and cool to room temperature. Filter the obtained crystals on a fritted glass and dry them between two pieces of filter paper.

Copper(II) sulphate pentahydrate, $CuSO_4 \cdot 5H_2O$

H302	Harmful if swallowed.
H315	Causes skin irritation.
H319	Causes serious eye irritation.
H410	Very toxic to aquatic life with long lasting effects.
P273	Avoid release to the environment.
P302+P352	IF ON SKIN: Wash with plenty of water and soap.
P305+P351+P338	IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.

Sodium bicarbonate, $NaHCO_3$

Not a hazardous substance or mixture according to Regulation (EC) No 1272/2008.

Basic copper carbonate, $Cu_2CO_3(OH)_2$

H302+H332	Harmful if swallowed or inhaled.
H315	Causes skin irritation.
H319	Causes serious eye irritation.
H335	May cause respiratory irritation.
H410	Very toxic to aquatic life with long lasting effects.
P261	Avoid breathing dust/fume/gas/mist/vapours/spray.
P270	Do not eat, drink, or smoke when using this product.
P273	Avoid release to the environment.
P305+P351+P338	IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.

Hydrochloric acid, HCl

H290	May be corrosive to metals.
H314	Causes severe skin burns and eye damage.
H335	May cause respiratory irritation.
P280	Wear protective gloves/protective clothing/eye protection/face protection.
P301+P330+P331	IF SWALLOWED: Rinse mouth. Do NOT induce vomiting.
P305+P351+P338	IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
P309+P310	IF exposed or you feel unwell: Immediately call a POISON CENTER or doctor/physician.

Sodium sulphate decahydrate, $Na_2SO_4 \cdot 10H_2O$

Not a hazardous substance or mixture according to Regulation (EC) No 1272/2008.

Copper(II) chloride, dihydrate $CuCl_2 \cdot 2H_2O$

H302+H312	Harmful if swallowed or in contact with skin.
H315	Causes skin irritation.

H318	Causes serious eye damage.
H410	Very toxic to aquatic life with long lasting effects.
P273	Avoid release to the environment.
P280	Wear protective gloves/protective clothing/eye protection/face protection.
P302+P352	IF ON SKIN: Wash with plenty of water and soap.
P305+P351+P338	IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
P313	Get medical advice/attention.