UNIVERSITY OF SCIENCE AND TECHNOLOGY OF HANOI

DEPARTMENT OF SPACE AND APPLICATION

THERMODYNAMICS II

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LAB WORK REPORT

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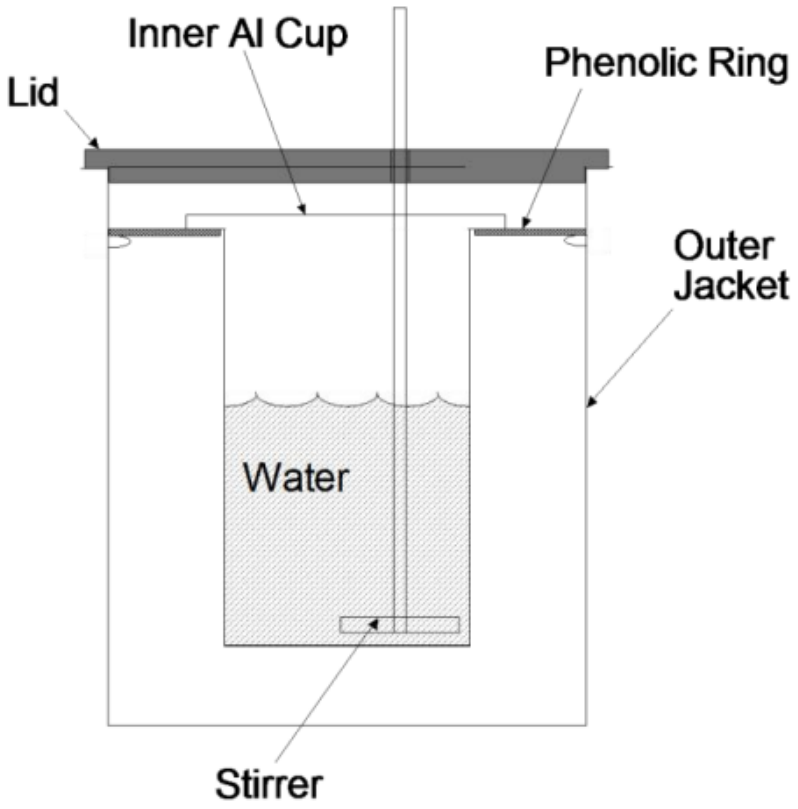
Experiment 1. Calorimeter

PURPOSE

- Perform simple calorimetry experiments
- Use calorimetry results to calculate the enthalpy change of the chemical reaction, then measure the energy content of the material.

APPARATUS



This figure shows the construction of the basic calorimeter. The calorimeter is designed to minimize heat flow between the inner cup and the outside world.

Conduction of heat is eliminated by supporting the inner cup only by the thin, insulating phenolic (a type of plastic) ring, and by providing an insulating air space around the cup.

Convection is eliminated by blocking air circulation with the solid ring and the lid.

Radiation is eliminated by making the inner cup and outer jacket out of aluminum, which is mirrorbright to infrared radiation.

To use the calorimeter, the inner cup is half filled with a known mass of water, and the temperature is measured. The sample is added, the temperature is measured again, and the desired quantity (latent heat or specific heat) is calculated.

OPERATIONS

Step 1: Prepare 1 g of materials that need to measure.The weight needs to be put in a closed container and precise.

Step 2: Put 1g of materials inside the “bomb”:

- Put the materials on the holder
- Note that the wire must touch the materials

Step 3: Then tighten with the lid. The “bomb” must be airtight in order to withstand high pressure.

Step 4: Prepare 2 kg of water inside the container:

- First the container must be clean, dry before weighing in order to minimize the error.
- Then exactly 2 kg of water will be put inside the container.

Step 5: Put the water container inside the calorimeter.

Step 6: Put the bomb inside the water container:

- When half of the bomb is under the surface, connect the electrode to the bomb.

Step 7: Close the calorimeter. Make sure that the spinner neither touches the bomb nor the electrode wire.

TIPS

The specific heat is the amount of heat required to raise the temperature of a gram of the material by one degree Celsius.

Extend this experiment by transferring hot metal washers into a cup of cold water keeping in mind every material has its own specific heat. Extend by adding different amounts or starting temperatures of hot or cold water to show that temperature and mass effect heat transfer.

EQUATION

Once the temperature change has been measured from the calorimetry experiment, the amount of heat energy transferred can be calculated using the expression:

$$Q = C_V \cdot (T_f - T_i)$$

Q : the amount of heat (J)
C_V : the calorimeter's heat capacity (J/K)
T_f : the final temperature
T_i: the initial temperature

SAFETY CONCERNS

Use safety glasses and heat resistant gloves.

Use tongs and wear goggles when removing the samples from the pot of boiling water!

Experiment 2. HydroThermal Carbonization

INTRODUCTION

When organic contents of a material are burnt down, the left behind is ash. It is the inorganic content present in any material. If any material is heated to its burning point in presence of oxidizing agents, only ash is left behind. To assess the quality of a material, it is very important to assess the presence of inorganic components.

PURPOSE

Measure the ash percentage of the sample.

OPERATIONS

Step 1: Turning on the Controller/Furnace. Turn on the power switch. After a couple of seconds, the temperature is displayed on the overview screen.

Step 2: Using the controller, set time for the first process.

Step 3: Set initial temperature T1.

Step 4: Set time for process 2.

Step 5: Set time for the third process.

Step 6: Set the final temperature T2.

Step 7: Set time for the fourth process.

Step 8: May press the save button to save for later use.

Step 9: Press start/stop button and hold for 2 seconds to operate.

EQUATION

$$p = \frac{M3 - M1}{M2} \, x \, 100\%$$

p : ash percentage (%)
$M1$: weight of the cup which contains the sample (g)
$M2$: weight of the sample (g)
$M3$: weight of cup and sample after calcined (g)

CALCULATION

After the HydroThermal Carbonization process, the sample is filtered to obtain the "ash". Mass of the cup $M_1 = 123.2638\ g$, mass of sample $M_2 = 1.2787\ g$, mass of cup and sample after calcined $M_3 = 130.0997\ g$.

Ash percentage of the sample: $p = \frac{M_3 - M_1}{M_2} \cdot 100\% = 9.40\%$.