Short term predictive testing for cut edge corrosion resistance in zinc aluminium alloy galvanised steels

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The scanning vibrating electrode technique (SVET) is shown to be a reasonably reliable and very rapid test method for ranking the cut edge corrosion resistance of zinc aluminium alloy galvanised steels[1]. The data obtained in 24-hours relates linearly to the organic coating delamination, determined by 5 years external weathering, and zinc metal ion runoff resistance, determined by up to 24 months external exposure. Four galvanised materials (G1-G4) have been prepared by altering the chemical composition and the processing conditions of the 4.5% Al containing zinc galvanising layer on 0.7 mm gauge steel, the volume percentage of primary zinc evolved during solidification has been carefully controlled to increase from 27(±0.25)%(G1 & G2), 28%(±0.25)% (G3) to 30(±0.25)% (G4). In addition, the number of primary zinc dendrites was also significantly altered from 650±50 (G1), 720±50 (G2), 914±50 (G3) to 1600±50 (G4) per mm^{-2}. SVET corrosion tests performed upon the cut edge of organically coated samples of these materials revealed that as the volume percentage of primary phase and number of dendrites increased the intensity of corrosion increased (with SVET determined current density maxima increasing from 8 Am^{-2} (G1&G2), 10 Am^{-2} (G3) to 13 Am^{-2}(G4)(as shown in Figure 1)). The average total zinc loss (*tzl*) measured in the 24 hour exposure also increased (from 166μg to 309μg). Zinc ion enriched rain water collected as runoff from externally weathered samples (industrial/marine location)[2] has revealed similar performance trends to those from the SVET as shown in figure 2 with the primary zinc volume fraction controlling the zinc ion release in each case. This is repeated for zinc runoff measurements recorded between 3 and 24 months exposure. Analysis of the total organic coating delamination area after five years external weathering has shown a direct correlation with zinc ion runoff levels from the coating over the first 24 months as shown in figure 3 and also to the SVET zinc losses measured in 24 hours. Hence the SVET appears to be a reliable and rapid tool for metallic coating optimisation and associated runoff measurements can be used as an environment specific corrosion test with an accurate performance indication within 3 months.

References:

1. Elvins J.; Spittle J.A.; Worsley D.A. Corrosion Engineering, Science and Technology, 38, 197-204 (2003)
2. J.H. Sullivan and D.A. Worsley. Corrosion Science, 44, 1639-1653 (2002)

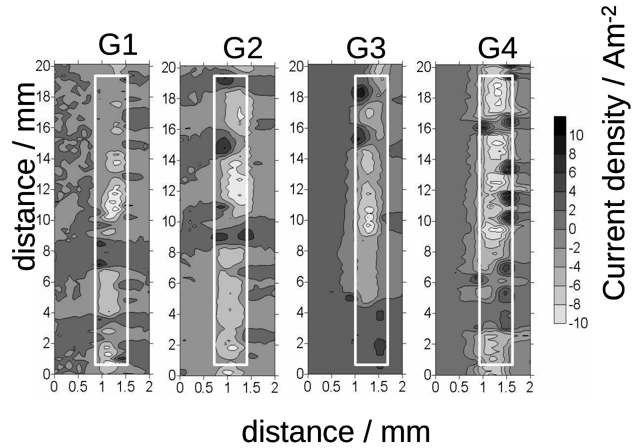

Figure 1 –

SVET iso-current contour plots showing the anodic (dark) and cathodic (light) current density distribution over samples G1-G4 corroding cut edge samples embedded in a resin block after 12 hours immersion in 0.1% aqueous NaCl. The sample position is shown.

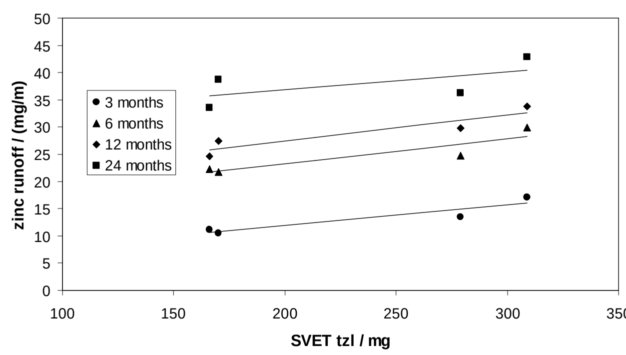

Figure 2 –

Comparison of the zinc runoff recorded at the Port Talbot weathering site for 3, 6, 12 and 24 months with the SVET measured zinc loss from a 20 mm exposed cut edge exposed for 24 hours in neutral aerated 0.1 % NaCl.

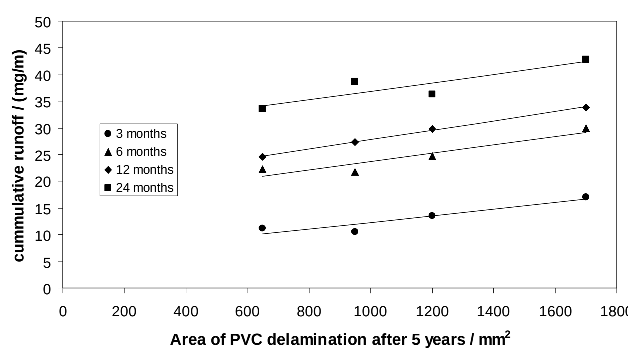

Figure 3 –

Plot showing the area of PVC delamination after 5 years external weathering at Port Talbot against the zinc runoff recorded for the same samples at the same location recorded after 3, 6, 12 and 24 months exposure.