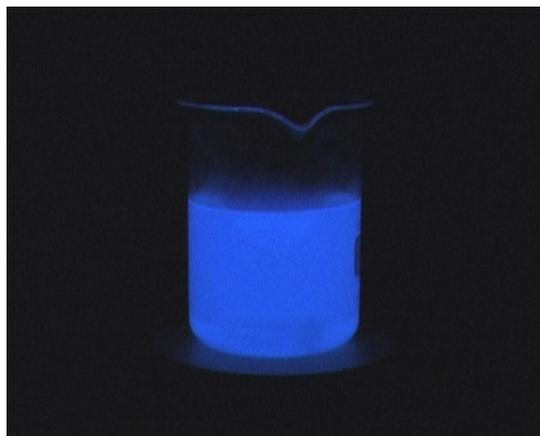


Chemical Light Buoy



Equipment:

three volumetric flasks (1000 mL)
two beakers (250 mL)
beaker (500 mL)
beaker (1000 mL)
graduated cylinder (50 mL)
two graduated cylinders (200 mL)
graduated cylinder (300 mL)
hotplate stirrer with stir bar
spatula

Chemicals:

hydrogen peroxide solution (30 % w/w)
potassium thiocyanate
copper sulfate pentahydrate
sodium hydroxide
luminol

Safety:

hydrogen peroxide solution (H₂O₂):



H302, H315, H318, H335
P280, P302 + P352, P305 + P351 + P338, P310

potassium thiocyanate (KSCN):



H302 + H312 + H332, H412
P261, P280, P302 + P352

copper sulfate pentahydrate (CuSO₄ · 5 H₂O):



H302, H318, H410
P273, P280, P301 + P312, P305 + P351 + P338, P330

sodium hydroxide (NaOH):



H290, H314
P280, P301 + P330 + P331, P305 + P351 + P338, P310

luminol (C₈O₇N₃O₂):



H302, H315, H319, H335
P280, P302 + P352, P304 + P340, P305 + P351 + P338

The chemicals cause very severe skin burns and eye damage. Therefore, it is absolutely necessary to wear a lab coat, safety goggles and protective gloves.

Procedure:

Preparation: The following solutions have to be prepared:

Solution A: 0.15 M KSCN: 14.55 g of potassium thiocyanate are dissolved in deionized water. Subsequently, the volume is made up to 1000 mL with deionized water.

Solution B: 6×10^{-4} M $\text{CuSO}_4 \cdot 5 \text{H}_2\text{O}$: 0.15 g of copper sulfate pentahydrate are dissolved in deionized water. Afterwards, the volume is made up to 1000 mL with deionized water.

Solution C: 0.1M NaOH and 3.7×10^{-3} M luminol: 4 g of sodium hydroxide are dissolved in 100 mL of deionized water and then 0.55 g of luminol are added while stirring. This solution is subsequently filled up to 1000 mL with deionized water.

Procedure: The 1000 mL beaker is placed on the hotplate stirrer. 150 mL of solution A are poured into the beaker. Subsequently, 300 mL of solution B and 150 mL of solution C are added while stirring. Then, the solution is heated to a temperature of about 45 °C. When the desired temperature is reached, 30 mL of the hydrogen peroxide solution are added. Then, the lights have to be switched off.

Observation:

After a short while, the solution produces an iridescent sky blue glow for about one second. The light pulses appear nine or ten times with intervals of about thirty seconds in between before the reaction stops. When the lights are turned on, one can observe an evolution of gas.

Explication:

In the present experiment, a chemiluminescent substance (luminol) interacts with a oscillating system (Cu(II)-catalyzed reaction between H_2O_2 and KSCN). Because of the light emission, such chemiluminescent oscillating reactions are especially fascinating.

Whereas the heating of the solution to a temperature of about 45 °C enhances the effect during the demonstration by decreasing the oscillation periods compared to room temperature, a temperature above 55 °C should be avoided because the oscillations would last for only a short time. The light emission would be even quenched at a temperature of 65-70 °C.

Disposal:

After the experiment, the solution is concentrated in a water bath and the residue is collected in the container for heavy metal waste.

Reference:

H. W. Roesky: „Glanzlichter chemischer Experimentierkunst“, Wiley-VCH (2006), p. 131-132 (in German)