

Corrosion of non-ferrous metal in the presence of humic substances

Zimbovskaya M.M., Makunin A.V., Pankratov D.A.

Lomonosov Moscow State University, Moscow, Russia, pankratov@radio.chem.msu.ru

Keywords: corrosion, non-ferrous metals

doi: 10.36291/HIT.2019.zimbovskaya.131

Chemistry of corrosion processes is one of the most important scientific domain. The most thoroughly studied mechanisms are that of corrosion of engineering materials under the influence of reagents of anthropogenic origin. However, a significant part of metallic structures contacts with ground and soils, containing natural polyelectrolyte of a multifactorial action (acid-base, redox, complexing, etc.) – humic substances (HS). On the one hand, due to their high reactivity, HS can directly interact, for example, with metallic iron. On the other hand, it is known that archeologists often find metallic artifacts in very good condition in saturated HS waters (bogs, peat bogs, etc.). In addition, mixed corrosion inhibitors based on lignosulfonates, tannins and amino alcohols are suggested for the protection of steel reinforcement in reinforced concrete. It is obvious that the mechanisms of interaction of HS with metals are complex, and require a comprehensive study.

Earlier [see HIT-2017], we showed the role of HS in the corrosive destruction of iron-containing engineering materials with metallic protective coatings of various nature. This article discusses corrosion under the action of HS of the following non-ferrous metals: aluminum, chrome, nickel, copper, zinc, tin, bronze, brass, nickel plated brass. As the corrosive medium were used: a) tridistilled water (pH 6.5); b) 3% NaCl solution (pH 8.5); c) 0.01% HS solution (obtained by alkaline extraction from "Natural Humic Acids", LifeForce, Saratov, Russia) (pH 7.6); and d) a solution containing 3% NaCl and 0.01% of the above HS (pH 7.7). Samples of materials were exposure in these solutions at a temperature of 45°C in the course of 48 hours. After the expiration, the properties of solutions for practically all samples have changed significantly. So, solutions containing HS was almost completely discolored (except for solutions that contacted with Cr, Ni and Al. For all samples, formation of brown sediments was observed (with the exception of the zinc which dense white sediment was observed). Scratches on the surface of some samples was covered with a dense layer of brown corrosion products. Visually, the highest corrosion intensity was observed for solutions with NaCl. The surfaces of the initial samples and the samples after treatment was studied by optical microscopy (5^x - 20^x), and SEM (with resolution to 200 nm). The compositions of the metal substrate and the coatings of the materials were determined by the energy-dispersion analysis method.

The nature of the changes on the metal samples surface and in the depth of the "scratch" was controlled by comparison with similar data for untreated materials. From the data of a microscopic study, it follows that on the surface of "active" metals (Al, Cu, Zn) corrosion products are formed unevenly - distinct regions with more and less dense coatings of corrosion products are clearly distinguished, clearly differing in their morphology and, possibly by chemical composition. On the surface of the samples of "passive" metals (Cr, Ni), thin layers of compounds are observed, but only under requirement of the presence of HS in the electrolyte. The most intense formation of corrosion products for all samples is observed in the area of "scratches" and natural defects, presented in the coating of the studied materials. Moreover, products of corrosion are formed in water or NaCl solution as loose morphology. In the case of solutions containing HS, including the presence of NaCl, a dense coating is formed above the active (unprotected coating) surface of the sample, possibly from sparingly soluble metal compounds and HS. Thus, using several samples of non-ferrous metals, it was shown by direct experiment that despite its high chemical activity to many metals, and in particular to iron, HS can serve as shielding corrosion inhibitors even in such aggressive media as NaCl solutions.