COSMOS 2013 Cluster 3
Living Oceans and Global Climate Change

Latent Heat Experiment

Instructor: Prof Joel Norris
Teaching Fellow: Megan Jones
Teaching Assistant: Jacob Sanchez

References: "Supercooled Sodium Acetate Solution."
Demo 42: Supersaturated Sodium Acetate Solution.
UC San Diego Department of Chemistry and Biochemistry

Objectives:
As part of the demonstration, the student will be able to:
1. Understand the concept of latent heat
2. Observe a noticeable state change from liquid to solid and what effects accompany it
3. Extrapolate what they have seen on a bigger scale and recognize its role in global climate change

Introduction:
When molecules go from the liquid phase to the less energetic solid phase, that energy is released from the molecules to the environment. That energy of the phase change is called latent heat. Many have experienced this concept with commercially available sodium acetate heat pads. This experiment works exactly like these heat pads.

At temperatures above 58 C, sodium acetate trihyrdate begins to lose its water of hydration and begins to dissolve in that water. The solution, once completely dissolved, can be cooled to give a solution which is supersaturated in a liquid state. In the presence of a seed crystal, this solution will “freeze” but in doing so must reach its freezing point which is 58 C and thus the crystallizing solution warms up as it releases latent heat.

A larger amount of latent heat is involved with the phase change of water. Through this transfer of latent heat, the water cycle determines surface and atmospheric conditions, as well as atmospheric circulation. Evaporative cooling and condensation heating moderate the surface temperature. Without this cooling and heating, daily temperature range would be significant, much like that of planets such as Mars or Venus, or of blacktop asphalt in summer.

Experimental:
Each trial needs the following:

1 Erlenmeyer flask
30 g Sodium Acetate Trihyrdate ($C_2H_9NaO_5$)
9 mL of water (about 2 teaspoons)
1 Hot plate
Weighing Scale

Scoopula or Teaspoon

***Sodium Acetate Trihydrate is a potential irritant and should be handled with care.

COMBINE the measured amount of Sodium Acetate Trihydrate with the water in an Erlenmeyer flask.

GENTLY shake the flask to dissolve as much of the Sodium Acetate Trihydrate as you can.

Place the flask onto the hot plate at a MEDIUM heat level to completely dissolve the rest of the crystals. The solution should be completely CLEAR, ALMOST WATER-LIKE.

When there are NO MORE CRYSTALS, take it off of the hot plate and cover the flask with a watch glass, saran wrap, etc. to keep the solution clean and pure.

Let cool until the flask is at or below room temperature. To expedite the cooling process, you can surround the flask in ice or cold water.

Move solutions WITH CAUTION as a slight bump can cause the solution to crystallize.

When the solution is completely clear and is at the appropriate temperature, uncover the flask and ADD a very small amount of sodium acetate to the solution. The solution should begin to crystallize IMMEDIATELY.

FEEL the bottom of the flask with a hand and note the heat coming emitted from the chemical reaction.

For a more visible effect, you can increase the amount of Sodium Acetate and water as long as you keep a 10 g $C_2H_9NaO_5$/3 mL H_2O ratio.

DISPOSAL: The materials in this demonstration can be reused. If materials are to be disposed of solid should be dissolved in water and placed in an appropriate aqueous waste container.

Afterthoughts

During this experiment, you should have observed the following:

1. The solution required heat to move from solid to liquid
2. The solution remained in a liquid state even after it was cooled past its freezing point
3. The solution emitted heat as it was crystallized after the addition of a very small amount of Sodium Acetate Trihyrdate

Why was heat emitted when the solution began to crystalize?

How can we relate this experiment and its results to certain processes that fuel global climate change?