

PG Semester – IV

Elective course – 1b: Physical Chemistry Special

Unit – V (A): Corrosion

Definition of Corrosion:

Corrosion is defined as the destruction or deterioration of a material because of reaction with its environment. Some insist that the definition should be restricted to metals, but often the corrosion engineers must consider both metals and nonmetals for solution of a given problem. For purposes of this course, ceramics, plastics, rubber, and other nonmetallic materials are included. For example, deterioration of paint and rubber by sunlight or chemicals, fluxing of the lining of a steelmaking furnace, and attack of a solid metal by another molten metal (liquid metal corrosion) are all considered to be corrosion.

Corrosion can be fast or slow. Sensitized 18-8 stainless steel is badly attacked in hours by polythionic acid. Railroad tracks usually show slight rusting-not sufficient to affect their performance over many years. The famous iron Delhi Pillar in India was made almost 2000 years ago and is almost as good as new. It is about 32 feet high and 2 feet in diameter. It should be noted, however, that it has been exposed mostly to arid conditions.

Corrosion of metals could be considered as extractive metallurgy in reverse as illustrated by Fig. 1.

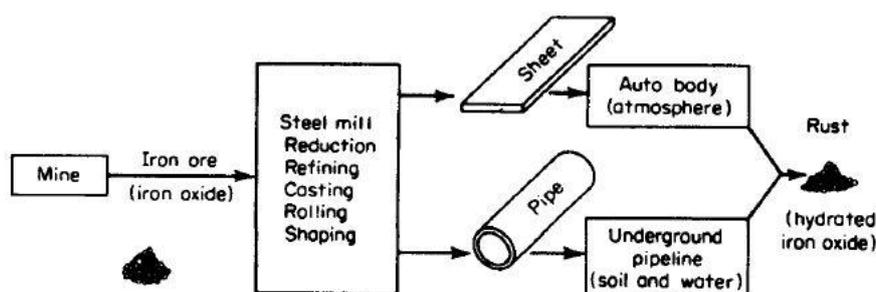


Fig. 1: Metallurgy in reverse.

Extractive metallurgy is concerned primarily with the winning of the metal from the ore and refining or alloying the metal for use. Most iron ores contain oxides of iron, and rusting of steel by water and oxygen results in a hydrated iron oxide. Rusting is a term reserved for steel and iron corrosion, although many other metals form their oxides when corrosion occurs.

Environments:

Practically all environments are corrosive to some degree. Some examples are air and moisture; fresh, distilled, salt, and mine waters; rural, urban, and industrial atmospheres; steam and other gases such as chlorine, ammonia, hydrogen sulfide, sulfur dioxide, and fuel gases; mineral acids such as hydrochloric, sulfuric, and nitric; organic acids such as naphthenic, acetic, and formic; alkalies; soils; solvents; vegetable and petroleum oils: and a variety of food products. In general, the "inorganic" materials are more corrosive than the "organics." For example, corrosion in the petroleum industry is due more to sodium chloride, sulfur, hydrochloric and sulfuric acids, and water, than to the oil, naphtha, or gasoline.

The trend in the chemical process industries toward higher temperatures and pressures has made possible new processes or improvements in old processes—for example, better yields, greater speed, and lower production costs. This also applies to power production, including nuclear power, missiles, and many other methods and processes. Higher temperatures and pressures usually involve more severe corrosion conditions. Many of the present-day operations would not have been possible or economical without the use of corrosion-resistant materials.

Corrosion Damage:

Some of the deleterious effects of corrosion are described in the next few paragraphs. However, corrosion is beneficial or desirable in some cases. For example, chemical machining or chemical milling is widely used in aircraft and other applications. Unmasked areas are exposed to acid and excess metal is dissolved. This process is adopted when it is more economical or

when the parts are hard and difficult to machine by more conventional methods. Anodizing of aluminum is another beneficial corrosion process used to obtain better and more uniform appearance in addition to a protective corrosion product on the surface.

Appearance:

Automobiles are painted because rusted surfaces are not pleasing to the eye. Badly corroded and rusted equipment in a plant would leave a poor impression on the observer. In many rural and urban environments, it would be cheaper to make the metal thicker in the first place (corrosion allowance) than to apply and maintain a paint coating. Outside surfaces or trim on buildings are often made of stainless steel, aluminum, or copper for the sake of appearance. The same is true for restaurants and other commercial establishments. These are examples where service life versus dollars is not the controlling factor.