Best in class protection

Heat-shrinkable sleeves are the most widely used technology in the world today for field girth-weld corrosion protection.

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Operators should make sure that the contractor(s) they select are fully trained in the installation of the product.

Heat-shrinkable sleeves are widely used because they're easy to install, provide excellent protection and are cost-effective. However, some specifiers may believe that the products on the market today are the same as those that were produced 20 years ago.

In fact, "shrink sleeves" have improved dramatically over the years. But what makes these products unique, and why is it that many specifiers rely on them for the high-quality field joint protection?

The first heat-shrinkable sleeves were introduced over 30 years ago when polyethylene pipeline coatings were first introduced and started to replace bituminous or tape coatings in the oil and gas industry. Back then, the processing for polyethylene to make the sleeve backing was new technology and the adhesives used in sleeves were pretty much the same as those used on pipeline coatings.

Since then, the technology behind cross-linking polyethylene to make sleeves has advanced considerably and the adhesives used today are formulated to provide performance under demanding pipeline construction and in-service operating conditions.

Let's go back to what makes them unique. As a matter of fact, the technology is quite interesting since it involves molecular chemistry combined with good old-fashioned pressure sensitive or hot-melt adhesives. Optional epoxy primers are also used to create a complete system.

Polyethylene backing

Heat-shrinkable means just that – you heat them up, and they shrink; or more correctly, they recover in length. A heat-shrinkable sleeve starts out with a thick, extruded polyethylene sheet that is formulated to be cross-linkable, which is the basis for being heat-shrinkable and for resistance to UV and long-term aging.

After extruding the thick sheet, the product is taken to the "beam" where it is passed under a unit that subjects the sheet to electron irradiation. The irradiation process, or "beaming," cross-links the polyethylene, which improves the molecular structure such that the polyethylene will work as part of a heat-shrinkable sleeve and provide the required high level of mechanical protection while in service. Basically, it makes the polyethylene perform more like a tough, heat-resistant, elastic material, than like a plastic material.

After cross-linking, the sheet is stretched by feeding it into a machine that heats the sheet up, stretches it, and cools it down. Because the sheet has been cross-linked, after it is stretched, if it is heated again it wants to recover to its original length.

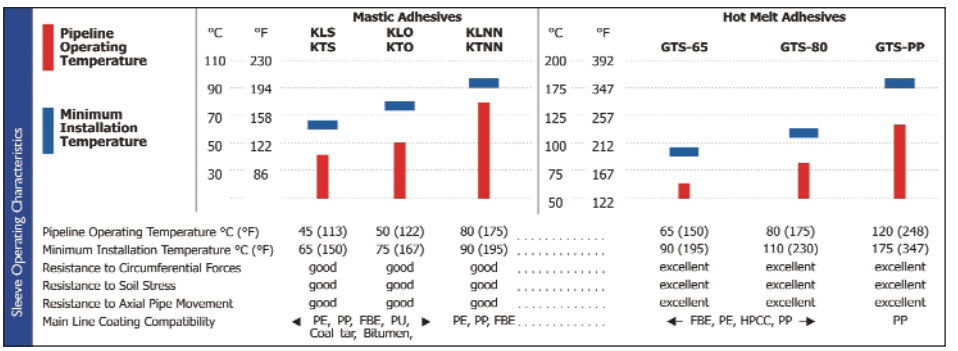
Specialty adhesives

After stretching, an adhesive is applied to the sheet. Various manufacturers use proprietary techniques depending on the type, viscosity and melting temperature of the adhesive. The adhesive is the key to ultimate performance of the installed system, which is why different adhesive types will be specified depending on the pipeline operating conditions.

The adhesive has many functions:

- Adheres the installed sleeve to the cutback and mainline coating
- Resists shear forces imparted by soil pressure after the pipeline is buried
- Provides long-term corrosion protection to the steel.

The choice of which adhesive to use is based on the pipeline design and operating conditions. As an example, for small-diameter flow lines operating at ambient temperatures, a soft mastic-based adhesive may be chosen. Large-diameter pipelines operating above 80°C would require a very hard, semi-



Before making a choice, pipeline operators should consult with a manufacturer or consultant who is knowledgeable about the products on the market.

crystalline (hot-melt) adhesive. The adhesive needs to be chosen based on its corrosion-protection properties, adhesion strength, resistance to shear forces imparted by lateral pipe movement while operating, and the effects of vertical soil pressure.

Now you have a sheet that is stretched and coated with a layer of adhesive applied. The next step is to cut the coated sheet into individual sleeves suitable for application on a pipeline, or packaged as bulk rolls that can be cut down to size at a local warehouse, or on site. As mentioned before, the sheet is stretched and wants to recover when heated, but if the sleeve is wrapped around the girth-weld area of a pipeline and shrunk down, what holds it on? Basically, a sealing strip or "closure" is used and applied before shrinking so that the sleeve will stay in place during and after recovery (Figure 1).

A final component, which is optional depending on the pipeline coating and performance requirements, is an epoxy primer. Epoxy primers for heat-shrinkable sleeves work in the same manner as an FBE primer does when it is specified on 3-layer polyethylene pipeline coatings. Depending on the specification, the primer is typically between 150µm and 300µm (6-12 mils) thick. Figure 2 shows a cross-section of a 3-layer sleeve system versus a 3-layer coating.

Backings and adhesives

The choice of which types of backings and adhesives are used in sleeves that are engineered for specific applications tends to rest with the manufacturer, in consultation with the specifier. Recommendations are made based on pipeline environmental and geographical construction conditions, along with consideration of operating and in-service performance requirements.

Quite often, a specifier or engineer would consult with manufacturer representatives to determine what grade of heat-shrinkable sleeve would be recommended to be compatible with the specific pipeline coating, and meet certain minimum performance requirements. The properties of the specified sleeve type would then be written into the specification, and a number of manufacturers would be invited to submit their products.

Within NACE[1], there is a program underway to write a number of Standard Recommended Practices concerning various corrosion protection technologies for pipelines. The standard for Heat-Shrinkable Sleeves[2] has just been published, and includes requirements for both mastic adhesive-based and hot-melt adhesive-based sleeves. This standard will help guide specifiers and engineers toward the basic requirements for inclusion in their specifications. It also provides details for qualification, installation and inspection guidelines.

After understanding the technology, what are the advantages of sleeves that lead many specifiers to favor them? Properly specified and applied heat-shrinkable sleeves will provide corrosion and mechanical protection that is equal or superior to the mainline coating, be it a tape, epoxy or multi-layer polyolefin.

The technology has also made sleeves easy to install. With minimal training, a contractor's crew can efficiently and effectively install sleeves that will perform long term. On major projects, specifiers may require product pre-qualification, crew training, certification and ongoing inspection, with the end result being an excellent field joint protection system, and all parties very satisfied.

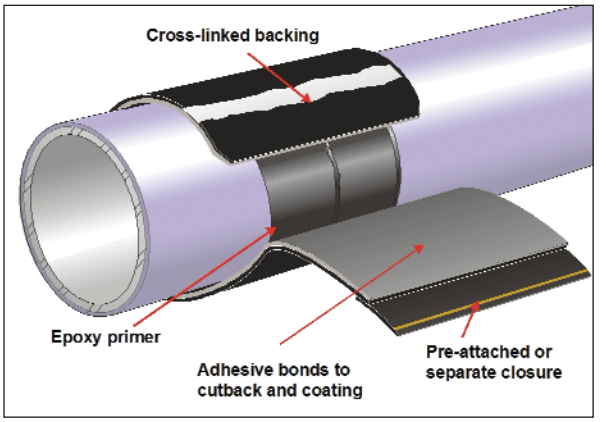


Figure 1. 3-layer heat-shrinkable sleeve.

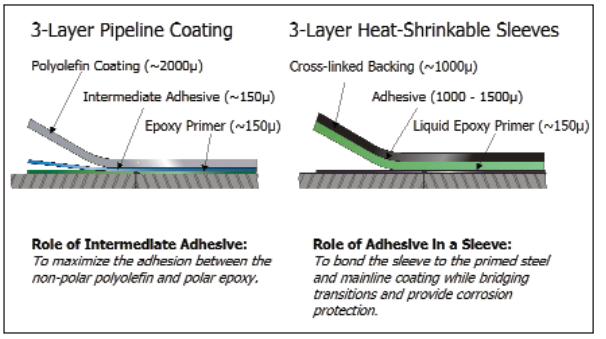


Figure 2. 3-layer coating and 3-layer sleeve compatibility.

Best practices

For any size of project, best practices need to be followed when specifying the product, during installation and for inspection. These are:

Product selection. Consult with the sleeve manufacturer or a consultant who is knowledgeable about available grades of products on the market.

Contractor qualification. Ensure that the contractor is fully trained in the installation of the product. Credible manufacturers will have the resources to send field service people to a job site to train the crew, and possibly train a foreman or senior crew member to train the line workers.

Ongoing inspection. Confirmation that the proper level of surface preparation is being done plus a simple, quick peel test will tell if the product has been installed properly. The peel test over the cutback and coating overlap can be done on the previous day's production, just before starting up for the day, and will serve as a reminder of how to properly install the product.

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Conclusions

As with any field-installed construction product, field-joint protection systems rely on proper selection and installation quality to attain optimum performance. For heat-shrinkable sleeves, the process can be simple, and result in a high-quality system when the manufacturer recommendations are followed. Ensure that a proven system is specified, manufacturer installation recommendations are followed, and ongoing inspection is done to ensure quality of installation. ✣

References

1. Nace International, Houston, Texas.

2. Nace Standard RP 0303-2003