Engineering Chemistry – Unit 5 Premium Notes

Phase Equilibrium and Corrosion

RGPV Engineering Chemistry Notes

Unit Overview

This unit is very important in Engineering Chemistry because questions related to:

- Phase Rule
- Water Phase Diagram
- Eutectic System
- Corrosion
- Corrosion Prevention

are repeatedly asked in RGPV examinations.

This unit is scoring because:

- Diagrams are frequently asked
- Definitions are direct
- Theory questions are repeated
- Corrosion mechanisms are important for long answers

Phase Equilibrium

Definition

Phase equilibrium is the study of balance between different phases of a system under equilibrium conditions.

Important Terms

1. Phase

Definition

A homogeneous and physically distinct part of a system is called a phase.

Examples

- Ice
- Water
- Steam

These are different phases of water.

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2. Component

Definition

Minimum number of chemically independent substances required to define a system.

Example:

For water system:

Component = 1

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3. Degree of Freedom

Definition

Number of independent variables like temperature and pressure that can be changed without disturbing equilibrium.

Phase Diagram of Water System

Water as One Component System

Water exists in three phases:

- Ice (solid)
- Water (liquid)
- Steam (vapour)

Important Curves in Water Phase Diagram

1. Fusion Curve

Represents equilibrium between:

- Ice and Water

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2. Vaporization Curve

Represents equilibrium between:

- Water and Steam

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3. Sublimation Curve

Represents equilibrium between:

- Ice and Steam

Triple Point

Definition

Point at which all three phases coexist in equilibrium.

For water:

- Temperature = 0.0075°C
- Pressure = 4.58 mm Hg

Critical Point

Definition

Point above which liquid and vapour phases become identical.

Important Features of Water System

- One component system
- Three phases present
- Triple point important
- Follows phase rule

Binary Eutectic System (Cu-Ag System)

Definition

A binary eutectic system contains two components and forms eutectic mixture.

Example:

Copper-Silver system.

Eutectic Point

Definition

Lowest temperature at which liquid mixture solidifies into two solid phases.

Characteristics of Eutectic System

- Two components present
- Lowest melting point
- Simultaneous solidification

Applications of Cu-Ag Eutectic System

- Alloys
- Soldering materials
- Electrical applications

Corrosion

Definition

Gradual destruction of metal due to chemical or electrochemical reactions with environment is called corrosion.

Examples of Corrosion

- Rusting of iron
- Tarnishing of silver
- Green coating on copper

Types of Corrosion

Mainly two types:

1. Dry Corrosion
2. Wet Corrosion

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1. Dry Corrosion

Definition

Corrosion caused due to direct reaction of metal with gases in absence of moisture.

Characteristics

- Occurs at high temperature
- Slow process

Example

Formation of oxide layer on metals.

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2. Wet Corrosion

Definition

Corrosion occurring in presence of moisture or electrolyte.

Characteristics

- Electrochemical process
- More common
- Faster than dry corrosion

Mechanism of Rusting of Iron

Step 1 → Oxidation

Iron loses electrons.

$Fe \rightarrow Fe^{2+} + 2e^-$

Step 2 → Reduction

Oxygen reacts with water.

$O_2 + 2H_2O + 4e^- \rightarrow 4OH^-$

Step 3 → Formation of Rust

$Fe^{2+} + OH^- \rightarrow Fe(OH)_2$

Further oxidation produces rust.

Factors Affecting Corrosion

- Presence of moisture
- Temperature
- Impurities
- pH of medium
- Presence of oxygen

Prevention of Corrosion

Main prevention methods are:

1. Protective Coating
2. Galvanization
3. Cathodic Protection
4. Alloy Formation
5. Painting

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1. Protective Coating

Metal surface is coated to prevent contact with environment.

Examples:

- Paint

- Grease
- Oil

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2. Galvanization

Definition

Coating iron with zinc.

Advantages

- Prevents rusting
- Increases life of metal

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3. Cathodic Protection

Definition

Metal is protected by making it cathode.

Methods

- Sacrificial anode method
- Impressed current method

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4. Alloy Formation

Corrosion resistant alloys are prepared.

Examples:

- Stainless steel
- Brass

Numerical Concept – Degree of Freedom

Formula

F = C – P + 2

Where:

- F = Degree of freedom
- C = Number of components
- P = Number of phases

Example

For water system at triple point:

C = 1 P = 3

F = 1 – 3 + 2

F = 0

Final Answer

Degree of freedom at triple point = 0

Most Important 14 Marks Questions

1. Explain phase diagram of water system.
2. Explain Cu-Ag eutectic system.
3. Define phase, component and degree of freedom.
4. Explain dry and wet corrosion.
5. Explain electrochemical mechanism of rusting.
6. Explain factors affecting corrosion.
7. Explain methods of corrosion prevention.
8. Explain galvanization and cathodic protection.
9. Derive phase rule equation.
10. Numerical problems based on phase rule.

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