Improving AISI 420 corrosion resistance by extracts of Pancratium Maritimum

Maria Pia CASALETTO[1], Viviana FIGA'[1], Maurizio BRUNO[2], Stefania SUT[3], Stefano DALL' ACQUA[4]

[1] Consiglio Nazionale delle Ricerche-Istituto per lo Studio dei Materiali Nanostrutturati, Palermo, Italy

[2] Università degli Studi di Palermo-Dipartimento di Scienze e Tecnologie Biologiche, Chimiche e Farmaceutiche, Italy

[3] Università degli Studi di Padova-Dipartimento di Agronomia, Animali, Alimenti, Risorse naturali e Ambiente, Italy

[4] Università degli Studi di Padova-Dipartimento di Scienze del Farmaco, Italy

AISI 420 is a martensitic stainless steel, commonly used for manufacturing components with good mechanical properties and corrosion resistance, and widely employed in power generation industry for steam generators and nuclear reactors, processing and reaction vessels, storage tanks, pumps, pipelines and tubes, heat exchangers, taps and valves. In order to ensure the durability and the safety in nuclear implants, it is necessary to mitigate the materials degradation by using insulation techniques or environment modifications. Due to the great attention to be paid to health and environment safety, an increasing number of research activities focus on the anti-corrosive properties of eco-friendly materials produced by chemical synthesis or by naturally derived formulations.

In this work, the improvement of AISI 420 corrosion resistance by using a naturally derived inhibitor was ascertained. Pancratium Maritimum is a common bulbiferous seashore plant belonging to the family Amaryllidaceae, widely occurring along the coastlines of the Mediterranean, the Atlantic, the Black, and Caspian seas. Bulb and flower extracts of Pancratium Maritimum have been proven to possess anti-oxidant, anti-microbial, anti-fungal, anti-viral, anti-tumor, immunostimulant, analgesic, acaricidal, insecticidal and purgative activities. In this work, the ethanolic extract of Pancratium Maritimum bulbs was tested as a corrosion inhibitor of AISI 420 steel in acidic solution (pH = 3.46). A detailed characterization of the chemical composition of the complex organic mixture was performed by one- and two-dimensional NMR and LC-DAD-MS^n analysis. Electrochemical impedance spectroscopy (EIS) and potentiodynamic polarization, were used for the evaluation of the electrical and kinetic parameters associated with the corrosion of steel. Experiments were performed as a function of the concentration in the range: 150 -1100 ppm and as a function of the immersion time at room temperature. The surface analysis of AISI 420 steel, exposed to the acidic environment in the absence and in the presence of the extract of Pancratium Maritimum, was carried out by means of X-ray Photoemission Spectroscopy (XPS).

Pancratium Maritimum extract showed an AISI 420 corrosion inhibition effect already at 150 ppm (IE ~ 30%). An inhibition efficiency higher than 90% corresponded to the addition of 1100 ppm. At this ‘optimum’ concentration, EIS spectra were recorded every hour up to 7 hours of total immersion and then also after 24 hours. EIS results showed a more evident loss of performance between the first 30 min and 5 hour of immersion. Then, in the range 5 to 24 hours, the loss of efficiency became negligible and the inhibition efficiency stabilized at a constant value around 70%. XPS analysis indicated the formation of a protective surface layer and confirmed the electrochemical results.