Whitepaper

Safely Extending Performance Life of PVC Coated Conduit in Demanding Applications

Atkore™
Calbond

SAFELY EXTENDING PERFORMANCE LIFE
OF
PVC COATED CONDUIT IN DEMANDING APPLICATIONS

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OVERVIEW

Corrosion is an extremely costly and potentially dangerous problem. It destroys the physical integrity of conduit and fittings, causing substantial and expensive damage. When metal conduit is installed in an area defined as both hazardous and corrosive, special considerations must be given to the selection of conduit system materials. PVC and polyurethane corrosion resistant coatings will not provide the intended corrosion protection without proper preparation of the conduit galvanized zinc surfaces. It has often been stated that 80% to 90% of premature coating failures are caused by improper or inadequate surface preparation. Most premature coating failures are caused by contaminants left on the surface when the coating is applied. Atkore Calbond has recently received 3rd party validation that its PVC coated conduit greatly exceeds parameters of ETL Certification while meeting UL 6 Safety Standards. This paper discusses the importance of UL 6 Safety Standards and the recently obtained ETL Verification and how that ensures proper PVC coating adhesion for long term conduit system protection, even in the harshest environments.

INDUSTRY CERTIFICATIONS

Corrosion is a challenge to the long-term safety and reliability of steel conduit systems. To help combat corrosion, the Underwriters Laboratory (UL) has developed safety protocols to combat corrosion. UL 6 is the UL Standard regarding Safety for Electric Rigid Metal Conduit – Steel. The safety standard defines many parameters for the development and implementation of metal conduit, metal elbows, couplings and nipples when installing metal raceway for wires and cables. One paramount requirement of UL 6 is Clause 5.3.1, which pertains to the application of corrosion-resistant coatings. UL 6 mandates a protective coating solely of zinc be applied to the exterior surface. This coating must completely cover the steel and adhere firmly at all points. The zinc coating must be smooth and free from blisters and other defects that can lessen the protective value of the coating. The protective zinc coating is the first line of defense against corrosive elements found in harsh environment applications.

It is important to note the UL 6 zinc coating requirement when discussing the ETL verification. ETL is a 3rd party verification test that examines the adhesion strength of PVC coating to rigid steel conduit substrate. The zinc protective coating requirement found in UL 6 makes the bonding of PVC coatings more challenging. PVC coating does not inherently bond to zinc. As a result, a special bonding agent was developed by Atkore Calbond to ensure a secure PVC coating bond that exceeds the requirements of the ETL test.

ETL CERTIFICATION OVERVIEW

In hazardous locations, conduit systems may be required to perform not only physical protection for the electrical conductors, but also to contain an explosive event that includes extreme pressure, and/or sparks and flames. As corrosion destroys the physical integrity of the conduit and/or fittings, a weak point may slowly develop that jeopardizes the integrity of the conduit system.

PVC coating is vital to providing maximum protection against corrosion. However, if the coating bond is ineffective or wears over time, moisture can seep through to the metal substrate underneath causing corrosion. Once corrosion sets in, it can never be eliminated completely, only controlled by such processes as hot dip galvanizing. The rate of corrosion depends on the environment and amount of moisture allowed to penetrate to the conduit substrate. Conduit systems used in harsh environments, including wastewater, petrochemical (oil & gas) and transportation applications, are more susceptible to corrosion.

To provide assurance that Atkore Calbond PVC coated conduit systems provide superior corrosion protection of steel conduit systems in highly corrosive areas, Intertek has conducted the Intertek ETL SEMKO PVC001 verification test for PVC coated conduit. The ETL PVC001 test subjects conduit systems to extreme heat and humidity, two proven environmental factors that reduce the effectiveness of PVC coating adhesion and accelerate corrosion. The ETL PVC001 adhesion performance test is comprised of two primary tests:

1. Immersion in Boiling Water according to the intent of ASTM D 870, Testing the Water Resistance of Coatings Using Water Immersion, for a period of 200 hours

2. Both the exterior and interior coating were tested for adhesion at predetermined intervals during the 200-hour test period.

The conditioning is performed as per ASTM D 870-15: Standard Practice for Testing Water Resistance of Coatings Using Water Immersion. It is an alternative practice to ASTM D 2247 (and vice-versa).

Before, during and after the conditioning period, two (2) standards test methods are used to qualify the adhesion of both the internal and external coatings.

1. For the internal coating, we use the standard ASTM D 3359-17: Standard Test Methods for Measuring Adhesion by Tape Test

2. Test Method B. The adhesion of the coating is rated using the following table, as found in the standard.

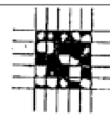
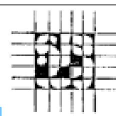
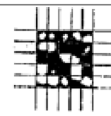
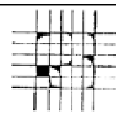
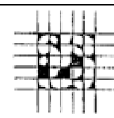
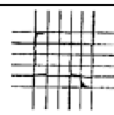
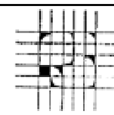
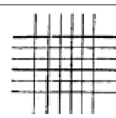
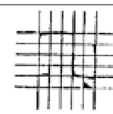
Rating	Description
0	 or worse
2	Worse than  but no better than 
4	Worse than  but no better than 
6	Worse than  but no better than 
8	Worse than  but no better than 
10	No worse than 

Table 1: Internal coating adhesion rating

A total of eleven readings are taken at the following immersion duration in water.

Test	Elapsed Time
1	Initial – before exposure
2	1 hour
3	4 hours
4	8 hours
5	12 hours
6	24 hours
7	2 days
8	5 days
9	10 days

Table 2: Test time intervals

The pass/fail criteria is established as follows: Two consecutive average adhesion values less than 6 at exposure times of 300 hours or less shall constitute a failure. The failure time shall be recorded as the time of the first average adhesion value less then 6.

The PVC coating adhesion process was completed in accordance with UL 6 Standards before the test was conducted. The testing of the PVC exterior coating during the test period was completed based on procedures outlined in Section 3.8, of NEMA Standards Publication No. RN 1, Polyvinylchloride (PVC) Externally Galvanized Rigid Steel Conduit and Intermediate Metal Conduit.

HIGHLY CORROSIVE APPLICATIONS

Transportation

The direct effects of corrosion cost U.S. industry and the government $276 billion annually, according to a study commissioned by the U.S. Federal Highway Administration (FHWA). Corrosion damage to transportation infrastructure like bridges and tunnels significantly reduces the operating life of vital infrastructure causing potentially dangerous scenarios. Today, as much of the aging infrastructure reaches the end of its designed lifetime, the emphasis is on maintaining and extending the life of these valuable assets. There are approximately 583,000 bridges in the United States, with some 200,000 made out of steel. Approximately 15% of these bridges are structurally deficient because of corroded steel and steel reinforcement. The costs to repair bridges and tunnels is in the tens of millions, with more costs associated with ongoing maintenance requirements. Indirect costs to the user, such as traffic delays and lost productivity, were estimated to be as high as 10 times that of direct corrosion costs.

Wastewater Treatment Plants

Wastewater treatment plants (WWTP) process and handle some of the most corrosive solids and liquids throughout process engineering. After prolonged operation, this often causes damage to pipes, tanks, pumps, and electrical conduit systems, among others. More specifically, cracks in the wastewater treatment tanks, leaks from the storage tanks, and leaching of contaminants from sludge in on-site storage areas can lead to corrosion in a WWTP. Hydrogen sulfide, methane, ammonia, oxygen, carbon dioxide, and nitrogen are found dissolved in wastewater, with anaerobic decomposition of such gases producing other odorous compounds, amines, and fatty acids that lead to unforeseen corrosion threats. The interaction of primary components of sewage producing secondary chemicals can create even more toxic or corrosive properties in existing wastewater, leading to faster, and more destructive, system failures in a plant.

A wastewater treatment plant contains just about the greatest possible potential for steel pipe and tank damage caused by microbiologically influenced corrosion (MIC). Odor control systems do not completely solve the corrosion problem in WWTP, for odor control systems themselves are not free of damaging exposures.

There is often a presence of harmful metal ions in wastewater. Copper, lead, mercury, and nickel are the most common. Low levels of harmful ions in wastewater can cause harmful effects. Galvanic coupling, also known as two-metal corrosion, to more noble metals – such as carbon steel, stainless steel or copper can cause further corrosion.

Wastewater treatment plants making use of extensive fabrication in PVC-coated aluminum offer a solution to the infrastructure corrosion problem. Corrosion rates of carbon steel and iron in wastewater can be accelerated 5 to 10 times by local acidic conditions produced by the microbiological action. Furthermore, pipes and other structure made from carbon steel and ductile iron can be externally corroded by the surrounding soil. This demonstrates why unprotected carbon steel and ductile iron are not suitable for long-term wastewater service. PVC and polyurethane corrosion resistant coatings will not provide the intended protection without proper preparation of the conduit galvanized zinc surfaces.

Petrochemical
The risk of fire and explosions are a serious concern for personnel working in industrial facilities, such as petroleum refineries and chemical processing plants. These facilities deal with the reality of day-to-day operation with indirect exposure to volatile materials. The threat of a catastrophic event is heightened by the presence of the electrical infrastructure in these facilities, as an inherent property of electricity is the capacity to produce arc and spark. One of the critical elements that pose a challenge to the safe operation of these facilities is corrosion. Rust is an explosive threat in harsh environment facilities. Rigid metal conduit is commonly used for electrical raceways in oil, gas and petrochemical facilities. Protecting conduit to eliminate rust is a top priority for facility managers.

CONCLUSION

PVC coated conduit systems are the proven solution to fight corrosion on public and infrastructure structures. It extends the life of metal conduit systems and lessens the effects of costly shutdowns for repairs in corrosive environments. Without a secure bond, the effectiveness of the PVC coating is drastically reduced. The application for PVC coated rigid conduit is in harsh environments that make the conduit susceptible to corrosion. The key corrosion resistance in these areas is the bond of the PVC coating to the substrate of the rigid conduit.