Data Base Lab: Determination of Enthalpy of Combustion for Alcohols

Introduction

Energy is released when alcohols undergo combustion. In this data base, experiments have been performed by students to determine how much heat is released when alcohols undergo combustion, the enthalpy of combustion, $?H_c$ 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 exchanged. 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 upon the amount of alcohol burnt. If the mass of alcohol undergoes combustion is known, then the molar heat of combustion can be determined.

The data provided in Data Table I and Table II are experimentally collected, where the temperature increase of a known mass of water was determined by the heat produced from the combustion of a known mass of alcohol. You will use these values to determine the enthalpy of combustion of several alcohols.

Data Table I: Qualitative Observations

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Alcohol	Observations
Methanol	• Clear, colorless liquid • Similar viscosity to water • Orange flame
Ethanol	• Clear, colorless liquid • Similar viscosity to water • Orange flame
Propanol, Butanol	• Clear, colorless liquid • Similar viscosity to water • Orange flame

Data Table II: Quantitative Observations

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Alcohol	**Mass Initial (±0.01g)**	**Mass Final (±0.01g)**	**Temp Initial of water (±0.1°C)**	**Temp Final of water (±0.1°C)**	**Mass of Water (±0.1g)**
Methanol	117.03	116.46	15.2	35.2	100.
Ethanol	125.88	125.33	15.0	34.8	100.
Propanol	134.46	134.08	14.7	35.2	100.
Butanol	121.92	121.58	14.2	34.5	100.

Prelab Assignment

1. From the Introduction, formulate a problem statement
2. Write balanced equations for the combustion of methanol, ethanol, propanol and butanol
3. Using bond dissociation enthalpies from the data table, calculate the enthalpy change for the combustion of the above listed alcohols.

Data Processing

1. Determine the mass of alcohol combusted
2. Determine the moles of alcohol combusted
3. Determine the mass of water heated
4. Determine the temperature, ? T, change of the water
5. Calculate the quantity of head absorbed by the water in the can
6. Calculate the heat of combustion of the alcohol (kJ mol^{-1}).
7. Create a Data Summary Table of all calculations.

Data Analysis

8. Plot a graph of ? H_c (on the y-axis), against the molar mass of the alcohol (x-axis).
9. What relationship may be deduced from this graph?
10. Deduce a relationship about the type of bonds being broken in the reactant and the type of bonds formed in the products.
11. Is there a relationship between the numbers of molecules formed in the combustion of alcohol?
12. The substance dimethyl-ether, CH_3OCH_3, has the same molar mass as ethanol, C_2H_5OH, but the enthalpy of combustion is different. Suggest a reason for this difference.
13. Assume some black soot formed on the bottom of the can of water during the experiment. Would this contribute to a high or lower value for ? H_c? Explain.

Conclusion

14. Summarise all data calculations and analysis.