The Activated Complex

Purpose

To demonstrate the observation of an activated complex and its action.

Materials

hot water bath
600 mL beaker
cobalt (II) chloride
hydrogen peroxide
potassium sodium tartrate

Solution A: Sodium potassium tartrate: 12 grams $KNaC_4H_4O_6 \bullet 4\ H_2O$ per 200 mL of water.

Solution B: Hydrogen peroxide: Use a 6% solution. Add 40 mL of 30% H_2O_2 per 200 mL of solution.

Procedure

1. Place 200 mL of Solution A in a 600 mL beaker.
2. Warm the solution gently to about 70 C on a hot plate.
3. Add 80 mL of Solution B to the beaker.
4. Add cobalt (II) chloride crystals to the solution.
5. A vigorous reaction will occur. Note the appearance of the green activated complex and the extensive bubbling.

Additional Information

1. This reaction involves the oxidation of tartaric acid [$HO_2CCH(OH)CH(OH)CO_2H$] by hydrogen peroxide in the presence of cobalt (II) chloride catalyst.
2. The green color is due to the formation of a cobalt-tartrate activated complex.
3. Not that the original catalyst, cobalt (II) chloride is pink. As the tartrate is oxidized, the activated complex is broken down to the original catalyst, and the pink color returns.
4. Oxygen and CO_2 gases are produced. Oxalic acid (HO_2CCO_2H) is also produced.
5. Do not exceed 70 C or the solution may froth and overflow.
6. This demonstration also shows the relationship between temperature and reaction rate. Typically, an initial temperature of 50, 60 or 70 C will produce a reaction time of 200, 90, or 40 seconds, respectively.
7. As a general rule, increasing the temperature of reaction by 10 C will double the rate of reaction.

Disposal

Solutions/solids should be placed in a properly labeled waste container with UI# 96493.

Reference

Summerlin, L. and Ealy, J. Chemical Demonstrations: A Sourcebook for Teachers, 1985