

Determination of the Heat of Combustion of Alcohols

Student Handout

Purpose: To determine the heat of combustion of a series of alcohols.

Introduction

In this experiment, a measured mass of an alcohol is burned and the heat released is transferred to a calorimeter made from an aluminium can. The heat capacity (i.e. the heat required for a rise in temperature of 1 K) of the calorimeter is first determined by calibration with an alcohol of known molar heat of combustion (e.g. 715.0 kJ mol⁻¹ for methanol). From the rise in temperature of the water in the calorimeter you can calculate the heat of combustion of other alcohols.

Materials and Apparatus

Methanol



Ethanol, propan-1-ol



Aluminium can, datalogger with temperature sensor, alcohol lamps, electronic balance, clamp and stand, 250 cm³ measuring cylinder, metal tray.

Safety

The alcohols are highly flammable. Always place the alcohol lamp on a metal tray to contain any accidental spillage of alcohol. Carefully use the cap of the alcohol lamp to smother its flame. Avoid skin contact with the chemicals.



Experimental Procedures

1. Design a data table to record the results of the experiment.
2. Connect the temperature sensor to the datalogger. Connect the datalogger to the computer. Ensure the datalogging software is loaded and set to record the temperature of the sensor. Set the sampling rate to 1 sample per second.
3. Add about 250 cm³ water into the can.
4. Weigh the alcohol lamp with methanol, including the cap, and record the mass.
5. Clamp the can in an upright position so that it will be just above the flame of the burner when lit.
6. Start recording the temperature. After 30 seconds, light the alcohol lamp. Gently stir the water at frequent intervals using the temperature sensor. The temperature sensor should not touch the bottom of the can. When the temperature of the water has risen by 20 °C, extinguish the flame by replacing the cap. Continue stirring and record the temperature for an additional 2 minutes. Save your file of data.
7. Re-weigh the alcohol lamp and cap as soon as possible after extinguishing the lamp.
8. If you have time, repeat steps (6)-(7) to increase the accuracy of your calibration.

9. Repeat steps (4)-(7) using ethanol and propan-1-ol.
10. Calculate the heat capacity of the calorimeter and hence the heat of combustion of ethanol and propan-1-ol respectively.

Discussion Questions

1. Compare the heat of combustion of the 3 alcohols. Do you notice any pattern?
2. Comment on the accuracy of your results for the heat of combustion of the alcohols. Give suggestions to improve the design of the experiment.
3. Using your results and the following information, explain whether the heat capacity of the aluminium can be ignored.

Specific heat capacity of water = $4.2 \text{ kJ kg}^{-1} \text{ K}^{-1}$