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Thymus algeriensis extract as a new eco-friendly corrosion inhibitor for 2024 aluminium alloy in 1 M HCl medium

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ABSTRACT

The inhibitive behaviour on 2024 aluminium alloy of *Thymus algeriensis* extract was investigated in an aerated 1 M HCl solution via weight loss, gasometric and electrochemical impedance spectroscopy (EIS) techniques. It was found that the addition of the extract reduces the corrosion rate of aluminium alloy. The inhibition efficiency increases with increasing extract concentration and attained 78.7% at 0.75 g/L. The inhibitive effect of the tested extract was discussed in view of adsorption of its components on the aluminium surface. The adsorption of the extract components of *T. algeriensis* on the aluminium alloy surface follows Langmuir adsorption isotherm. The effect of the temperature on the corrosion behaviour with addition of the optimal concentration of *T. algeriensis* extract was studied in the temperature range of 298 and 338 K. The inhibition efficiency is independent of temperature. The presence of extract increases the activation energy of the corrosion process of aluminium alloy. The synergistic action caused by iodide ions on the corrosion inhibition of aluminium in 1 M HCl by 0.75 g/L was studied using weight methods at 298 K. The inhibition efficiency synergistically increased on addition of potassium iodide.

1. Introduction

Aluminium and its alloys have proved to be strategically important materials and have extensive use in many industries. They are used in the automotive, aviation and aerospace industries, in the making of household appliances, in ship building and military hardware [1–3].

Corrosion of aluminium in mineral acids represents a terrible waste of both resources and money [4]. Corrosion prevention systems favour the use of environmental chemicals with low or zero environmental impacts. The use of organic molecules as corrosion inhibitor is one of the most practical methods for protecting against the corrosion and it is becoming increasingly popular. The existing data show that organic inhibitors act by the adsorption on the metal surface and protective film formation. It was shown that organic compounds containing heteroatoms with high electron density such as phosphorus, nitrogen, sulphur, oxygen as well as those containing multiple bonds which are considered as adsorption centres, are effective as corrosion inhibitor [5–11].

Naturally occurring substances as inhibitors of acid cleaning process has continued to receive attention as replacement for synthetic organic inhibitors [12–18]. The greatly expanded interest on naturally occurring substances is attributed to the fact that they are cheap, readily available, ecologically friendly, and poses no threat to the environment. In addition, they are biodegradable and renewable source of materials. The extracts from the leaves, seeds, heartwood, bark, roots and fruits of plants have been reported to inhibit metallic corrosion in acidic media [19–24]. Medicinal plants were previously used as corrosion inhibitors of aluminium alloys in various environments [25–31].

Also, synergistic effects describe an increase in effectiveness of the corrosion inhibitor in the presence of another substance in the corrosive medium. The role of synergism on the corrosion inhibition mechanism of steel in acidic solutions has been reported by several authors [32–34].

The present work is another trial to find a cheap and environmentally safe inhibitor for aluminium corrosion in the acidic solution. The *Thymus algeriensis* belongs to the family Labiacées; growing to 15–30 cm tall by 40 cm wide, it is a bushy, woody-based evergreen subshrub with small, highly aromatic, grey-green leaves and clusters of purple or pink flowers in early summer. In Algeria and northern Africa, this aromatic plant is well known as “Zaater”. Weight loss

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