14.3 Catalytic Decomposition of H_2O_2 I – "Elephant's Toothpaste"

Subjects: Kinetics, catalysis, exothermic reactions

Description: When a catalyst is added to hydrogen peroxide along with some dish soap, a large amount of foam is produced.

Materials:
1 L graduated cylinder*
plastic tray (or use sink)
50 mL 30% H_2O_2‡
dishwashing detergent
Solid KI or NaI (~1/4 spatula)‡

*1L graduated cylinder is located on the prep shelf.
‡The 30% H_2O_2 is located in the refrigerator. The KI and NaI are located in the general chemical storage cabinets.

Procedure:
Note: Perform this demo in the sink or in an extra demo bin.
1. Place H_2O_2 in the cylinder.
2. Add the dishwashing detergent drop wise down the side of the cylinder to produce a layer of soap.
3. Add the KI or NaI.
4. The oxygen evolved produces a large volume of foam with the dish soap. The toothpaste-like foam will rise from the graduated cylinder in a column (i.e. elephant's toothpaste).

Discussion:
The decomposition of H_2O2 to O_2 and water occurs on its own. The rate of the reaction can be substantially increased with the addition of a catalyst. Several substances, including potassium iodide, sodium iodide and manganese dioxide are known to catalyze the reaction.

Overall reaction: $2H_2O_2(aq) \rightarrow 2H_2O(l) + O_2(g) + heat$

Hydrogen peroxide is catalyzed by iodide ion in a two-step process shown below. The IO- ion is believed to be the reaction intermediate:

$H_2O_2(aq) + I^-(aq) \rightarrow H_2O(l) + OI^-(aq)$

$H_2O_2(aq) + OI^-(aq) \rightarrow H_2O(l) + O_2(g) + I^-(aq)$

The oxygen generated creates bubbles in the soap to produce a toothpaste-like foam. A glowing splint can be used to test that the gas produced is oxygen. This experiment demonstrates the concept and utility of catalysts.

Safety: Concentrated H_2O_2 can cause burns. Be sure to wear gloves and goggles when performing this experiment.

Disposal: The reaction contents can be flushed down the drain with plenty of water.

References:

1. L. Summerlin, J. Ealy; *Chemical Demonstrations: A Sourcebook for Teachers*; Volume 1; 1985; p. 71.
2. NCSU Department of chemistry lecture demonstration website: http://www.ncsu.edu/project/chemistrydemos/DemoList.html