CORROSION IN INDUSTRIAL STEEL STRUCTURES AND MITIGATION

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INTRODUCTION

The subject of corrosion is associated with many aspects of various branches of chemistry, metallurgy, metal physics, and bacteriology. Scientific studies have revealed that few billions of dollars of national wealth are lost annually due to corrosion of metals of daily use. Reasons of many premature failures of metallic structures and components are due to undeterred corrosion of metal parts. With the advancement of material science, the causes and control of many aspects of corrosion have been established but even then, the corrosion science is still under investigation and will continue to be so due to the inherent complexity. The article presents a brief outline only on atmospheric corrosion of iron and steel, the most common engineering metal and the simplest form of protection by use of selective painting/organic coatings.

DEFINITION OF CORROSION

Precise definition of the process of corrosion is difficult and controversial. L. L. Sheer has given a logical definition of corrosion as a combination of processes in which a metal or alloy used as construction material is transformed from metallic to combined state during interaction with the elements of the environment. Metals are generally reactive and except for noble metals they tend to exist in nature as combined stable forms in oxides, sulphates, carbonates etc. Metal extraction processes are designed to recover the metal in pure form from these compound forms of ores, but upon exposure to environment the metals tend to revert to stable compound forms. Metals are useful in pure forms and such conversion during the use is undesirable. Corrosion is defined as the 'undesirable deterioration' of a metal. It is an interaction of the metal with the environment which adversely affects the useful properties of the metal.

It may be noted that corrosion is not detrimental in all situations. The oxidized metal coats the surface and prevents further corrosion by hindering the access of metal with oxygen.

BASIC PRINCIPLES OF CORROSION

Corrosion has been defined as the process of transformation of metal to more stable compound form. Metal atom changes to ionic form by losing electrons in natural environment where they are absorbed by other atoms. The rusting of iron takes place in presence of simultaneous presence of water and oxygen in the environment. The chemical reactions are given here.

$H_2O \rightleftharpoons H^+ + OH^-$ (1)

Fe (metal) $\rightleftharpoons Fe^{++} + 2e$ (2)

$2H^+ + 2e \dashrightarrow 2H$ atoms (3)

$2H$ atoms $\dashrightarrow H_2$ gas (prevalent in acidic medium) (3a)

$2H + \frac{1}{2} O_2 \dashrightarrow H_2O$ (3b)

$Fe^{++} + 2(OH)^- \dashrightarrow Fe(OH)_2$ (insoluble rust) (4)

Further oxidation of $Fe(OH)_2$ in presence of air or dissolved oxygen proceeds:

$4 Fe(OH)_2 + O_2 \dashrightarrow 2Fe_2O_3.H_2O + H_2O$, (stable rust) (5)

Rusting of iron under wet condition will not proceed unless reaction 3b proceeds and for which presence of oxygen is essential.

Corrosion can therefore be represented through the simple chemical reaction.

$aA + bB = cC + dD$ (6)

Where,

A = Metal, B = Non-metal reactants playing as oxidants
C & D = the products of reaction.

The non-metallic reactant "B" represents the "Environment", although in a complex environment, the major constituents may play only subsidiary role in the reaction. Though atmosphere contains 78% nitrogen, its effect on atmospheric corrosion of iron and steel is negligible compared to oxygen, carbon dioxide, sulphur dioxide, and salt particles (in coastal environment). However, nitrogen plays critical role in specific cases like reaction of titanium with air at high temperatures.

TYPES OF CORROSION

Galvanic Corrosion

As illustrated earlier corrosion involves flow of electrons from the metal to moisture in atmosphere, ground, salt solution or from one part of metal surface to another at different galvanic potential. A corrosion cell is formed with the metal forming the anode end (positive potential) and the surrounding medium forms the cathode (negative potential).

Galvanic corrosion occurring between dissimilar metals is another common principle of corrosion. When such dissimilar metals are immersed in electrolyte (acidic or salt solution) and connected by wire, current flow continues till the anode metal end dissolves in the electrolyte. Table 1 lists galvanic series of metals that can form such electrode pairs. This principle is used in design of cathodic protection of steel for underground installations or in seabed. A metal with higher galvanic potential like magnesium or zinc is bonded to the steel surface. This metal forms the sacrificial anode and protects the steel by forming a coating on its surface[1].

Table 1: Galvanic Series Classification of Metals

Corroded End, Active, Anodic, Less Noble	**Protected End, Passive, Cathodic, Noble**
Magnesium	Lead
Magnesium alloys	Tin
Zinc	Nickel (active)
Aluminium 2S	Inconel (active)
Cadmium	Hastelloy C (active)
Aluminium 17 ST, Steel or iron	Brass
Chromium iron (active)	Copper
Ni-resist	Bronzes
18-8 Chromium-Nickel-Iron (active)	Copper-Nickel alloy
19-8-3 Chromium-Nickel-Molybdenum-iron (active)	Monel
	Silver Solder
	Nickel (passive)
	Inconel (passive)
	Chromium ion (passive)
	18-8 Chromium-Nickel-Iron (passive)
	19-8-3 Chromium-Nickel-Molybdenum-iron (passive)
	Hastelloy C
	Silver
	Graphite
	Gold
	Platinum

In another case of galvanic corrosion, crack in mill scale on steel surface forms galvanic couple with underlying steel and the galvanic couple is strong enough to corrode the steel below. This effect is illustrated in Figure 1. Mill scale varies in thickness from 50 microns to 5000 microns and usually consists of outer layer of stable ferric oxide (Fe_2O_3), intermediate layer of ferrosol-ferric oxide (Fe_3O_4), and unstable ferrous oxide (FeO) as innermost layer intermingled with crystalline steel structure. The unstable FeO oxidizes to ferric state with increase in volume resulting in loss of the scale layer exposing more steel surface to corrosion.

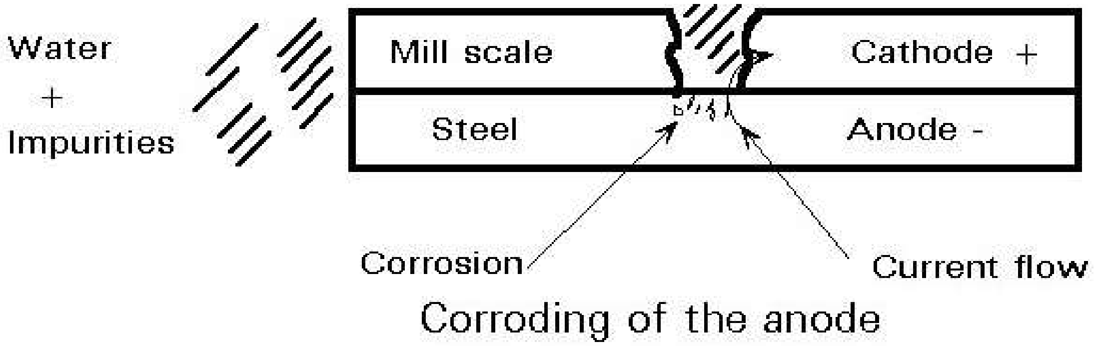

Figure 1: Corrosion Between Mill Scale and Steel[1]

Concentration Cell

Severe corrosion, leading to pitting is often caused by concentration of cells particularly where there are differences in dissolved oxygen concentrations. This type of corrosion is very common in industrial steel structures in contact with water relatively low in dissolved oxygen. The steel is anodic in areas in contact with water with higher dissolved oxygen and cathodic in areas with minimum oxygen contact. There can also be difference in metal ion concentrations in different regions of steel in contact with electrolyte that can lead to formation of electrode pair. Metal from the anodic part disintegrates from the matrix to increase ion concentration that manifests as corrosion. Typical examples are crevice corrosion due to jointing of metals or pits formed due to breakage of mill scale or coating voids. Schematic illustration for the two types of concentration cell corrosion is presented in Figure 2.

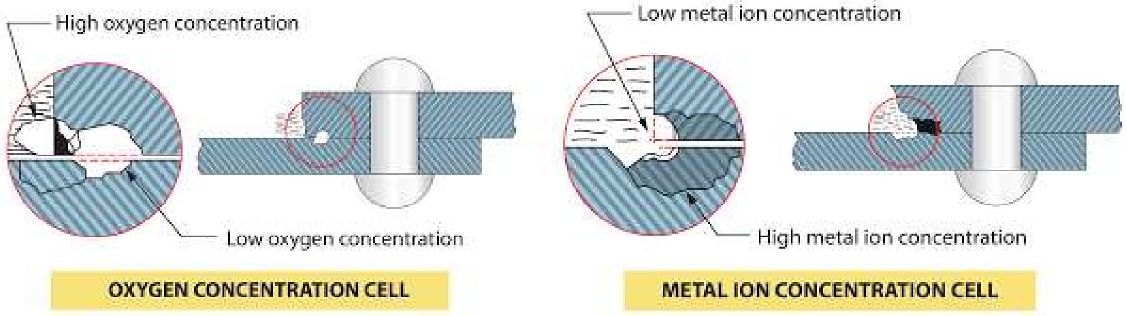

Figure 2: Concentration Cell Corrosion Mechanism[1]

Other Forms of Corrosion

There are many others forms of corrosion all of which are not discussed in detail but a summarised list of corrosion mechanisms prevalent in industrial structures is presented in Table 2.

Table 2: Corrosion Mechanisms for Steel Structures in Industrial Settings

Sl. No.	Failure Mechanism-Rank	% of occurrence
1	General Corrosion	25.8
2	Fatigue or corrosion fatigue	18.7
3	Stress Corrosion	11.7
4	Erosion Corrosion	8.7
5	Pitting	6.8
6	Weld and fabrication defects	5.0
7	Overload, mechanical abuse	4.2
8	Brittle fracture	3.9
9	Wrong material selection	3.4
10	Wear	3.2
11	High temperature oxidation or creep	1.8
12	Casting flaws	1.6
13	Crevice Flaws	1.6
14	Intergranular corrosion	1.1
15	Hydrogen Embrittlement	0.6
16	Dissimilar metals	0.5
17	Heat treatment errors	0.3
18	De alloying	0.6
19	Others	

ENVIRONMENT/EXPOSURE CONDITIONS

As discussed earlier, environment plays the governing role in initiating the corrosion. The designer tries to assess the environmental conditions before selection of specific paint system. All the environmental factors that are considered have one thing in common that is aqueous environment. Water is an important, sometimes a major constituent of such environment and plays an essential part in the corrosion process that occurs. The first environmental factor taken up for discussion in this article is water.

Water

Natural water is ultimately derived from sea water or from rainwater. The composition of seawater varies especially near large estuaries or at different depths. The main controlling parameters are dilution or pollution (both from rivers) and dissolved oxygen which varies with the depth and temperature. Rainwater usually has low probability of contact with metals except when it has a considerable bearing on atmospheric corrosion. Dissolved gases in water is another factor that controls the corrosion process. Carbon dioxide that remains uncombined in solution is a frequent source of corrosion for structures in contact with water. Dissolved oxygen is almost always present in sufficient quantity to be important. Traces of a few parts per million oxygen in the purest of water can accelerate corrosion. It is the environment in the immediate vicinity of the metal surface that counts as far as corrosion is concerned.

In de-aerated natural water, the rate of corrosion may be usually high due to the presence of sulphate reducing bacteria in water. The bacteria only thrive in the absence of Oxygen and within the pH range of about 5.5 to 8.5. This type of corrosion of is generally seen in buried pipelines of deep-water wells and casing of oil Wells.

Soils

The next environment to which structures are exposed is soil. Here the water is held in the soil structure in many complex ways and contains a wide variety of corrosive ingredients. The soil itself may consist of sand, clay, chalk, decomposed organic matters and other minerals/ chemicals. The soil may be well aerated or relatively air free; the soil water level may be permanently above or below the buried metal. Further if the electrical resistivity of the soil is low, the localized corrosion will accelerate and spread due to low electrical resistance. The protection system by paints or coatings will not suffice - cathodic protection by using impressed current or sacrificial anode in most cases are adopted along with other options.

Chemical Environment

There are endless variety of aqueous environments to which metals are exposed in process plants. The most common corrosion chemicals are acids, chlorides, salt, particularly oxidizing salt which take away the free electrons from metal surface and is difficult to prevent or stop completely.

Atmosphere

This is the most common environment to which plants and equipment are exposed in some form or other. Air itself is not particularly corrosive to the main structural metals. In clean air steel is attacked very slowly even if the air is moist. It would take 70 years to fully corrode steel plate of 3 millimeters thickness if located in rural atmosphere and can go up to thousand years in hot dry climates. In salt laden area in marine environments and especially in the immediate vicinity of the coast much higher rates of attack becomes common. Examples of these higher corrosion rates are given in Table 3[1].

Table 3: Atmospheric Corrosion Rate (Microns) for One-Year Exposure to Sea Salt[6]

Distance from Surface (metres), apprx.	Corrosion rate microns/yr. – Ingot Iron	Corrosion rate microns/yr. – Zinc	Salt Content in air (ref 1)
50	38	1.5	11.1
200	15	0.6	3.1
400	2.2	0.1	0.8
1300	1.6	0.02	-0.2
3000	-	-	

Note: Salt contents expressed as mg NaCl/day/100 m² cloth area

The most serious cause of atmospheric pollution is from manmade polluting environment. Atmospheric pollution from burning of fossil fuels and from other industrial processes, makes all the structural metals corrode more rapidly. Presence of water in some form is necessary, even if the relative humidity is shown below 100%, many common metals particularly iron and steel are found to corrode. It is certain that at a given temperature there is a critical humidity for metals such as steel, copper, zinc etc. above which corrosion is considerably increased especially when pollutants like SOx/ NOx, and/ or sea salts are present.

In summary, the designer must go in depth for the correct assessment of the environment in which designed metal atoms are exposed. The basic classes of environment are as listed below.

- Dry
- Tropical
- Rural
- Humid
- Temperate
- Urban
- Marine
- Arctic
- Industrial

A site can be a combination of these basic environment classes. In case of a structure located in marine tropical industrial environment it is easy to understand its corrosion severity. ISO 12944 classifies environment into five lasses based on the exterior condition and impact on structural components as shown in Table 4.

ROLE OF PAINTING IN CORROSION PREVENTION

The use of paints and industrial coatings is the most common way to control a large segment of the general atmospheric corrosion. Industrial paintings can provide superior resistance against corrosive environment, chemicals, water, temperature, and abrasion.

Table 4: Corrosion Class and Environment (Internal/External)[6]

Class	Impact	Interior	Exterior
C1	Very low	Heated buildings with clean air, such as offices, shops, schools, hotels, etc.	None
C2	Low	Buildings not heated, where condensation may occur, such as warehouses and sports halls.	Atmosphere with low pollution e.g., in the country.
C3	Middle	Buildings for production with high atmospheric humidity and some air pollution such as food manufacturers, breweries, dairies and laundries.	Urban and industrial areas, moderate sulphur dioxide pollution. Coastal areas with low salt content.
C4	High	Chemical manufacturers, swimming baths and ship- and boatyards by the sea.	Industrial areas and coastal areas with moderate salt impact.
C5-I	Very high - Industry	Buildings or areas with almost permanent condensation and with high pollution.	Industrial areas with high humidity and aggressive atmosphere.
C5-M	Very high	Buildings or areas with almost permanent condensation and with high pollution.	Coast and offshore areas with high salt content.

Action of Paint

Paint is a mixture of pigment which gives opacity and a liquid binder material (vehicle) which binds the pigments together. The purpose of paint coat is to protect the metal surface from its environment.

Paint retards the corrosion of steel in number of ways:

i. Paint forms more or less an impervious barrier between the metal surface and the surrounding environment. This mechanical barrier is not totally impervious. Even with the best paint products and best method of application there will be pores through which moisture and air/ gases will diffuse to corrode the metal. Therefore, application of multiple coats is adopted to hinder the diffusion process.

ii. It is well known that certain chemical compounds either completely stop or retard the corrosion of the steel. It is understood that these compounds form films on the anodic or cathodic area which lead to the suppression of the corrosion. For example, chromate salts can easily be leached away; therefore, less soluble zinc chromate pigments find use as rust inhibitor. Zinc phosphate pigment which is occupationally safest rust inhibitor pigment is used extensively for primer paint formulations. Similarly, red lead (lead oxide) pigment when dispersed with linseed oil and alloyed to dry form lead soaps which form a dense rough film of very low water permeability.

iii. Corrosion is an electrochemical process where electric current from anode (corroding metal) to cathodic area or environment causes metal to corrode away. Paint films formed due to polymerisation of organic vehicle act as insulating membrane which disrupts the flow of electrical current if the film is intact.

In summary, it might be stated that a suitable metal protective paint must be one with rust inhibitive properties, low permeability to corrosive agents, low absorption of water and the ability to wet the surface to which it is applied. In special cases the paint should have fire retardant properties when the installation is prone to fire hazard.

Performance of Paint System

The important factors which govern the desired performance of an industrial paint system are:

i. Proper design of the structure/equipment to be painted and the appropriate selection of the material which can withstand the environment. If the selection of basic engineering material is inappropriate with respect to the environment, the paint alone cannot protect the metal; paint at best retards the corrosion rate but cannot stop the process.

ii. Correct assessment of the likely exposure conditions and the operating temperature of the surface to be painted. Corrosion rates generally increase with rise in temperature, but presence of oxygen also plays crucial role in controlling the rate[7].

iii. Location of the structures/equipment – indoor or outdoor installation.

iv. Whether the structure/equipment are underground or over ground or immersed in water; in case of immersion in water, the water quality and existence of any splashing zone where the structure undergoes alternate cycles of wetting and drying need to be assessed.

v. Selection of specific paint system for specific environmental consideration.

vi. Proper surface preparation and formulation and application of paint

vii. Monitoring of paint condition and timely maintenance of painting by touch-up and re-painting.

CORROSION IN STEEL PLANT AND CORROSION PROTECTION COATING SYSTEM

The following case study is from a typical environment in Steel Plant. Table 5 identifies the plant area, corrosion zone and the corrosion rate. Steel plant atmosphere have high dust loads and these tend to settle on structural members. The accumulated dust contains polluting chemicals and absorbs moisture from air or gets wet in rain. This mixture aggravates the corrosion process in the steel structure. Table 6 shows anticipated dust accumulation in various areas of steel plant.

Table 5: Areas of Steel Plant with Corrosion Rates

Sl. No.	AREA/PLANT	ZONES	Corrosion Rates (mils per year)
1.	Rolling Mill area, Engg. Work Shops, Raw Material Area	Normal Corrosive Zone.	Corrosion rate less than 1 mpy
2.	E.T.P. Area, SMS Area, Captive Power Plant Area	Mild Corrosive Zone.	Corrosion rate between 1 & 3 mpy
3.	Coke Oven area, Coke Plant By-Product Area	Corrosive Zone.	Corrosion rate between 3 & 5 mpy
4.	Pig Casting Machine Area, Pickling Mill area.	Highly Corrosive Zone.	Corrosion rate of 5 mpy & above

Paint System

A paint film forms only mechanical bondage with the virgin metal surface. The surface should be artificially prepared to provide anchoring profile for the paint film. Application of paint on the rusted metal surface or on greasy surface the paint will not hold. Up to 70% of coating failure have been blamed on poor surface preparation. There are various methods of surface preparation like wire brushing, power tool cleaning, or shot blasting, chemical cleaning (pickling) that is quickly and even flame cleaning depending on degree of cleanliness desired. degree of cleanliness of Steel surface represents as St. 1 to St. 3 and Sa1 to Sa3 are pictorially represented in Swedish Standard S/S 055900.

The anti-corrosive paint system comprises of following:

Prime Coat

Prime coats are the initial basic coats to be applied preferably by brush on the freshly prepared steel surface. Primers provide adhesion to the metal plus corrosion control to protect it. There are three main types of primers

- barrier primers
- inhibitor primers
- zinc rich primers

Table 6: Dust Deposition in Steel Plant Areas

DUST DEPOSITION in ISP				
Location	Type of Dust	Deposition rate per year (Thickness in mm)	Density (Kg/Cu.M)	Remarks
SMS	Iron	75mm and more	1700	Irone Fines
Lime Calcining Plant	Lime	100 and more	1300	Lime, Dolo etc
Sinter Plant	Sinter	100mm and more	1850	Sinter Mix
Captive Power Plant	Coal/Ash	50mm and more	870 1000	Coal Dust Fly Ash
Blast Furnace	Iron Ore/Sinter	300mm and more	2400 1850	Iron Ore Sinter
Raw material	Iron	75mm and more	1700	Various Raw Materials including Iron
Coke Ovens	Coal/Coke	300mm and more	870 750	Coal Dust Coke Dust

Note:

1. Table formed based on experience and various interactions with plant personnel
2. The accumulated thickness is indicative, can be bettered with proper maintenance

Barrier primers are impermeable films such as vinyls, chlorinated rubber, epoxies etc. these primers reduce the access of water, chlorides, and sulphates to the Steel. They impart corrosion resistance by artificially increasing the electrical resistance of the corrosion cell. Barrier primers are most favoured where there is continuous exposure to corrosive electrolytes such as Marine installations, chemical installations, water storage tanks or buried pipelines.

Inhibitive primers are commonly composed of oil base, alkalyds of phenolic alkalyd vehicle that contains small additions of soluble inhibitors such as chromates, molybdates etc. These inhibitor chemicals dissolve as moisture diffuses through the paint system to the Steel surface. The inhibitor then retards the electrochemical corrosion reactions at the microscopic anodic or cathodic areas on the steel surface.

Zinc rich primers are highly loaded with metallic zinc e.g., 86% by weight. The zinc sacrificially corrodes to protect the steel which acts as non-corroded cathode. Zinc-rich Primers protect against corrosive undercutting of paint system and in additions offers good abrasion resistance.

There are other organic (e.g., epoxy) and inorganic (e.g., ethyl silicate) zinc rich primers. Organic zinc rich primers can tolerate slightly poorer surface preparation quality and easier to apply than inorganic ones. chemical resistant wise organic zinc rich primer is better than inorganic based. However, dry heat resistance for organic primer is limited to 120° Celsius to 150° Celsius for the inorganic primers.

In outdoor exposure or other environment, essentially in neutral pH condition the inorganic zinc primers can be left without top finish coat (ignoring aesthetics). However, if the pH of the environment is below 5 or above 10, untop-coated zinc rich increase primers are favoured for shop priming of steel that is slated for use in severely corrosive environment such as continuous or intermittent immersion of seawater or for long outdoor life. Zinc rich primers have been called the “ultimate contribution of the paint technologies to the work on corrosion”.

Top Coat

The role of the topcoat is to

I. protect the primers from weathering
II. provide the protection as listed in the Table 7[8]
III. provide aesthetics including long lasting colour and gloss preferably without excessive chalking, fading, or yellowing.

Relative resistance of different types of top quotes against various types of environment is given in Table 7.

Paint Film Thickness

Enough paint must be applied for corrosive environment and is usually a minimum of three coats with the total dry film thickness that is DFT of at least 125 microns. In one comparison for structures in steel plant exposure, it is reported that oil-based coatings of 100 to 125 micron give 8 to 10 years of protection in rural environment whereas for marine environment the coating need to build more, minimum 220 microns for oil-based paint, 125 microns for alkalyds, 115 microns for epoxy and 120 microns for chlorinated rubber and 75 micron for vinyl if 8 to 10 years protection are desired.

High Build coatings of thickness DFT 50 to 75 microns per coat provide an economical means of adding more microns for application but are not as protective as regular build coating applied in several coats to give an equivalent film thickness.

Compatibility of Paint System

This is a very important aspect while recommending a paint system. All paints are not compatible which means by selection of any specific paint as a primer the top coat cannot be chosen at random. With alkali primer epoxy top coat is not compatible as if it will chemically decompose the epoxies. There are similar such incompatibilities with many paints.

Table 7: Relative resistance of common topcoat paints to exposure[8]

Paint	Acids	Alkalis	Salts	Solvents	Water	Weather	Oxidation	Abrasion
Oil Based	1	1	6	2	7	10	1	4
Alkyd	6	6	8	4	8	10	3	6
Chlorinated rubber	10	10	10	4	10	8	6	6
Coal tar epoxy	8	8	10	7	10	4	5	5
Epoxy-amine /amide	9	10	10	9	10	8	6	6
Silicon Alkyd	4	3	6	2	8	8	6	6
Vinyl	10	10	10	5	10	10	10	7
Urethane	9	10	10	9	10	8	9	10
Zinc (inorganic)	1	1	5	10	5	10	10	10

Note: A value of 10 represents the best protection.

Specifying a suitable painting system for steel structure should address the following aspects at minimum:

1. assessment of the environment
2. selection of right paint system
3. surface preparation standard
4. method of application including number of coats/paint thickness
5. drying time and coating intervals
6. crucial application limitations
7. strict observance of the maker’s directions
8. safety precautions
9. clean up
10. inspection and quality control

Paint Failure

Despite design and application of the best paint system the paint film is susceptible to fail for various reasons some of which are listed below.

i) Faulty mechanical design of the structures and equipment by which the surface contours are such that uniform coating thickness cannot be developed.

ii) Improper application of paint, most of the defects in an applied paint which do not stem from improper surface preparation but from incorrect mixing of paint ingredients or application in a hurry without waiting for drying.

iii) Incorrect paint formulations or old paints in use

iv) Loss of adhesion

v) Application of paint in humid weather

vi) Mechanical stresses and other abuses on the paint film

vii) Under film corrosion - this occurs most readily when the coated metal is exposed in high humidity environment (50- 200% R.H>) and situation becomes worse if the environment is saline as in the case of marine environment. It can be retarded if the relative humidity of the environment is maintained at less than 50%, if an inhibitor is added to the paint or if the reactivity of the metal surface is decreased by means of metal surface treatments that form on the substrate metal a compound of the metal (e.g., a phosphate or an oxide) that is less reactive than the bare metal.

It is thus mandatory to chalk out a regular paint and structure health inspection plan and carry out periodic checks and maintenance of the paint coatings throughout the service life of the structure.

MAINTENANCE OF PAINTING

If the engineering structures and equipment need to be protected from corrosion, the protection measures adopted need equal maintenance care as plant and machinery. It is more important to have regular maintenance on retaining the paint film than to replace the entire metal badly affected by corrosion.

In all maintenance painting the aim is to repaint before the old paint has deteriorated to a stage where it must be entirely removed. This is done by periodically applying a single new coat of paint over the cleaned old paint substrate. The normal span of such a period for a marine installation should be around 2 years both for outside and inside painting if required.

In maintenance painting it is not intended that sound, adherent old paint system be removed unless it is excessively thick or brittle or is incompatible with the new paint. However, the defective paint layer shall be removed beyond the edges of the defect spot or area till a zone of intact and perfectly adherent paint layer without rust or blister below the film is reached. The retained part of old paint zone should have adequate adherence to prevent it getting lifted as a layer when putty knife is inserted under the coating. The edges of adherent paint coat outside the defective area are feathered to create a gradual taper towards the zone of recoating to create smooth overlap zone. For defective areas of old paint substrate, work involves spot cleaning to provide new anchoring profile and application of adequate number of coats of compatible primer over those areas is carried out to build them up to a satisfactory level. Then an overall finish coat is applied as final coat.

Today everybody is aware that timely remedial measures against corrosion would not only save the huge expenditure in replacing the corroded defunct equipment/steel structure by new one but also of the production shut down time can be reduced. In recent times computers have been deployed to compile systematically all sorts of corrosion data, results of corrosion preventive measures and predict future plan of action to combat the corrosion.

CONCLUSIONS

Steel / Steel Structure is subjected to degradation by corrosion. Corrosion is a natural phenomenon which occurs in simultaneous presence of water and oxygen (air). However, rate of corrosion is not uniform everywhere. There are several factors which influence the rate of corrosion. Rate of corrosion can be minimized but can't be eliminated. Corrosion is controlled by changing the environment, though it is difficult. Rather it is easier when protective system is adopted. Painting is the best method of preventing corrosion in steel structure. However, its effectiveness is depending on many factors. However, steel structure can last more than 100 years with application of proper protective maintenance painting.

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