

POLYUREA COATINGS. IF YOU KNEW WHAT COULD GO WRONG...

Cynthia L. O'Malley, Laboratory Manager
KTA-Tator, Inc.
Pittsburgh, Pennsylvania, USA

Introduction

The use of polyurea-based thick film coating materials for substrate protection and corrosion prevention has taken an exponential rise in the marketplace in the past 10 years or so. When properly installed, polyurea coatings offer a variety of performance characteristics. Further, these coatings cure rapidly, are compliant with volatile organic compound (VOC) regulations and are high build, so they can provide multiple coat performance in a single coat application, making them attractive to facility owners representing many different industries. However, polyurea formulations are not a panacea, and if mis-specified or improperly applied, they will fail just like any other coating. This paper explores the limitations of polyurea coatings by describing failure mechanisms observed by the author over the past few years.

Polyurea Formulation and Hybrids

Polyurea-based thick film coatings encompass a diverse group of products. A pure polyurea is the combination of isocyanate with a long chain amine, excluding the hydroxyl reactive sites. For reference, pure polyurethane coatings are formulated using an isocyanate combined with hydroxyl-containing polyols. Polyurea coatings can be formulated as hybrids by combining isocyanate with a mixture of polyols and long chain amines, resulting in a coating that bears the performance characteristics of a polyurethane and a polyurea coating. Polyurea coatings can be

either aromatic or aliphatic, and can be formulated with catalysts, pigments, fillers and other performance-enhancing additives. Pure polyurea coatings offer the highest degree of chemical resistance, but hybrids offer improved wetting (the cure time is retarded) and other desirable performance characteristics. The relative production cost is lowest for a polyurethane, increases for polyurea hybrids, and is the highest for pure polyurea coatings.

Growing Pains

With any new technology, there is typically a relatively steep (and sometimes painful) learning curve. Primarily the product manufacturers provide guidelines for the proper use and application of polyureas and polyurea hybrids. While industry consensus standards (i.e., SSPC Paint standards) for these coatings are under development, they are not yet available to the industry. As a result, in some cases pure polyurea coatings have been improperly specified (based on the prevailing service environment), due in part to a misconception of the product's performance capabilities, and non-recognition of the product's relatively low tolerance for mis-application. Ironically, some of the desirable characteristics of these coatings (fast gel time, ease of film build, etc.) can also be detriments.

Polyurea Failure

Within the past five years, the author has conducted investigations of over two-dozen failures involving polyurea thick film

coatings. These failures, although limited in number, exhibited consistent modes of failure. The failures were not necessarily formulation or product-related, but rather caused by product mis-use and poor installation practices. While lack of proper surface preparation has accounted for the majority of the failures, installation in an inappropriate service environment is also a culprit.

Polyurea coatings, and to a lesser degree their hybrids do not have the ability to thoroughly wet-out the surface, and are therefore not considered surface tolerant materials. In general, these coatings will adhere tenaciously to the surface they are intimately in contact with during the relatively short gel time. However, if the substrate is contaminated or moisture is present on the surface, the coating will attach itself to the contaminants rather than the substrate. The coating will stay in place as long as the contaminants remain adherent. However, in most cases the weight of the thick film system (typically 60-120 mils [1525-3050 μm]) causes a loss of adhesion, since the adhesive/cohesive strength of most surface contaminants is relatively low, compared to the high tensile forces of the cured polyurea film. A pure polyurea will cure within 5-15 seconds. This relatively short surface-wetting time limits the adhesion properties of the coating. Without intimate contact with a properly prepared surface, the coating cures without forming an initial bond (anchor) to the substrate. Service conditions and coating weight can cause catastrophic disbonding of the applied film. Typical surface preparation requirements include a minimum near-white blast (SSPC-SP10/NACE No. 2) and an

angular surface profile of 3-4 mils (75-100 μm).

While inadequate surface preparation has caused the majority of the polyurea adhesion failures investigated by the author, use of the product in an environment for which it was not designed was a minor but notable cause of failure. As described earlier, polyurea coatings and their hybrids have excellent chemical resistance, but they have limitations. Pure polyurea coatings should not be exposed to service temperatures in excess of 200°F in combination with organic hydrocarbons such as gasoline or kerosene (which will plasticize the coating), dilute acids or caustics, or chlorinated materials. Ultraviolet (UV) light (sunlight) will degrade aromatic based systems and cause the film to chalk and color fade.

Table 1 provides a cross-section of examples of various failure modes exhibited by polyurea coatings (based on actual case histories).

Conclusion

New technology polyurea coatings and their hybrids offer the industry an environmentally compliant, high performance option (with very attractive film forming properties) for corrosion prevention and asset protection. However, like all industrial protective coatings they have performance limitations and minimum surface preparation requirements. Use of these materials outside of the recommended service environments or over marginally prepared surfaces can result in catastrophic failure and costly rework.

Table 1

Failure Mode	Description
Adhesion (Disbonding)	Polyurea coating applied to ceramic tile surface.
Adhesion (Disbonding)	Polyurea coating applied to surfaces abrasive blast cleaned to SSPC-SP10/NACE No. 2 (near-white metal). Surface contained abrasive blast residue and an inadequate 1-2 mil surface profile depth.
Severe Discoloration & Cracking	Polyurea coating subjected to service conditions of pH 3-4 and intermittent 200°F temperature.
Yellowing and Delamination	Polyurea coating applied to exterior surfaces abrasive blast cleaned to SSPC-SP5/NACE No. 1 (white metal) with a 2 mil surface profile. Film contained dry spray. Moisture present on surface during application (surface temperature at or below dew point temperature).