Studi Penggunaan Campuran Natural Green Corrosion Inhibitor Piper Betle dan Green Tea untuk Proteksi Korosi Material Baja API 5L X52 di dalam Lingkungan 3,5% NaCI Pada Kondisi Turbulen

Andi Rustandi, author

Abstrak

Laju korosi material baja API 5L X52 di dalam larutan 3,5 % NaCl teraerasi pada kondisi aliran turbulen berlangsung relatif tinggi yang dapat mencapai lebih dari 80 mpy (2 mm/tahun). Upaya menurunkan laju korosi tersebut umumnya dilakukan secara konvensional dengan penambahan zat inhibitor seperti oxygen scavenger atau senyawa organik jenis adsorpsi. Bilamana efektifitas kinerja inhibitor tersebut relatif rendah maka diperlukan jenis inhibitor altematif dengan kinerja yang lebih baik. Dalam penelitian ini dilakukan pengujian eksperimental terhadap suatu jenis inhibitor barn yaitu ekstrak campuran antara green tea (teh hijau) dengan kandungan utama epiga/lo cacethin gallate dan piper betle (daun sirih) dengan kandungan utama hydroxychavicol yang bersifat ramah lingkungan (green corrosion inhibitor).
Penelitian bertujuan untuk menganalisis penurunan besaran laju korosi material baja (API 5L X52) di dalam lingkungan larutan 3,5 % NaCI teraerasi, pada kondisi aliran turbulen (0-5000 rpm) dengan penambahan inhibitor campuran ekstrak piper betle dengan green tea sehingga dapat dievaluasi effisiensinya. Selain itu dilakukan pula analisis serta sintesis terhadap mekanisme inhibisi elektrokimia ekstrak campuran inhibitor tersebut.
Metoda pengukuran laju korosi dilakukan dengan menggunakan simulasi Rotating Cylinder Electrode (RCE) serta pengukuran elektrokimia kurva polarisasi. Mekanisme korosi diteliti dengan metoda Electrochemical Impedance Spectroscopy (EIS). Sedangkan karakterisasi ekstrak green inhibitor dilakukan dengan menggunakan metoda Fourier Transform Infra Red (FTIR).
Hasil penelitian menunjukkan bahwa laju korosi material baja API 5L X52 di dalam larutan 3,5 % NaCl meningkat secara tajam hingga 195 mpy atau 5 mm/tahun pada 5000 rpm tanpa penambahan inhibitor. Sebagai pembanding, penggunaan inhibitor oxygen scavenger yang berupa senyawa sodium sulfit dapat menurunkan laju korosi dengan effisiensi inhibitor > 90 %. Pada konsentrasi campuran green inhibitor I 000 ppm piper betle + 4000 ppm green tea, effisiensi inhibitor dapat mencapai ±90 %. Inhibitor korosi tersebut berpengaruh terhadap kurva polarisasi anodik mapun katodik sehingga dapat berperan sebagai mixed inhibitor. Pengujian EIS menunjukkan pada kondisi turbulen dengan penambahan inhibitor, proses korosi dikontrol oleh mekanisme aktivasi yang ditunjukkan oleh adanya impedansi kapasitif. Pengujian FTIR menunjukkan adanya gugus-gugus fungsi ikatan kimia yaitu: hydroxyl phenolic, C=O dan alkena =CH2 yang berkombinasi sebagai pembentuk lapisan (film- forming).
Pada kondisi 3,5% NaCI dengan tekanan gas C02 sebesar I atmosfir dan keadaan stagnan, dengan penambahan konsentrasi ekstrak campuran inhibitor I 000 ppm piper betle + 4000 ppm green tea, effisiensi inhibitor yang diperoleh adalah sebesar ± 74 %. Sintesis lapisan inhibisi campuran ekstrak green tea dengan piper betle ditunjukkan dengan usulan model lapisan yang bekerja secara sinergis antara karakteristik sifat-sifat: adsorpsi, antioxidant dan hydrophobic.
<hr>
The corrosion rate of type API 5L X52 steel in 3.5% NaCl aerated solution under turbulent flow condition is

relatively high (can reach more than 2 mrnlyear). Method to reduce the rate of corrosion is generally done conventionally by the addition of corrosion inhibitor substance such as oxygen scavenger or adsorption of organic compounds. In case of the effectiveness of inhibitor performance is low then types of alternative inhibitors with better performance are required. This study was carried out dealing with experimental testing of a new inhibitor type i.e. a mixture extracts of green tea with the main content epiga/lo cacethin gallate (EGCG) and piper betle with the main content hydroxychavicol which were classified as environmentally friendly inhibitor (green corrosion inhibitor).

The purpose of this study was to analyze the decreasing of corrosion rate of type API 5L X52 steel in aerated 3.5% NaCl solution under turbulent flow conditions (0-5000 rpm). The effect of green inhibitor addition in the solution was observed and its inhibitor efficiency was evaluated. Moreover, analysis as well as synthesis of the electrochemical inhibition mechanism of the extract mixture of these inhibitors was performed.

Corrosion rate measurement method was conducted by using a simulation of the Rotating Cylinder Electrode (RCE) and by electrochemical measurements of polarization curves. Corrosion mechanism was examined by Electrochemical Impedance Spectroscopy (EIS) while the characterization of green inhibitor material was carried out using the method of Fourier Transform Infra-Red (FTIR).

The results showed that the corrosion rate of type API 5L X52 steel in 3.5% NaCl aerated solution increased sharply up to 195 mpy (5 mm/year) at 5000 rpm without the addition of corrosion inhibitor. As a comparison, the use of inhibitor of type oxygen scavenger using sodium sulfite compound decreased the corrosion rate with inhibitor efficiency > 90%. The addition of green inhibitor concentration of 1000 ppm piper betle + 4000 ppm green tea resulted in approximately 90% inhibitor efficiency. The green inhibitor affected the cathodic as well as the anodic polarization curves which were known as mixed corrosion inhibitor type. EIS testing showed that under turbulent conditions with the addition of corrosion inhibitor, the processes were controlled by an activation mechanism which indicated by the presence of capacitive impedance. The type of chemical bonds on the steel surface layer was analyzed by FTIR method which indicated the presence of function groups : phenolic hydroxyl, C=O and alkene C=CH2 which combined as film forming.

In a solution containing 3,5 % NaCl with I atm C02 gas pressure and stagnant condition, the addition of 1000 ppm piper betle + 4000 ppm green tea extracts resulted in approximately 74% inhibitor efficiency. Synthesis of inhibition layer created by a mixture of extracts of green tea and piper betle was proposed which had several characteristics : adsorption, antioxidant and hydrophobic which were believed to have a synergistic effect.