Electrical Enclosures

By Jeff Seagle

The key to proper specification of electrical protection materials is understanding their role in protecting water and wastewater components. Specifying a material that is not truly suited to application needs creates the significant risks of premature product and systems failure, downtime, added labor costs and potential litigation. It is vital that industry professionals learn the basics of metallic, ceramic, polymeric and composite materials in order to match materials to performance and application requirements.

Proper materials specification ensures superior protection

ARTICLE SUMMARY

Challenge: City Water LLC observed that after a few years of operation in demanding environments, its wastewater treatment systems' controls became vulnerable to failure despite stainless steel enclosures.

Solution: The material selected for the electrical enclosures was not appropriate for the given environment, so the company investigated new options and selected a better suited composite.

Conclusion: Proper material selection for water and wastewater controls enclosures begins with a detailed consideration of the application at hand.

Materials Available

The material used to protect water and wastewater electrical components can be made from metallic or nonmetallic material, but it must serve its function of protection for the life of the installation. Durability and longevity are key. Three typical types of materials are available: metal, plastic and composites.

Common metal enclosure choices include carbon steel, stainless steel and aluminum. Carbon steel, the most prominent choice based on its low initial cost, is typically galvanized or painted to prolong the service life. Premium metals such as stainless steel and aluminum are used where long life, corrosion resistance and weatherability are critical (e.g., in protecting controls for junction boxes for utility power PV installations).

Thermoplastics such as polycarbonate, polyester and polyvinyl chloride offer a degree of corrosion protection beyond painted carbon steel. Thermoplastics, though, are more susceptible to ultraviolet (UV) and weathering degradation over time. Certain stabilizers can be added, but ultimately the nature of the thermoplastics will yield to extended weathering.

Thermoset materials—a polyester resin combined with glass, for example—create a composite fiberglass-reinforced polyester (FRP) that is exceptionally durable and weather resistant. Like thermoplastics, FRP provides a greater degree of corrosion than painted carbon steel, yet it will perform better than metal and plastics in extremely harsh environments.

Choosing the Right Material

A material failure caused by environmental corrosion or impact damage resulting in a breach of proper sealing can cause a multitude of problems, including catastrophic and dangerous system collapses, production downtime, increased maintenance costs and losses in customers and revenue.

Proper material selection is critical, therefore, to both the design and the material of the enclosure. Ultimately, selection comes down to optimal performance and value. Often trade-offs between performance, acquisition cost and life-cycle cost are made in the process to find the choice in a unique application. Consider factors that influence enclosure specification for water and wastewater applications and how an enclosure might stack up. These include environmental characteristics as well as material and material utility.

The foremost motivator influencing water and wastewater electrical component material selection is environmental considerations—moisture, UV radiation, dust, etc. This consideration envelops temperature, chemicals, moisture and concern for the physical world of the permanent installation. Whether the environment is hostile or passive, an attempt is made to match capabilities of the enclosure and the anticipated ambient environment. An over-specified enclosure will work effectively in a natural environment, but there are severe repercussions for using an under-specified enclosure in a hostile environment, thus making environment the overriding consideration.

Corrosive environmental conditions can act as accelerants for corrosion, just as gasoline does for fire. The factors that determine the level of corrosion in an environment include extreme weather conditions such as moisture and UV radiation.

The level of corrosion typically increases with moisture content. If there was no moisture, there would be no electrolyte and, hence, no corrosion. Common atmospheric sources of moisture are rain, dew and condensation. Rain can have a beneficial effect in that it washes away contaminants from exposed surfaces. If rain collects in pockets or crevices, however, it can be detrimental because it supplies a source of continued moisture. When relative humidity exceeds 70%, a thin film of moisture will form on a metal surface, providing an electrolyte. This dew or condensation can become very corrosive if it is saturated with a contaminant like sea salt or acid compounds from industrial sources.

UV has been a concern among nonmetallic manufacturers for many years. The rate at which the UV degradation occurs will vary depending on the heat, humidity and latitude with which the product is installed. There are also differences in the way UV breaks down different nonmetallic materials. For instance, the effects of UV light become critical more quickly with thermoplastics than with thermosets of similar chemical structure. This happens

Corrosion Resistance

CONTINUUM OF USE	GENERAL CATEGORY OF CHEMICALS		
	ACIDS	ALKALINES	SOLVENTS
Recommended	Fiberglass, Stainless Steel	Fiberglass, Stainless Steel	Fiberglass, Stainless Steel, Aluminum, Powder Coated Steel
Acceptable	Powder Coated Steel	Galvanized Steel, Powder Coated Steel	Galvanized Steel
Limited or Unacceptable	Aluminum, Powder Coated Steel	Aluminum	

because thermoplastic materials have a much lower mass (molecular weight) than thermosets, so breaking of each bond in thermoplastics cuts the polymers into much smaller fragments than does each breaking bond in thermosets. In thermosets, the cross-linking limits unzipping of the polymer chain and requires more UV energy to break it down, giving increased UV resistance and weatherability.

A metal enclosure exposed to heavy moisture in the Abita Brewery facility in Louisiana had to be replaced sooner than anticipated.

Why Choose Composites?

Consider the following:

- Life-cycle costing of composites—despite a higher prime cost compared to traditional materials like steel and aluminum—favors the use of composites. Negligible maintenance, minimal recurring cost and requiring no replacement (due to deterioration in service) translates into a lower overall cost over the life span of the product.
- Composites (FRP) enclosures were developed as an answer to corroding stainless steel enclosures in marine environments.
- They offer inherent safety, as composite enclosures are not conductive.
- Composites are less likely to be affected by temperature due to material stability.
- Painting of carbon steels increases cost and risk of failure due to failure at or near penetrating and mounting locations.
- Lighter weight reduces installation headaches.
- Modifications of composites are simple.

City Water LLC's turnkey wastewater treatment plant solution, featuring nonmetallic enclosure for protection of the controls system.

Case Study: City Water LLC

City Water LLC provides municipalities a turnkey wastewater treatment plant solution capable of effectively accommodating between 500 to 10,000 gal. The evolution of this system was based on the need to overcome a significant challenge specific to the reliable protection of critical controls.

Many of the company's wastewater treatment systems are in demanding environments subject to high humidity, corrosive saltwater and strong UV degradation. After two to three years of service in such applications, the company began to notice that the integrity of controls was being threatened by failure of the electrical enclosures used to house and supposedly protect them. The stainless steel enclosures being used were not suitable for long-term reliability within this particular combination of environmental pressures. Part of the problem originates with the fact that although tensile strength is high with metal enclosures, flexural strength (the material's ability to withstand denting) is relatively low. Once metal has gone beyond its elastic limit, it has created a potential leak path that could compromise an enclosure's seal integrity.

Consequently, City Water LLC began to explore property performance characteristics of available product lines and discovered a composite that was up for the task. A primary difference in this product line is the fact that this product is molded with a patented sheet-molded compound formulation that provides superior molded-in UV resistance. The company is now successfully using this line of composite enclosures to protect its control systems from UV damage and other environmental threats.

Best Practices for Material Selection

Enclosure specifiers for water and wastewater applications must carefully evaluate all factors to ensure material type will withstand the environment in question. The process for proper material selection begins with a detailed consideration of the application. Each water and wastewater environment is unique, and all possible applications should be identified for the intended enclosure application. Start with a simple list of custom needs and ask plenty of questions because material failure cannot be an option when people are relying on the industry for their water needs. WWD

Jeff Seagle is president of Stahlin Non-Metallic Enclosures. Seagle can be reached at jseagle@stahlin.com or 616.794.0700.

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