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DEPARTMENT: CHEMICAL ENGINEERING

COURSE CODE: CHE 582

COURSE TITLE: CORROSION ENGINEERING

1. What is corrosion?

Corrosion is the deterioration of a metal as a result of chemical reactions between it and the surrounding environment. Both the type of metal and the environmental conditions, particularly gases that are in contact with the metal, determine the form and rate of deterioration.

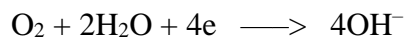
ferrous metal corrosion is the oxidation of iron metal from Fe to Fe⁺², further to Fe⁺³, caused by electrons flowing from an anode (a point of positive polarity) to a cathode (a point of negative polarity).

2. With the aid of chemical reactions, briefly describe corrosion mechanisms

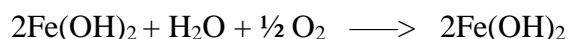
When an iron is immersed in water or sea water which is exposed to the atmosphere, corrosion will occur due to the anodic reaction;



Also when the medium is exposed to the atmosphere, it contains dissolved oxygen. Both water and sea water are nearly neutral, thus the cathodic reaction takes place as follows



Now, remember that the sodium and chloride in the sea water do not participate in the reaction. The reaction is only between the iron and water. The reaction can be rewritten as follows



Now the final product is familiarly called as “**Rust**”.

Normally the acid solution containing dissolved oxygen will be more corrosive than air free acids. Oxygen reduction simply provides a new means of “electron disposal”. The same effect is observed if any oxidizer is present in acid solution.

Since the anodic and cathodic reactions occur during corrosion are mutually dependent, it is possible to reduce the corrosion by reducing the rate of either reaction.

3. Give three catastrophic incidences that had been recorded historically as a result of corrosion failure.
 1. Aloha incident
 2. Bhopal incident
 3. Carlsbad pipeline explosion

i. 1988 - The Aloha Incident

The structural failure on April 28, 1988 of a 19 year old Boeing 737, operated by Aloha airlines, was a defining event in creating awareness of aging aircraft in both the public domain and in the aviation community. This aircraft lost a major portion [of the upper fuselage](#) in full flight at 24,000 feet , near the front of the plane. Miraculously, the pilot managed to land the plane on the island of Maui, Hawaii. One flight attendant was swept to her death. Multiple fatigue cracks were detected in the remaining aircraft structure, in the holes of the upper row of rivets in several fuselage skin lap joints

ii. Bhopal Accident

Bhopal is probably the site of the greatest industrial disaster in history. **Between 1977 and 1984**, Union Carbide India Limited (UCIL), located within a crowded working class neighborhood in Bhopal, was licensed by the Madhya Pradesh Government to manufacture phosgene,

monomethylamine (MMA), methylisocyanate (MIC) and the pesticide carbaryl, also known as Sevin.

On the **night of the 2-3 December 1984** water inadvertently entered the MIC storage tank, where over 40 metric tons of MIC were being stored. The addition of water to the tank caused a runaway chemical reaction, resulting in a rapid rise in pressure and temperature. The heat generated by the reaction, the presence of higher than normal concentrations of chloroform, and the presence of an *iron catalyst*, produced by the corrosion of the stainless steel tank wall, resulted in a reaction of such momentum, that gases formed could not be contained by safety systems.

As a result, MIC and other reaction products, in liquid and vapor form, escaped from the plant into the surrounding areas. There was no warning for people surrounding the plant as the emergency sirens had been switched off. The effect on the people living in the shanty settlements just over the fence was immediate and devastating. Many died in their beds, others staggered from their homes, blinded and choking, to die in the street.

iii. Rupture and Fire Near Carlsbad New Mexico August 19, 2000

Accident Synopsis

At 5:26 a.m., mountain daylight time, on Saturday, August 19, 2000, a 30-inch diameter natural gas transmission pipeline operated by El Paso Natural Gas Company (EPNG) ruptured adjacent to the Pecos River near Carlsbad, New Mexico. The released gas ignited and burned for 55 minutes. Twelve persons who were camping under a concrete-decked steel bridge that supported the pipeline across the river were killed and their three vehicles destroyed. Two nearby steel suspension bridges for gas pipelines crossing the river were extensively damaged. According to EPNGS property and other damages or losses totaled \$998,296.

Accident Narrative

The EPNG pipeline system transported gas west from Texas and New Mexico to Arizona and California. A portion of the pipeline system crossed the Pecos River about 4 1/2 miles north of the Texas-New Mexico State line and 30 miles south of Carlsbad, New Mexico. About 1 mile

west of the river crossing was the Pecos River compressor station, which received gas from four natural gas transmission pipelines 26-inch-diameter line 1100, 30-inch-diameter line 1103, 30-inch-diameter line 1110, and 16-inch-diameter line 3191. Three of these lines (1100, 1103, and 1110) ran parallel to Whitethorn Road (also known as Pipeline Road) from the Pecos River to the Pecos River compressor station. Lines 1103 and 1110 were supported at the river crossing a one-lane concrete-decked steel service bridge that was not open to the public.

This bridge, which had been built by EPNG in 1950, also supported a water pipeline and a gas gathering pipeline. EPNG which was at the time of the accident a subsidiary of El Paso Energy, owned and operated the water pipeline but not the gas gathering pipeline. Line 1100 was supported across the river on a pipeline suspension bridge approximately 70 feet northeast of the service bridge. Another EPNG pipeline, 16-inch-diameter line 1000, was supported by a separate suspension bridge in this area, but this line had been removed from service and was filled with nitrogen at the time of the accident. The fourth pipeline, line 3191, ran from EPNG's South Carlsbad compressor station to the Pecos River compressor station.