# Coating compatibility

**Currently available field joint options for advanced pipeline coatings offer engineers and specifers more choices than ever before.**

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The selection of pipeline coatings over the years has followed development of corrosion protection materials and application technologies.

From hot bituminous coatings "granny-ragged" over the ditch in the early years, to epoxy and polymer based materials applied in highly sophisticated coating plants that operate today, the technology has come a long way. Relative to current technology, depending on where in the world the pipeline is engineered, specified and constructed, the pipeline coating system is chosen to meet the preferences of the specifying engineer and the demands of the project.

High performance pipeline coatings, such as Fusion Bonded Epoxy (FBE), dual-layer FBE, composite coatings, 3-layer polyethylene (3LPE) and, more recently, multi-layer polypropylene (MLPP), have been developed to meet the demanding requirements of new pipelines being constructed around the world.

Pipeline coatings selection has evolved along geographical lines. In North America, FBE and 2-layer polyethylene continue to be the dominant coatings, although the market is increasingly accepting multi-layer coatings. In many other parts of the world, multi-layer coatings tend to be favored. These coating decisions are generally based on the owner-company or engineering company preferences, but also on the pipeline construction conditions and operating conditions. For example, in countries with limited transportation infrastructure, rough pipe handling and aggressive backfills are prevalent, and pipe coating damage is a real concern. In these cases, significant delays or problems during pipeline construction could occur, which creates the need for robust, multi-layer coatings.

Once the coated pipe makes it to the right-of-way or laybarge, 39 in. of the 40-in. pipe is done, but the last bit is just as important. Applying field joint coatings involves a number of unique challenges. Unlike pipeline coatings, which are generally applied under well-controlled factory conditions, field joint coatings are applied under unpredictable field conditions, be it a sand-swept desert, frozen tundra, rainforest or offshore barge. The resulting field joint is expected to provide performance and quality consistent with plant-applied coatings. Complicating this is the fact that the joint protection installation is one of the last items done before burying the pipeline or dropping it off the back of a laybarge.

A plethora of options for field applied joint protection systems exist in the market today and each different supplier touts the benefits of their proprietary systems. How does a design engineer cut through the claims and make an educated decision? The key is that the joint protection system must be compatible with and provide, at minimum, the same level of protection as the mainline coating.

## Compatibility

Field applied coatings for the weld area have advanced to meet the performance of today's mainline coating options, and give pipeline owners confidence in having a continuous corrosion protection layer. Caution, however, must be exercised since a high-performance joint protection system that is engineered for one type of pipeline coating may not be compatible with another type of coating. So, a basic principle evolves: the joint protection system must be compatible with, and at least equal in protection to, the mainline coating.

Over the years, joint coating developments have mirrored advancements in mainline coating technologies. In review of current field joint technologies, three leading systems are summarized below, along with an overview of field joint systems for polypropylene-coated pipelines. A common thread of these systems is that they are field applied by a contractor, and meeting the design performance is dependent on proper installation.

## Fusion bonded epoxy

FBE used for field joints is very similar to plant applied FBE, and closely replicates an FBE mainline coating. Some specifiers favor this type of joint protection, simply because of compatibility and performance relative to FBE mainline coatings.

The system is field installed, since it must be applied under similar conditions as plant applied FBE. This means that the surface preparation must be to near-white metal, so the steel must be pre-heated to ~240°C (465°F), and the FBE powder must be environmentally controlled prior to application with a spray nozzle. These parameters can be difficult to attain under highly variable field conditions.

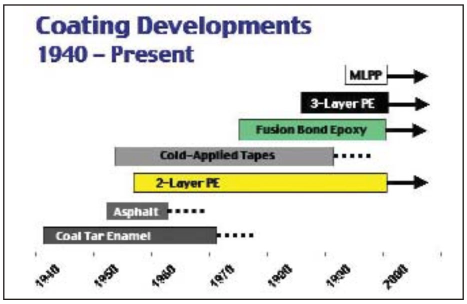


**Figure 1.** Pipeline coatings have developed from simple bituminous materials to high performance polymers.

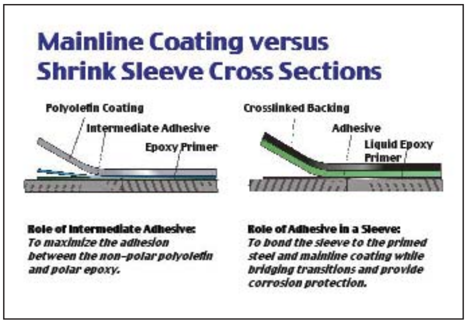


**Figure 2.** Joint coatings development stayed in step with pipeline coatings development.

## Liquid epoxy systems

Two-component liquid epoxies for field joint protection have gained favor with specifiers who previously preferred FBE. Liquid epoxy systems have been formulated to provide performance similar to or better than FBE mainline coatings, and they are generally more field-friendly than field applied FBE.

As with FBE, the steel must be cleaned to near-white metal, but pre-heating is not normally required aside from ensuring that the substrate temperature is above the dew point. In cold temperatures, however, substrate pre-heating is required to cure the epoxy. Typically supplied in either a spray grade or brush grade format, the contractor can choose the method of application that best suits the project.

Figure 3. Heat-shrink sleeve applications are installed using hand-held torch and roller.


Figure 4. Peel test of shrink sleeve is performed over the mainline coating.

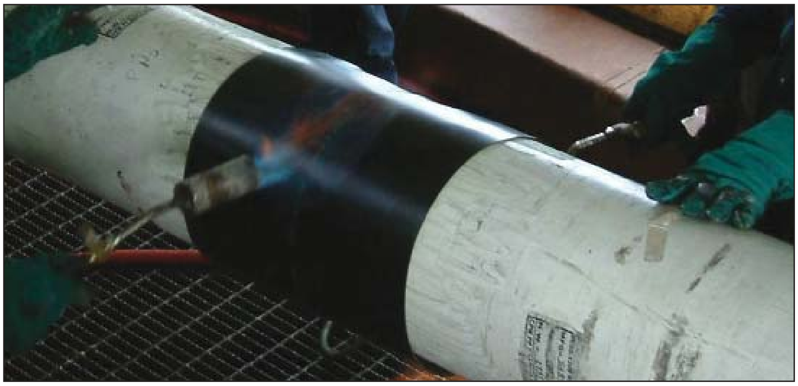

Figure 5. Polypropylene shrink sleeve is applied on an offshore line.

From a compatibility standpoint, liquid epoxy systems are only compatible with FBE and other epoxy-based coatings. As epoxy does not naturally adhere to polyolefin materials, it is not recommended as a joint protection system for multi-layer polyolefin coatings. This incompatibility with the mainline coating may result in potential sources of failure such as loss of adhesion, cracking and moisture ingress, which leads to the formation of corrosion cells.

## Polyethylene sleeves

Heat-shrinkable sleeves consist of a cross-linked and stretched polyolefin backing with a plant-applied adhesive layer. The backing is the carrier for the adhesive and provides mechanical protection to the installed system. The adhesive provides corrosion protection at the steel cutback, and holds the system in place by adhering to and being compatible with the mainline coating. Depending on the coating type, pipe diameter, construction conditions and pipeline operating conditions, the backing type and adhesive type will vary, so consultation with the manufacturer will ensure that the chosen type of shrink sleeve is correct.

The design of the shrink sleeve requires a backing that is resistant to construction and in-service damage, while the adhesive must provide the corrosion protection under pipeline operating conditions. This typically means that the adhesive must be resistant to shear forces imparted by soil stress and lateral pipe movement while the pipeline is operating, sometimes at very high temperatures.

Due to the wide range of adhesive types available for shrink sleeves, they are compatible with several coating types and are favored on many projects, be it large-diameter transmission or small-diameter gathering lines. Minimal training is required to install shrink sleeves and surface preparation can be much more forgiving than with epoxy-based systems.

Another aspect of a 3-layer high-performance joint protection system is an epoxy primer. This is used to provide primary corrosion protection, as is common for 3-layer coatings. When considering compatibility and minimum performance expectations, a pipeline coated with a 3-layer mainline coating should have a 3-layer joint protection system.

## Polypropylene systems

The systems noted above are predominantly used on conventional FBE or polyethylene coated pipelines, which constitutes the bulk of pipeline coatings currently applied. A relative newcomer into the pipe-coating realm is polypropylene, which offers improved mechanical, thermal and chemical resistance over both FBE and polyethylene. Relative to field-joint protection systems, a number of unique options have been introduced. Protecting the field joint of polypropylene-coated pipelines presented new challenges because of increased pipeline operating temperatures and the nature of the coating material.

To meet the need, various companies have developed joint protection systems based on either polyethylene shrink sleeves or polypropylene polymers. The latter generally is a system whereby raw materials such as powdered epoxy, polypropylene adhesive and polypropylene top coating are field applied using flame spray, tape wrap or injection molding technologies.

Recently, however, one manufacturer developed and introduced a polypropylene heat-shrinkable sleeve, which meets the performance levels of polypropylene mainline coatings but offers similar ease of application as traditional polyethylene shrink sleeves. After completion of several successful onshore and offshore projects, this is viewed as a technology breakthrough and is changing the way that many engineers and specifiers are looking at heat-shrink technology. ✣