Designing a Heat Pack

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ABSTRACT

In order to heat a cold hand, the temperature of the hand must be warmed from 15˚C to 37 ˚C. The object of the experiment was to make a heating pack that would be able to heat a cold hand. In order to make a heat pack, the correct kind of salt needed to be used; this salt would have to be exothermic. The heat pack was a success because the right amount of heat (46.2ºC) was released without being too hot. The enthalpy change, ΔH, measures how much heat is released. The enthalpy change was calculated to be -143.3 kJ/mol.

PROCEDURE

Three salts (Sodium Chloride, Potassium Chloride, and Calcium Chloride) were considered for this experiment. Computer generated simulations were performed in order to figure out which salt would be best for the experiment. Both Sodium Chloride and Potassium Chloride were endothermic, meaning they were unable to give off any heat. Calcium Chloride was chosen to be dissolved in water because it was the only exothermic salt provided. Measurements were made in order to determine heat flow and use the correct amount of salt and water to release enough heat to warm a hand. Many trials were performed in order to have a good idea of how much heat needed to be released. Based on previous results, a heat pack was designed. The amount of salt and water needed to heat the hand was determined. The heat pack was tested by the use of a foam cup calorimeter. Calcium Chloride was dissolved in water in the foam cup calorimeter. The temperature change was measured and the heat released (q) was calculated. The enthalpy change was determined by a calculation; the enthalpy change measures how much heat is released per mole of salt dissolved.

RESULTS AND DISCUSSION

Many trials were performed to determine the heat given off by the dissolution of Calcium Chloride. In order to determine this heat given off, the mass of salt and volume of water were changed. The equation (q=-mc(Tf-Ti)) was used to determine the amount of heat released. Trial results are shown in Figure 1.

Trial	**Mass of salt used (g)**	**Volume of water (mL)**	**Mass of solution (g)**	**Initial Temp. ºC**	**Final Temp. ºC**	**Heat (q) released (J)**
1	2.0g	100mL	102g	24 ºC	27.50 ºC	-1492.96 J
2	4.0g	100mL	104g	24 ºC	30.86 ºC	-2983.18 J
3	4.0g	200mL	204g	24 ºC	27.50 ºC	-2984.52 J
4	5.0g	200mL	205g	24 ºC	28.35 ºC	-3727.52 J
5	1.0g	50mL	102g	24 ºC	27.50 ºC	-746.13

Figure 1. Trials performed in order to determine how much heat was released in the reaction. While decreasing the amount of salt and water, q decreased.

Based on the results in Figure 1, it was determined that about 24,010 J would be needed in order to warm the hand from 15 ºC to 37 ºC. Based on a calculation (-24101=-(x) (4.18 J g-1 ºC-1) (37-15)) it was determined that 260mL of water and 1.1g of salt should be used. The group combined with another and agreed upon the use of 20.963g of salt and 200mL of water.

In order to test the heat pack, the mass of the solution, initial temperature, and final temperature were measured in order to calculate the heat released (q). The results from the trial are shown in Figure 2.

Trial	Mass of solution (g)	Initial Temp. ºC	Final Temp. ºC	q (J)
1	221.747g	17.0 ºC	46.2 ºC	-27060 J

Figure 2. Trial performed in order to determine how much heat is released in the heat pack. The final temperature was enough to warm a hand from 15 ºC to 37 ºC without being too hot. The value of q was extremely close to the amount of heat required.

The enthalpy change (ΔH) was determined by the equation:

ΔH (kJ/mol) = q(J)/mass of salt used (g) x [molar mass of salt (g/mol)] x 1 kJ/1000J)

The calculation of the enthalpy change came out to -111.2 kJ/mol

As a whole, the experiment was a success as the group was able to design a heat pack in order to heat a hand from 15 ºC and 37 ºC.