

Redox reaction between copper oxide and carbon

Purpose:

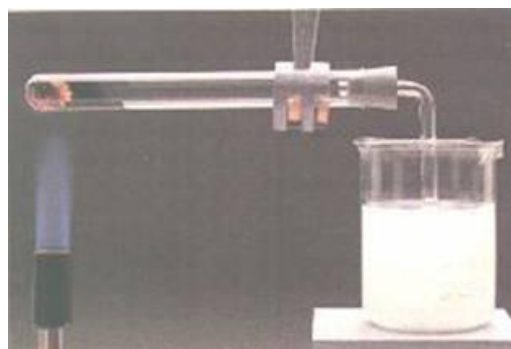
In the following experiment I am going to demonstrate a redox reaction between copper oxide (CuO) and carbon (C). The aim of this experiment is to produce elemental copper.

Equipment:

- test tube;
- rubber bung with whole;
- bent glass pipe;
- laboratory burner;
- copper oxide;
- activated carbon;
- support base and rod;
- support clamp
- filtered lime water in a beaker (Ca(OH)₂)
- socket

Procedure:

First of all the apparatus is set (see photo). The copper oxide is mixed with the activated carbon in a ratio 1:1. This mixture is put into the test tube and closed with a rubber bung. A bent glass pipe connects the test tube with the beaker that is filled with filtered lime water. Now the test tube is heated with a laboratory burner for some minutes. After a time a lot of fume is set free. This fume directly goes through the bent glass pipe into the filtered lime water. When the lime water gets in contact with this fume it gets very cloudy.



When there is already a coppery substance viewable the heating process is stopped. But before the laboratory burner is taken away one must disconnect the lime water and the test tube. Otherwise the lime water is sucked into the test tube because there is low pressure (the air has expanded during the heating process and has left the test tube). Then the test tube certainly breaks (as it happened in my experiment) because of the big difference of temperature.

Observation:

After heating the formally black mixture of copper oxide and activated coal a coppery substance was formed. The transparent lime water got cloudy.

Conclusion:

The substance that was formed is elemental copper. The lime water (Ca(OH)₂) changed its colour when it came in contact with the CO₂ that was produced during the heating process. CO₂ and calcium hydroxide reacted to form calcium carbonate and water.

Assumption:

I think that a redox reaction took place. The oxygen from the copper oxide is quite reactive and formed a new stable compound with carbon. I have no idea why the lime water got cloudy.

Explanation:

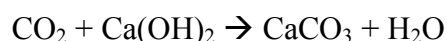
1) reaction in the test tube



The reaction in the test tube is called redox reaction. This means that one substance receives electrons (it is reduced) whereas the other substance provides electrons (it is oxidized).

Copper oxide is an ionic linkage. The copper atoms have a positive charge because they give two electrons to the oxygen atom. The supply of heat breaks this compound. The copper receives its two electrons from the oxygen again and becomes elemental copper. (It is reduced). Oxygen wants to reach its noble state (noble state = eight valence electrons). The added carbon can provide even four valence electrons and forms a new compound with the oxygen (CO_2) (Carbon is oxidized). This compound is also an ionic linkage. Oxygen has six valence electrons and needs two electrons to get a noble state. So one carbon atom forms a compound with two oxygen atoms (CO_2).

2) reaction in the beaker



white precipitate

When the CO_2 comes in contact with $\text{Ca}(\text{OH})_2$ (calcium hydroxide solution) which is an alkaline solution, a new compound is formed. This new compound is CaCO_3 (calcium carbonate) and causes the white precipitate in the solution. The side product of this reaction is water.

Sources:

1) http://www.iuz.tu-freiberg.de/files/PROFIS/chemie_glossar.pdf?PHPSESSID=a442565f9e9534395241051a462a9da7 14:52 June 9th 2007

2) http://www.seilnacht.com/Chemie/ch_cuo.htm 15:07 June 9th

3) Chemie Kompakt P.67. Vienna, Austria: tosa-verlag. 2005.

4) Erlebnis Chemie Heute 4. P. 37. Vienna, Austria: E. Dorner; 2004.

5) Mag. Elisabeth Klemm

Comparison of copper and copper oxide

Copper (Cu):

Elemental copper is a transition metal with the atomic number 29. Its state of matter is usually solid and it can be found in nature as a nugget or can be produced by a chemical process with chalcopyrite. It is most commonly used for making electric cables, coins, decoration and many other things.

Copper(II)-oxide (CuO):

It is a chemical compound between copper and oxygen. In nature it often can be found as the mineral Tenorit. Copper oxide is non soluble in water and alcohol but in some acids. It is not only used to dye glass, porcelain and ceramic but also in batteries, as a catalyst or to desulphurise crude oil.

	Copper	Copper oxide
melting point:	1084,4 °C (1357,6 K)	1326 °C
boiling point:	2567 °C (2840 K)	1026 °C
matter of state:	solid (salmon metal)	solid (black powder)
danger symbol:	none	harmful
electric conductivity:	58 · 106 S/m	doesn't transport electricity
density:	8920 kg/m ³	6,4 g/cm ³

Sources:

6) <http://de.wikipedia.org/wiki/Kupfer%28II%29-oxid> 10:40 June 10th

7) <http://de.wikipedia.org/wiki/Kupfer> 10:51 June 10th