New Predictability Of FBE Pipeline Coatings

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During the last 40 years, both the products and application of fusion-bonded epoxy (FBE) pipe coatings have undergone tremendous improvements. Efforts on behalf of FBE formulators, manufacturers and applicators have resulted in an applied coating that should sustain its place as a performance standard well into the 21st century. FBE is a technology that is improving to meet the new challenges of the pipeline industry.

In the very early days of pipe coating the concept of measurable performance was limited to "is there a hole in my pipe?" Product literature for pipeline coatings was a mixture of information that was both speculative and self-promotional. Furthermore, few standards were universally used and testing was difficult to compare or duplicate. For example, coating specifications consisted of a minimum standard that was open to exceptions and interpretations. Coating application for some technologies was accomplished in the field with all the associated problems of uneven/poor surface preparation, unpredictable weather and variable coating equipment. Hats off to those brave pioneers who did the very best possible job with what resources were available on their projects.

Current FBE coatings have been constantly improving in the areas of formulations, product manufacture and application. These advances have changed the face of fusion bonded epoxy powder coatings and merit an overview.

North America has evolved as a single-layer FBE pipe coating community while Europe has embraced a three-layer philosophy utilizing polyolefin as a mechanical barrier overcoat. Both coating systems use FBE as the corrosion protection coating.

FBE Formulations

Fusion-bonded epoxy has been the dominant pipeline coating in North America for more than 20 years. Some standard FBE formulations are now being replaced by those same manufacturers' new formulations with improved performance, specific physical and chemical characteristics, and targeted pipeline operating conditions. FBE manufacturers have responded to the applicators' requests to offer better application parameters. As a result, new powder formulations generally offer a friendlier window of application than past formulations, which gives the application facility a better opportunity to optimize the coating performance.

In addition, formulators have responded to specifications such as CSA-Z245.20-98 from the Canadian Standards Association, which require testing over a wide spectrum of temperatures. There are difficulties engineering a specific performance characteristic into a coating without losing performance in another area. Remarking on this problem, Tom Fauntleroy, now retired from 3M, once said, "It is difficult to be a singer and a dancer."

For example, meeting high and low temperature performance requirements within the new specifications has caused changes in both formulations and powder manufacture practices in order to compete in today's environment. High temperature water soaks and cathodic disbondment testing, as well as low temperature flexibility requirements, are testing realities that applied FBE coatings face daily.

Overcoats such as textured FBE for use under concrete and complementary liquid coatings and mechanical barrier powder coatings have made fusion-bonded epoxies more competitive against other technologies. These new products may be applied over the FBE corrosion coating during the application process without additional handling and with very little additional equipment. Applicators generally find these powder overcoat technologies more cost-effective and less problematic than other alternatives. These powder overcoats also offer pipeline companies performance specific solutions to construction and operating challenges.

FBE Powder Manufacturers

Like most manufacturing, powder pipe coatings suppliers have adopted internal programs that complement customer requirements. Powder suppliers have learned the aspects of coating manufacture that can be controlled internally to enhance performance characteristics of applied powder coatings.

For instance, drier powder is one aspect of controlling applied coating interfacial and through film porosity. Most manufacturers have an outbound product specification that monitors moisture/total volatiles very closely. Some application facilities have instituted a maximum allowable moisture level to their inbound powder testing. In some manufacturing facilities, additional equipment has been added to compensate for high relative humidity during powder production.

During the very early days of powder manufacture, particle size control was difficult. Grinding was sometimes accomplished by the same methods used for wet paints. Ball mills were basically ceramic balls inside rotating drums. As the drum rotated, the ceramic balls ground together, crushing and mixing the powder/paint. The particle size distribution consisted of everything from "boulders" to minute dust. This caused a number of problems with the flow characteristics of the powders on the surface of the pipe to the extent a liquid primer was once used as a primer under the FBE. Ball mills long ago gave way to more complex grinding equipment and techniques which now allow powder manufacturers to precisely control particle size to their internal product specification. Today, particle size distribution is routinely measured using very sophisticated equipment and is an integral part of all manufacturers' outbound quality control.

The additional quality issues of packaging and transportation of FBE powders have always been essential to manufacturers. Moisture and high temperatures are deadly enemies to powder coatings. As a precaution, better packaging has been constantly sought and improvements are regularly being made. "Super-Sacks" are commonplace and these 600- to 2,200-pound containers are well-suited to protect powder products while saving space and reducing manpower requirements at the applicator.

Going hand-in-hand with packaging, air-conditioned transportation is the industry standard for conveying FBE powder coatings. Humidity and temperature controls during finished goods storage and transport are part of every powder manufacturer's standard operating procedures and quality program. Only under the most favorable and unusual conditions would powder be shipped outside a controlled environment.

Outbound quality testing has changed to reflect manufacturers' compliance to the new standards such as Canadian Standards Association (CSA-Z245.20-M98). It has become critical for powder manufacturers to have fully integrated quality programs that complement the powder applicators' inbound quality systems. The information developed and documented by the powder manufacturers becomes a crucial part of the applicator's quality system. This criterion verifies the performance characteristics of the powder from the manufacturer and is coordinated with the applicator's inbound results to assure compliance with the applicable specification.

Due to the improved manufacturing process, product formulations that have been available for many years are performing to higher standards. These formulations are optimized through tighter controls and consistencies.

More than ever, the product data sheet is an important point of reference for information. Product data sheets are a credible source concerning typical properties of a particular product. The testing standards referenced for the individual tests may vary so it becomes important to study them carefully. It continues to be important to compare "apples to apples" and differences are not always apparent. A manufacturer's product data sheet occasionally might still document the most favorable test results and may or may not represent plant-applied coating results.

FBE Application

With the advent of tougher performance requirements from the pipeline customers, the pipe-coating applicators have responded admirably. The industry that once had a quality manual "around somewhere" is now actively complying with a multitude of standards. Of course, there are differences between companies and even between locations of the same company, but an evaluation of the quality program is always part of any major project and standard procedure for certain pipeline company quality audits.

Applicator inbound powder qualification has nearly eliminated the finger pointing associated with applied coating test failures. This means less grief for all concerned as all resources can be targeted on solving the problem, not assessing blame. The additional documentation assures customers they are getting everything they expected regarding their applied pipeline coatings.

Quality inspection points are numerous and document the application process inside the coating application plant. The amount of useful information provided can facilitate trouble-shooting, if necessary, and allows examination of the coating process to optimize testing performance and plant production rates.

Fusion-bonded epoxy powder coatings have new application challenges with the introduction of multi-powder applications. Rather than single product application, there may be two or occasionally three powders applied to achieve specific performance criteria.

The outbound applied coating test methods again reflect the internal applicator standards and those imposed by the pipe owner. In some cases, internal applicator standards may be more stringent than those requested by the owning companies. Most applicators have expressed the desire to continue to improve their quality and feel internal minimum standards reflect their best interests as well as those of their customers.

CSA performance standards challenged old practices that plagued the pipe-coating industry for years and deserve credit for motivating it to higher standards. Not only is test performance a criterion for applied coating acceptance, but now consistency must also be an integral part of every powder formulation. Powder manufacturer CSA plant certification, outbound powder manufacturer testing, inbound powder applicator testing and outbound applicator applied coating testing have almost eliminated time-consuming debates and finger pointing. This has expedited troubleshooting and benefited the entire pipe-coating industry.

The National Association of Pipe Coating Applicators (NAPCA) supports higher industry standards. NAPCA represents pipe-coating applicators worldwide and has been developing an educational training program addressing fusion-bonded epoxy pipe coatings. The association actively continues to make contributions through its regular and associate members.

Conclusions

Fusion-bonded epoxy pipe coating industry has evolved and the industry can take pride in today's continuous improvements. Perhaps it is not entirely correct to refer to the proceeding comments as "new," but the process is certainly more predictable. Expectations are high in every quarter of the coating process and, most importantly, those expectations are being met. The FBE pipe coating has been, and continues, to be changing within the realms of powder formulation, powder manufacture and powder application.

Entering the 21st century, the efforts of pipe-coating pioneers who responded to the changing demands of the industry are to be congratulated. The lists of those who deserve leadership credit are long and represent a cross section of formulators, manufacturers and applicators. Independent testing laboratories and third-party inspection companies have also made contributions toward improved applied FBE coatings.

In today's FBE pipe-coating industry, there is an atmosphere of cooperation between fusion-bonded epoxy coating manufacturers and applicators to provide quality-coated pipe to their customers. Meeting the challenges of the 21st century will demand that this teamwork continue. ***P&GJ***

Author's Note

Buddy Miller has 19 years experience working with FBE pipe coatings. He has been active in numerous industry organizations such as NACE International, Southern Gas Association, and Appalachian Underground Corrosion Short Course where he teaches several courses on fusion-bonded coatings. He holds a BA degree from St. Edwards University, Austin, TX.