In conventional transmission pipeline construction, pipe lengths are first coated in a plant and then shipped to the onshore pipeline site (Fig. 1, p. 44) or, for offshore installation, to either the dockside for loading onto a lay-barge or to a spoolbase for assembly into a pipeline for reel barge laying. Both ends of the pipe are left uncoated to a length of 150 mm (5.9 inches) to allow the individual pipes to be welded together onsite to form the pipeline. These uncoated areas — field joints — need to be protected from corrosion, heat loss and mechanical damage, and there is a range of different technologies used to do it. To ensure that the field joint is not a weak point in the protection of the pipeline, the coating system selected must also be compatible with, and match as closely as possible, the properties of the factory-applied mainline pipe coating.

Pipeline laying is a continuous process and any field joint system must be able to be applied quickly so as not to slow down progress. In addition to the various coating solutions available, tailored application equipment is commonly used to provide high speed and repeatable application of the field joint materials. The automated equipment is designed to reduce material waste and therefore, limit environmental damage. Automated application methods minimize risk to the health and safety of the operator by both reducing exposure to harmful materials and mitigating the fatigue that can lead to errors or accidents. This article takes a brief look at some of the different field joint coating technologies available.

Fused Field Joint Coating or Heat-Assisted Tape Wrap
Heat-assisted helically wrapped tape, or fused field joint coating, can provide a totally compatible field joint coating system for three-layer polyolefin coated pipelines. In the field, the system uses existing equipment for abrasive blasting/surface preparation, and for the application of a fusion bonded epoxy (FBE) and chemically modified polypropylene (CMPP).
machines guarantees that each field joint will be coated consistently, in accordance with the requirements of the specification.

FBE-coated field joints offer superior adhesion to the pipe substrate, greater stability and resilience against higher pipeline operating temperatures and chemical contaminants in sub-soil or sub-sea environments. Any holidays in the field-applied coating can be easily detected and repaired. There is no shielding of the cathodic protection (CP) system, good resistance to cathodic disbondment and total compatibility with the factory-applied FBE coating.

FBE can be applied as either a single layer or dual layer, with the dual layer offering greater mechanical abrasion resistance. In single-layer systems, the powder is applied to the pipe by an “on-pipe” rotating machine, in a fixed number of passes, to a thickness of up to 800 microns (.03 inches) and a bandwidth of up to 750 mm (29.5 inches).

For dual-layer systems, the second layer is applied during the gel time of the first layer of FBE with the same on-pipe rotating machine but via a different feed. A permanent chemical bond is established between the two layers of FBE, offering the best possible field joint characteristics. Typical thickness of the dual-layer system is up to 1,000 microns (.04 inches) and the bandwidths are the same as those for a single-layer system.

 Particularly for offshore and spoolbase applications (Fig. 3), closed-cycle abra-

**Fig. 1: Onshore field joint coating**

or polyethylene (CMPE) dual-powder base layers. Immediately following is the machine-applied polypropylene (PP) or polyethylene (PE) tape, involving a series of heating processes. The use of heat ensures that there is total integration between factory and field joint coatings, and thus comparable performance. In other words, there is no “weak link.”

The fused field joint results from complete fusion between both the individual layers of helically wrapped tape to one another and to the factory coating overlap so that there is no discernible interface between the factory and field joint coatings. This type of system has an extensive track record of use on on-land and offshore pipelines, as well as in spoolbases.

**Fusion Bonded Epoxy**

Fusion bonded epoxy (FBE) is a one-part, heat-curing (thermosetting) powder. Its use as a mainline pipe coating has been established for many years, and the application of a comparable FBE material at the field joint area ensures compatible anticorrosion protection for the entire pipeline length. Using automatic...
sive blasting and a vacuum recovery system on the FBE application machines are used to ensure a clean and healthy environment in the vicinity of the coating stations.

Multi-Component Liquid
As a result of the need to produce repeatable, high-quality and reliable field joint coating systems, multi-component liquid (MCL) coatings have become the coating system of choice for multilayer and fusion bonded epoxy-coated pipelines in the international onshore pipeline construction industry (Fig. 2, p. 42). An MCL field joint coating system offers compatibility with the factory-applied coating, excellent adhesive bond to the factory coating overlap areas and consistent onsite application. The system offers a short application cycle time (high daily production rates) with fast cure times.

Another advantage of the liquid system is that the CP system will not be compromised, ensuring a continuous flow of current to any defect. Many other field joint coating systems “shield” the CP system, and as a result, defects may go undetected, leading to serious failure in the anticorrosion coating system.

There are many different urethane- and epoxy-based MCL coatings that offer particular properties appropriate to the pipeline parameters. Material selection is based on a number of factors, including parent coating type, climatic conditions, operating temperature and pipeline handling conditions during construction.

In order to make the most of the technical benefits of the MCL coatings that are available in the market, there are specially designed and developed automatic coating application machines. Not only does the equipment meter the individual liquid components to the spray head in the correct ratio, but the on-pipe rotating spray ring applies the material in a consistently even and repeatable manner to the specified thickness and band width. Liquid coating consumption is reduced to the absolute minimum since overspray and waste is virtually eliminated, with obvious HSE benefits.

The application thickness is directly related to the number of rotations of the machine; therefore, once preproduction testing has proven the procedure, the machine can be preprogrammed for the project. It can then be operated by supervised local personnel, which makes the use of MCL field joint coating systems commercially attractive. The equipment can also be insulated and trace-heated to assist with application in low ambient temperature conditions.

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Pipeline Field Joints

Fig. 4: Injection molded polypropylene

three-layer polypropylene (3LPP) anticorrosion coated pipelines as well as a versatile solution for multilayer polypropylene (IMPP) and syntactic polyurethane (SPU) insulated pipelines, specially developed and refined injection molded polyurethane (IMPU) processes are available (Fig. 4).

These field joint coating systems provide anticorrosion and where necessary, thermal insulation similar to the mainline factory coating, while allowing routine application within the rapid production cycle times demanded by today’s pipeline construction industry. Similar performance to that of the parent coating can consistently be achieved using state-of-the-art solid or SPU injection molded coatings. These combine a low overall heat transfer coefficient (OHTC) with the ability to perform at elevated operating temperatures, while also providing excellent stand-alone anticorrosion properties.

Portable containerized IMPU coating modules which house purpose-built dispensing equipment can easily be transported to the job site by conventional shipping methods, facilitating rapid setup and deployment alongside the pipeline welded joints at site.

IMPU field joint systems are now available offering total compatibility with the following factory-applied coatings:

- Standard thin-film, typically 1.5- to 4.5-mm thickness (.06- to .18-inch), three-layer polypropylene or polyethylene external anticorrosion coating systems.
- Multilayer fusion bonded epoxy powder (FBE)/solid polyurethane elastomer systems.
- Solid or syntactic polyurethane systems for pipelines where a very low OHTC (low “K” factor) is necessary. Multilayer composite coatings incorporating an FBE base coat, copolymer layer, a thick foamed polypropylene, plus a solid polypropylene sleeve (topcoat).

In addition to offshore laybarge production, the IMPU system is suited to onshore spoolbase operations. The IMPU field joint coating offers these benefits:

- High compatibility with thin-film and
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  • Fast application and cure times.

Injection Molded Polypropylene
Newer, deeper oil and gas fields produce hydrocarbons at higher temperatures and thermal insulation is installed to hydrocarbon transmission pipes in order to maintain the required flow rates, optimize productivity and reduce processing costs. This has led to the development of new and innovative thermal insulation systems, which in addition to improved thermal efficiencies, can lead to greater energy savings and reduced environmental impact.

An injection molded polypropylene coating system (IMPP) has been developed based on proven technology, providing excellent thermal insulation values and offering the same overall U-value as the factory coating. Following the welding of thermally insulated pipes at the project location, IMPP thermal insulation is then applied to the welded joint area in order to maintain the integrity and thermal properties of the pipe system. The IMPP system has been designed to be fully compatible with the
Pipeline Field Joints

Pipe line coating and the injection molding process can be applied both in spoolbase and offshore environments, both in S-lay and J-lay configurations.

Polyurethane Foam Field Joint Infill

Infilling the field joint void on concrete weight-coated pipe has traditionally been performed by pouring hot marine mastic into a mold around the joint. The mold is usually left in place when overboarded by the laybarge. The mastic needs to be heated to melt it prior to pouring — a process that consumes a large amount of energy. Furthermore, the mastic is poured hot, at approximately 200 °C (392 °F), and is therefore hazardous to handle.

In response to this, an alternative PU-based infill system is available, offering improved HSE security as well as the following beneficial features:

- Rapid cycle times.
- Reusable or expendable/disposable (metallic or plastic) mold systems.
- Compact, reliable application equipment.
- Compatibility with all conventional anticorrosion field joint coating systems.
- Freedom from any ozone depleting blowing agents.
- Air/water-purged equipment requiring no solvents.
- Range of foam densities.

The custom-designed high-density polyurethane foam (HDPF) has a typical unsaturated molded density between 90 to 160 kg. per cubic meter (5.6 to 10 lbs. per cubic feet). Formulated specifically for pipeline field joint applications, the HDPF system develops a rigid, open-cell structure. Upon immersion, the open cells absorb water, thereby increasing in overall density to approximately 1,025 kg. per cubic meter (64 lbs. per cubic feet), similar to seawater itself.

The low-viscosity product formulation of the HDPF system allows “free-flow” of chemicals to assure quick and complete filling of the mold within the cycle times demanded by today’s laybarge operators.

The infilling system can incorporate reusable or permanent molds. Reusable molding is used in conjunction with a cardboard fiber liner to create a superior, high-strength composite skin. This system will allow the demolded field joint to pass over the
laybarge rollers and stinger without damage due to the fiber liner becoming embedded in the surface of the foam, creating a resilient outer skin to the joint.

Permanent plastic or metal molds can be used as required by environmental and operational demands. The application equipment is neat and compact, consisting of little more than two holding tanks, small pumping equipment, dispensing hoses and nozzles.

**Polypropylene Flame Spray**

In order to provide a totally compatible field joint coating system for 3LPP- or 3LPE-coated pipelines, PP or PE powder can be applied by the flame-spray technique. Powder is carried in a stream of air and is fed into the center of an annular combustion flame where it is heated. A second outer annular nozzle feeds a stream of air around the powder stream that accelerates the spray particles toward the substrate and prevents burning of the powder.

The system uses existing equipment for abrasive blasting/surface preparation and application of fusion bonded epoxy (FBE) plus chemically modified polypropylene or polyethylene dual-powder base layers. The overall thickness required is then achieved by applying powder via a flame-spray gun.

The flame-spray field joint coating system provides a full three-layer system, which is highly adjustable to field conditions where coating thicknesses of up to 5 mm (.19 inches) are required. While the flame-spray system can also provide a useful service for tie-ins or as a back up for a polypropylene or polyethylene fused field joint system, it is a thoroughbred field joint coating system by itself.

The PP powder system has an extensive track record of use on overland and offshore pipelines, as well as in spoolbases.

**Conclusion**

The common, high-performance field joint coating systems covered here are by no means an exhaustive list. There are also simple “tape-wrap” systems, such as PVC and petrolatum, heat-shrink tape systems and non-hardening viscoelastic products.

Whether onshore or offshore in the world of pipeline construction, no two operations are exactly the same. With this in mind, specialist field joint coating contractors design customized solutions that address every aspect of the field joint coating requirements for each specific project. **JPCL**
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