A capable, simple cyclic replacement to salt spray testing
Part 2 - Corrosion mechanistic aspects

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1939 the first ASTM B117 standard was issued and since the fifties the neutral salt spray method remains essentially the same and has been dominating the scene of corrosion testing. In industrial sectors dealing with corrosion protection as a core concern, like surface treatment of car bodies, severe misjudgements based on this type of exposures was experienced decades ago and resulted in the development of alternative, more realistic test regimes were developed based on alternating wet/dry climate cycles and moderated salt loads. This process and its continuation was dealt with in the introductory presentation of this project in Eurocorr 2014. In the context of a work item in ISO/TC 156/ WG7 and the Automotive Corrosion member programme at Swerea-KIMAB in Stockholm, with an involvement of Volvo Cars, a test programme has been conducted with the aim of defining a capable, simple and robust replacement to salt spray testing.

In this part of presentation of achieved findings we discuss fundamental possibilities and constraints to consider, when testing under accelerating conditions, i.e. with the objective to keep different field aspects of atmospheric corrosion to correct scale for a representative blend of materials and their combinations.

In this context it is crucial to consider basic aspects of corrosion kinetics. For corrosion of mild steel, especially in crevices and under-paint, but also in mixed conditions with zinc (alloy) coatings, it is found that the corrosion behaviour is sensitive to the proportions of electrolyte loads in the wet-dry cycles. A main cause is attributed to the reduction-oxidation transitions within the complex rust composition during wet-dry transitions and their significant temperature dependencies. This can be compared with the less temperature dependent corrosion rates of zinc.
A systematic study using a zinc grid-line corrosion sensor has been performed. It allows mapping of the corrosion rates of pure zinc under atmospheric conditions as a function of relative humidity, temperature and surface deposition load of NaCl in the range of interest, as well as the influence of the degree of Zn corrosion. The NaCl-load is shown to mainly determining the corrosion rate. Temperature and relative humidity (above 80 % RH) seem to be of subordinate importance, provided intermittent load of NaCl, typically applied as doses or short periods of spray a few times a week followed by humidity cycling. Calibrating the corrosion of zinc and steel proportionally under accelerated conditions then becomes a problem. Adding the corrosion variables from other materials or corrosion modes further complicates solving the equation of correct test scaling. One example is the often addressed inability to initiate and propagate filiform type of corrosion of painted aluminium, which has also been subjected to experimental work in this programme. An alternative type of initiation procedure is suggested.