DÖRKEN MKS®
THE CORROSION EXPERTS

RUST-FREE DRIVING: TEST PROCEDURES FOR CORROSION PROTECTION IN CARS

From bolts to chassis components and on to engine mounts: cars incorporate parts made from a range of different materials which, depending on use, need to satisfy numerous requirements with regard to corrosion protection. Each individual component requires a special coating precisely tailored to specifications, in order to guarantee long-lasting function and satisfy the strict automobile specifications of the national and international OEMs. Different test procedures are applied to test or examine the surface coatings of components used in cars.

Corrosion testing - complex and time consuming

Testing the corrosion resistance of components for the automotive market frequently presents problems for laboratories, due to the range of different stresses, complex requirements and different climatic conditions. Outdoor testing usually proves to be difficult, because: the first signs of corrosion damage often only become evident here after many years – in so-called outdoor weathering in particular, the conditions over time vary greatly and are seldom constant. To be able to simulate the various weathering conditions nonetheless, a distinction is made between different climates – from dry desert to tropical and/or salty conditions by the sea. The problem with this: for this approach, too, the time for intensive testing and therefore the achievement of dependable quality or development findings is generally too long.

Independent tests of the car manufacturers

Against this background, in some cases the car manufacturers have developed their own test procedures to test corrosion resistance. For example, the manufacturer Audi conducts one of the most exacting tests, the Ingolstädter Korrosions- und Alterungstest (Ingolstadt corrosion and ageing test - INKA). This involves the simulation of twelve car years within 19 weeks – in five stages: Firstly, the car is sprayed with salt in a climate chamber set to 35°C. After this it is exposed to tropical weathering conditions of up to 50°C and a maximum humidity of 100 %. In the next stage the bodywork is heated up to 90 degrees by 80 metal-halide lamps of 1,200 watts each. The colours in the interior are not allowed to fade – nor the materials become brittle. Stage four is the simulation of Arctic temperatures of minus 35°C. At the same time, a so-called hydropulser shakes the vehicle to recreate the twisting of the bodywork and stressing of the chassis parts on uneven roads. Finally, test drivers drive the car approximately 12,000 km on test tracks – including gravel roads and muddy trails. Mercedes has a similarly tough testing routine, the MEKO Test, whilst at BMW vehicles are required to prove their corrosion resistance in an extensive Dynamic Corrosion Test (DyCo).

One thing is clear, however: Even these extreme tests can only simulate the actual life of a car and do not reflect it completely. Nevertheless, they provide comprehensive findings for the evaluation and optimisation of the necessary corrosion protection systems

Constant climate testing in accordance with ISO 9227 NSS

In addition to the special tests of the car manufacturers, a less comprehensive test procedure for the corrosion resistance of individual parts and components in vehicle construction has also proved its value: the constant climate test in accordance with ISO 9227 NSS.

Test chamber for the salt spray test ISO9227 NSS

This involves the coated test pieces being sprayed continuously with a 5% salt solution at an ambient temperature of 35°C and 100° humidity. To ensure reliable and dependable test results for corrosion resistance are received the temperatures, degree of purity of the salt and the quality of the water are precisely specified. In addition, the condensation quantity is also collected according to defined criteria. Finally, a precise calibration is specified for the constant climate test. This means: blank test plates are weighed before and after testing – to identify loss of weight due to red rust. The uniform structure of the test and the specified framework conditions mean that numerous empirical values are available for this test procedure. Various test chamber manufacturers of different systems on the market.

Climatic extremes tests

So-called climatic extremes tests are also frequently used. These typically combine the salt spray test partially with other salt concentrations than those in ISO 9227 with defined drying phases and a stressing stage with pure water spray.

Test chamber for the climatic extremes test (-40/+80°C)

In the process, the parts that are to be tested are exposed to in part extreme temperatures of -40°C to +80°C. A different test idea has established itself in

Sweden – developed by vehicle manufacturers Volvo and Scania. In the so-called ACT I (Accelerated Corrosion Test) the salt solution is not applied as a spray, but instead sprinkled onto the components that are to be tested several times a day. The temperature in the test chamber causes that the

Test chamber for tests ACT I/ACT II/L467

liquid evaporates again. In the modified test ACT II the solution is only sprinkled once a day, with the salt concentration also altered. On a range of different test surfaces the ACT II variant proves to be the tougher stress test. A separate procedure from Japan is the CCT-A (Cyclic Corrosion Test) applied by Toyota. This involves the parts initially undergoing the normal salt spray test, before being immersed in a salt solution.

INFOBOX

Influences on corrosion protection:

Temperature:
Higher temperatures signify a higher "chemical activity" and therefore faster corrosion. At the same time, very high temperatures can lead to the failure of coating systems – for example, a galvanic zinc coating (yellow passivated, containing chromium 6+) is destroyed at 70°C. In turn, below-zero temperatures result in the cracking of the system in the case of water intake.

Moisture:
Depending on intensity, moisture can lead to washing out. This accelerates the process of rust formation.

Salt concentrations:
The influence of salt concentration is low. However, alternating pH levels result in enhanced reactions – as does the change in climate itself.

Immersion:
The immersion of the test piece in salty water results in a higher intake of the coating and stronger wash out than with stressing via salt spray.

All of the tests listed in the table below can also be conducted in the laboratories at Dörken MKS in Herdecke:

An internal evaluation at Dörken MKS has shown that the highly different test conditions make it impossible or barely possible to compare test findings. Because the time until reaction of the test piece to white or red rust varies considerably depending on test procedure. The following factors have an Influences on corrosion protection:

Test	Description	Constant/ Alter-nating climate	Temperature range	Relative Humidity	NaCl Solution
ISO 9227 NSS	Salt spray test	C	35°C (NSS)	-	5% NaCl (pH 6,9)
VW PV 1210	Cycles with humidity control and NSS at times	A	20°C - 40°C	50%rH - 100%rH	As in ISO 9227
VW PV 1200	Cycles with humidity control	A	-40°C - 80°C	30%rH - 80%rH	-
VW PV 1209	Combination of PV 1210 and PV 1200	A	-40°C- 80°C	30%rH - 100%rH	5% NaCl (40g NaCl + 10g CaCl2 per l water)
VDA 233- 102 (VDA 621-415 B)	Cycles with humidity control and NSS at times	W	-15°C - 50°C	50%rH-100%	1% NaCl (pH as in ISO 9227)
ACT I Volvo VCS 1027,149 Volvo STD 1027,14 Volvo STD 423-0014 Scania STD 4319	Cycles with humidity control and NSS at times	W	35°C - 50°C	40%rH-95%	1% NaCl, pH-setting using 0,5M sulfuric acid (pH 4,2)
ACT II Volvo VCS 1027,1449 Ford L 467	Cycles with humidity control and NSS at times	A	25°C - 50°C	50%rH - 100%rH	0,5% NaCl
Toyota TSH1555G CCT-A	Cycles with humidity control and NSS, and dipping at times	W	20°C - 70°C	-	5% NaCl (pH 6,5-7,2)

Comparison of test methods

Further information on the test procedures, corrosion protection and high-performance micro-layer corrosion protection systems for the automotive market can be found at **www.doerken-mks.de**