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Modelling of microbiologically influenced corrosion (MIC) of metallic alloys in seawater by electrochemical impedance spectroscopy in a nano-meter scale

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The main purpose of this study was to model the growth of the marine bio-film, of micro/macro-organisms, on the surface of two metallic alloys in seawater by electrochemical impedance spectroscopy (EIS). The alloys used in this study were; UNS 1020 carbon steel and stainless steel 304. The EIS was used to measure the double layer capacitance (C_{dl}) of the formed bio-film in seawater on a frequent basis. The total exposure time of the tests was ranged between 90 days to 180 days. The visual inspection of the tested samples showed a bio-film formation on the surface of these samples. The microbiologically influenced (induced) corrosion (MIC) was observed only on the carbon steel. Monitoring the growth of the bio-film formation was accomplished by the EIS during the 90-180 days exposure of the tested samples. A gradual monitoring of the growth of the bio-film formation was achieved by mathematically correlating the obtained double layer capacitance (C_{dl}) of the bio-film to the thickness of the bio-film formation. The mathematical correlation was derived based on taking into the account parameters such as; the dielectric constant of the formed bio-film, the dielectric constant of the seawater at two temperatures 18°C and 33°C, the volume fraction of the seawater in the bio-film, the dielectric constant of corrosion products in the bio-film. The advantage of EIS is a non-invasive technique with a sensing (spatial) resolution in a nanometer scale in a comparison to other techniques of monitoring the growth of bio-films on metallic alloys in aqueous solutions.

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