

EVALUATION OF THE PROTECTIVE PERFORMANCE OF SEVERAL DUPLEX SYSTEMS EXPOSED TO INDUSTRIAL ATMOSPHERE

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Abstract- The atmospheric corrosion behavior of galvanized steel sheets and steel/55%Al-Zn system with or without different paint schemes was analyzed. The samples were exposed to the atmosphere in the experimental station of CIDEPINT. Periodically, all specimens were visually inspected and sampling was made to evaluate the general behavior of the protective system. Normalized physicochemical and EIS tests were performed on each specimen. The corrosion products were characterized by SEM. The data included in the present work concern to the first step of exposure (800 days). The foreseen whole period of testing is 7 years. From the present results may be concluded that: 1) on the analyzed industrial environment, the bare sheets of steel/55%Al-Zn system have suffered less damage than the bare galvanized ones, 2) chloride and sulphide are present in the corrosion products denoting the aggressiveness of environment, and 3) in general, all duplex systems have shown a fairly good protective behavior.

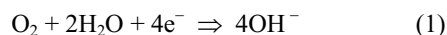
Keywords- Duplex system, paint, corrosion, protection.

I. INTRODUCTION

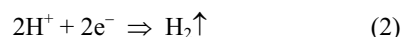
It is well-known that all materials are damaged by the atmospheric conditions, mainly by oxygen, humidity and atmospheric pollutants (SO₂, NaCl, NO_x, etc.); another important degradation source is the global radiation of the sun. From a practical point of view, at ambient temperature and in dry atmosphere, metallic corrosion could be ignored; otherwise, it is important on wet surfaces. The corrosion mechanism is electrolytic (Feliú and Morcillo, 1982; Rozenfeld, 1972; Kucera and Mattson, 1986). The electrolyte is a very thin film of moisture (a few monolayers), or an aqueous film (a thickness of hundreds of microns) when metals show up perceptibly wet. It is proved that relative humidity (RH) plays an important role in atmospheric corrosion. Below a RH specific level, the corrosive attack is not important because the film of electrolyte on the metallic surface is almost negligible. Generally, the corrosion of iron and other metals is negligible for RH<60-80%, depending on the metal. Though humidity presence is necessary it

is not enough to develop corrosion. Even in very humid environments, corrosion of uncontaminated surfaces is often relatively low in unpolluted atmospheres. Among the external factors that are determinant on the corrosion rate definition, it is possible to mention: 1) the lifetime of the electrolytic film on the metal surface, 2) the chemical composition of atmosphere (level of pollutants), and 3) the ambient temperature.

Under the electrolytic film, most of metals exposed to the atmosphere will corrode by coupling with cathodic reduction of oxygen:



although, when the level of contamination with acid products is high, the hydrogen evolution gets importance as cathodic reaction:



with independence of which reaction prevails, the pH on the cathodic region increases. From a certain level of acidity it is possible that the SO₂ of a polluted atmosphere acts as an oxidant able to impart a great acceleration to the cathodic process. The O₂ diffusion through the aqueous film is usually the controlling step of the metallic corrosion rate. This corrosion rate increases when the aqueous film thickness decreases, until reaching a maximum at intermediate thickness. A thick film of water difficults the oxygen arrival and, therefore, reduces the attack rate. On the other hand, a very thin film slows down the corrosion process due, not only to the high ohmic resistance, but to the obstruction of ionization reactions and metallic dissolution.

The stability of metals or alloys in an aggressive environment will depend on the protective properties of organic or inorganic films, as well as on the layer of corrosion products. Some film characteristics, such as chemical composition, conductivity, adhesion, solubility, hygroscopicity, and morphology, determine its ability as controlling barrier to different kinds of attack and corrosion rates (Stratmann *et al.*, 1983). On the other hand, the stated characteristics depend, in turn, on chemical composition and metallurgical history of the metal, on physicochemical properties of coating, and on environmental variables such as atmospheric conditions, type and amount of pollutants, wet-dry cycles, etc. (Stratmann *et al.*, 1983; Stratmann and Streckel, 1990; Pourbaix, 1969). In this sense, a common example is

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