NATURAL PRODUCTS AS CORROSION INHIBITOR FOR ALUMINIUM ALLOY IN TROPICAL SEAWATER

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UNIVERSITI MALAYSIA TERENGGANU
MALAYSIA

2010

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ROSLIZA BINTI RAMLI

Thesis Submitted in Fulfilment of the Requirement for the
Degree of Doctor of Philosophy in the
Faculty of Science and Technology
Universiti Malaysia Terengganu

February 2010

To my lovely husband

Adnan Mohamad

Thank you for your enthusiastic support and encouragement

And

To my beloved kids

Nurul Ardini

Nurul Alissa

Adam Nasihin

Nurin Afrina

All of you are my inspiration and spirit of achievement.

Special thanks for my mom and dad

Tg Shariah Tg Hj Abd Kadir

And

Ramli Mohamed

Abstract of thesis presented to the Senate of Universiti Malaysia Terengganu in fulfilment of the requirement for the degree of Doctor of Philosophy.

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The potential of natural products i.e. natural honey (NH), vanillin (VL) and tapioca starch (TS) as corrosion inhibitor for Al-Mg-Si alloy were studied in tropical seawater at room temperature. Weight loss and electrochemical measurements of Al-Mg-Si alloy as well as adsorption and their surface morphology in the presence of these natural products were investigated. Weight loss experiment involving immersion of Al-Mg-Si alloy in seawater was conducted for 60 days. The electrochemical properties of Al-Mg-Si alloy were determined by potentiodynamic polarization, linear polarization resistance and electrochemical impedance spectroscopy (EIS) measurements. The corrosion products and the microstructure on the aluminium alloy were characterized using Scanning Electron Microscope (SEM) and Energy-Dispersed X-ray Spectroscopy (EDS), respectively. Results obtained in this study indicated that weight loss and electrochemical measurements for Al-Mg-Si alloy in tropical seawater after varied immersion period showed that in the presence of NH, VL and TS, the corrosion currents densities (i_{corr}), corrosion rates (CR) and double layer capacitance (C_{dl}) of the

alloy were significantly decreased, simultaneously the values of polarization resistance (R_p), degree of surface coverage (θ) and inhibition efficiency, IE (%) were increased. All the studied parameters showed good inhibitive characteristics against the corrosion of Al-Mg-Si alloy in the tested solution, and their performance was observed to increase with the inhibitor concentration. Polarization data indicated that the studied inhibitors are mixed-type inhibitors. Linear polarization and EIS studies showed that there were significant increases in the overall resistance after the addition of NH, VL and TS. EIS measurements clarified that the corrosion process was mainly charge-transfer controlled. The adsorption of inhibitor on Al-Mg-Si alloy was found to obey the Langmuir adsorption isotherm. All four different measurement techniques give consistent results and good agreement from which can be concluded that the efficiency of the three studied inhibitors follow the order: NH < VL < TS. The analysis of SEM and EDS confirmed the formation of precipitates of NH, VL and TS on the metal surface, which reduced the overall corrosion reaction. The studied natural products give above 90% of inhibition efficiency in their tested solutions. The comparison of present results with the results of the other researchers on the same studied inhibitors proves that NH, VL and TS are comparable to the other natural products as corrosion inhibitor for aluminium alloy. Furthermore, TS is explored and proven as a newly green corrosion inhibitor for aluminium alloys.

Abstrak tesis yang dikemukakan kepada Senat Universiti Malaysia Terengganu sebagai memenuhi keperluan untuk ijazah Doktor Falsafah.

PRODUK SEMULAJADI SEBAGAI PERENCAT KAKISAN UNTUK ALOI ALUMINIUM DI DALAM AIR LAUT TROPIKA

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Februari 2010

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Keupayaan bahan semulajadi iaitu madu asli (NH), vanillin (VL) dan tepung ubi kayu (TS) sebagai perencat kakisan untuk aloi Al-Mg-Si telah dikaji di dalam air laut tropika pada suhu bilik. Pengukuran kehilangan berat dan elektrokimia aloi Al-Mg-Si serta penjerapan dan morfologi permukaannya dengan kehadiran bahan-bahan semulajadi ini juga diselidik. Eksperimen kehilangan berat yang melibatkan rendaman aloi tersebut di dalam air laut telah dikendalikan selama 60 hari. Sifat elektrokimia aloi tersebut ditentukan dengan pengukuran pengutuban keupayaan dinamik, rintangan pengutuban linear dan spektra impedan elektrokimia (EIS). Hasil-hasil kakisan dan mikrostruktur di atas aloi aluminium telah dicirikan menggunakan Mikroskopi Pengimbasan Elektron (SEM) dan Spektroskopi Serakan Tenaga Sinar-X (EDS). Keputusan yang diperolehi dalam kajian ini menunjukkan bahawa pengukuran kehilangan berat dan elektrokimia bagi aloi Al-Mg-Si di dalam air laut selepas masa rendaman yang tertentu menunjukkan kehadiran NH, VL dan TS berkesan dalam mengurangkan ketumpatan arus kakisan (i_{corr}), kadar kakisan dan lapisan berganda kapasitan, pada masa yang sama

meningkatkan nilai-nilai rintangan pengutuban (R_p), darjah liputan permukaan (θ) dan juga kecekapan perencatan, IE (%). Kesemua parameter yang diuji menunjukkan sifat perencatan yang baik dalam menentang kakisan aloi Al-Mg-Si dalam larutan ujian dan prestasinya dilihat meningkat dengan peningkatan kepekatan bahan perencat kakisan. Data pengutuban yang diperolehi menunjukkan bahan perencat kakisan yang diuji adalah perencat kakisan jenis campuran. Kajian pengutuban linear dan EIS menunjukkan bahawa terdapat peningkatan yang ketara dalam keseluruhan ketahanan bahan selepas penambahan NH, VL dan TS. Pengukuran EIS menjelaskan bahawa proses kakisan terutamanya adalah pertukaran cas terkawal. Penjerapan perencat atas permukaan aloi Al-Mg-Si adalah mengikut isoterma penjerapan Langmuir. Kesemua empat pengukuran yang berbeza telah memberikan hasil yang konsisten dan bersesuaian yang mana boleh disimpulkan bahawa kecekapan ketiga bahan perencat kakisan itu adalah dalam turutan berikut: NH < VL < TS. Hasil dapatan dari SEM dan EDS mengesahkan pembentukan mendapan NH, VL dan TS di atas permukaan logam yang mengurangkan tindakbalas kakisan keseluruhan. Bahan semulajadi yang dikaji memberikan nilai kecekapan perencatan melebihi 90% di dalam larutan ujian masing-masing. Perbandingan hasil kajian yand didapati dengan kajian oleh penyelidik-penyelidik yang lain untuk bahan yang sama membuktikan bahawa NH, VL dan TS adalah setanding dengan bahan semulajadi yang lain sebagai bahan perencat kepada aloi aluminium. Malahan, TS telah diterokai dan terbukti sebagai bahan perencat mesra alam yang baru untuk aloi aluminium.