Preparation of copper carbonate-dihydroxide

Copper(II) carbonate-dihydroxide occurs in nature in the form of the mineral *malachite*, which is one of the most beautiful minerals known. Malachite is usually green in color, which can vary in shades from light green to black-green. From a chemical point of view, it is a combination of copper carbonate and copper hydroxide, $CuCO_3$ $Cu(OH)_2$. Malachite has been used as a mineral pigment in green paints since ancient times. It is very sensitive to acids.
Another mineral of the composition $Cu_3(CO_3)_2(OH)_2$ – *azurite* – is deep blue in color. Both minerals are used as starting compounds in the preparation of other copper salts.
Copper(II) carbonate-dihydroxide is a green microcrystalline substance, poorly soluble in water. It is prepared by the precipitation reaction of a highly soluble copper salt with bicarbonate according to the equation:

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

Work

Prepare copper(II) carbonate-dihydroxide from 4.5 g of copper(II) sulphate pentahydrate.

Chemicals

- copper(II) sulphate pentahydrate, $CuSO_4 \cdot 5H_2O$, light blue crystalline substance,
- sodium bicarbonate, $NaHCO_3$, white crystalline substance,
- ethanol, C_2H_5OH, colourless liquid.

Procedure

In a tall 200 cm^3 beaker, dissolve 4.5 g of copper sulphate pentahydrate in 25 cm^3 of water. Similarly, in another beaker, dissolve approximately 3 g of sodium bicarbonate in 25 cm^3 of water. Gradually add sodium bicarbonate solution to the copper sulphate solution until carbon dioxide gas is observed to escape from the reaction mixture. Then place the beaker in a water bath at 50 °C to expel dissolved carbon dioxide, and allow the precipitate to settle for about 20 minutes. Purify the precipitate by decanting with water. Then filter the precipitate under reduced pressure on a Büchner funnel, wash thoroughly with water and finally with ethanol. Dry in air at room temperature.

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.

Sodium sulphate decahydrate, $Na_2SO_4 \cdot 10H_2O$

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.

Carbon dioxide, CO_2

H280	Contains gas under pressure: may explode if heated.
P403+P410	Store in a well-ventilated place. Protect from sunlight. Asphyxiant in high concentration.

Ethanol, CH_3CH_2OH

H225	Highly flammable liquid and vapour.
H319	Causes serious eye irritation.
P210	Keep away from heat, hot surfaces, sparks, open flames and other ignition sources. No smoking.
P240	Ground and bond container and receiving equipment.
P305+P351+P338	IF IN EYES: Rinse continuously with water for several minutes. Remove contact lenses if present and easy to do. Continue rinsing.
P403+P233	Store in a well-ventilated place. Keep container tightly closed.