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Durability Performance Attributes

TriFLEX™

About This Paper

This white paper from Advanced Polymer Coatings explores the durability performance attributes of our innovative product, TriFLEX™. The primary aim of this document is to detail the challenges that exterior coatings face in protecting assets from corrosion caused by environmental factors such as UV radiation and salt spray. It further explains how TriFLEX™ addresses these challenges, with a particular focus on rail car applications.

The paper emphasizes the limitations of traditional coatings, such as epoxies and polyurethanes, in terms of their chemical resistance, UV stability, and overall durability. It introduces TriFLEX™ as a groundbreaking solution that combines three distinct resin systems—polyurethane, polyaspartic, and a proprietary polymer technology—to deliver exceptional durability and performance.

This document serves as a valuable resource for technical professionals, asset managers, and decision-makers in industries reliant on exterior coatings. It provides in-depth insights into TriFLEX™'s superior durability benefits, supported by standardized testing methods, including ISO 12944-6, which evaluates coatings' resistance to corrosion. The paper presents data demonstrating TriFLEX™'s outstanding performance in accelerated weathering tests and chemical resistance evaluations.

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Executive Summary

Exterior coatings are designed to protect steel from corrosion, maximize the asset's lifetime, and reduce the number of times the asset needs to be recoated or repaired. Different environments provide varying degrees of corrosivity, from inland areas with minimal city pollution to extreme environments such as offshore, where coatings are challenged with UV exposure combined with salt spray from the ocean. To determine how coatings will perform in these environments, standard tests have been developed that, through correlation to real-world performance, can predict the estimated lifetime of a coating in different service environments. For example, ISO 12944-6 outlines procedures for testing the performance of protective paint systems on steel structures exposed to corrosive environments. It specifies various accelerated laboratory tests to evaluate the resistance of these coatings against corrosion, including methods for assessing adhesion and corrosion resistance. These tests are crucial for ensuring that protective paint systems meet the durability and performance standards required for the long-term protection of steel structures in diverse environmental conditions.

Challenges with Traditional Coatings

Epoxies

Epoxies offer superior chemical resistance due to their aromatic chemical structure, which protects against splashes and spills of chemicals in exterior applications. However, these aromatic chemical structures are prone to degradation by UV light, causing them to quickly chalk, fade, and lose color and gloss. Once an epoxy starts to chalk and fade, the film thickness continually decreases, leading to premature corrosion of the substrate that the epoxy is trying to protect. For external rail coatings, the longest-lasting epoxy coating is estimated to have a lifespan of about 10-15 years, as measured by ISO 12944-6 testing. This results in compromised corrosion resistance and poor aesthetics, with the asset looking dull and faded in a short period.

Polyurethanes

Polyurethanes offer better UV resistance than epoxies for external applications and can retain color and gloss over a more extended period. However, they do not provide the same level of chemical resistance as epoxies and are more prone to scratching. Thus, no single coating can handle UV resistance, retain color and gloss, manage mechanical impact, and resist a wide range of chemicals that might be splashed and spilled on exterior coatings.

Innovation with TriFLEX™

TriFLEX™ was developed to meet the need for a coating that can handle all these durability challenges without sacrifices. By combining three different resin systems (polyurethane, polyaspartic, and a proprietary polymer technology based on Nobel prize-winning chemistry), TriFLEX™ excels in durability. The polyurethane chosen for TriFLEX™ has a unique chemical structure that offers outstanding chemical resistance to various chemicals, rivaling the chemical resistance of an epoxy. The proprietary polymer blend provides high water and corrosion resistance, resisting degradation by atmospheric conditions and salt spray exposure. Each resin's chemical structure was explicitly chosen to be aliphatic, not aromatic, to resist degradation by UV light, allowing the coating to retain its color and gloss over its lifetime.

TriFLEX™'s Triple Resin System

- **Polyurethane Component:** Provides flexibility, UV resistance, and outstanding chemical resistance.
- **Polyaspartic Component:** Contributes to rapid curing and chemical resistance.
- **Proprietary Polymer Technology:** Enhances water and corrosion resistance, ensuring long-lasting protection.

Extensive Testing and Proven Durability

ISO 12944-6 Testing

TriFLEX™ has undergone extensive testing to prove the benefits of using three different resin systems in one coating. ISO 12944-6 testing was performed on TriFLEX™ with one coat at six mil DFT. The results showed that a one-coat TriFLEX™ system could provide approximately 25 years in a C4 environment, which, according to ISO 12944-6, is the harshest environment for anything not considered offshore. This is the longest lifetime for commercial coatings for a single-coat system in this type of environment and can often replace two- and three-coat systems with a single coat at a low film thickness.

UV and Water Condensation Testing

TriFLEX™ was also tested in cyclic conditions between UV exposure and 50°C water condensation compared to an industry-standard exterior epoxy coating. Performance was monitored by retention of color and gloss and by electrical chemical impedance spectroscopy (EIS). This analytical method can detect corrosion and coating degradation that is not visible to the naked eye. The standard epoxy coating became dull, chalked, and turned white to yellow within three weeks of testing. TriFLEX™, on the other hand, retained its color and gloss throughout the entire eight weeks of testing. EIS evaluation showed that the epoxy coating experienced a drop in impedance at low frequencies, indicating the beginning of damage and corrosion. In contrast, TriFLEX™ showed a slight increase in impedance at low frequencies, likely due to post-curing during testing, indicating improved corrosion and barrier properties.

Chemical Resistance Testing

TriFLEX™ was tested for resistance to nearly 80 aggressive chemicals, including highly aggressive acids such as hydrofluoric, formic, and fluorosilicic acid. TriFLEX™ resisted these and almost all the tested acids, bases, and solvents. This chemical resistance is comparable to that of epoxies and, when combined with UV and corrosion resistance, offers an outstanding solution to protect assets exposed to harsh conditions, achievable with only one thin coat.

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Real-World Applications and Benefits

Rail Car Applications

Rail cars are subject to significant mechanical stresses and impacts during transportation and loading/unloading processes. The superior durability of TriFLEX™ ensures that the coating remains intact, protecting the substrate from corrosion and other environmental damage. This extends the lifespan of the railcars and reduces maintenance costs and downtime.

Benefits of TriFLEX™ for Rail Cars

- Enhanced Durability: Provides exceptional protection against mechanical damage and environmental factors.
- Reduced Maintenance: Minimizes the need for repairs and maintenance, reducing downtime and costs.
- Extended Lifespan: Protects the substrate from corrosion, extending the service life of railcars.
- Cost-Effective: One-coat application reduces labor and material costs.
- Aesthetic Maintenance: Retains color and gloss, maintaining the visual appeal of the asset over time.

Conclusion

TriFLEX™ represents a significant advancement in exterior coating technology, combining the best attributes of epoxies and polyurethanes while addressing their respective shortcomings. Its superior durability, UV resistance, chemical resistance, and corrosion protection make it a versatile and reliable choice for protecting railcars and other industrial assets. By choosing TriFLEX™, industries can ensure long-lasting protection, reduce the risk of mechanical and chemical-related damage, and ultimately enhance the performance and longevity of their assets.

TriFLEX™