Connector reliability evaluation using salt spray testing

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The object of this study was to examine and compare the reliability of electrical connectors. The object of the test was to compare connectors from two different manufacturers: A and B. In total there were 4 types of connectors. These were grouped on the basis of similarity into two categories. The test was conducted according to SFS-ISO 9227 standard (Corrosion tests in artificial atmospheres. Salt spray tests). With the selection of this test type, the experimental focus was on the accelerated occurrence of corrosion in the contact pins or crimps and also has a long history of use in testing. The salt spray test also enables a comparison to be made between different types of connector and it makes possible to study the effect of a corrosive environment on operating behavior. In the test two different types of connector from two different manufacturers were placed in a salt spray chamber for a period of 1500 hours. The test sequence involved a period of 300 hours in salt spray mode, a 600 hour interval to repair the exhaust system of the chamber and a further 600 hours in salt spray mode. During the interruption for repairs, the test items remained in the chamber. Once started, corrosion is an inexorable process so failures could also occur during the interruption.

The main difference between the connectors from different manufacturers was in the coating materials of the connector pins. Manufacturer 'A' uses tin for the outermost coating layer, nickel for the second layer, and brass for the pin material. Manufacturer 'B' also uses tin for the outermost coating and brass for the pin material, but copper for the second coating layer. Examination of the cross-sectional area of the failed connectors showed that a new material had formed on the pin surface and in some cases this had spread into the pin. Differences were also observed in coatings in respect to mechanical behavior in manufacturing of the connectors, leading to fractured coatings and thus reduced corrosion resistance in some cases.

Since salt spray corrodes the contact area, the resistance will increase and normal operation is impaired. Operating failure can be detected in the changes in real-time measured voltage. A 10 % increase in the measured voltage served as a failure criterion. The voltage increases suddenly or gradually. The measurement data was examined and failures were identified from the data. Failed connectors were molded in acryl, ground and polished, and analyzed by means of a microscope and a scanning electron microscope (SEM).

An elementary analysis was performed to determine the material changes to the damaged parts of the connector. The pin itself is made of brass, which contains copper and zinc. In the elementary analysis of the untested connector it was observed that the brass contained about 65 wt% of copper and 35 wt% of zinc. The elementary analysis of the damaged connector revealed that the damaged area contained 95 wt% of copper and 5 wt% of zinc. The disappearance of zinc phenomenon with the damaged connector can be explained by dezincification. This is a common mode of galvanic corrosion in brasses containing less than 85 % copper. Zinc corrodes preferentially and leaves porous remains of copper and corrosion products. In the dezincification process the brass dissolves, the zinc ions stay in solution, and the copper plates back on.

As a conclusion, the usability of salt spray testing for connector reliability analysis was found to be adequate for the purpose. The duration of the tests until sufficient number of failures were produced, was relatively long, but could most probably be shortened without test equipment failures. Significant differences could be found between manufacturers, not only related to used materials, but related to manufacturing process effects as well. Further results and conclusions will be presented at the final paper.