High-quality epoxy powder coating on valves and fittings makes water networks durable: Results from the 25-year Bad Bentheim long-term trial

The reliability of water supply systems depends largely on the durability and resistance of their components. Valves and fittings, which are indispensable components of any water infrastructure, are under constant stress from water, chemical substances, and mechanical loads from outside. Corrosion protection plays a key role in ensuring the long-term durability of these components. In this context, the Bad Bentheim long-term test, carried out by the Quality Association Heavy-Duty Corrosion Protection of Valves and Fittings with Powder Coating e.V. (GSK) in cooperation with former Wasserbeschaffungsverband Obergrafschaft Bentheim und Umgebung, Germany, has set new standards.

Background and objectives of the test

The Bad Bentheim long-term test began in 1996 as a co-operation between the GSK, the Wasserbeschaffungsverband Obergrafschaft Bad Bentheim und Umgebung (Water Supply Association of Upper County Bad Bentheim and Surrounding Areas in Germany) and eleven other companies. The participating companies with the GSK quality mark were AVK Armaturen GmbH, Belgicast Internacional, S.L., Düker GmbH, Frischhut GmbH & Co. KG, Georg Fischer Waga N.V., E. Hawle Armaturenwerke GmbH, VAG GmbH and vonRoll hydro ag. The MPA Hannover (independent testing institute) accompanied the test scientifically on behalf of GSK.

The aim of the test was to analyse and evaluate the long-term durability of epoxy powder coatings under real operating conditions. The valves and fittings are first brought to the required object temperature, after which the epoxy powder coating is applied using a fluidized bath or spray process. This process produces a fully cross-linked coating with a thickness of 250 to 600 microns in a very short time without releasing any solvents

The experiment followed on from earlier long-term tests that had begun in 1979 and were carried out between 1982 and 1991 and between 1984 and 1996. Due to the promising results of these preliminary tests, GSK decided to extend the test duration to 25 years. This period was intended to simulate the protective effect of the epoxy powder coating under real conditions over a quarter of a century.

Carrying out the test

On 13 December 1996, a total of 18 gate valves and 8 fittings were installed in a drinking water pipe belonging to the Wasserverband Bad Bentheim. Most of these components were coated with an epoxy powder coating, while some samples were treated with an enamel coating on the inside surface or a liquid coating. In order to test the load capacity of the coatings under extreme conditions, an artificial defect with a diameter of 6 mm was applied to all samples. This simulates

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possible damage to the coating that could occur during installation and enabled a realistic assessment of the corrosion protection.

Test section consisting of 26 valves and fittings during installation in 1996

Results after 25 years of continuous use

After 25 years in continuous operation, the test section was removed on 4 May 2022 in collaboration with the Trink- und Abwasserverband Bad Bentheim, Schüttorf, Salzbergen und Emsbüren (Drinking and wastewater association) and the MPA Hannover. The samples were first roughly cleaned in order to carry out an initial visual inspection. This initial inspection already revealed that most of the powder-coated samples did not show any significant signs of corrosion.

Removal of the test section on 04/05/2022

Dismantling and initial visual assessment by GSK and MPA Hannover

Close-up of a gate valve immediately after removal:
no corrosion visible on the inside surface.

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The samples were then transferred to the MPA Hannover for further analysis, where they were thoroughly cleaned and disassembled. The detailed analysis focused on the presence of corrosion, blistering and the integrity of the coating on both the inside and outside of the samples.

From the 20 powder-coated samples, 18 showed no detachment, flaking, infiltration or blistering on the exterior. One sample showed minor signs of corrosion, which could be attributed to damage of the coating during installation.

Another sample, on the other hand, showed pronounced blistering on the outside surface as well as cracks in the coating and corrosion on the top of the cap. This damage, which occurred in contrast to the other 19 powder-coated samples, can be attributed to faulty process control during coating. Possible reasons for this could be inadequate surface preparation or too low a temperature control, which can lead to incomplete cross-linking of the coating.

Blistering on the gate valve body; cracking and corrosion on the outer coating of the cap

In contrast to most of the other gate valves analyzed, this sample was not subject to GSK quality assurance. The defects that occurred therefore emphasize the crucial importance of quality assurance in the coating process. Such failures, which can be attributed to inadequate process control, confirm GSK's 35-year commitment to seeing quality assurance as an integral part of the entire coating process - from workpiece preparation to temperature control and application through to final inspection - and to having this monitored by independent testing institutes.

The artificially created defects, which were supposed to be particularly susceptible to infiltration, showed only minimal impairment, with maximum infiltration values of just 2 mm.

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Close-up of the artificial defect: no corrosion or delamination visible

The internal coatings of the components also proved to be extremely resistant. Of the eleven exclusively powder-coated gate valves, nine showed no blistering or delamination. Only two samples showed signs of corrosion at specific points, but this does not call into question the general resistance of the epoxy powder coating.

Significance and implications of the results

The results of the Bad Bentheim long-term test series provided an impressive proof of the effectiveness and durability of epoxy powder coatings in corrosion protection. After 25 years of continuous underground installation, no significant corrosion damage was detected in the vast majority of the powder-coated samples. This emphasizes the high reliability of this coating technology and confirms its suitability for long-term use in water supply systems.

Sustainability and economic benefits

In addition to the technical performance of epoxy powder coatings, the Bad Bentheim trial also demonstrates their sustainability potential. The exceptional durability of these coatings helps to significantly extend the service life of valves and fittings, reducing the need for frequent maintenance and replacement by operators. This not only saves costs, but also conserves valuable resources and reduces the ecological footprint of water supply systems.

By using epoxy powder coatings, water network operators can realize significant long-term cost savings. Less maintenance, reduced downtime and an extended service life of infrastructure components help to reduce the overall costs of operating and maintaining water networks. In addition, this technology makes an important contribution to conserving resources and reducing environmental impacts, making it a sustainable choice for the future of water supply networks.

Conclusion

The Bad Bentheim long-term test series has impressively demonstrated that epoxy powder coatings are an outstanding solution for the long-term corrosion protection of valves and fittings. Their ability to remain effective for decades, even under extreme conditions on underground installations, makes them an indispensable technology for safeguarding water supply systems. In addition, the durability of these coatings offers both economic and environmental benefits, making them a sustainable and future-proof choice for water network operators.