Catalytic Decomposition of H_2O_2 – Elephant's Toothpaste

Description: The iodide ion (from KI or NaI) is used as a catalyst to decompose H_2O_2, liberating water, oxygen and heat.

Materials:

30% H_2O_2	1 L Graduated cylinder
KI or NaI	Food coloring
Liquid dish detergent	Large bin

Procedure:

1. Pour 50 mL of 30% H_2O_2 in the 1 L graduated cylinder. Add 3 drops of food coloring. Add a small layer of liquid dish soap to the colored H_2O_2 solution by adding the soap drop wise down the side of the graduated cylinder.

2. To generate toothpaste, add KI (or NaI) from a half-filled spatula to the H_2O_2 solution. Oxygen gas generated from this reaction will create large amounts of colored foam which will rise out of the graduated cylinder. To test for oxygen gas, a glowing wood splint can be reignited by placing it near the emerging foam.

3. A variation of this demonstration for a higher level chemistry class which also demonstrates an enzymatic decomposition of H_2O_2 is detailed in the Lister reference.

Discussion: The decomposition of hydrogen peroxide yields oxygen and water. The reaction is catalyzed by the iodide ion (I^{1-}) from KI (or NaI) as shown in the two-step process below. 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.

$$H_2O_2\,(aq) + I^-_{(aq)} \rightarrow H_2O\,(l) + IO^-\,(aq)$$

$$IO^-\,(aq) + H_2O_2\,^{(aq)} \rightarrow H_2O\,(l) + O_2\,(g) + I^-\,(aq)$$

Overall Reaction: $2\,H_2O_2\,(aq) \rightarrow 2\,H_2O\,(l) + O_2\,(g)$

Safety: Wear proper protective equipment including gloves and safety glasses when preparing and performing this demonstration. Concentrated hydrogen peroxide can cause burns.

Disposal: Remaining solution can be flushed down drain with plenty of water.

Reference:

Shakhashiri, B. Z. In Chemical Demonstrations: A Handbook for Teachers of Chemistry; The University of Wisconsin Press: 1983; Vol. 1, p 180-185.

Trujillo, C. A. J. Chem. Educ. **2005**, 82, 855.

Conklin, A. R.; Kessinger, A. J. Chem. Educ. **1996**, 73, 838.

Lister, T. In Classical Chemical Demonstrations; The Royal Society of Chemistry: 1996; p 145-146.

Video:

http://www.youtube.com/watch?v=tnB-uU3w6g8

http://www.youtube.com/watch?v=ezsur0L0L1c

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