PG Semester – IV

Elective course – 1b: Physical Chemistry Special

Unit – V (A): Corrosion

Corrosion: Corrosion is the destructive attack of a metal by chemical or electrochemical reaction with its environment. Deterioration by physical causes is not called corrosion, but is described as erosion, galling, or wear. In some instances, chemical attack accompanies physical deterioration, as described by the following terms: corrosion – erosion, corrosive wear, or fretting corrosion. Nonmetals are not included in this definition of corrosion. Plastics may swell or crack, wood may split or decay, granite may erode, and Portland cement may leach away, but the term corrosion, in this book, is restricted to chemical attack of metals.

"Rusting" applies to the corrosion of iron or iron - base alloys with formation of corrosion products consisting largely of hydrous ferric oxides. Nonferrous metals, therefore, corrode, but do not rust.

Cost of corrosion: Estimates of the annual cost of corrosion in the United States vary between $8 billion and $126 billion. I believe $30 billion is the most realistic figure. In any case, corrosion represents a tremendous economic loss and much can be done to reduce it. These large dollar figures are not surprising when we consider that corrosion occurs, with varying degrees of severity, wherever metals and other materials are used. Several examples follow.

According to the Wall Street Journal (Sept. 11, 1981) cost to oil and gas producers is nearly $2 billion. Costs are increasing because of deeper wells and more hostile environments-higher temperatures and corrosive sulfur gases (e.g., 500°F and hydrogen sulfide).

Corrosion of bridges is a major problem as they age and require replacement, which costs billions. The collapse (because of stress corrosion) of the Silver Bridge into the Ohio River cost 40 lives and millions of dollars. Corrosion of bridge decks costs about $500 million.

Proper design and use of cathodic protection reduce costs substantially. One large chemical company spent more than $400,000 per year for corrosion maintenance in its sulfuric acid plants, even though the corrosion conditions were not considered to be particularly severe. Another spends $2 million per year on painting steel to prevent rusting by a marine atmosphere. A retinery employing a new process developed a serious problem after just 16 weeks of operation; some parts showed a corrosion loss of as much as 1/8 inch. The petroleum industry spends a million dollars per day to protect underground pipelines. The paper industry estimates corrosion increases the cost of paper $6 to $7 per ton. Coal conversion to gas and oil involves high temperatures, erosive particles, and corrosive gases, thus presenting severe problems that must be solved.

Corrosion costs of automobiles-fuel systems, radiators, exhaust systems, and bodies-are in the billions. I personally incurred costs of $500 in refurbishing an automobile fuel system in which water had been mixed with gasoline! (A photograph of the gasoline tank is on the cover of Materials Performance, March 1982.) Approximately 3 million home water heaters are replaced every year. Corrosion touches all-inside and outside the home, on the road, on the sea, in the plant, and in aerospace vehicles.

Total annual costs of floods, hurricanes, tornadoes, fires, lightning, and earthquakes are less than the costs of corrosion. Costs of corrosion will escalate substantially during the next decade because of worldwide shortages of construction materials, higher energy costs, aggressive corrosion environments in coal conversion processes, large increases in numbers and scope of plants, and other factors.