EXPERIMENT

Aim

To determine the enthalpy of neutralization of the reaction between strong acid (HCl) and strong base NaOH.

Theory

Heat is evolved during neutralization of an acid with an alkali. Known volumes of the standard solutions of an acid and alkali are mixed and the change in temperature is observed and from this, the enthalpy of neutralization is calculated. Enthalpy of neutralization is the heat evolved when one gram equivalent of the acid is completely neutralized by a base in dilute solution.

Material Required

A wide-mouthed polythene bottle (to serve as calorimeter), a rubber (cork having two holes, thermometer ($1/10^{th}$ degree), stirrer fitted with a cork on the handle, and a 100 ml measuring cylinder. 1.0 M hydrochloric acid and 1.0 M sodium hydroxide solution.

Procedure

1. Clean and dry the polythene bottle.
2. Place 100 ml of 1.0 M hydrochloric acid solution in it.
3. Record the temperature of the acid solution.
4. Note the initial temperature of the sodium hydroxide solution taken in a separate vessel.
5. Both the solutions should have the same temperature, otherwise wait for some time so that they attain the same temperature.
6. Transfer 100 ml of sodium hydroxide solution into the acid solution quickly.
7. Immediately fit the cork having the thermometer and then stir in the mouth of the polythene bottle and stir well.
8. Note the temperature after small intervals till it becomes constant.
9. Record the highest temperature (to 0.1°) reached.

Observations

Initial temperature of the acid and base = t_1 °C

Final temperature after neutralization = t_2 °C

Change in temperature, $\Delta t = (t_2 - t_1)$°C.

Mass of the mixture solution after neutralization = 200 g

Calorimeter constant of calorimeter = W J/°C

Calculations

Heat produced during neutralization of 100ml of 1.0 M HCl

$$= (200 + W) \times (t_2 - t_1) \times 4.184 \text{" Joules "}$$

∴ Heat produced during neutralization of 1000ml of 1 M HCl

$$= -((200 + W) \times (t_2 - t_1) \times 4.184 \times 1000)/(1000 \times 0.1) \text{ Joules } (1 \text{ kJ} = 1000 \text{ J})$$
$$= -((200 + W) \times (t_2 - t_1) \times 4.184)/1000 \text{ kJ}$$

Since heat is produced during neutralization, the enthalpy of neutralization is negative.

∴ Enthalpy of neutralization $= \frac{(200+W)\times(t_2-t_1)\times 4.184}{1000}$ kJ

Result

The enthalpy of neutralization of HCl with NaOH is..... kJ.

Percentage error =.....

Note: Enthalpy of neutralization of all strong acids with strong bases and vice versa is – 57.3 kJ. It may be noted that 1000 mL of 1 M HCl contains 1 mole (or 1 equivalent) of HCl.

VIVA VOCE

Q 1. What is the enthalpy of neutralization, and how is it defined in the context of the reaction between a strong acid (HCl) and a strong base (NaOH)?

Ans. The enthalpy of neutralization is the heat energy released or absorbed when one mole of a strong acid reacts with one mole of a strong base to form one mole of water and a salt. In the reaction between HCl and NaOH, it represents the energy change associated with the formation of water and sodium chloride.

Q 2. What experimental techniques can be employed to determine the enthalpy of neutralization for the reaction between HCl and NaOH?

Ans. Experimental techniques such as calorimetry, specifically solution calorimetry, can be utilized to measure the temperature change that occurs when HCl and NaOH react. By monitoring the temperature change and knowing the masses and concentrations of the reactants, the enthalpy of neutralization can be calculated using the equation $q = mc\,\Delta T$.

Q 3. How does the stoichiometry of the reaction between HCl and NaOH affect the calculation of the enthalpy of neutralization?

Ans. The stoichiometry of the reaction ensures that one mole of HCl reacts with one mole of NaOH to produce one mole of water and one mole of sodium chloride. This balanced equation allows for the direct calculation of the enthalpy of neutralization based on the heat change observed during the reaction.

Q 4. How might experimental factors such as heat loss to the surroundings or incomplete mixing influence the accuracy of determining the enthalpy of neutralization?

Ans. Factors such as heat loss to the surroundings or incomplete mixing can lead to underestimation of the enthalpy change observed during the reaction. To minimize these effects, it is essential to insulate the calorimeter, ensure thorough mixing of reactants, and account for any corrections needed in the calculations.