Experiment No.4 : Electrode potential of Copper Metal

I Practical Significance

Determination of electrode potential of metal, enable the student to understand the position of metal in electrochemical series. This will help the student to design the structure using two dissimilar metals, to protect the metal corrosion that can be used in solving broad based engineering problems.

II Relevant Program Outcomes (POs)

PO3 Experiments and practice.

PO4 Engineering tools

III Relevant Course Outcomes

e) Use corrosion preventive measures in industry.

IV Practical Learning Outcome

Determine the electrode potential of copper metal.

V Practical Skills:

1. Measurement
2. Calculation

VI Relevant Affective domain related Outcomes:

1. Follow safety practices.
2. Maintain tools and equipment.
3. Follow ethical practices.

VII Minimum Theoretical Background

Due to reaction between metal and solution, an electrical double layer forms around the metal. It gives rise to potential difference between the metal and solution, known as electrode potential.

Electrode potential is a measure of tendency of metal electrode to lose or gain electrons when it is in contact with a solution of its own salt solutions of unit molar concentration at 25°C.

Oxidation Potential : The tendency of electrode to lose electrons is direct measure of its tendency to get oxidized.

Reduction Potential : The tendency of electrode to gain electrons is a direct measure of its tendency to get reduced.

Electrode potential of metal can be determined by building electrochemical cell in which one half cell contain reference electrode whose electrode potential is known.

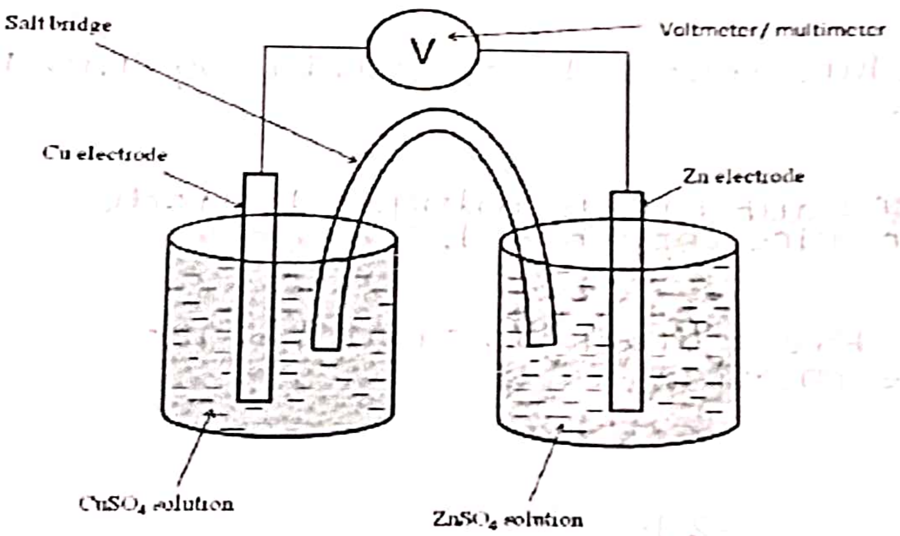
In the field of metal corrosion, reference electrode such as hydrogen electrode, the zinc-zinc sulphate electrode, calomel, silver-silver chloride electrode etc. are used.

Electro-chemical Series

Potassium	-2.92
Calcium	-2.87
Sodium	-2.71
Magnesium	-2.37
Aluminium	-1.66
Zinc	-0.76
Iron	-0.44
Tin	-0.14
Lead	-0.13
Hydrogen	0.00
Copper	+0.34
Silver	+0.80
Mercury	+0.85

Metal activity increasing (↑)

VIII Circuit diagram / Experimental set-up / Work Situation



IX Resources required

Sr. No.	Resources	Specifications	Quantity	Remark
1	Beakers	Capacity -250 ml	2 per group	
2	Salt Bridge / porous pot	'U' shaped glass tube with KCl solution	1 per group	
3	Voltmeter / multimeter		1 per group	
4	Electrodes	Zn(Rod/Plate), Cu(Rod/Plate)	1 per group	
5	Sample material/chemicals	Copper salt solution, zinc salt solution, connecting wires	As per requirement	

X **Procedure**

1. Make surface of zinc rod and copper rod smooth by using polish paper, then clean with dilute HCl and then with water.
2. Take 1 M $ZnSO_4$ and 1 M $CuSO_4$ solutions in two different beakers.
3. Place zinc rod in $ZnSO_4$ solution and copper rod $CuSO_4$ solution.
4. Connect zinc rod to negative terminal (anode) and copper rod to positive terminal (cathode) of digital multimeter/ voltmeter.
5. Place salt bridge in both the solutions.
6. Note down the cell EMF (E_{cell}) in volts displayed by the digital multimeter.
7. Calculate electrode potential of copper as per the given calculations.

XI **Precautions**

1. While making connections take proper precautions whether wires are properly connected.
2. Check the voltmeter or multimeter before using.

XII **Actual procedure followed**

procedure followed of given in experiment NO. 6.

XIII **Resources used (with major specifications)**

Beaker salt Bridge things electrode meter wire copper rod.

XIV **Precautions followed**

check the voltmeter or multimeter before merge.

XV **Observations and Calculations**

Observations

1) Temperature = 27 °C.
2) Theoretical value of reduction potential of Zn = - 0.76 volts.
3) Electrode potential of cell = 2 V

Calculation for determination reduction potential of copper electrode (E_{Cu})

$E_{Cell} = E_{Reduction\ (Cu)} + E_{Oxidation\ (Zn)}$

$\therefore E_{Reduction\ (Cu)} = E_{Cell} - E_{Oxidation\ (Zn)}$

$\therefore E_{Reduction\ (Cu)} =$ 0.16 $- (+0.76)$

($\because$ Oxidation potential of Zn = + 0.76 Volts)

$\therefore E_{Reduction\ (Cu)} =$ 0.16 $- 0.76$

$\therefore E_{Reduction\ (Cu)} =$ 0.40 Volts

− 0.16 = 0.24

XVI RESULT

1. Reduction electrode potential of Cu = 0.34 Volts.
2. Reduction electrode potential of Zn = 0.76 Volts.

XVII Interpretation of result

In electrochemical series zinc is placed above (above/below) the copper metal.

XVIII Conclusions and Recommendations

Zinc is more...(more/less) electropositive than copper. Hence Zn (Zn/Cu) under goes corrosion.

XIX Practical Related Questions:

1. Write the chemical reactions taking place at cathode and anode in the electrochemical cells formed in the experiment
2. State the relation between reduction electrode potential of metal electrode and its tendency towards corrosion.
3. Name cathode and anode in the given electrochemical cell.

XX References / Suggestions for further Reading

Sr. No.	Title of Book	Author	Publication
1.	Applied Chemistry :Theory and practice	O.P.Vermani,A.K.Narula	New age International Publication New Delhi 2005 ISBN: 8122408141
2.	Experiments and calculations in engineering chemistry	Dr.Dara, S. S.	S.Chand. Publication, New Delhi, 2011. ISBN:8121908647
3.	Practical chemistry	Dr. N.K.Varma	Laxmi Publication New Delhi ISBN:8170085942
4.	Engineering chemistry	Shashi Chavla	S. Chand publication New Delhi 2013 ISBN : 1234567155036

Sr. No.	Title of Book	Author	Publication
Link	https://www.youtube.com/watch?v=dHVFvO38nRs		

XXI Assessment Scheme

Process related assessment scheme

Sr. No.	Process related	Weightage(60%)
1.	Cleaning of cathode and anode	20%
2.	Assembly set up	30%
3.	Reading of electrode potential	10%

Product related assessment scheme

S. No.	Product related	Weightage(40%)
1.	Calculation for electrode potential of copper	20%
2.	Answer to sample questions	10%
3.	Submission of report in time	10%

List of Student Team Members

1. ....
2. ....
3. ....
4. ....

Marks Obtained			Dated Signature of Teacher
Process Related (15)	Product Related (10)	Total (25)	
15	09	24	[signature]

[Space to Write Answers]

1. At anode $Zn \longrightarrow Zn^{+2} + 2e^-$ (oxidation)

At cathode $Cu^{2} + 2e^- \longrightarrow Cu$ (Reduction)

$Zn + Cu^{+2} \longrightarrow Zn^{+2} Cu$

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1. At anode $Zn \longrightarrow Zn^{+2} + 2e^-$ (oxidation)
At cathode $Cu^{2} + 2e^- \longrightarrow Cu$ (Reduction)
$Zn + Cu^{+2} \longrightarrow Zn^{+2} Cu$

2. In the electrochemical cell zinc is more electropositive zinc as anode and copper cathode.

3. In the electrochemical cell.

4. In the electrochemical cell zinc is followed electropositive and less electropositive so zinc. so zinc anode and copper cathode.

5. In the electrochemical cell zinc is positive and copper cathode + zinc anode.