EXPERIMENT: 9

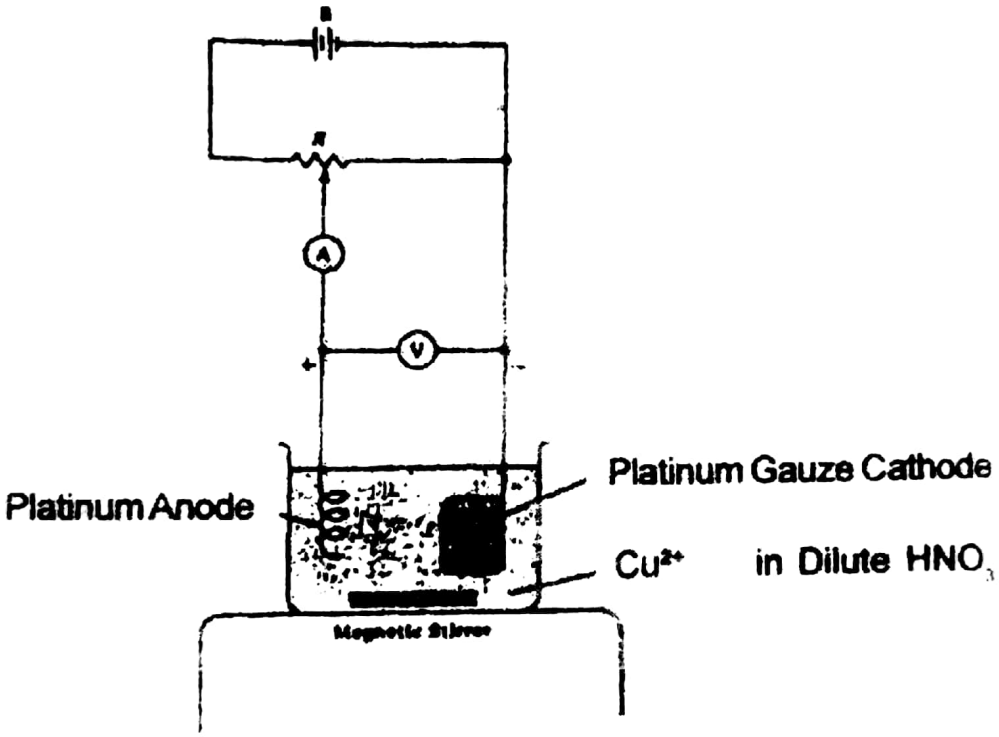
Date 26/10/18

AIM: To study electro-deposition of Cu on cathode.

APPARATUS: Ammeter, Rheostat, Magnetic stirrer, Electrical oven, Analytical balance.
Electrodes: Spiral Platinum (Anode) and Platinum Gauze (Cathode).

CHEMICALS: (2%) Copper sulphate solution, Urea, Conc. H_2SO_4, Conc. HNO_3, Acetone

CIRCUIT DIAGRAM:



B = Battery. R = Rheostate, A = Ammeter,

REACTIONS:

1) At Cathode

a) $Cu^{+2}_{(aq)} + 2e \rightarrow Cu_{(s)}$

b) $2H^{+}_{(aq)} + 2e \rightarrow H_2$

2) At Anode

$2\,H_2O \rightarrow 4\,H^{+}_{(aq)} + O_2 + 4e$

PROCEDURE:

(1) Check the gauge electrode given to you. Consult the instructor if it needs any pretreatment. If necessary give the treatment as it is to be given for spiral platinum anode. Dry it in oven & weight accurately.

(2) Clean the platinum spiral in 1:1 HNO_3 solution for 3-4 minutes. Wash with tap water and then distilled water.

(3) Take exactly 150 mL of 2% copper sulphate solution with a burette into 250 mL beaker. The given solution already contains 5 mL conc. H_2SO_4 & conc. HNO_3 which acts as a depolarizer. Add about 50 mL of distilled water.

(4) Arrange the circuit as shown in the circuit diagram. Be sure that the gauge cathode is connected to the negative terminal & platinum spiral anode is connected to the positive terminal of the power source, as in the circuit diagram. Complete the circuit by plugging in the switch key & raise the beaker containing the electrolyte unit the cathode is completely immersed in the electrolyte. Adjust the rheostat such that the current reading, on the ammeter is about 0.2 ampere. Be sure that the electrodes are not short-circuited & that the magnetic, paddle does not but either of the electrodes.

(5) Stir the solution vigorously with magnetic stirrer. Continue the electrolysis unit blue color of solution has entirely disappeared (This will take about 45 minutes). Reduce the current to 0.1 amp. By adjusting rheostat, add 1.0 g of Urea and continue the electrolysis for another 5 minutes. Test the completion of copper deposition by taking a drop of test solution with glass rod on a filter paper and placing drop of concentrated ammonia solution close to it. Where the boundaries of the two solutions meet, a blue color will be formed if the solution contains copper, if no such blue color is observed; it is an indication that all Cu^{2+} ions reduced to Cu and deposited on the cathode.

(6) To stop electrolysis, turn off magnetic stirrer. Remove the support under beaker and slowly lower the beaker with one hand, while washing the exposed portion of the cathode with distilled water. As soon as the cathode is completely out of solution, cut off the current. Remove the cathode, wash it thoroughly with distilled water and then dip it in a beaker of acetone. Place it on a watch glass and keep it in electric oven for 2 to 3 minutes. Cool the electrode to room temperature in desiccators and then weight accurately

NOTES:

1. Acid concentration should not be too high otherwise copper deposition may be incomplete & the deposition may be on adherent.
2. Addition of nitrate ion is necessary for its polarizing action. It acts at cathode as follows $NO_3^- + 10H^+ + 8e^- \rightarrow NH_4^+ + 3H_2O$
3. Reduction potential of nitrate ion is lower than the discharge potential of H_2 & hence H_2 is not liberated.
4. Nitrite ion is formed as follows : $2H^+ + NO_3^- + 2e \rightarrow H_2O + NO_2^-$
5. Urea is added for removal of nitrate, which prevents complete deposition. Nitrite is removed accordingly to $2NO_2 + 2H^+ + CO(NH_2)^{2-} \rightarrow CO_2 + 2N_2 + 3H_2O$ eqn. Solution should be free from Ag, Bi, Hg, Se, Te, As, Sn, Au, & Pt metals: CNS, Cl^- & oxidizing agents, etc.

SAMPLE VIVA QUESTIONS:

What is the function of nitric acid in the electricity? Explain why Urea is added in the final phase of electrolysis? What happens if the electrodes are placed in the electrolyte before the external E.M.F is impressed upon the electrodes?

OBSERVATION:

(1) Weight of copper gauge electrode (W_1) 14·01687 g.
(2) Weight of copper gauge + copper deposited (W_2) 14·32785
(3) Weight of copper deposited (W_3) = (W_2-W_1) = 0·31098 g.
(4) Current employed = 400 amp.
(5) Duration of electrolysis = 2700 seconds.
(6) Volume of stock copper solution taken 150 mL.

CALCULATION:

Copper present in 150 ml of the given stock solution W_3 = 0·31098 g.
Weight of copper per liter in the given stock solution of copper sulphate

$$W_3 \times \frac{1000}{150} = 2.0732 \text{ g}$$

249 g CuSO4.5H2O = 63.5 g of Cu
So, 1.5 g $CuSO_4$.5H2O = 0.3825 g of Cu (Theoretical)

$$\text{Percentage of copper deposited} = \frac{100 \times W_3}{0.3825} = 81.301$$

Where W_3 = grams of copper deposited (practically)

RESULTS:

(1) 150 mL of the given stock solution contains 0·31098 g of Cu.
(2) Amount of Cu in one liter of the given stock solution = 2·0732 g.
(3) Percentage of Cu deposited = 81·301 %.

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