

Le Chatelier's Principle

Purpose

To demonstrate how the equilibrium position of a gaseous reaction shifts when the volume of the container is changed.

Materials

100 mL graduated cylinder	copper metal
250 mL Erlenmeyer flask	concentrated HNO ₃
one hole stopper	2 feet tygon tubing
2 oz. plastic syringe plunger	

Procedure

1. Use lecture bottle of NO₂ to fill the Erlenmeyer flask. DO THIS IN THE HOOD!
2. Immediately place the stopper on the flask and insert the other end of the tygon tubing into the 100 mL graduated cylinder. This will allow the NO₂(g) formed in the flask to flow into the cylinder.
3. After enough NO₂(g) has flowed into the cylinder to give a medium brown color, place the plunger from the syringe into the top of the graduated cylinder, trapping the gas.
4. Suddenly push the plunger from the 100 mL mark to about the 50 mL mark causing the concentration of the NO₂ to approximately double. Notice the darkening of the color of the gas.
5. Continue holding the plunger at the 50 mL mark and observe that the color lightens as the equilibrium shifts.
6. The process can be repeated any number of times.

Additional Information

1. The equilibrium reaction occurring in the graduated cylinder is:
$$2 \text{NO}_2(\text{g}) \rightleftharpoons \text{N}_2\text{O}_4(\text{g}) \quad \text{brown colorless}$$

As the plunger is suddenly pushed in, halving the volume, the NO₂ concentration is doubled. This causes the equilibrium to shift to the right, toward the colorless N₂O₄, illustrating Le Chatelier's Principle, which predicts that if the volume of the vessel containing a gas phase equilibrium reaction is decreased, the position of the equilibrium shifts toward the side with fewer molecules.
2. Warning NO₂(g) is a highly toxic, highly corrosive gas. The NO₂(g) should be generated in a fume hood.
Alternative method for NO₂ generation:

- a. Insert a piece of glass tubing into the one hole stopper and connect the tygon tubing to it.
 - b. Place a few grams of copper metal in the 250 mL Erlenmeyer flask.
 - c. In a hood, pour enough concentrated HNO_3 onto the copper in the Erlenmeyer flask to cover the copper pieces.
3. Rinse the plunger with water immediately after use to minimize the corrosive effects of the NO_2 on the rubber seal.
4. Trial and error is necessary in order to find a 100 mL graduated cylinder with the correct size bore for the plastic plunger. A snug fit is essential for correct functioning of the demonstration.

Reference

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