Comparative Report on the Performance of Polyester Powder Coatings

Excellent Corrosion Protection from a Single Coat

In a recent study, the influence of the curing conditions on the corrosion protection properties of coatings on a number of different substrates was investigated. In addition, powder coatings which provide corrosion protection of at least category C4 medium with a single coat were identified. The objective was to find alternatives to the widely used primid systems that provide significantly improved protection against corrosion in the low-temperature range.

Acid-functional polyester powder coatings, which are cross-linked with β-hydroxyalkylamide or aromatic glycidyl ester (Araldite PT910 or PT912), are normally used in Europe for external applications. The specific type of system depends on the application and the properties needed.

The construction and agricultural machinery industry has specific technological requirements for its powder coatings, as a result of the complex welded structures and the combination of solid steel components, which are sometimes centimetres thick, and thin sheet steel:

- high resistance to overbaking, especially on parts with thin walls, because of the very high curing temperatures of up to 220°C
- a wide range of curing temperatures
- no blooming
- good edge and weld coverage (corrosion protection)
- no running when the coating is applied thickly
- good degassing properties in coatings of normal thicknesses up to 200 μm, in particular when applied to electrocoated or blast-cleaned steel
- good interim adhesion when a second coat is applied to an electrocoating or epoxy powder primer
- high gloss finish with good leveling properties
- high levels of UV resistance (the benchmark is a two-component polyurethane top coat)

As coating large, solid components is particularly time-consuming and costly because of the long heating and cooling processes, powder coatings with higher reactivity are often needed. These coating systems allow for a lower curing temperature or a shorter process time, which leads to an increase in productivity.

However, the closer the production process comes to the minimum curing conditions of the powder coating in question, the more likely it is to reach the limits of the coating properties. This has a disproportionately negative effect on the corrosion protection and mechanical properties.

The objective of the study was to investigate the influence of curing conditions on the corrosion protection properties of coatings on different substrates and to identify powder coating systems that provide corrosion protection of at least category C4 medium with a single coat.

The corrosion tests were carried out in accordance with DIN EN ISO 12944, which is now increasingly applied to industrial goods made from steel with a thickness of less than 3 mm. This means that the standard is not relevant for the whole of the components in question. In general terms, only the division of the atmospheric conditions into the six corrosivity categories (C1-CX) and the laboratory tests for each category can be used.

The corrosivity categories are broken down into three time ranges or protection periods:

- Short: 2 to 5 years
- Medium: 5 to 15 years
- Long: more than 15 years

The protection period does not provide a guarantee and should only be regarded as a guideline. As on-

Evaluation of the corrosion and delamination from the scribe line after corrosion protection tests.
Table 1: Overview of the polyester-based powder coatings in the test

<table>
<thead>
<tr>
<th>System</th>
<th>Article</th>
<th>Curing</th>
<th>Weather resistance</th>
<th>Reaction mechanisms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primid-G</td>
<td>PF1004</td>
<td>10 min/180°C</td>
<td>+++ (GSB standard)</td>
<td>Polycondensation (separation of water) results in pinholes on thick coatings</td>
</tr>
<tr>
<td>LT-Primid-G</td>
<td>PR1004</td>
<td>10 min/160°C</td>
<td>+++</td>
<td></td>
</tr>
<tr>
<td>Primid-M</td>
<td>PP1001</td>
<td>10 min/180°C</td>
<td>+++</td>
<td></td>
</tr>
<tr>
<td>LT-Primid-M</td>
<td>PP3501</td>
<td>10 min/160°C</td>
<td>+++</td>
<td></td>
</tr>
<tr>
<td>PT910-G</td>
<td>PT3005</td>
<td>10 min/180°C</td>
<td>+++</td>
<td>Polyaddition (no decomposition products)</td>
</tr>
<tr>
<td>LT-PT910-G</td>
<td>PT3504</td>
<td>10 min/160°C</td>
<td>+++</td>
<td></td>
</tr>
<tr>
<td>LT-PT910-M</td>
<td>PT3501</td>
<td>10 min/180°C</td>
<td>+++</td>
<td></td>
</tr>
<tr>
<td>PT910-SD-G</td>
<td>PS2005</td>
<td>10 min/180°C</td>
<td>++++</td>
<td></td>
</tr>
<tr>
<td>LT-PT910-SD-G</td>
<td>PS2505</td>
<td>10 min/180°C</td>
<td>++++</td>
<td></td>
</tr>
</tbody>
</table>

Table 1: These coatings achieved a corrosion protection category greater than or equal to C4 medium.

The tests were carried out on steel with the following pre-treatments:
- Iron phosphating (Gardobond WH WOC) – 3-zone pre-treatment
- Zinc phosphating (Gardobond 26S 6800 OC) – chrome-free passivation using a titanium and zirconium-based treatment
- Blast cleaned to the Sa 2.5 standard in accordance with DIN EN ISO 8501-1, surface roughness 30 – 40 μm

The figures show the partial results, which highlight the advantages and disadvantages of each system most clearly.

Conclusions

The range of PT910 systems recently developed by FreiLacke presents a viable alternative to the commonly used primid systems and offers a significantly higher level of corrosion protection, particularly in the low-temperature range.