Pengaruh Komposisi 2-Methylimidazole dalam Fusion Bonded Epoxy sebagai Aplikasi Pelapisan Temperatur Rendah pada Pipa Pancang = Effect of 2-Methylimidazole Composition in Fusion Bonded Epoxy as Low Temperature Coating Application in Pipe Piles

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Abstrak

Pelapisan berbasis epoksi seperti Fusion Bonded Epoxy (FBE) banyak digunakan untuk pipa gas/minyak karena menunjukkan ketahanan kimia yang tinggi, permeabilitas yang sangat rendah terhadap ion klorida, fleksibilitas mekanik yang baik, daya rekat yang kuat pada baja. Pada pipa pancang (diameter>40 inci), sangat sulit dilakukan aplikasi pelapisan di PT X karena kemampuan mesin induksi untuk memanaskan pipa dengan temperatur aplikasi yang direkomendasikan oleh manufaktur cat. Penambahan 1, 2, 3 % wt 2-methylimidazole (2MI) dilakukan ke dalam campuran basis epoxy phenol-formaldehyde, glycidyl ether polimer untuk mempercepat proses pengeringan dan menurunkan temperatur aplikasi. Analisa termal dilakukan dengan Differential Scanning Electron (DSC) dimana penambahan 3%wt 2MI didapatkan penurunan maksimum sebesar 134,76oC karena pengurangan energi aktivasi. Penambahan 2MI bersifat sebagai katalis dalam reaksi pengeringan yang ditunjukan pada hasil uji Fourier Transform Infrared (FTIR), dimana 2MI dapat membuka ring epoksi untuk mempercepat proses pengeringan. Analisa karakterisasi elektrokimia dengan menggunakan polarisasi potensiodinamik dimana laju korosi paling baik yaitu 0,00991 mm/tahun dan rapat arus sebesar 0,847µA/cm2, pada penambahan 1%wt 2MI. Hasil pengujian Electrochemical Impedance Spectroscopy (EIS) untuk mengetahui tahanan transfer muatan dan kapasitansi kapasitor pelapisan maksimal pada penambahan 1%wt 2MI sebesar 9,9 k? dan 8,45 x 10-5 F. Cathodic Disbondment Test (CD-Tes) dilakukan untuk mengetahui radius pelepasan pelapisan dibawah pengaruh arus proteksi katodik yaitu 4.32mm. Karena penambahan lebih akan mengurangi densitas cross-linking karena adanya adduct epoksi-imidazol. Analisa mekanikal dengan pengujian tarik adhesi pelapisan (cat), penambahan 2MI 2%wt sebesar 7,28 Mpa dan mengalami penurunan setelah diberikan penambahan 3%wt 2MI menjadi 6,63 Mpa . Fleksibilitas juga dilakukan pada derajat defleksi 3o mengalami kerusakan karena penambahan 2MI akan meningkatkan nilai kekakuan pelapisan. Penambahan 2MI tidak berpengaruh besar pada tingkat porositas dari pelapisan dengan aplikasi temperatur rendah 170-175oC dimana seluruh sampel mencapai skala 1 secara penampang bujur dan interfasa antara pelapisan dan permukaan pipa baja. Sehingga penambahan 1%wt 2MI sangat baik untuk aplikasi temperatur rendah 170-175oC pada pipa pancang dengan performa pelapisan yang sangat baik.

.....Epoxy based coatings such as Fusion Bonded Epoxy (FBE) are widely used for gas/oil pipelines because they exhibit high chemical resistance, very low permeability to chloride ions, good mechanical flexibility, strong adhesion to steel. On the pile pipe (>40 inches in diameter), it is very difficult to apply the coating at PT X because of the ability induction machine to heat the pipe according to the application temperature recommended by the paint manufacturer. The addition of 1, 2, 3 % wt 2-methylimidazole (2MI) was carried out into the epoxy phenol-formaldehyde base mixture, glycidyl ether polymer to accelerate curing process and lowering the application temperature. Thermal analysis conducted using Differential Scanning Electron (DSC) where the addition of 3% wt 2MI resulted in a maximum decrease to 134.76oC due to reduced

activation energy. The addition of 2MI acts as a catalyst in the curing reaction as shown in the results of the Fourier Transform Infrared (FTIR) test, where 2MI can open the epoxy ring to increase curing process. Electrochemical characterization analysis using potentiodynamic polarization show the best corrosion rate is 0.00991 mm/year and current density is 0.847µA/cm2, at the addition of 1% wt 2MI. Electrochemical Impedance Spectroscopy (EIS) conducted to determine the charge transfer resistance and maximum coating capacitor capacitance at the addition of 1%wt 2MI of 9.9 k? and 8.45 x 10-5 F. Cathodic Disbondment Test (CD-Test) was conducted to determine disbondment radius of the coating under the influence of the cathodic protection current is 4.32mm. Because the addition of more 2MI will reduce the cross-linking density due to the presence of epoxy-imidazole adducts. Mechanical analysis by pull off adhesion test, the addition of 2MI 2%wt was 7.28 MPa and decreased after being given the addition of 3%wt 2MI to 6.63 MPa. Flexibility test show at a degree of deflection of 3o damaged because the addition of 2MI will increase the coating stiffness. The addition of 2MI did not have a major effect on the porosity of the coating with low temperature applications of 170-175oC where all samples reached rate 1 in longitudinal cross-section and the interface between the coating and the steel pipe surface. So the addition of 1% wt 2MI is very good for low temperature applications of 170-175oC in piles with very good coating performance.