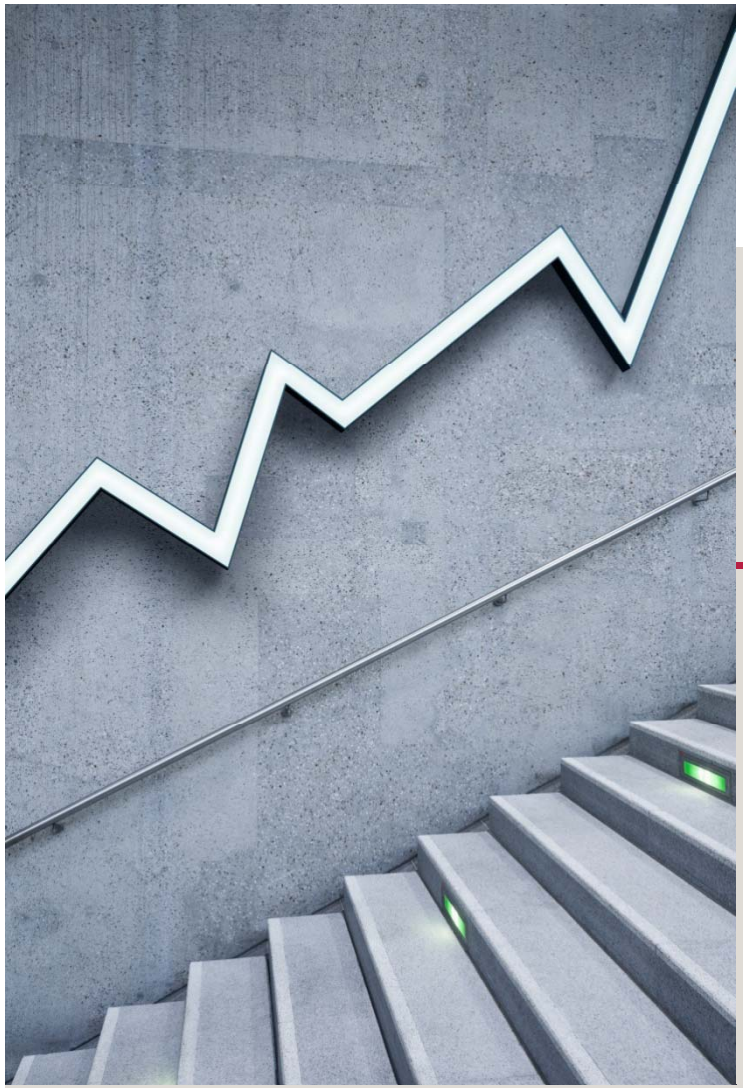

CORROSION IN PETROLEUM REFINERIES

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CONTROLLING FACTORS

- Material
- Environment
- Stress
- Geometry
- Temperature
- Time

CORROSIVE ENVIRONMENTS

- **All environments are corrosive to some degree**
- **Typical corrosive environments:**
  - Air and humidity
  - Fresh, distilled, salt and marine water
  - Natural, urban, marine and industrial atmospheres.
  - Steam and gases, like chlorine
  - Ammonia
  - Hydrogen sulfide
  - Sulfur dioxide and oxides of nitrogen
  - Fuel gases
  - Acids Alkalies
  - Soils

IMPORTANCE OF CORROSION

The three main reasons for the importance of corrosion are:

- **economics,**
- **safety, and**
- **conservation**.

IMPORTANCE OF CORROSION

The **economic** factor is a very important motivation for much of the current research in corrosion. Losses sustained by industry and by governments amount to many billions of dollars annually, approximately $276 billion in the United States, or 3.1% of the Gross Domestic Product (GDP).

- It has been estimated that about 25 – 30% of this total could be avoided if currently available corrosion technology were effectively applied.
- The cost of corrosion to Australia, Great Britain, Japan, and other countries have is approximately 3 – 4 % of the Gross National Product.

Category	Industry Sectors	Estimated Direct Cost of Corrosion per Sector	
		$billion	percent
Infrastructure (16.4% of total)	Highway Bridges	8.3	37
	Gas and Liquid Transmission Pipelines	7.0	27
	Waterways and Ports	0.3	1
	Hazardous Materials Storage	7.0	31
	Airports	—	—
	Railroads	—	—
	Subtotal	**$22.6**	**100%**
Utilities (34.7% of total)	Gas Distribution	5.0	10
	Drinking Water and Sewer Systems	36.0	75
	Electrical Utilities	6.9	14
	Telecommunications	—	—
	Subtotal	**$47.9**	**100%**
Transportation (21.5% of total)	Motor Vehicles	23.4	79
	Ships	2.7	9
	Aircraft	2.2	7

Table 1.2 Summary of Estimated Direct Cost of Corrosion for Industry Sectors Analyzed in the 2001 Study

Category	Industry Sectors	Estimated Direct Cost of Corrosion per Sector	
		$billion	percent
	Railroad Cars	0.5	2
	Hazardous Materials Transport	0.9	3
	Subtotal	**$29.7**	**100%**
Production and Manufacturing (12.8% of total)	Oil and Gas Exploration and Production	1.4	8
	Mining	0.1	1
	Petroleum Refining	3.7	21
	Chemical, Petrochemical, and Pharmaceutical	1.7	10
	Pulp and Paper	6.0	34
	Agricultural	1.1	6
	Food Processing	2.1	12
	Electronics	—	—
	Home Appliances	1.5	9
	Subtotal	**$17.6**	**100%**
Government (14.6% of total)	Defense	20.0	99.5
	Nuclear Waste Storage	0.1	0.5
	Subtotal	**$20.1**	**100%**
	Total	**$137.9**	

TABLE 1.2 Summary of Estimated Direct Cost of Corrosion for Industry Sectors Analyzed in the 2001 Study (*continued*)

IMPORTANCE OF CORROSION

Economic losses are divided into

(1) direct losses and

(2) indirect losses.

IMPORTANCE OF CORROSION

(1) direct losses

The costs of replacing corroded structures and machinery or their components, such as condenser tubes, mufflers, pipelines, and metal roofing, including necessary labor.

- Other examples are
- (a) repainting structures where prevention of rusting is the prime objective and
- (b) the capital costs plus maintenance of cathodic protection systems for underground pipelines.

IMPORTANCE OF CORROSION

(1) indirect losses

Indirect losses are more difficult to assess, but a brief survey of typical losses of this kind compels the conclusion that they add *several billion dollars* to the direct losses already outlined.

IMPORTANCE OF CORROSION

Examples of indirect losses are as follows:

1- Shutdown.

- The replacement of a corroded tube in an oil refinery may cost a few hundred dollars, but shutdown of the unit while repairs are underway may cost $ 50,000 or more per hour in lost production. Similarly, replacement of corroded boiler or condenser tubes in a large power plant may require $ 1,000,000 or more per day for power purchased from interconnected electric systems to supply customers while the boiler is down.
- Losses of this kind cost the electrical utilities in the United States tens of millions of dollars annually.

Najaf refinery (2017):

مصفى الديوانية

Diwaniya refinery (2017):

مصفـى السـماوة

Samawah refinery (2017):

قيام المصفى السماوة برفع جهاز Aut oSampl er لاغراض الصيانة رغم دخوله حديثاً للخدمة كما في الصورة الموضحة ادنـاه :-

Samawah refinery (2017):

النفط الخام يكفي بتشغيل يومين الى ثلاثة ايام من حالات الايقاف وتبين وجود حالات تاكل للخزانات كانت واضحة في الخزان رقمه (2101) نتيجة احتواء النفط الخام على الاملاح وكما مبين في الصورة ادنـاه :-

Dauah refinery (2017):

IMPORTANCE OF CORROSION

2- Loss of Product.

Losses of oil, gas, or water occur through a corroded -pipe system until repairs are made. Antifreeze may be lost through a corroded auto radiator; or gas leaking from a corroded pipe may enter the basement of a building, causing an explosion.

IMPORTANCE OF CORROSION

3- Loss of Efficiency.

Loss of efficiency may occur because of diminished heat transfer through accumulated corrosion products, or because of the clogging of pipes with rust necessitating increased pumping capacity. For example, in internal - combustion engines of automobiles where piston rings and cylinder walls are continuously corroded by combustion gases and condensates. Loss of critical dimensions leading to excess gasoline and oil consumption can be caused by corrosion to an extent equal to or greater than that caused by wear.

IMPORTANCE OF CORROSION

4- Contamination of Product.

A small amount of copper picked up by slight corrosion of copper piping or of brass equipment that is otherwise durable may damage an entire batch of soap. Copper salts accelerate rancidity of soaps and shorten the time that they can be stored before use.

IMPORTANCE OF CORROSION

5- Overdesign.

Overdesign is common in the design of reaction vessels, boilers, condenser tubes, oil - well sucker rods, pipelines transporting oil and gas at high pressure, water tanks, and marine structures. Equipment is often designed many times heavier than normal operating pressures or applied stresses would require in order to ensure reasonable life.

IMPORTANCE OF CORROSION

Safety

- Corrosion can compromise the safety of operating equipment by causing failure (with catastrophic consequences) of, for example, pressure vessels, boilers, metallic containers for toxic chemicals, turbine blades and rotors, bridges, airplane components, and automotive steering mechanisms.
- Safety is a critical consideration in the design of equipment for nuclear power plants and for disposal of nuclear wastes.
- Loss of metal by corrosion is a waste not only of the metal, but also of the energy, the water, and the human effort that was used to produce and fabricate the metal structures in the first place. In addition, rebuilding corroded equipment requires further investment of all these resources — metal, energy, water, and human.

IMPORTANCE OF CORROSION

Conservation

- Materials are precious resources of a country.
- Our material resources of iron, aluminum, copper, chromium, manganese, titanium, etc. are dwindling fast.
- Some day there will be an acute shortage of these materials.
- There is bound to be a metal crisis and we are getting the signals.
- To preserve these valuable resources, we need to understand how these resources are destroyed by corrosion and how they must be preserved by applying corrosion protection technology.

NEEDS FOR CORROSION EDUCATION

- The specific needs for corrosion education vary greatly with the level of education required, the functions expected of the personnel, and of course the applications where corrosion is a concern. In order to indicate the suitability of the various teaching aids and texts for particular types of training, four categories of corrosion personnel based upon their particular activities have been identified by the European Federation of Corrosion (EFC).

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There are four categories of corrosion personnel based upon their particular activities have been identified by the European Federation of Corrosion (EFC).

- **Group A: corrosion scientists and engineers**
- **Group B: technologists**
- **Group C: technicians**
- **Group D: operatives**

CORROSION ENGINEERING

Is the application of science and art to prevent or control corrosion damage economically and safely.

CORROSION ENGINEER

His job is to protect corrosion of various metallic structures , e.g.: corrosion protection of SHIPS , PIPE LINES, INDUSTRIES …etc.

Corrosion Engineering is supposed to have the knowledge of Metallurgy, Electro-Chemistry, Mechanical behaviors of Materials, Electrical Engineering, corrosion test, the nature of corrosive environments and the knowledge of Cost analysis.

CORROSION ENGINEER

Distribution of disciplines in which active corrosion engineers have graduated.