Progresses on mild steel protection toward surface service performance in structural industrial: An Overview

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Abstract. Mild steel has been widely used in domestic and industrial applications due to its excellent properties. Their property in engineering application makes it one of the leading engineering materials with multifaceted usage. Despite this growing interest in manufacturing because of cost and durability, challenges arising from wear, corrosion and structural damages has been a concern and the need to search for continuous way-out become necessary. This overview provides concise progresses on mild steel toward active protection for service performance.

Keywords: Mild steel, performance, protections, industry

1. Introduction
Mild steel is extensively used in industry, especially for structural applications because of some unique properties exhibited. Mild steel has an ultimate strength of somewhere in the region of 29 to 30 ton/in², a modulus of elasticity about 13000 to 13500 ton/in², a yield strength of 15 to 16 ton/in² and very ductile properties [1-3]. The excellent features of mild steel are: relative cheapness of production, high mechanical properties, ease of cold working, and the ability to be hot worked without loss of mechanical properties [4]. It has the disadvantage that it requires efficient protection to prevent corrosion. When riveted construction gave way to welding, it eventually became possible to mild steel quickly, and high-efficiency joints could be obtained [5]. The mild steel has a chemical composition mainly iron with small percentages of other materials, principally carbon and manganese. The rate of carbon is usually somewhere about 0.2%, and in modern steels, the manganese content is not less than 2.5 times the carbon content. Impurities such as sulfur and phosphorus are kept at a low level, usually 0.05% for each [5, 6].

Mild steel's susceptibility to rusting in humid air and its high dissolution rate in acidic media is the major obstacle. Therefore, the development of corrosion resistance mild steel has become an interesting investigating idea lately by numerous researchers [7]. And the effort has been towards surface technology application. Surface treatment for the properties of the material or metal such as hardness, wear, and corrosion resistance are the basic requirements for the development of modern industrial applications. Every material properties requirement differ with the compositions used to develop supportable environmental application [8]. Deterioration of materials is natural phenomenon degradation due to the reactions with the ecological conditions. Material selection is the best tool to use against the avoidance of corrosion service. Even though the deterioration cannot be permanently prevented, choosing the best material is the choice that will serve as a reduction of the corrosion rate to be infinitely small for years [9]. Economic aspects should play a role in material selection to minimize the cost while producing product requirements that meet application performance goals.
Understanding the alloying process, coating methods, and the effect of compositions is a fundamental tool to use for consideration specifications for essential material properties [10].

Degradation of metals leads to failure conducts for most mechanical components. The development of a new barrier coat of zinc hydroxide at the steel/Zn-phosphate boundary leads to blocking the pores of the coating [11]. The electrolytic coatings produced on mild steel showed an exceptionally high corrosion resistance in salt spray tests and long-term atmospheric exposure. In the initial stage of corrosion, the cathodically coated steel was found to show a high electrochemical activity compared to chemically phosphate steel. This was credited to the existence of metallic zinc in the cathodically formed coating. In an alkaline solution, the zinc phosphate coating is converted chemically into a stable zinc oxide layer, which shows excellent corrosion resistance [12-14].

The microstructure of the coated-body often provides excellent improvement properties. Metallic corrosion is concerned with all-metal interactions with its environment; it is the passage of metal into a chemically combined state. From the metallurgical aspect of view, it can be said to be extractive metallurgy in reverse that is metal is derived from their ores, and when they corrode, they go back into their minerals or a component of it [14, 15]. Thus, this study carefully looks into the progress of mild steel, corrosion phenomena and new protective based coatings.

2. Steel surface corrosion and protections
Corrosion reaction by electrochemical or chemical activities is destructive and susceptibility on steel surfaces. Harsh condition with temperature gradient in the presence of environmental reactor influences corrosion mechanism which also promotes pitting evolution. Undoubtedly, corrosion phenomena involving submerged component in water, moisture or atmospheric condition are enhanced through electrochemical processes. Atmospheric corrosion, because of exposed steel structures bridges, trusses, towers, etc are used in open space of Bangladesh. Atmospheric corrosion is stimulated by humidity, damp atmosphere, since these maintain a film of water on the metal, providing the essential electrolyte. Other factors are acid gases in the atmosphere or sulfur compounds from cinders, coke, coal dust, etc; salts dissociate to produce an acid reaction; oxygen dissolved in the water film [5]. Rust may accelerate corrosion and cause pitting. The probable explanation is that surface accumulations of rust shield the underlying metal from free access to oxygen, thus rendering such portions anodic (corrodible) with respect to unshielded areas to which oxygen has freer access (cathodic areas).

With few exceptions, any marketable product of low carbon steel must be surface-finished by grit/air/sand blasting or acid pickling for good adhesion before any coating for surface protection [8]. While the primary purpose of a coating or finish may often be to improve the appearance and sales of the item, coatings must be used on metals to give reasonable resistance to destructive influences due to wear, electrolytic decomposition and contact with the weather or corrosive atmosphere [10-12]. Corrosion may be minimized through application of protective metal such as zinc, nickel, copper. In most cases where advance application services are required, the use of oxide, phosphate, or similar coatings on iron and steel are often engage for surfaces enhancement. The application of protective paints also renders the surface of the metal passive.

Metallic coatings are in general, the application of a finite thickness of some material over the metal, or are the transformation of the surfaces by chemical or electrical means to an oxide of the original metal. Galvanizing is a zinc coating used extensively for protecting low carbon steel from atmospheric deterioration. Galvanizing by zinc is generally applied to metal surfaces by the Sherardizing process, by dipping into a bath of molten zinc, by electrode position, or by metal spraying. But we here consider (1) the hot-dip galvanizing process and (2) a new technique--the cold-galvanizing process.

Although electroplated zinc coatings are considered as one of the main methods used for the corrosion protection of steel [14]. This has led to a growing interest in the manufacturing industry. Deposition of zinc on mild steel offers great protection at low costs. Zinc composite coatings exhibit
better corrosion resistance property. Nowadays the nano-sized materials are co-deposited to get better zinc composite with better corrosion resistance [13-15]. Corrosion of metals occurs by the electrochemical reactions taking place with either their natural or man-made environments, which would often result in deterioration of the metals’ properties. Through oxidation and reduction reactions, the surface of the metal develops anodic and cathodic zones forming oxides of metal alloys. In recent times, transitional metal and nitrides based are considered due to their attractive responses in application in relation to chemical and physical properties.

3. Electrodeposition, metallic coating development and its responses in the environment

Electroplating is the process of depositing a skinny layer of metal over the surface of the cheaper metal, using electric current. It is divided into D.C, pulse plating, and electroless plating. Electrodeposition presents a cost-effective and less equipped method. In recent times, composite electroplating has taken the lead over contemporary ordinary zinc-based coating. Composite electroplating is the co-deposition of insoluble of metallic or non-metallic compounds with metals or alloys in a plating bath. A composite material is composed of two or more individual elements comprising of either metals, ceramic, or polymer. The invention of the electrolytic plating was introduced and consisted of applying a composite coating on the metal's surface. These metals have been used in many fields due to their unique properties (Fayomi et al. 2011). The process variable influences the physical, chemical, and structural properties of components, especially with insight on performance. Among numerous are the following parameters affecting the electrodeposition

- **The applied potential and current densities (direct current, pulse time).** Normally, electrodeposition has been carried out by using either potentiostatic or galvanostatic techniques to produce composite coatings. Within the galvanostatic mode, direct current (DC), pulsed direct current (PDC), and pulse reverse current (PDC) techniques have been reported in the literature to provide thin-film applications [12]. A study by Steinbach et al compares the coating that was deposited using direct current and pulse current. It was shown that the synthesis of nanocrystalline Zn-ZrO2 composite coating was possible by using a direct pulse current.

- **Particle size, shape, type (micro or nanoparticles), and concentration affect the composite coatings’ synthesis.**
  The particle content varies for each particle type. The shape of the particle can influence some of the co-deposition parameters, including the adsorption of the particles to the cathode [1]. Different kinds of results have been observed regarding the particle size during electrodeposition. In most cases, larger particle size tends to have higher incorporation of grain crystal at metal surfaces.

- **Bath agitation and electrode movement.**
  The initial step in co-deposition involves the transport particles to the cathode. This means that the particles have to be moved from the electrolyte to the cathode. Researchers have reported that there is always a decrease in particle incorporation due to too much agitation of electrolytes. This is caused by the particles moving away from the cathode surface before they can be incorporated. On the contrary, some authors also affirmed that agitation increases the particle transport towards the cathode, thereby enhancing the particle incorporation [6].

- **The electrolyte composition and pH.**
  The rate of incorporation of particles in coating depends on the bath composition. But again, the additional agents affect the co-deposition process. Many researchers claim that different reagents have different effects, but they usually increase the incorporation of the particles. [4-7] has shown that the addition of small amounts of oxides, nanocarbon, ceramics, and amines promotes co-deposition [6-8]. When the influence of pH in an electroplating bath is discussed, researchers give one similar and consistent conclusion, which is also a significant boost to coating adhesion. In a recent study, authors have observed that particle incorporation influences electroplating bath framework and alter bath pH. There is a connection between the effects of temperature on the co-
deposition process. Most composite coating is difficult to deposit without a change in a temperature gradient. It was reported that particular systems do not show any influence of temperature, whereas other systems reveal a rise in the incorporation of the particles that affect such coating formation.

4. Conclusion
The major challenge of structural steel in application is environment and this has resulted into both physical and chemical deterioration of engineering component in service. Thus, this study has concisely looks into persistence effort and continuous approach to finding solution to environmental setback, reaction pose from the corrosive solution. Development of coating is seen as the most economic way-out to retard the accelerated responses of corrosion catastrophes through the use of composite coating or surface active metallic coatings.

Declaration of Competing Interest
The authors will like to declare that this research has no any financial or work related competing interest

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