Intisari

Aluminium paduan seri 2024-T3 umum digunakan pada industri dirgantara karena rasio kekuatan terhadap densitas (*spesific strength*) yang tinggi, ketangguhan baik dan ketahanan perambatan retak yang baik. Namun, Aluminium paduan 2024-T3 rentan mengalami serangan korosi sumuran dan beban dinamis ketika beroperasi sehingga umur komponen berkurang akibat *corrosion fatigue crack growth* (CFCG). Upaya pengendalian korosi adalah menggunakan inhibitor kromat (CrO_4^{2-}) namun mempunyai sifat karsinogenik yang berbahaya sehingga perlu alternatif inhibitor yang ramah lingkungan namun tetap efektif menurunkan laju korosi dan laju perambatan fatik. Penelitian ini bertujuan untuk mempelajari inhibitor alternatif: molibdat (MoO_4^{2-}) dan nitrat (NO_3^-) dalam menurunkan laju korosi dan laju perambatan fatik pada aluminium paduan 2024-T3.

Penelitian ini mempelajari karakteristik CFCG aluminium paduan 2024-T3 di 3,5% NaCl dengan menambahkan inhibitor CrO_4^{2-}, MoO_4^{2-}, dan NO_3^- masing-masing dengan konsentrasi 0,1%, 0,3%, dan 0,5%. Uji korosi dilakukan menggunakan tiga sel elektroda dengan *saturated calomel* (SCE) sebagai elektroda acuan agar didapatkan konsentrasi inhibitor paling optimum. CFCG akan dilakukan dengan metode *middle tension crack* pada spesimen yang terendam larutan 3,5% NaCl dengan penambahan 0,3% inhibitor. Beban yang diberikan adalah *sinusoidal load* dengan amplitudo dan frekuensi konstan berturut-turu adalah 0,1 dan 10 Hz. Data lain yang diambil adalah data uji tarik, uji kekerasan dengan metode *Vickers*, uji komposisi *atomic adsorption spectroscopy* (AAS), pengamatan struktur mikro, dan pengamatan SEM-EDX pada permukaan patahan.

Hasil penelitian menunjukkan efektivitas inhibitor berturut-turut adalah (CrO_4^{2-})>(MoO_4^{2-})>(NO_3^-). Mekanisme perlindungan inhibitor anodik terhadap CFCG adalah dengan menghadirkan lapisan pasif pelindung yang dapat melindungi ujung retak akibat *hydrogen embrittlement*. Inhibitor MoO_4^{2-} dapat menjadi opsi inhibitor alternatif yang ramah lingkungan dan efektif sedangkan Inhibitor NO_3^- tidak efektif mencegah laju perambatan fatik akibat umur fatik yang rendah.

Kata kunci: AA2024, *Corrosion fatigue crack growth*, Kromat, Molibdat, Nitrat

Abstract

Aluminium alloy 2024-T3 is widely used for aerospace application due to its hight strength to weight ratio, good toughness, and good fatigue crack growth resistance. However, aluminium alloy 2024-T3 is suffered from combined effect of pitting corrosion and dynamic load hence reducing the life of components due to corrosion fatigue crack growth (CFCG). One of methods to control of corrosion rate is to add chromate (CrO_4^{2-}) inhibitor. Unfortunately, this inhibitor can cause dangerous carcinogenic effect thus other alternative inhibitors that are environmentally friendly and effective to reduce corrosion rate are necessary. This experiment aims to study the potential use of alternative inhibitors: molybdate (MoO_4^{2-}), and nitrate (NO_3^-) to reduce corrosion rate and CFCG rate on aluminium alloy 2024-T3.

In this experiment, corrosion characteristics of high strength 2024-T3 aluminium alloy were studied by immersing the samples in 3.5% NaCl solution with the addition of different inhibitor, namely CrO_4^{2-}, MoO_4^{2-}, and NO_3^- at the concentration of 0.1%, 0.3%, and 0.5%. Subsquently, the corrosion rates were measured using using three cell electrode with saturated calomel (SCE) as reference electrode whereas the counter electrodes used were graphite rods. Following this experiment, corrosion fatigue crack growth (CFCGR) tests were performed using middle tension crack, M(T) specimen immersed in 3.5% NaCl with 0.3% inhibitor addition. In this study, sinusoidal load with constant amplitude was selected whereas stress ration, R and frequency, f used were 0.1 and 10 Hz respectively. Additional test were alse performed including tensile strength, Vickers microhardness test, composition analysis using atomic adsorption spectoscopry (AAS), microstructure observation, and observation on fracture surface using SEM and EDX.

Results of this study showed that the inhibitive effect of the inhibitors under study could be ranked as follows: (CrO_4^{2-})>(MoO_4^{2-})>(NO_3^-). The mechanisms of CFCGRs under anodic inhibitors were likely controlled by the ability of inhibitors to form passive film which sealed of the crack tip from hydrogen embrittlement. Inhibitor MoO_4^{2-}showed potential as an alternative inhibitor due to its capability of reducing corrosion rate and CFCGs meanwhile inhibitor NO_3^- was less effective as the alternative inhibitor due to lower fatigue life.

Keywords: *AA2024, Corrosion fatigue crack growth, Chromate,Molybdate,Nitrate*