Chemistry of Our Environment – Lab

Energy Measurement – Heat of Neutralization

Introduction:

All chemical reactions involve changes in the substances present and energy changes. These energy changes most commonly are in the form of heat changes. Heat is either absorbed by the reaction or given off by the reaction. Having information about the energy changes is important, especially in industrial production, where small heat changes in the laboratory can translate to huge heat changes, perhaps dangerously so, when room size vats are used in large scale production. The study of heat changes is called calorimetry. A calorimeter is an instrument that is used to help chemists measure heat changes during a reaction. In today’s experiment we will use a crude calorimeter to measure the heat change that takes place when an acid reacts with a base, a reaction known as neutralization. Hence this particular heat change is called Heat of Neutralization.

Procedure:

1) Prepare a setup similar to the one pictured below. Any modifications needed will be provided by your instructor.

2) Measure out 50 mL of 1 M NaOH (sodium hydroxide) in a graduated cylinder. Measure out 50 mL of 1 M HCl (hydrochloric acid) in another graduated cylinder.
3) Turn on the magnetic stirrer and make sure the thermometer is about 1 inch from the bottom of the calorimeter. Make sure the stirrer is not hitting the thermometer.

4) Measure the temperature of the NaOH and the HCl solutions. They should be at the same temperature. If not, wait 5 minutes and measure again. Record this temperature as the initial temperature.

5) Pour the 2 solutions into the calorimeter and begin monitoring the temperature inside the calorimeter. Record the highest temperature reached by the mixture as the final temperature.

6) Discard the solutions as directed by your instructor and wipe out the calorimeter with a paper towel. Get it as dry as possible.

7) Repeat steps 2 through 5 and record the data under Trial #2.

Calculations:
Heat of Neutralization can be calculated using the following formula:

\[
\text{Heat of neutralization} = (\text{final T} - \text{Initial T}) \times \text{(mass of the solution)} \times \text{(specific heat of H}_2\text{O)}
\]

Or in our case

\[
\text{Heat of neutralization} = (\text{final T} - \text{Initial T}) \times (100 \text{ g}) \times (4.184 \text{ joules/ g}\cdot{}^\circ\text{C})
\]

Calculate the heat of neutralization for each trial and then average the 2 results. Report the average. The units will be joules.

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<th>TRIAL #1</th>
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Questions:

1) How much heat would be generated if 500 liters of each solution were used. Remember that the mass of each ml is 1.0 grams. Compare this to the heat generated when the same amount of heating oil is burned, which is approximately 34.5 million joules. Would you want to use the neutralization of NaOH and HCl as a source of heating your house?