

Determination of Energy of Combustion for Alcohols

Introduction

Energy is released when alcohols undergo combustion. In this experiment you will determine how much heat is released, the enthalpy of combustion, ΔH_c in kJ mol^{-1} .

What is the source of energy? Energy is needed to break chemical bonds and energy is released when chemical bonds form. The main source of energy for the combustion of alcohols is found in the balance of these energy exchanges. When an alcohol undergoes combustion, more energy is released when the bonds form to make the products than is needed to break the bonds in the reactants.

The amount of heat produced will depend on the amount of alcohol burned. If the mass of alcohol undergoes combustion is known, then the molar heat of combustion can be determined.

The procedure is to determine the temperature increase of a known mass of water by adding to it the heat produced by the combustion of a known mass of alcohol.

Prelab Assignment

1. From the Introduction, formulate a problem statement.
2. From the Procedure,
 - a) state the manipulated and responding variables
 - b) list some controlled variables,
3. Prepare data tables for your observations and measurements.
4. Write balanced equations for the combustion of methanol, ethanol, propanol and butanol.
5. Using bond dissociation enthalpies from the data table, calculate the enthalpy change for the combustion of methanol, CH_3OH , ethanol, $\text{C}_2\text{H}_5\text{OH}$, propanol, $\text{C}_3\text{H}_7\text{OH}$, and butanol, $\text{C}_4\text{H}_9\text{OH}$.

Procedure

Weigh the spirit lamp, (alcohol burner). Place measured amount of water that is $\sim 10^\circ\text{C}$ below room temperature. in a copper calorimeter (or beaker).

Take the temperature of the water.

Place the alcohol burner under the can, light it.

Stir the water with the thermometer and when the temperature has risen $\sim 10^\circ\text{C}$ above room temperature extinguish the lamp and record the final temperature.

Reweigh the lamp and its contents.

Repeat the experiment with each of the four alcohols provided.

Processing The Data

1. Determine the mass of alcohol combusted.
2. Determine the mols of alcohol combusted.
3. Determine the mass of water heated.
4. Determine the temperature change, ΔT , of the water.
5. Calculate the quantity of heat absorbed by the water in the can.
6. Calculate the heat of combustion of the alcohol (kJ mol^{-1}).
7. Draw a graph of ΔH_c (on the y-axis), against the molar mass of the alcohol (x-axis).
8. What relationship may be deduced from this graph.
9. Look at the Prelab assignment, and deduce a relationship about the type of bonds being broken in the reactant and the type of bonds formed in the products.
10. Is there a relationship between the number of molecules formed in the combustion of alcohol? (see Prelab assignment)
11. The substance dimethyl-ether, CH_3OCH_3 , has the same molar mass as ethanol, $\text{C}_2\text{H}_5\text{OH}$, but the enthalpy of combustion is different. Suggest a reason for this difference.
12. Assume some black soot formed on the bottom of the can of water during your experiment. Would this contribute to a high or low value for ΔH_c . Explain.
13. Evaluate the procedure, apparatus, manipulations and calculations and make suggestions on how to improve any weaknesses that you encountered during this lab.

Extension :

A green plant carrying out photosynthesis has been referred to as a “device for the destruction of entropy”. What do you think is meant by this phrase and how appropriate is it as a description of the chemistry of photosynthesis?