Chemistry TAS Report

1. Experiment Number : 4

2. Date : 15/10/07

3. Title : Enthalpy change of a displacement reaction

4. Aims/Objective :
   To determine the enthalpy change of a displacement reaction (Between zinc and copper (II) ions)

5. Introduction :
   Excess zinc powder is added in a measured amount of aqueous copper (II) sulphate. The temperature change is then measured over a period of time so the enthalpy of this reaction can be calculated.

6. Relevant Equations/Chemical Reactions Involved :
   $Zn\ (s) + CuSO_4(aq) \longrightarrow ZnSO_4(aq) + Cu(s)$

7. Chemicals :
1.00M copper (II) sulphate solution	25.0 cm^3
Zinc powder (in excess)	5.9g

8. Apparatus and equipment :
Safety spectacle	x 1	Spatula	x 1
25 cm^3 pipette	x 1	Balance	x 1
Pipette filler	x 1	Thermometer(0 -100 ^{o}C)	x 1
Polystyrene cup with lid	x 1	Digital timer	x 1
Weighting bottle	x 1		

9. Procedure :
   1. An empty polystyrene cup was weighted.
   2. 5.9g of zinc powder (in excess)was weighted and then added into the polystyrene cup.
   3. The temperature of the copper (II) sulphate solution in beaker was recorded every half minute for 2.5 minutes and then 25.0 cm^3 of the copper (II) sulphate solution was pipetted into a polystyrene cup.
   4. Thermometer was put through the hole of the lid. The solution was stirred continuously and the temperature was recorded every half minute for 6 minutes.

10. Observation :

The blue colour of the solution disappears. Brown solid is formed. Some zinc
powder remains there.

11. Data, Calculation and Results :

a. Results Table

Time/min	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5
Temperature/°C	25.0	25.0	25.0	25.0	25.0	25.0	25.0	60.0	73.0	71.0

Time/min	5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	9.5
Temperature/°	69.0	68.0	67.0	65.5	64.5	63.5	62.5	61.5	60	59

b. Calculations

1&2.   Graph of temperature against time

3. Energy change of solution $= 25 \times 10^{-3} \times 4.18 \times (76.5 - 25)$
$$= 5.38175 \text{ kJ mol}^{-1}$$
Energy change of the cup $= 2.27 \times 10^{-3} \times 1.3 \times (76.5 - 25)$
$$= 0.1519765 \text{ kJ mol}^{-1}$$
Enthalpy change for the quantities used $= -(5.38175 + 0.1519765)$
$$= -5.5337265 \text{ kJ mol}^{-1}$$

Assumptions :

    (1)   The specific heat capacity of the solution is the same as that of water.

    (2)   Heat is not lost to the surrounding.

  4. No. of mole of $CuSO_4 = 1 \times 25 \times 10^{-3} = 0.025$ mol

    Required enthalpy change $= -[(5.5337265)/0.025]$

$$= -221 \text{ kJ mol}^{-1}$$

    $Zn\,(s) + CuSO_4(aq) \longrightarrow ZnSO_4(aq) + Cu(s) \qquad \Delta H = -221 \text{ kJ mol}^{-1}$
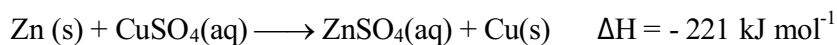
12. Conclusion :

It was found that the enthalpy change of a displacement reaction (Between zinc and copper (II) ions) was - 221 kJ mol^{-1}.

13. Answer to questions

  1. % error $= \{[-221 - (-217)]/-217\} \times 100\% = 1.84\%$

    The experimental value is more negative than the accepted value.

  2. Reasons :

    (1) Heat is lost to the surrounding.

    (2) The specific heat capacity of the solution is not the same as that of water.

  3. $CuSO_4$ is not in excess which is used up totally. No matter that more zinc is used or powder is very finely divided, same amount of the solution is used so there is same increase in temperature.