Synthesis of 3-butyl-2,4,5-triphenylimidazole as corrosion inhibitor towards carbon steel in 1% NaCl solution

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Abstract

The major problem of oil and gas companies in the world is inside and outside corrosion of pipelines. To handle this problem, many researches focused to develop organic or inorganic compounds called corrosion inhibitor to deter the corrosion process. Various corrosion inhibitors have been developed to overcome the corrosion which occurred in the internal parts of pipelines, especially the carbon steel pipelines in oil and gas industry. Therefore, in this study 3-butyl-2,4,5-triphenylimidazole was synthesized to be applied as a corrosion inhibitor. The synthesis of 3-butyl-2,4,5-triphenylimidazole utilized Microwave Assisted Organic Synthesis (MAOS) method. The $^1$H-NMR spectrum of 3-butyl-2,4,5-triphenylimidazole showed proton signals at the chemical shifts of 3.23; 1.61; 1.29; and 0.93 ppm as well as the $^{13}$C-NMR spectrum which showed carbon signals at 19.2; 30.1; 33.0; and 49.9 ppm. The ESI-MS spectrum of the synthesized product showed molecular mass (as [M+H]) of 353.2017. The spectroscopy results indicated that butylated imidazole derivative was successfully synthesized with the chemical yields of 32.18%. The electrochemical impedance spectroscopy (EIS) measurement results show that the adsorption mechanism of 3-butyl-2,4,5-triphenylimidazole onto carbon steel surface obeyed Langmuir adsorption isotherm with the value of $\Delta G_{ads} = -34.49$ kJ.mol$^{-1}$ which corresponds to semi-chemisorption/semi-physiosorption.

Keywords: carbon steel, corrosion inhibitor, imidazole derivative, MAOS (Microwave Assisted Organic Synthesis), EIS (Electrochemical Impedance Spectroscopy)

Introduction

The major problem of oil and gas companies in the world is inside and outside corrosion of pipelines. Several methods which are commonly involved in corrosion prevention are cathodic protection, anodic protection, painting, and coating. To solve corrosion process, especially which occurred inside of pipelines, many researches focused to develop organic or inorganic compounds called corrosion inhibitor to prevent the corrosion process. Various corrosion inhibitors have been developed to overcome the corrosion which occurred in the internal parts of pipelines, especially the carbon steel pipelines in oil and gas industry. Corrosion inhibitor is compound with highly resistance toward corrosion conditions and can reduce the corrosion reaction rate. Generally, precursor compound used to produce many corrosion inhibitors were imidazole derivatives (Zunita, et al., 2010), because imidazole has two nitrogen atoms with free electron pairs for each of nitrogen atoms (Zunita et al., 2010). Furthermore, imidazole ring has a resonance of electrons where resonance of electron can lead physical interactions between imidazole and surface of carbon steel. In this study, a modification of the imidazole derivative compounds was performed to be applied as corrosion inhibitor towards carbon steel. Method used to synthesis corrosion inhibitor is MAOS (Microwave Assisted Organic Synthesis) which is a method of synthesis with the aid of microwave. MAOS method is a relatively ‘green’ method, effective, and efficient method to synthesis various compounds, either inorganic or organic (Loupy, 2002). This method utilizes the microwave to carry out a chemical reaction based on the polarity of compounds, especially when the compounds are interacting with the microwave energy (Loupy, 2002).

Materials and Methods

The materials used for synthesis were directly used without further purification. Benzaldehyde, thiamine chloride, ethanol, acetic acid glacial, acetone, copper acetate, ammonium hydroxide, ammonium acetate, acetonitrile, DMF (N,N-dimethyl-formamide), bromobutane, KOH, NaOH, filter paper, NaCl, aqua demineralization, n-hexane, ethyl acetate, aluminum TLC plates of silica gel GF254 and Celite were purchased from MercK. Carbon steel coupons were previously analyzed with the following composition (in percent, %): Fe (99.5756), Mn (0.22984), C (0.05991), Al (0.04752), Si (0.02986), Cr (0.01895), P (0.0123), S (0.00731), Cu (0.0066), Ni (0.0046), Mo (0.003), V