DEMONSTRATION 7.10

THE PRODUCTION OF AN ACTIVATED COMPLEX

A pink cobalt catalyst is added to a solution of sodium potassium tartrate and hydrogen peroxide. A green activated complex is formed and the reaction proceeds. When the green complex disappears, the reaction ceases.

EQUIPMENT

- 600 mL beaker
- 2 x 250 mL beakers
- 100 mL measuring cylinder
- hot plate
- spatula
- scales
- thermometer

REAGENTS

- sodium potassium tartrate-4-water, $NaKC_4H_4O_6 \cdot 4H_2O$ (12 g)
- hydrogen peroxide, H_2O_2 (5%, 80 mL)
- cobalt(II) chloride-6-water, $CoCl_2 \cdot 6H_2O$ (9–13 g)
- distilled water (300 mL)

PREPARATION

- Prepare a solution of sodium potassium tartrate (200 mL) by dissolving 12 g of $NaKC_4H_4O_6 \cdot 4H_2O$ in distilled water (200 mL) in a 250 mL beaker.
- Prepare a solution of 5% hydrogen peroxide by adding 20 mL of 30% hydrogen peroxide to 100 mL of distilled water in the other 250 mL beaker.
- Pour 80 mL of the 5% hydrogen peroxide into the measuring cylinder.
- Heat the hot plate to 70˚C .

PROCEDURE

- Pour the sodium potassium tartrate (200 mL) solution into the 600 mL beaker and place it on the hot plate. Checking with the thermometer heat the solution to 70˚C.
- Add the hydrogen peroxide and the cobalt(II) chloride-6-water.

RESULTS

This reaction involves the oxidation of tartaric acid $HO_2CCH(OH)CH(OH)CO_2H$ by hydrogen peroxide in the presence of a cobalt(II) chloride catalyst. It is a complex set of reactions involving the production of carbon dioxide, carbon monoxide and oxygen. The green colour is due to the formation of a cobalt-tartrate activated complex. Note that the original catalyst, cobalt(II) chloride, is pink in aqueous solution. As the tartrate is oxidized, the activated complex is broken down to the original catalyst, and the pink colour returns. Oxygen and carbon dioxide gases are also produced. Oxalic acid, HO_2CCO_2H, is probably produced also.

This demonstration can also be used to show the relationship between temperature and the reaction rate. Typically, initial temperatures of 50, 60 or 70˚C produce a reaction times of 200, 90 or 40 seconds, respectively. Thus as a general rule, increasing the temperature of reaction by 10˚C will double the reaction rate.