JECRC Foundation

JAIPUR ENGINEERING COLLEGE AND RESEARCH CENTRE

Year & Sem. – B. Tech I year, Sem.-I
Subject –Engineering Chemistry
Unit – III
Presented by – Dr. Seema Joshi
Designation - Professor
Department - Chemistry

VISION OF INSTITUTE

To become a renowned centre of outcome based learning, and work towards academic, professional, cultural and social enrichment of the lives of individuals and communities.

MISSION OF INSTITUTE

❖**Focus on evaluation of learning outcomes and motivate students to inculcate research aptitude by project based learning.**

❖**Identify, based on informed perception of Indian, regional and global needs, the areas of focus and provide platform to gain knowledge and solutions.**

❖**Offer opportunities for interaction between academia and industry.**

❖**Develop human potential to its fullest extent so that intellectually capable and imaginatively gifted leaders may emerge.**

Engineering Chemistry: Course Outcomes

Students will be able to:

CO1: Explain the impurities of water (mainly hardness) and boiler troubles.

CO2: Describe processing technologies of fuel with numerical aspects of combustion of fuel.

CO3: Describe the engineering material (cement, glass and lubricant) with respect to their manufacturing, composition, classification & properties.

CO4: Explain corrosion with its controlling measures, organic reaction mechanism and synthesis of drugs (Aspirin & Paracetamol) with their properties and uses.

JECRC
Department of Applied Sciences
Lecture Plan (Session- 2020-2021)

Course Name: Engineering Chemistry **Year/Semester: 1st Year/ Semester- I**

Course code: 1FY2-03 **No. of Lecture Req. /(Avl.): /(40/44)**

Semester starting: 21 Sept. 2020 **Semester Ending: 24 Dec. 2020**

Unit No./ Total Lect. Req.	Topics	Lect. No.	Date of Delivery	Book Referred	Pg. No.
Unit-I 10	Introduction to syllabus, Common natural impurities, hardness, Degree of hardness,	1		Engg. Chemistry (New Age International)	2-12
	Units of hardness, Determination of hardness by complexometric (EDTA method).	2		Engg. Chemistry (Jain & Jain)	
	Municipal water supply, Requisite of drinking water, purification of water, Sedimentation,	3			
	Filtration, disinfection, Breakpoint chlorination.	4			
	Boiler troubles: Scale and Sludge formation, Internal treatment Methods	5			
	Priming and Foaming, Boiler corrosion and caustic embrittlement	6			
	Water softening: Lime-Soda process	7			
	Water softening: Zeolite (Permutit) process, Demineralization process.	8			
	Numerical problems based on Hardness, EDTA,	9			
	Numerical problems based on Lime-Soda and Zeolite process.	10			

Unit-II 10	**2.Organic Fuels: Solids fuels: Coal, Classification of Coal, Proximate analysis of coal and its significance**	**11**		**Engg. Chemistry (Jain & Jain)**	**116 -117**
	Ultimate analysis of coal and its significance,	12		Engg. Chemistry (Jain & Jain)	117 -118
	Gross and Net Calorific value, Determination of Calorific value of coal by Bomb Calorimeter.	13			
	Metallurgical coke, Carbonization processes; Otto-Hoffmann byproduct oven method.	14			
	Liquid fuels : Advantages of liquid fuels, Mining, Refining and Composition of petroleum, Cracking	15			
	Synthetic petrol, Reforming, Knocking, Octane number, Anti-knocking agents, Cetane number	16			
	Gaseous fuels; Advantages, manufacturing, composition and Calorific value of coal gas and oil gas	17			
	Determination of calorific value of gaseous fuels by Junker's calorimeter, Numerical problems based on Junkers calorimeter	18			
	Numerical problems based on determination of calorific value bomb calorimeter, /Dulongs formula, proximate & ultimate Analysis.	19			
	Numerical problems based on combustion of fuel.	20			

Unit-III 3	**3.Corrosion and its control: Definition and significance of corrosion, Mechanism of chemical (dry) corrosion**	**21**			
	Mechanism of electrochemical (wet) corrosion, galvanic corrosion, concentration corrosion and pitting corrosion.	22			
	Protection from corrosion; protective coatings-galvanization and tinning, cathodic protection, sacrificial anode and modifications in design.	23			

Unit-IV 10	**4.Engineering Materials: Portland Cement; Definition, Manufacturing by Rotary kiln.**	**24**			
	Chemistry of setting and hardening of cement. Role of Gypsum.	25			
	Glass: Definition, Manufacturing by tank furnace, significance of Annealing	26			
	Types and properties of soft glass, hard glass	27			
	Borosilicate glass, glass wool, safety glass.	28			
	Lubricants: Classification	29			
	Lubricants: Mechanism	30			
	Properties; Viscosity and viscosity index	31			
	Flash and fire point, cloud and pour point.	32			
	Emulsification and steam emulsion number.	33			

Unit-V 7	**5. Organic reaction mechanism and introduction of drugs: Organic reaction mechanism: Substitution; SN1, SN2.**	**34**			
	Electrophilic aromatic substitution in benzene, free radical halogenations of alkanes,	35			
	Elimination: elimination in alkyl halides, dehydration of alcohols,	36			
	Addition: electrophilic and free radical addition in alkenes, nucleophilic addition in aldehyde and ketones	37			
	Rearrangement: Carbocation and free radical rearrangements	38			
	Drugs : Introduction, Synthesis, properties and uses of Aspirin	39			
	Drugs : Introduction, Synthesis, properties and uses of Paracetamol, Revision	40			

Lecture-21(Unit-III) Corrosion

CONTENTS:

- Definition and significance of corrosion,
- Theories of corrosion
- Mechanism of chemical (dry) corrosion

Definition and significance of corrosion

Metal exists in nature in the form of sulphides, oxides, sulphates & carbonate etc.This combined state is known as low energy & thermodynamically stable state.The extraction of metal from ore makes it thermodynamically unstable. Thus it is the tendency of metal to go back to the thermodynamically stable state. This process is known as corrosion. It is just reverse of the extraction of metal from its ore.

Corrosion : Definition

"Any process of deterioration of a metal through an unwanted chemical or electrochemical attack by environment is called corrosion." etc.

A high loss occurs due to corrosion throughout the world and costs several billion dollars annually.

The metal loses its strength. It increases the production and maintenance cost and loss in efficiency.

Theories of Corrosion

There are three basic theories which govern the mechanism of corrosion as

- Acid theory
- Dry or chemical corrosion
- Wet or electrochemical corrosion

Acid theory

This theory is mainly applicable for the rusting of iron. According to this theory traces of an acid are necessary for the corrosion to occur. Even carbon dioxide dissolved in water is sufficient to initiate the corrosion because it forms carbonic acid.

$$CO_2 + H_2O \longrightarrow H_2CO_3$$

$$Fe + H_2CO_3 \longrightarrow FeCO_3 + H_2$$

$$4FeCO_3 + 10H_2O + O_2 \longrightarrow 4Fe(OH)_3 + 4H_2CO_3$$

Dry or Chemical Corrosion

The dry corrosion occurs through the direct chemical attack of gases like O_2, H_2, H_2S, N_2, SO_2, Cl_2, anhydrous liquids on the surface of metals etc.

On the basis of corroding environment, dry corrosion can be categorized into three types

- Corrosion by oxygen or oxidation corrosion ;
- Corrosion by other gases; and
- Corrosion by anhydrous liquids or liquid metal corrosion.

Corrosion by Oxygen: (Oxidation Corrosion)

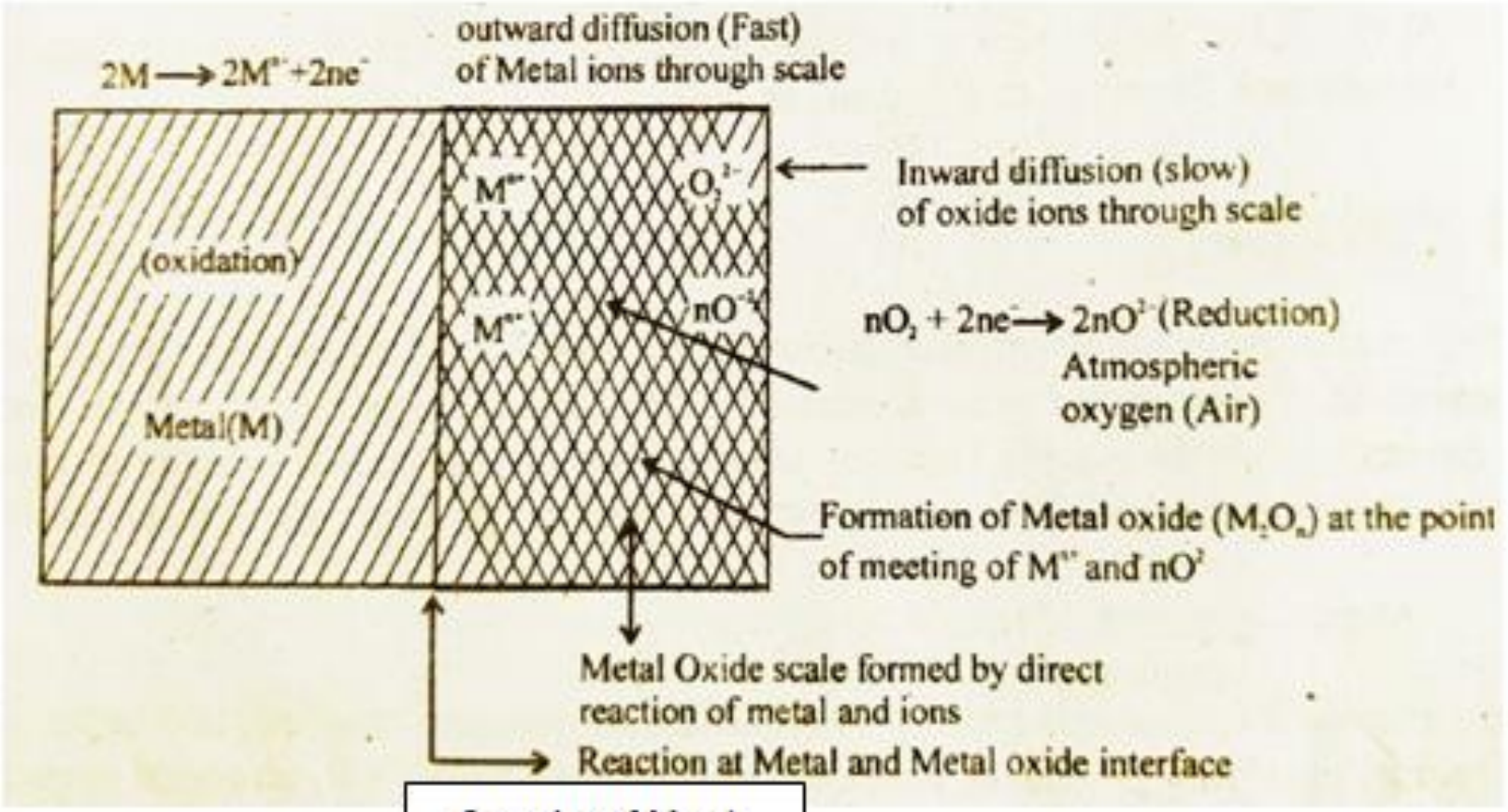
This type of corrosion occurs by direct chemical action of oxygen at low or high temperature on metals, usually in the absence of moisture. Oxidation of alkali and alkaline earth metals are example of such corrosion.

$$2M \rightarrow 2M^{n+} + 2ne^- \text{ (Oxidation of metal)}$$

$$2ne^- + \tfrac{1}{2}\, nO_2 \rightarrow n\, O^{2-}$$

$$2M^{n+} + nO^{2-} \rightarrow \text{Metal oxide}$$

Oxidation Corrosion



Nature of metal oxide

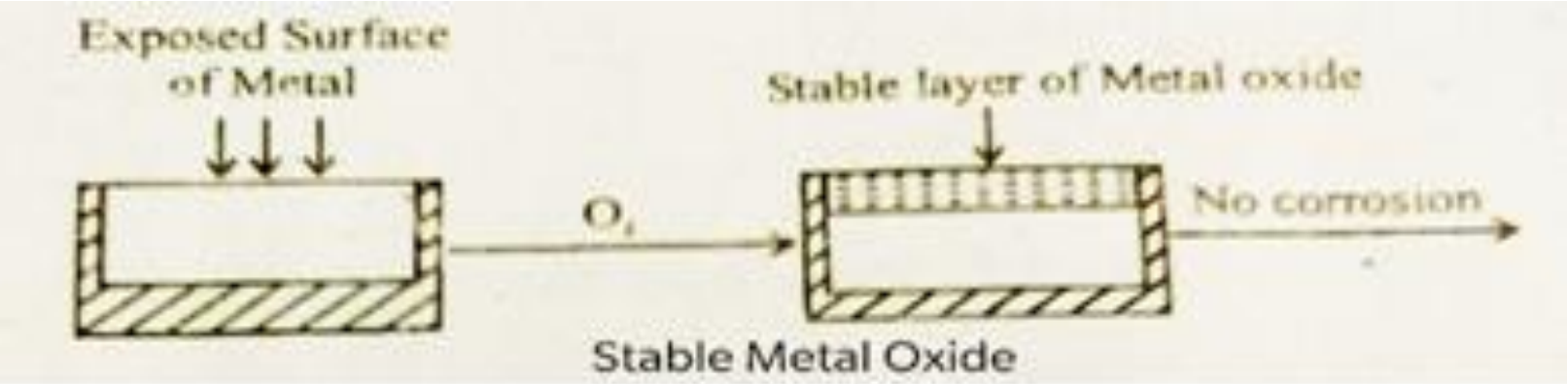
The nature of metal oxide decides the further corrosion reaction.

- Stable
- Unstable
- Volatile
- Porous

Stable Oxide

The stable (film) behave as protective coating in nature because the metal oxide layer formed avoids the contact of metal surface with atmospheric oxygen. Consequently, further oxidation corrosion is prevented example Cu, Al, etc forms the layer which is protective in nature.

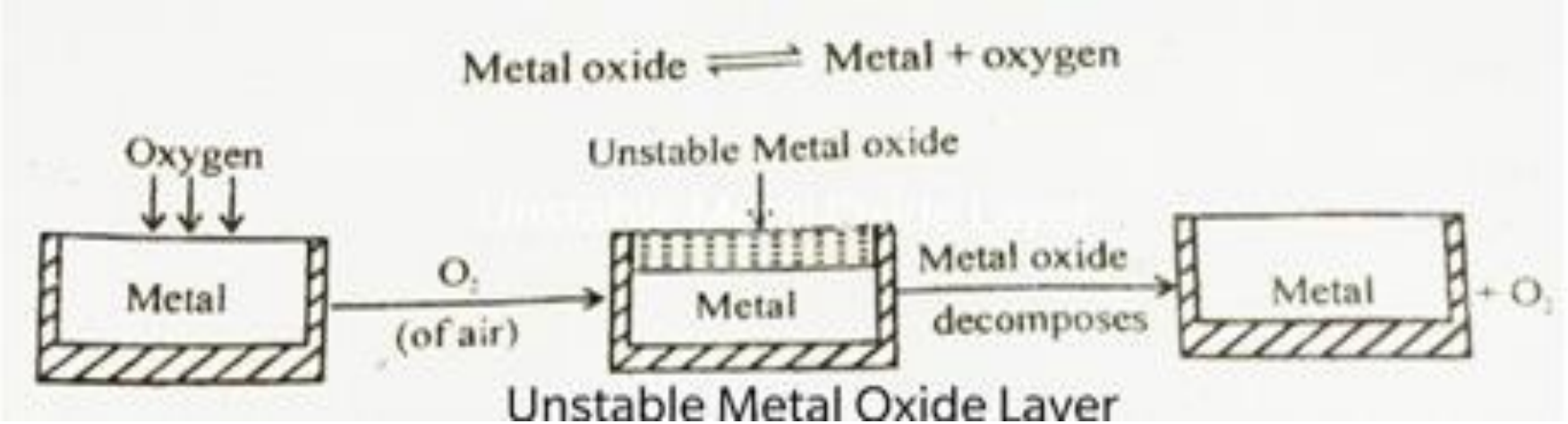
Stable Oxide Layer



Unstable Oxide Layer

When oxide layer formed is unstable, it decomposes back to metal and oxygen i.e. a temporary oxidation only takes place. Hence corrosion does not take place example Au, Ag, Pt, etc. forms unstable oxide layer

Unstable Metal Oxide Layer

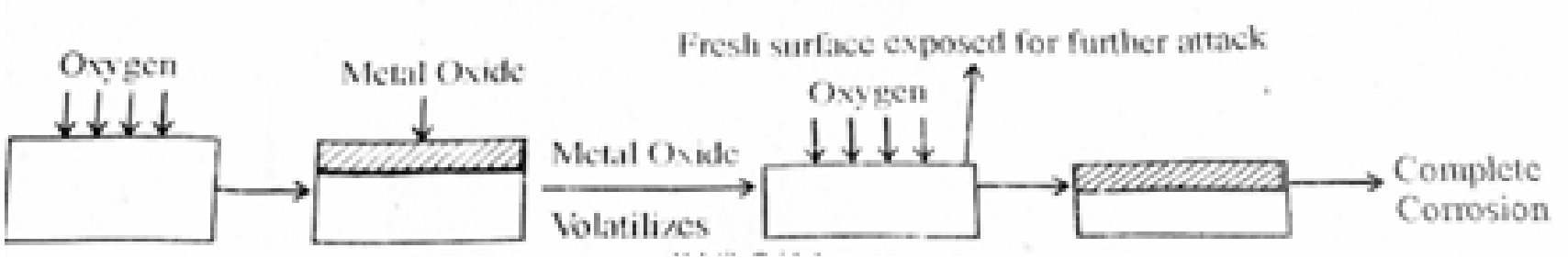


Volatile Metal Oxide Layer

The oxide layer volatilizes as soon as it is formed. After evaporation of metal oxide layer, fresh metal surface is exposed to air and again metal oxide formed and evaporated.

This causes rapid and excessive corrosion till the metal completely vanishes ex. Molybdenum oxide (MoO_3)

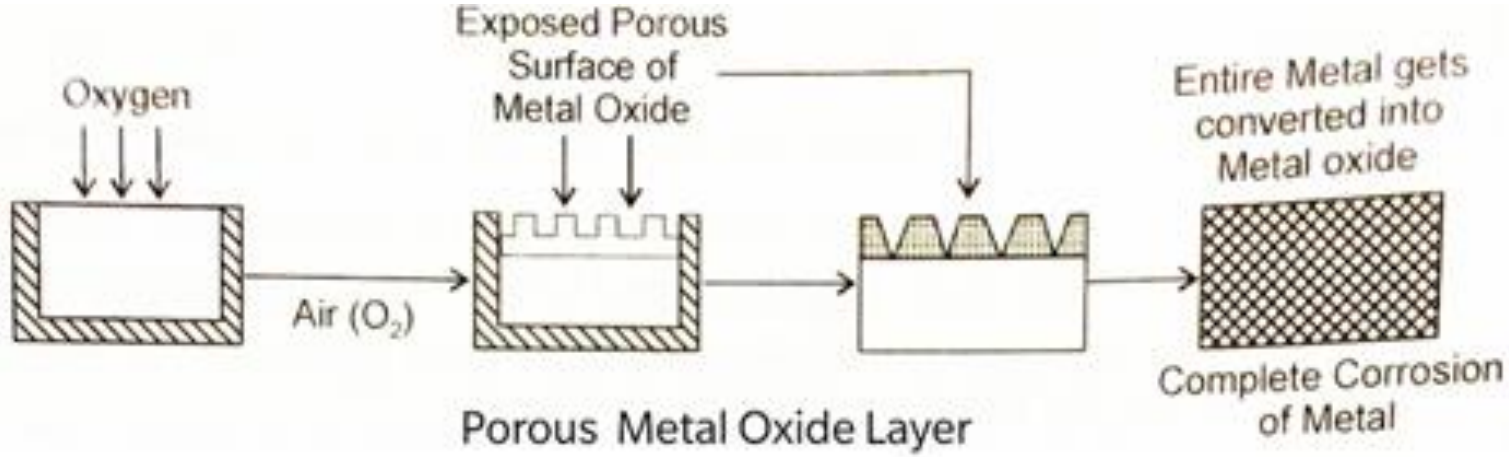
Volatile Metal Oxide Layer



Porous Metal Oxide Layer

When layer of metal oxide formed have pores or cracks, the atmospheric oxygen penetrate inside the metal through these pores and cracks and corrosion continues till the entire metal converted into oxides example Li, Na, K, Mg, etc forms porous oxide.

Porous Metal Oxide Layer



Pilling Bedworth Rule

According to it “an oxide is protective or non-porous, if the volume of the oxide is at least as great as the volume of the metal from which it is formed”. On the other hand, if the volume of the oxide is less than the volume of metal, the oxide layer is porous (or non-continuous) and hence, non-protective, because it cannot prevent the access of oxygen to the fresh metal surface below.

Corrosion by other gases

The gases like H_2, Cl_2, CO_2, SO_2, H_2S etc directly attacks on the surface of the metals. For example Ag in the presence of Cl_2 forms a protective and non-porous layer of a AgCl. Whereas Sn in presence of Cl_2 forms non-protective layer of $SnCl_4$. The extent of corrosion in such cases depends upon the chemical affinity or formation of protective or non-protective film and the nature of film.

(c) Corrosion by Anhydrous liquids and liquid metal:

Anhydrous liquids like phenols, picric acid, bromine and hydrofluoric acid attack the metal surface directly and cause corrosion. Corrosion by liquid metal may occur either by
(i)Dissolution of metal; or by
(ii)Internal penetration of the liquid metal into the solid metal.

Question Bank

Q:1What is corrosion?
Q:2What is pilling Bedworth rule?
Q:3What do you mean by oxidation corrosion?
Q4.What is the difference between chemical and electrochemical corrosion?
Q5. Rusting of iron is quicker in saline water than in ordinary water why?
Q6. Why does impure metal corrode faster than pure metal?
Q7. Define corrosion of metal.
Q8. What are different types of corrosion?
Q9. What is corrosion? Discuss the mechanism of dry corrosion.
Q10. Define corrosion and explain its significance.

Practice Questions contd……

Q11. How corrosion of metals takes place by liquid metals and non aqueous solvents?

Q12. How corrosion of metals takes place by chlorine, sulphur di oxide and some other gases?

Q13. Discuss in detail mechanism of oxidation corrosion with the help of neat diagram.

Q14. How corrosion is affected by nature of metal oxide?

Suggested links from NPTEL & other Platforms:

- https://nptel.ac.in/content/storage2/courses/113108051/module1/lecture1.pdf
- https://nptel.ac.in/courses/113/104/113104082/

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