CORROSION RESISTANCE OF FERROUS ALLOYS IN TROPICAL SEAWATER ENVIRONMENT

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Dedication for my beloved parents:

Seoh Seng Peng and Poh Chin Choo

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Corrosion behaviour of AISI 1053 and AISI 304 ferrous alloys has been determined in seawater environment at room temperature. The effects of dissolved oxygen and circulating condition on both alloys have been investigated. Mass loss experiments have been conducted for duration of one year. Both alloys were exposed in conditions of seawater circulated with aeration, seawater circulated without aeration, seawater static without aeration and seawater static with aeration. Corrosion rate of both alloys in different exposure conditions ware obtained. The electrochemical behaviour of the alloys has been determined by Open Circuit Potential (OCP) and Polarization Resistance (R_p). The corrosion behaviour and electrochemical analysis of both alloys show identical behaviour. Overall, AISI 304 alloys were more resistance to seawater as compared to AISI 1053 alloys. AISI 1053 alloys were heavily corroded in the presence of the abundance dissolved oxygen, while AISI 304 more susceptible to corrosion in the exposure condition of seawater static without aeration. The microstructure and the corrosion products on the alloys have been characterized using Scanning Electron Microscope and Energy-Dispersed X-ray

Spectroscopy (SEM-EDS), respectively. SEM micrographs showed that the surface of AISI 1053 alloys were fully covered by porous corrosion product, whereas, surface of AISI 304 alloys were covered by diatom phytoplankton. EDS results have shown that the deposited films for AISI 1053 alloys were rich in ferrous and oxide, while the films formed on AISI 304 alloys were rich in carbon and silicon. The compounds of both alloys have been investigated by X-Ray Diffraction (XRD) analysis. Results have shown that magnetite (Fe_3O_4), hematite (α-Fe_2O_3) and maghemite (γ-Fe_2O_3) were presence in the corrosion product of AISI 1053 alloys, while, corrosion film of AISI 304 alloys only showed the presence of ferrous. Both alloys affected by pitting corrosion and AISI 1053 alloys displayed enhance deleterious effect on their surface.

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RINTANGAN KEKAKISAN BAGI ALOI-ALOI FERUM DI DALAM PERSEKITARAN AIR LAUT TROPIKAL

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Penyelidikan tentang sifat kekakisan aloi AISI 1053 dan aloi AISI 304 dalam air laut pada suhu bilik telah dilaksanakan. Kesan oksigen terlarut dan keadaan pengaliran air laut terhadap aloi-aloi tersebut telah dikaji. Eksperimen telah dijalankan selama satu tahun. Kedua-dua aloi itu telah direndamkan dalam keadaan air laut yang bergerak dan diudarakan, air laut bergerak tanpa diudarakan, air laut statik dan diudarakan dan air laut statik tanpa diudarakan. Sifat kekakisan bagi kedua-dua aloi terdedah kepada keadaan-keadaan tersebut telah dikaji. Sifat elektrolisis kimia bagi aloi-aloi tersebut telah diselidik dengan menggunakan teknik Keupayaan Litar Terbuka (OCP) dan Rintangan Polarisasi (R_p). Analisis daripada kinetik kekakisan dan elektrolisis kimia bagi aloi AISI 1053 dan aloi AISI 304 menunjukan sifat yang amat serupa. Keseluruhannya, aloi AISI 304 menunjukkan ketahanan yang lebih tinggi dalam air laut jika dibandingkan dengan aloi AISI 1053. Aloi AISI 1053 mengalami kekakisan yang amat sangat apabila kandungan oksigen terlarut adalah tinggi. Aloi AISI 304 pula lebih cenderung kepada kekakisan apabila terdedah dalam persekitaran air laut yang statik dan tanpa diudarakan. Hasil daripada proses

kekakisan yang terlekat di atas aloi-aloi telah diselidik dengan menggunakan Mikroskopi Pengimbasan Elektron dan Spektroskopi Serakan Tenaga Sinar-X (SEM-EDS). Mikrograf daripada SEM menunjukan permukaan aloi AISI 1053 dilekati sisa-sisa yang poros. Aloi AISI 304 pula dilekati oleh diatom-diatom. Keputusan EDS menunjukkan sisa-sisa kekakisan yang terlekat di atas AISI 1053 kebanyakkannya terdiri daripada ferum dan oxida. Manakala, filem kekakisan yang terbentuk di atas permukaan aloi AISI 304 kaya dengan carbon dan silikon. Dengan menggunakan teknik pembelauan sinar-X (XRD), keputusan menunjukkan komposisi yang terbentuk di permukaan aloi AISI 1053 adalah terdiri daripada magnetit (Fe_3O_4), hematit (α-Fe_2O_3) and maghemit (γ-Fe_2O_3). Manakala, permukaan aloi AISI 304 hanya menunjukkan komposisi ferum sahaja. Kedua-dua aloi itu mengalami kekakisan dimana lubang-lubang terbentuk di atas permukaan aloi (dikenali sebagai pitting). Aloi AISI 1053 telah mengalami kerosakan yang lebih dominan di permukaannya.