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Corrosion Performance of Zinc Magnesium Aluminium Coated steel: Effect of chloride deposition and CO_2

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Zinc alloyed with magnesium or magnesium and aluminium coated steels such as Zn-11Al-3Mg-0.2Si (Super Dyma) and Zn-6Al-3Mg (ZAM) have been available since the late 1990s. Mainly produced as relatively thick coatings used for heavy corrosive building applications, they show improved performance compared to zinc coated steel. More recently, new zinc coatings with lower amounts of Mg and Al (typically 0.2-11% Mg and 0.1-3,5% Al) have been developed for continuous galvanised steel, offering evident application for automotive and building industry [1-5].

The corrosion performance of Zn-Mg(1-4%)-Al(1-4%) (ZMA) coatings has been compared to zinc-iron alloy (galvannealed, GA) and zinc-aluminium coating (Zn-5Al, Galfan) as well as to conventional zinc coatings produced by hot-dip galvanization (HDG) and electrogalvanization (EG). For this purpose, cosmetic samples (painted and uncoated) and hem-flange panels were produced to simulate different situations on vehicles. The corrosion performance of ZMA coated steel was compared in different accelerated corrosion tests, as regularly used by the automotive industry e.g. VDA621-415, N-VDA (VDA233-102) and Volvo STD 423-0014 and under field exposures.
From the results it is seen that the performance of ZMA coatings is largely dependent upon test conditions and in particular on chloride deposition. This is shown as an example in Figure 1.

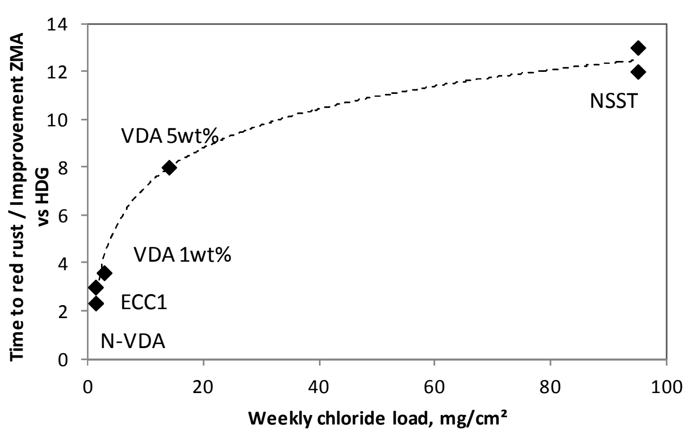

Figure 1: Improvement in time to red rust of ZMA coated steel compared to hot-dip galvanized steel as a function of the weekly chloride load in cyclic corrosion tests

The performance of ZMA coated steel was also shown to be largely dependent upon configuration of the panels (e.g. open and confined configurations) with lower relative performance in confined situations. This is explained by the fact that for the confined area of hem-flanges CO_2 diffusion will be restricted.
Additional laboratory experiments have been performed with and without $C0_2$ in order to validate this hypothesis. The corrosion of zinc coatings was enhanced in low CO_2 conditions and ZMA materials were more affected than hot-dip galvanized steel, and in the range of the Galfan coating. An obvious pH effect was underlined in low CO_2 conditions. Layered double hydroxide (LDH) and simonkolleite were mainly formed on ZMA coatings in the absence of CO_2 while hydroxycarbonate and simonkolleite were dominating in ambient air. The results obtained in low CO2 are in good agreement with the relative poor performance of ZMA coatings in confined zones and confirmed the importance of CO_2 in the atmospheric corrosion of zinc and zinc alloyed coated steel.

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