A COAT FOR ALL WEATHERS

Damien Grimopont, EUPEC PIPECOATINGS, France, describes several recent pipeline coating projects and the approach taken for a successful job.

French pipe coater EUPEC announced earlier this year that it had been awarded a €5 million contract. Having found an innovative agreement with its works council at the beginning of 2017, the contract marks the success of the performance programme that EUPEC's management had set up with the support of its shareholder, Mutares.

The awarded contract of approximately 25 km of dual FBE and concrete weight coating of 100 mm thickness, represents a key milestone for EUPEC's development strategy, that was initiated by François Martin, President of EUPEC, and Damien Grimopont, Managing Director.

With support from Mutares, EUPEC's management have completely reviewed the company's strategy and its business

Figure 1. 3LPE coated pipes before CWC application.

approach, with regard to innovation, co-construction and partnership, based on five strategic axes:

- Foster business opportunities.
- Maintain the relationships with existing customers.
- Maintain the unique expertise of the company by keeping employees and jobs on its sites.

Figure 2. Induction heating prior to 2LPE coating.

Figure 3. 36 in. 2LPE field joint coating.

- Invest in production tools.
- Pursue the labour innovation policy started in January 2017 by signing a job retention agreement in return for wage concessions, with the support and assistance of public authorities.

"We are looking forward to work on this large-scale project. The signature of this contract confirms the strategy we have defined and represents a successful milestone for the turnaround of EUPEC," stated Damien Grimopont.

"The proposed recovery and business plan for EUPEC received the support of our shareholder, Mutares, whose involvement was strategic in the transformation and construction process of the new EUPEC – especially during the negotiation of the job retention agreement, which made it possible to implement the necessary measures for the turnaround of the company. Together with our employees we want to continue along this path, based on giving priority to our clients' expectations." said François Martin.

A European base

EUPEC serves customers all around the world from its head office in Gravelines and its two plants located in northern France, close to Dunkirk seaport.

A European supplier of coatings for oil, gas and water pipelines for various onshore and offshore applications, EUPEC provides many coating services, as illustrated by the following case studies.

Field joints onshore

Technical skills and the development of the flame spray technology are valuable assets to master the process of flame spray.

- The SWSOS project in Scotland was a 36 in. × 14.27 mm and 19.1 mm WT pipe. 50 km of the pipe had 2LPP/2LPE flame spray joints with a high rate of 58 joints/d.
- Directional drilling in the Val de Saône project involved a 48 in. pipe with 2LPP flame spray joints.

Field joints offshore

EUPEC provides flexibility and adaptability to customers' requirements, combined with technical skills and experience in many projects that bring value to the customer.

The offshore field joints may be executed on barges or on spool base with different systems (anti-corrosion and mechanical protection, or thermal insulation with PU foam, Solid PU or GSPU).

Flame spray and IMPU are the common technologies used.

On each project, the design studies are mandatory to adapt the field joint coating process to the customer installation process (S-lay and J-lay on barges).

On IMPU, some local plants can be installed to satisfy the project requirements (e.g. quad plant installed on a spool base in Nigeria).

For both activities, the mould design phase is also a key point that will ensure a proper flow of product during the injection but also the correct geometry of the joint after curing. The second key point is the manufacturing engineering to develop the process, as different types of joints can be required with multiple quantities per day.

Involving local partner skills is frequent, as local content requirements are becoming more and more common.

Before executing field joints, it is important to be able to coat the raw pipes or bends in order to cover the full scope of the pipeline installation work.

Figure 4. Horizontal drilling.

Figure 5. Thermal insulation on spool base.

Figure 6. Reel to reel 3LPP coating line.

Line pipe

Line pipe is the original activity of EUPEC, developed more than 50 years ago.

Many types of coatings are available, as 3LPP, 3LPE, FBE, Dual FBE, Dual FBE or single FBE + ARO for anti-corrosion external coating. These are applied in the Grande-Synthe plant, which has rail, road and sea port connections.

5LPP or PP foam for thermal insulation may also be applied in the Grande-Synthe plant. Internal coating is also an asset available in a specific line on the same location.

Concrete weight coating for negative buoyancy – generally mandatory in any offshore pipeline – is combined with the anti-corrosion system and applied in the St Pol's plant, close to the Grande-Synthe site and interconnected by road and sea with the port.

Many major projects have been coated in these plants, for example 3LPE+CWC for a Kashagan project and currently FBE/Dual FBE+CWC for a major project in the Middle East.

Reel to reel

EUPEC has also developed a unique process to coat umbilical pipe in a reel to reel manner.

The process is capable to apply 3.2 mm of PP by extrusion for reel length between 100 - 3760 m for pipe diameter from 14.7 - 42.6 mm.

EUPEC has participated in several large projects, including West Hub and Ichthys.

Custom coatings

Having the capacity within Europe, or locally in the field (if required), to coat bends and fittings is a valuable ability offered to any customer.

Many types of coatings are applied, as Liquid epoxy, Protegol, 2LPP, 2LPE, FBE, Dual FBE and TSA in any size or weight of parts.

Thermal insulation of these custom parts is also achieved with IMPU solid or foam, GSPU and IMPP.

Inevitably, the technical capacity is combined with packaging capacity to ensure door to door protection to the coated parts.

In 2018, EUPEC will have coated more than 1000 bends.

Research and development

Working on materials and processes, continuous technology improvement has always been in the DNA of EUPEC.

Technical skills and two internal laboratories, combined with a network of partners, are effective supports to bring value to the market.

Flame spraying in Scotland

Yuri Mozetic and Paolo Defina, Sicim S.p.A., Italy, provide an overview of the recent implementation of a polyolefin flame spray applied system in a cross-country pipeline.

The use of flame spray coating systems was traditionally limited, in oil and gas projects, to high-demanding specific applications with relatively limited work scopes accommodating low productivities – such as horizontal directional drilling (HDD) and trenchless crossings. The selection of a flame-sprayed system as the primary field joint coating method for the mainline was a unique request to Sicim S.p.A that provided a major challenge for the delivery of the Cluden to Brighouse Pipeline project in the UK.

The project was awarded by Gas Networks Ireland (GNI), previously known as Bord Gáis, to Sicim-Roadbridge Ltd. The company was established in 2001 in Ireland by Sicim S.p.A. (Italy) and Roadbridge Ltd (Ireland) in order to pursue projects primarily in Ireland and in the British Isles in general.

Sicim-Roadbridge Ltd has, since the time of its establishment, successfully executed various projects. It has a record accomplishment of installing over 700 km of large bore gas pipelines in Ireland and the UK.

In particular, the Cluden to Brighouse Pipeline was granted the status of Project of Common Interest by the European Commission in October 2013 and has been co-financed by the European Union under the Connecting Europe Facility (CEF) programme.

The work consisted of the construction of a 50 km, 36 in. diameter gas pipeline in the southwest of Scotland. The pipeline route originated at Cluden and ran in a south-westerly direction to terminate at the Brighouse Bay compressor station.

The pipeline was routed through and crossed: farmland; 32 roads (including a primary trunk road); three main rivers; as well as several locations where the pipeline ran close to and/or parallel to: existing pipelines; other services/utilities; and boundaries such as ditches, fences, mounds, structures, etc. which significantly impacted on the construction activities.

The field construction activities started in February 2017 and were completed in September 2018. At the time of writing this article, commissioning product gas of the system was planned to be finalised in October 2018.

For the field joint coating works, Sicim hired the specialist subcontractor EUPEC PIPECOATINGS France, one of the leading companies in the application of polyolefin-based coating systems.

Flame spray applied system

The selected externally field applied coating system was a two layer system – a high performance fusion bonded epoxy (FBE) base with a flame-sprayed outer coating of solid high density polyolefin (polyethylene/polypropylene). This system combines the chemical resistance and corrosion protection of the epoxy with the mechanical protection and moisture barrier properties of the polyolefin. The system had to be implemented in compliance with the requirements of the ISO 21809-3, as well as client specifications.

The mainline production started on May 2017 with a challenging schedule planned of 40 joints/d, which was necessary to complete the job in September 2017.

The responsibility for the execution of the activities was split between Sicim and EUPEC. Sicim executed the joint preparation, sand blasting, pre-heating and the application of the epoxy powder (FBE), while EUPEC executed the flame spray application with the flame-spray gun system. The required polyolefin thickness was reached by multiple passes.

The application of the flame spray was carried out manually on a wide area (36 in. field joint). Furthermore, the thickness to be reached was very high compared to the common multi-layer anti-corrosion systems for field joint coating. As a consequence, the challenge in adopting this coating method as field joint coating on a cross-country pipeline was double in terms of quality, due to both the reliability of the process and the repeatability of the applications.

The organisation of the job

With regards to productivity, the main challenge was to organise and co-ordinate the team of the mainline to meet a production of 40 joints/d. For this purpose, manufacturing engineering analysis and several lean manufacturing concepts, such as Takt time, were applied to optimise the process. A Takt time of 15 min./joint was

Figure 1. Overview map of the Cluden to Brighouse pipeline.

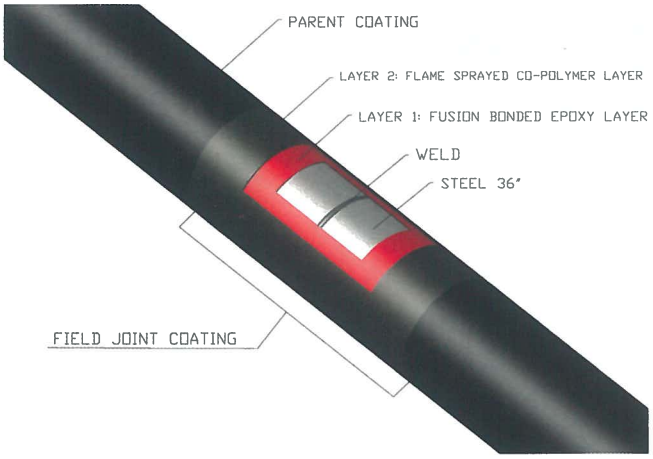

Figure 2. Configuration of the field joint coating.

Figure 3. Manual application of the flame spray.

determined using the required production rate within a working time of 10 hrs/d.

It was decided to arrange the production line with a theoretical production rate of 60 joints/d, in order to ensure achievement of the required average daily production of 40 joints/d and to accommodate the impact of some relevant factors which were significantly limiting the construction activities – such as climatic conditions, equipment breakdowns and large numbers of crossings. Therefore, the Takt time to be considered was 10 min./joint.

The number of work stations was determined by analysing the cycle time for working operation (e.g. heating, blasting), summing up all the cycle times and dividing the total cycle time by the Takt time. The working time for each working operation was also assessed and adjusted to optimise the production rate. Lastly, the working stations were resourced to meet the required production rate. Figure 4 illustrates the final configuration of the production line.

It has to be highlighted that after some weeks of ramping-up and fine tuning, a stable daily production rate of over 40 joints was achieved, with a peak of 57 joints in a single day.

Started in May 2017, flame spray coating activity on mainline front was completed in September 2017. Coating of tie-ins continued through 2018 with a limited number of resources.

Quality assurance and quality control

The three main factors that determined the final quality of the topcoat application, in terms of reliability of process and repeatability of application, were the following:

- The flame spraying process was heavily dependent on workmanship.
- The high thickness of the coating layer to be applied by flame spray.
- The process parameters were highly influenced by environmental conditions.

The flame spray application is highly affected by the manual operations. Consequently, the condition of the individual particles applied on the substrate can significantly vary across time. It is virtually impossible to ensure that all particles have the exact same size and achieve the same temperature and velocity when applied. This intrinsic characteristic of the sprayed coatings causes some porosity that cannot be eliminated.

The powder adheres to the substrate, provided that the substrate has a wet and glossy surface. The heat to fully melt the powder comes from the substrate and from the flame. While applying the first passes, the heat in the underlying steel (resulting from the induction pre-heating for the FBE application) makes a very significant contribution to the fusion of the powder. As the coating thickness builds, the applied coating creates an increasingly insulating layer that reduces the rate at which the heat from the substrate contributes to the melting of the newly applied layers. At this stage, the flame has to be used to supply additional heat during the application as necessary. Therefore, controlling the external heating using the flame becomes increasingly important as the coating thickness increases.

In order to apply the coating in a homogenous and quick succession of thin layers, the main objective was to balance the

heat input from the temperature of the substrates and the one from the flame. During the application process, it was required to alternate between heating and cooling. Heating was required to obtain melting and interlocking of the polyolefin particles; intermediate cooling was also necessary to avoid sagging of the molten polyolefin.

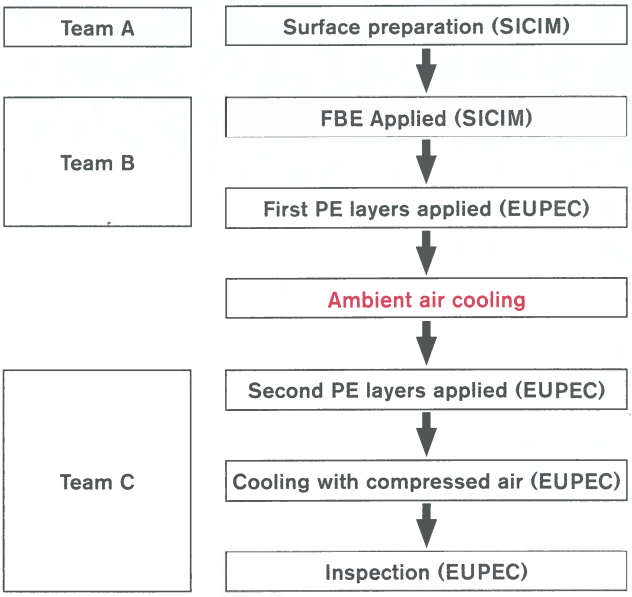

Figure 4. Mainline configuration.

Figure 5. General view of the mainline production team.

Figure 6. Flame spray into a closed habitat.

Special attention had to be given to the cooling process of the flame-sprayed layer and to the temperature of the substrate. The risk of delamination increased since a hard surface film can be formed if the polyolefin is allowed to cool down excessively during the coating process. Discontinuity and delamination may occur if this hard surface is not properly reheated and melted before applying the next layer of coating. The entire process is therefore dependent on environmental conditions, ambient temperature and relative humidity. If these parameters are not under control, tensile stress within the particles and a compression stress within the surface of the substrate – which are very difficult to eliminate as the coating is built up – might be generated. Due to the combination of the environmental conditions and the high thickness of coating to be reached, internal tensile stresses may exceed the bond strength or cohesive strength and coating failure may occur. Furthermore, the high humidity level present on the site can lead to entrapment of micro-bubbles and the consequent formation of pinhole defects.

To overcome all of these challenges, Sicim and EUPEC implemented a strong training and quality assurance programme of practical workshops, based primarily on the outcome of the analysis of operational feedback.

Health, safety and environmental aspects

From a health and safety point of view, several important challenges needed to be addressed. Hot surfaces, noise, particle inhalation and the use of high-voltage equipment constituted the main issues. To address all the hazards' control measures, the use of specific personal protective equipment, electrical maintenance, worker awareness, training, preparation of the working area, workplace signalling and maintaining a regular monitoring regime, became paramount. Another important aspect to be considered was all the hazards related to the logistics and handling of the required consumables for the flame spray process, especially gas bottles. The selection of specific lifting elements and the development of a thorough operational procedure became the key to implement a safe and effective gas management system. Furthermore, since the selection of a flame-sprayed system as the primary field joint coating method implies the use and operation of air compressors, generators and other equipment along the right of way, a robust maintenance programme was developed for the required plant and equipment.

Lastly, environmental conditions in Scotland were extremely challenging for the flame spray application.

Complying with the requirements for pollution prevention and control of the national environmental regulations, resulted in the implementation of a stringent environmental plan – especially important in terms of waste management and water pollution prevention. To this effect, all the activities related to the mainline coating were performed in closed habitats. Moreover, waste segregation was performed to collect all grit, epoxy, polyethylene and polypropylene leftovers, and any contaminated water was pumped into portable containers and transported for safe disposal.

Flame spray coating on cross-country pipelines, outside of a controlled environment plant, can be successfully implemented providing that a robust plan to identify and analyse risks and develop responses is managed, such as how Sicim and EUPEC undertook the Cluden to Brighouse Pipeline project.