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Monitoring of microbial corrosion in soil by means of an advanced multiparametric probe

Microbial corrosion (also named microbial induced corrosion) is driven by the presence of microorganisms which build up complex biofilms on metallic surfaces, changing their electrochemical behaviour by influencing the chemical-physical properties of the materials in soils as well as in water environments. Microbial activity towards corrosion is present on all materials, including ones exhibiting passive behaviour, both in aerobic and anaerobic conditions. This effect is due to the changes occurring in the kinetics of the corrosion process at the metal-biofilm interface. The ennoblement of corrosion potential of stainless steel induced by biofilms in aerated seawater was well documented in the past [1]. Based on this effect, electrochemical sensors of biofilm growth were developed and are currently commercialized in US as well as in Europe [2]. A similar probe was experimented also for monitoring biofilm growth in soil [3], but never reached the commercialization.

Based on these previous experiences, in this work a multiparametric probe is engineered and used to monitor different chemical-physical parameters of soil: redox potential, conductivity and temperature. The probe utilizes the required electrochemical sensors to detect the activity of microorganisms growing on a titanium wire with a zinc counter electrode. A preliminary experimentation with this multiparametric probe, carried out at laboratory level in a pot of soil (50 cm diameter, 50 cm height), at different temperature and humidity is presented here. The results show correlations between microbial presence and the other chemical-physical parameters. The probe is designed to be portable, reliable and easy to use and install. Different cable adapters allow for the change in the measured parameter, interchangeable working electrodes allow for testing of different materials, zinc reference electrode ensures stability in many soils and titanium spring-like counter electrode provides high surface area and mechanical anchoring of the soil avoiding its detachment. A water dripping system allows for control of soil water content.

Results show the minimal effect of temperature on monitored parameters, which are by far more influenced by water content in soil. Free corrosion potential monitoring is not able to detect the formation of the biofilm, which is instead identified by tracking the current of the suited galvanic couple Ti-Zn.

Forthcoming research is dedicated to correlation of all the monitored parameters, looking for trends to be directly correlated to microbial activity and microbial pool evolution. Several materials are under testing, among which copper alloys, AISI 303 stainless steel and ARMCO iron.

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