Experiment No. 5

Heat of solution of Potassium nitrate in water

Principle

Heat of solution of a solute is defined as the quantity of heat evolved or absorbed when one mole of the solute is dissolved in a definite quantity of the solvent.

A known weight of finely powdered Potassium nitrate is quickly dissolved in a known amount of water taken in a calorimeter of known water equivalent. The temperature falls down which is accurately measured using a Beckmann thermometer. From this, the quantity of heat absorbed by dissolving one gram molecular mass of Potassium nitrate in a particular quantity of water is calculated.

procedure

About 15 g of finely powdered Potassium nitrate is weighed accurately in a clean dry test tube. The test tube is placed in a water bath. Exactly 400ml of distilled water is taken in a Ostwald's calorimeter. A Beckmann thermometer set up between 4 and 5°C is placed in the calorimeter. The weighed Potassium nitrate is quickly transferred into the calorimeter. (The test tube is weighed after the transfer which gives the mass of the Potassium nitrate transferred). The contents of the calorimeter are vigorously stirred so that the salt dissolves readily and the temperature is read every minute, until there is steady increase after reaching the minimum. Temperatures are plotted against time and from the graph, the correct initial and the final temperatures are noted, and the fall in temperature is found out from which the heat of solution is calculated.

Calculation

Water equivalent of the Calorimeter = Wg

Initial temp. of water = t_1°C

Final temperature of solution = t_2°C

Lowering of temperature = $(t_1 - t_2)$°C

Mass of water taken = 400g

Mass of KNO_3 taken = a g

Molecular mass of KNO_3 = 101.1

Healt absorbed by 1gram - Molecular mass of KNO_3 = $\frac{(400 + W)(t_1 - t_2) \times 101.1 \text{ cals}}{a}$

Healt of solution of KNO_3 in 400ml of water = $\frac{[(400 + W)(t_1 - t_2)] \times 101.1 \text{ cals}}{a}$

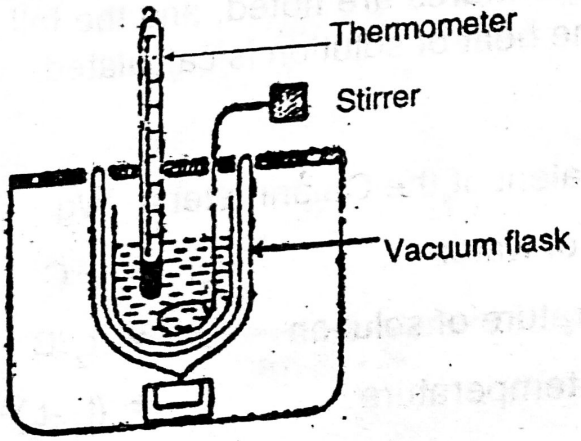
ote: The same method can be used to determine the heat of solution of NH_4Cl. he salts should be taken in a finely powdered state since, the accuracy of the ethod depends a lot on the rapidity of the dissolution of the solute.

o find out the water equivalent of a Calorimeter

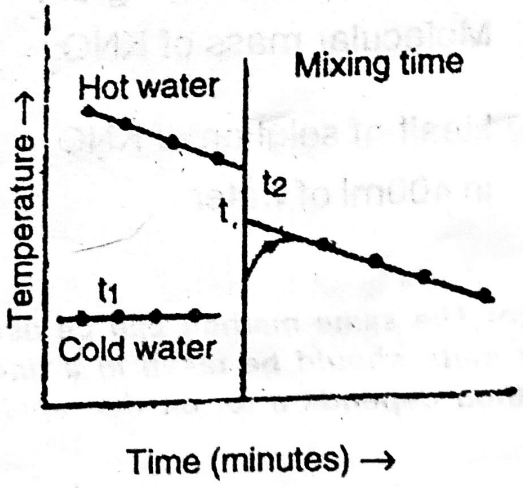
Water equivalent of a calorimeter may be defined as the amount of heat equired to raise the temperature of the calorimeter by 1°C. For most

practical purposes, a glass beaker serves as a calorimeter. In such a case it is not practicable to obtain the water equivalent, by multiplying mass and specific heat of the material of the vessel but, the water equivalent value can be found for such part of the vessel which is usually in contact with the reacting system.

The water equivalent of a glass beaker is found out by supplying a known amount of heat to the system and determining the rise of temperature, which it produces. Equal volumes are used as far as possible so that the area of the calorimeter in contact with the system does not change.



To determine the water equivalent of this calorimeter, take 50 ml of cold water in a beaker and keep it in a thermos flask. Note down the temperature after every one minute for 5 minutes. Let it be t_1°C. In another beaker heat 50 ml of water to t_2°C. Add this water to the beaker in the thermos flask. Stirr and note down its temperature after every one minute with a stop clock. Calculate the final temperature t°C from the plot of temp. versus time as in the figure extrapolating it backward.



Calculation

The water equivalent of the calorimeter W can be calculated as follows:

Heat lost by hot water = Heat gained by cold water and calorimeter

i.e. $m_2 \times s(t_2-t) = m_1 \times s(t-t_1) + (Wt - t_1)$

m_1 = Mass of cold water

m_2 = Mass of hot water

W = Water equivlent of the calorimeter

s = Specific heat of water

For water, s = 1

$m_2(t_2-t) = m_1(t-t_1) + W(t-t_1)$

Water Equivalent of the Calorimeter, $W = \frac{m_2(t_2-t) - m_1(t-t_1)}{(t-t_1)}$

Result:

The water equivalent of calorimeter = ... g.

Its value can be expressed as the number of grams of water which have the same heat capacity as the calorimeter