Experiment No. 6: Daniel cell

I Practical Significance

Diploma engineers have to deal with electrochemical cell during their course of work. The electrochemical cell provides electrical energy from chemical reaction. Determination of voltage generation due to reaction in Daniel cell enable students to understand the ion exchange reaction takes place at different metal electrodes. This leads to inform about the relation between change of concentration of electrolytes and relevant voltage changes that can be used in solving broad based engineering problems.

II Relevant Program Outcomes

PO3 Experiments and practice
PO4 Engineering tools

III Relevant Course Outcomes

e) Use corrosion preventive measures in industry.

IV Practical Learning Outcome

Determine the voltage generated from chemical reaction using Daniel Cell.

V Practical Skills

Assembly or practical set up

VI Relevant Affective domain related Outcomes:

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

VII Minimum Theoretical Background

A galvanic cell is an important electrochemical cell. A galvanic cell generally consists of two different metal rods called electrodes. Each electrode is immersed in a solution containing its own ions and these form a half cell. Each half cell is connected by a salt bridge, or separated by a porous membrane/partition. The solutions which conducts electricity either in molten state or in aqueous solution are called electrolytes. The chemical reaction that takes place in a galvanic cell is the redox reaction. One electrode acts as anode where oxidation takes place and the other acts as the cathode where reduction takes place. Daniel cell is an example of a galvanic cell

Daniel cell consists of two half cells in which oxidation-reduction (redox) reaction occurs. Oxidation occurs in the half cell containing more active metal i.e. anode (-) and reduction occurs in the other half cell containing less active metal i.e. cathode (+). In the Daniel cell, copper and zinc electrodes are immersed in a $CuSO_4$ and $ZnSO_4$ solution respectively. The two half cells are connected through a salt bridge or porous partition. Here zinc acts as anode and copper acts as cathode. At the anode, zinc undergoes oxidation to form zinc ions. The zinc ions pass into the solution. As the two electrodes are connected using an external wire, the electrons produced by the oxidation of zinc travel through the wire and enter into the copper cathode, where they reduce the copper ions present in the solution and form copper atoms that are deposited on the cathode.

The two half-cells are connected by a *salt-bridge* that allows a "current" of ions from one half-cell to other to complete the circuit of electron current in the external wires. When the two electrodes are connected to an electric load (such as a light bulb or voltmeter) the circuit is completed, the oxidation-reduction reaction occurs, and electrons move from the anode (−) to the cathode (+), producing an electric current.

The electrode reactions in Daniel Cell are :-

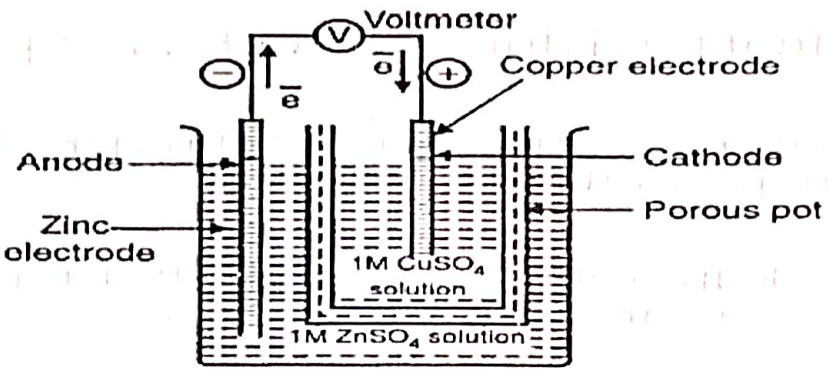
At anode (-ve electrode) : $Zn \longrightarrow Zn^{++} + 2e^-$ (Oxidation reaction)

At Cathode (+ve electrode) : $Cu^{++} + 2e^- \longrightarrow Cu$ (Reduction reaction)

Net Reaction: $Zn + Cu^{++} \longrightarrow Zn^{++} + Cu$

Voltage produced in Daniel Cell (E° Cell) = E°Reduction + E°Oxidation=(1.1 to1.4V)

VIII Circuit diagram / Experimental set-up / Work Situation:



Representation of Daniel Cell : Zn (s) / $ZnSO_4$ (aq) // $CuSO_4$ (aq) / Cu (s).

IX Resources required (In tabular form)

Sr. No.	Resources	Specifications	Quantity	Remark
1	Beakers	Capacity -250 ml	2 per group	
2	Salt Bridge / porous pot	'U' shaped glass tube with $KCl/KNO_3/Na_2SO_4$ solution	1 per group	
3	Voltmeter / multimeter	Range 0 - 2 volt	1 per group	
4	Electrodes	Zn(Rod/Plate), Cu(Rod/Plate)	1 per group	
5	Sample material/chemicals -	$ZnSO_4$ and $CuSO_4$ 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 $ZnSO_4$ and $CuSO_4$ solutions of required concentration in two different beakers.
3. Place zinc rod in $ZnSO_4$ solution and copper rod in $CuSO_4$ solution.
4. Connect zinc rod to negative terminal (anode) and copper rod to positive terminal
5. (cathode) of digital multimeter.
6. Place salt bridge in both the solutions.
7. Note down the voltage developed in volts displayed by the digital multimeter.

XI Precautions

1. While making connections take proper precautions whether wires are properly connected.
2. Check the voltmeter or multimeter before using.
3. Surfaces of electrodes should be cleaned before use.

XII Actual procedure followed

Actual procedure followed on experiment

XIII Resources used (with major specifications)

Beakers, Salt Bridge, Voltmeter, Electrodes
Sample material / chemicals

XIV Precautions followed

check the voltmeter or multimeter before
use wear apron and shoes

XV Observations and Calculations

Observations

Temperature = 28° °C.

Observation Table

Sr. No.	Concentration of $CuSO_4$	Concentration of $ZnSO_4$	Voltage produced in volts
1	1 M	1M	
2	0.1 M	1M	
3	1M	0.1 M	
4	0.1 M	0.1 M	

Calculations
Not applicable

XVI RESULT :

1) Voltage developed due to chemical reaction in Daniel cell
(Zn | 1 M Zn^{2+} || 1 M Cu^{2+} | Cu) = ...1.08.....V
2) Voltage developed due to chemical reaction in Daniel cell
(Zn | 1 M Zn^{2+} || 0. 1 M Cu^{2+} | Cu) = ...1.079.....V
3) Voltage developed due to chemical reaction in Daniel cell
(Zn | 0.1 M Zn^{2+} || 1 M Cu^{2+} | Cu) = ...1.071.....V
4) Voltage developed due to chemical reaction in Daniel cell
(Zn | 0.1 M Zn^{2+} || 0.1 M Cu^{2+} | Cu) = ...1.082.....V

XVII Interpretation of result:

Voltage developed due to Daniel cell decreases(increases/decreases) with decrease in concentration of electrolyte around anode and increase in concentration of electrolyte around cathode.

XVIII Conclusions and Recommendations (if any)

Maximum voltage produced at 0.4 concentration of $ZnSO_4$ and concentration of $CuSO_4$

XIX Practical Related Questions

1. Mention the names of anode and cathode in Daniel cell.
2. State the chemical reactions taking place at cathode and anode in the Daniel cells formed in the experiment?
3. Explain half cell?
4. State the function of salt bridge or porous pot.
5. Name the electrolytes that can be used in salt bridge.

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
5.	https://www.youtube.com/watch?v=dHVFvO38nRs https://www.youtube.com/watch?v=0MFc5n2C03o		

XXI Assessment Scheme

Process related assessment scheme

Sr. No.	Process related	Weightage (60%)
1.	Cleaning of cathode and anode	20%
2.	Assembly set up	40%

Product related assessment scheme

Sr. No.	Product related	Weightage(40%)
1.	Reading of voltage produced in Daniel Cell	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)	
14	09	23	

[Space to Write Answers]

1. zinc is the anode and copper is a (cathode in the Daneil cell).

2. anode

$Zn \longrightarrow Zn^{+2} + e^-$ (oxidation)

2. Cathode

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

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

3. A half cell is half of an electroyte or rotahile cell. where eighter oxidation or reduction anode is oxidation cell reachon of cathode called reduction.

4. Fn daniel cell the main function of salt bridge is to maintain electrical.

5. Fn cannot solution of tax half cell complete cell di circuit.

6. F Ft prevent liquid Junchon potenHal.