Making an Instant Cold Pack

Introduction

Ever used a cold pack on an injury? This quick and easy procedure will demonstrate how to make a cold pack with chemicals. The process in making the cold pack is not a chemical reaction but merely the physical act of dissolving. When ammonium nitrate is dissolved in water, the process is endothermic, thus producing the cold pack.

Concepts

- Heat of solution
- Endothermic process

Background

Thermodynamics is the study of energy changes in a system. In chemistry, thermodynamics is usually the study of heat transfer and work that accompanies chemical reactions or changes of state. Enthalpy is a measure of the heat content of a system. The heat transfer into or out of a system at constant pressure is equal to the enthalpy change and is symbolized by ΔH. The enthalpy change is simply the difference in the enthalpy of the starting materials (usually the reactants) and the ending materials (usually the products). The enthalpy of a system will almost always change when the physical state of a material changes (e.g., a solid melting or solute dissolving in a solvent). When looking at the enthalpy change of a system, it is extremely important to understand the difference between the system and the surroundings. Typically, the system is only the reactants and products of the reaction.

The rest of the universe (solvent, containers, atmosphere above the reaction, or students) are part of the surroundings and are not included in any enthalpy calculations for the system.

$\Delta H = qp$ — where qp is the heat transferred to or from a system at constant pressure

$\Delta H = \Delta H_f(\text{products}) - \Delta H_f(\text{reactants})$ for a reaction—where ΔH_f is the enthalpy of formation

$\Delta H = \Delta H_f(\text{final}) - \Delta H_f(\text{initial})$—for a process

Sometimes a reaction or process requires heat to proceed and the system will take heat from the surroundings. Since heat is being removed from the surroundings, the reaction vessel will feel cool. This means that the enthalpy of the products is higher than the enthalpy of the reactants and heat is one of the reactants. This is called an endothermic reaction (endo = "into"). A common example of an endothermic process is the melting of ice. Solid water (ice) needs heat energy to help break apart the forces holding it together as a solid. The heat flowing into the ice will cool the surroundings.

When ammonium nitrate is dissolved in water, heat is required to break apart the forces holding the ammonium nitrate together as a crystal.

The process is endothermic and is represented by the following chemical and enthalpy equations.

$NH_4NO_3(s) + H_2O(l) + \text{heat } NH_4NO_3(aq)$

$\Delta H = \Delta H_f(\text{products}) - \Delta H_f(\text{reactants})$

$\Delta H = \Delta H_f(NH_4NO_3(aq)) - \Delta H_f(NH_4NO_3(s))$

$\Delta H = -339.9 \text{ kJ/mole} - (-365.6 \text{ kJ/mole}) = 25.7 \text{ kJ/mole}$

Materials

Ammonium nitrate (NH_4NO_3), 100 grams
Water, tap, 200 mL
Ziplock plastic bag, 1 quart size
Balance, 1-g precision
Graduated cylinder, 500 mL
Weighing dish

Safety Precautions

Ammonium nitrate is a strong oxidizer and may explode if heated under confinement; will explode at temperatures of 250 °C and explodes more readily if contaminated with combustible material. Ammonium nitrate is also toxic by ingestion and inhalation and is a

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skin, eye and respiratory irritant. Wear chemical resistant goggles, chemical-resistant gloves, and a chemical-resistant apron. Wash hands thoroughly with soap and water when finished. Make sure the bag is sealed before squeezing it to avoid spillage. Please review current Material Safety Data Sheets for additional safety, handling, and disposal information.

Procedure

1. Weigh out 100 grams of ammonium nitrate in a tared weighing dish.
2. Transfer the ammonium nitrate into a one-quart zipper-lock plastic bag.
3. Using a graduated cylinder, measure out 200 mL of water.
4. Quickly, but carefully, pour the water into the bag of ammonium nitrate, and seal the bag. (Try to remove the excess air before sealing the bag.)
5. Gently squeeze the bag to mix the solid and water.
6. Let the students feel the bag. It becomes cold within seconds and will remain cold for about 20 minutes.

Disposal

Please consult your current *Flinn Scientific Catalog/Reference Manual* for general guidelines and specific procedures, and review all federal, state and local regulations that may apply, before proceeding. The ammonium nitrate solution may be disposed of according to Flinn Suggested Disposal Method #26a. Rinse the plastic bag with water and dispose of it in the trash.

Connecting to the National Standards

This laboratory activity relates to the following National Science Education Standards (1996):

Unifying Concepts and Processes: Grades K–12
Evidence, models, and explanation
Constancy, change, and measurement
Content Standards: Grades 5–8
Content Standard B: Physical Science, properties and changes of properties in matter
Content Standard E: Science and Technology
Content Standards: Grades 9–12
Content Standard B: Physical Science, structure of atoms, structure and properties of matter, chemical reactions
Content Standard E: Science and Technology

Reference

O'Brian, Don, Sue Berger, Herb Bryce, Nancy Gettman, Larry Squires. Chem Pacs. Flinn Scientific, Inc., Batavia, 1989.

Materials for *Making an Instant Cold Pack* are available from Flinn Scientific, Inc.

Catalog No.	Description
A0241	Ammonium Nitrate, 100 g
A0055	Ammonium Nitrate, 500 g

Consult the Flinn Scientific website for current prices.