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Influence of natural seawater variables on the corrosion behaviour of aluminium-magnesium alloy

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ABSTRACT

Corrosion is an important issue for alloys in natural seawater, where microorganisms can accelerate or mitigate corrosion. Al-Mg alloys are used for marine activities and various associated technologies. Here, the behaviour of AA5083 alloy was investigated in natural seawater with marine exposure lasting up to 50 days and detailing the first 8 days in two experimental series.

Experimental work was carried out, including semi-field tests in natural seawater (biotic conditions) compared with abiotic conditions. The open circuit potential (OCP) measurements, during the immersion time, exhibited significantly different behaviours: an OCP downward displacement occurred under abiotic conditions, while, in biotic conditions OCP remained generally stable since the beginning of the immersion, revealing an inhibiting effect of the biological activity on the Al-Mg corrosion. This was accompanied by different surface modifications under biotic conditions: surface and cross-section characterization, performed by scanning electron microscopy with energy dispersive X-ray spectroscopy, showed less corrosion developed on the surface after 8-day immersion and formation of a protective layer during 50-day immersion.

The present study shows that marine biological activity positively influences the Al alloy corrosion process, with surface modifications resulting in a protective effect counteracting the aggressiveness of chloride ions.

1. Introduction

The development of marine activities and the various associated technologies (shipbuilding, offshore oil & gas extraction, ocean renewable energy, aquaculture and blue biotechnology) poses new challenges for the durability of infrastructures and facilities due to the aggressiveness of the marine environment [1–7].

The exposure of any material to seawater initiates a series of sequential biological and chemical events, which must be understood if we are to tackle the microbiological aspects in marine corrosion. In recent years, it has become clear that microorganisms do not only cause corrosion (Microbiologically-Influenced Corrosion - MIC), but can also inhibit it or protect against it, a process known as MIC Inhibition (MICI) [8–10].

At present, most of the published research on metallic corrosion induced by microbiological activity is centred on steel and stainless steel, which have been in use in marine constructions for many years. However, over recent years, Aluminium (Al) has attracted the attention of many industrial sectors linked to seawater [11–13]. Pure Al is relatively soft but alloying it with different elements can induce new properties, such as additional mechanical strength and corrosion resistance. The aluminium - magnesium alloys (Al - Mg) of the 5XXX series are among the most widely used in the shipbuilding industry as they have excellent properties for marine applications, such as low density, easy workability and high recyclability [14,15].

The majority of the literature dedicated to the study of Al-Mg alloys

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