P Chem Lab

Heat of Solution: Hot Packs

Introduction

There are several types of commercial hot packs. In one type a supersaturated solution is allowed to crystallize. Usually this material is **sodium acetate**. In another type the rapid oxidation of **iron** is used to produce heat. In yet another type of hot pack the heat of solution of an ionic compound is used. This type of reaction can be used to make either hot or cold packs. In the classic hot pack, there is a small inner bag containing water. This is put into another bag with a fixed amount of anhydrous **calcium chloride**. To activate the hot pack, the inner bag is crushed, and the water and $CaCl_2$ are shaken together. The exothermic reaction occurring when the $CaCl_2$ dissolves releases the heat needed to reach the desired temperature. Hot packs are available in either of two temperature ranges, 120° - 130° F (49°-54°C) and 150-160°F (66°-71°C). Cold packs have a similar design with ammonium nitrate (NH_4NO_3) used in place of the $CaCl_2$ and a temperature range of 37°-41°F.

Purpose

You are working for a company called ***Household Injuries***. The management wants you as a research chemist to develop a mathematical model for your hot packs. Each pack is to contain 100 ml of water and is contained in a double walled zip-lock bag type of package. Your job is to determine how much $CaCl_2$ must be present in any hot pack that your company decides to produce. This will allow the business folks and chemical engineers to develop a cost analysis for the hot packs.

Procedure

You are to devise the specific procedure for this lab. In general you want to take 100 ml of water, add some $CaCl_2$, stir and measure its maximum temperature. Repeat this procedure for various amounts of solid. Around 10 g increments of $CaCl_2$ is probably appropriate. An example of a data table is below. Make sure your data table is in your lab notebook.

grams $CaCl_2$	**initial temp (°C)**	**final temp (°C)**	**ΔT (C°)**

Data Analysis

In some appropriate fashion plot the data. Use *Graphical Analysis, Excel* or another curve-fitting program to determine the best equation for this relationship. You may need to be able to extend the range of this model past the values tested (depends on your data), so think about the shape of the mathematical model that you choose as well as the fit within the range tested.

Write-up

Your write-up should be in the form indicated in the syllabus. Be sure and include appropriate background info from the references in the introduction section. Don't forget to include a discussion of sources of error in the conclusion section. No propagated error is necessary for this lab.

References: *J. Chem. Ed*., 71(9), Sept. 1994, 791.
"Hot and Cold Packs", *ChemMatters*, February, 1987