The University of Texas at Austin
Department of Chemistry
College of Natural Sciences

Genie in a Bottle: The Decomposition of Hydrogen Peroxide by Manganese Catalysts

Preparer's Version

Introduction

The catalyzed decomposition of 30% hydrogen peroxide, facilitated by manganese(III) oxide, is a notable chemical reaction that demonstrates both thermodynamic and kinetic principles. Thermodynamically, the reaction involves breaking the bonds within hydrogen peroxide molecules to form water and oxygen gas. This process requires energy to break apart the stabilizing bonds of the reactants, but releases even more energy once bonds are formed in the products, making it ultimately exothermic. However, without a catalyst, the decomposition of hydrogen peroxide occurs at a relatively slow rate due to the high activation energy barrier required to initiate the reaction. The decomposition of hydrogen peroxide can be described by the reaction below:

$$2H_2O_2\,(\ell) \xrightarrow{Mn_2O_3} 2H_2O\,(\ell) + O_2\,(g)$$

Safety Hazards

- Personal Protective Equipment:
  - Safety glasses/goggles
  - Nitrile gloves
  - Chemical & flame retardant lab coat
- Physical Hazards
  - Hydrogen peroxide is extremely flammable and may intensify fire.
  - Manganese (III) oxide can release reactive gases.
- Chemical Hazards
  - Hydrogen peroxide is harmful if swallowed or inhaled and may irritate skin and eyes.
  - Manganese (III) oxide may cause skin irritation and eye damage.

Materials

- Plastic 2 L soda bottle *or* 250 mL Erlenmeyer flask
- 50 mL 30% Hydrogen peroxide
- Manganese (III) oxide powder
- Metal scoopula

Safety Data Sheet(s)

- Manganese (III) oxide
- Hydrogen peroxide

Procedure

1. Measure 50 mL of 30% hydrogen peroxide. Keep the hydrogen peroxide in the refrigerator until immediately before the demonstration to preserve its reactivity.
2. Provide a sample of solid manganese(III) oxide. This can either be in the original container or a smaller quantity in a prep bottle.

Tips & Tricks

- The faster the manganese(III) oxide is added, the faster the reaction will take place. Make sure the performer takes a heaping scoop, but can still dump it into the reaction vessel quickly.

Clean-Up Procedures

1. Wait until the bottle has cooled off and finished reacting to screw the cap back on the plastic bottle or to place a rubber stopper in the flask. The reaction is extremely exothermic and generates gas, and capping/sealing it too early could be very hazardous.
2. Keep segregated from other waste and request for pickup.