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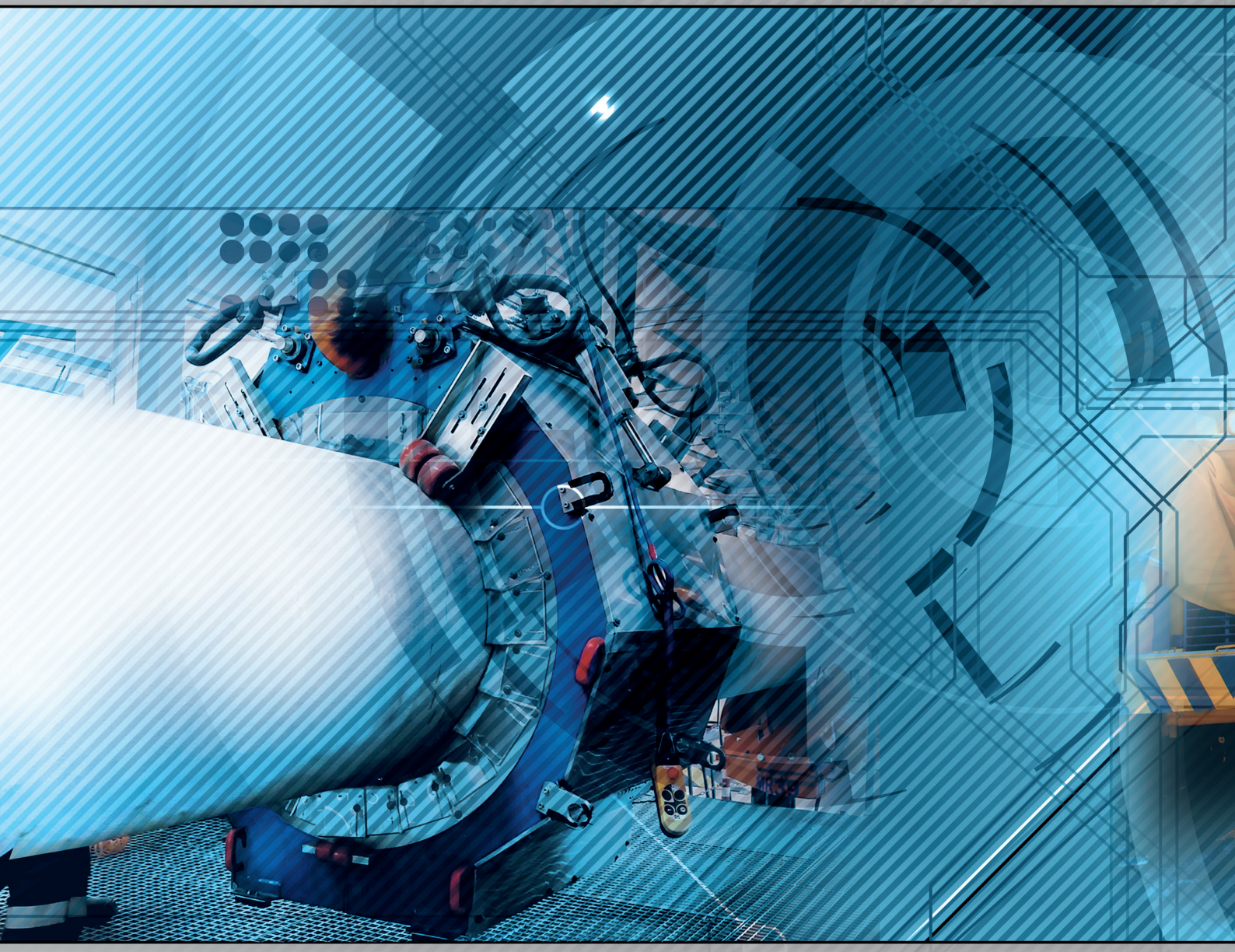

Shawn Doyle and Jarrod Shugg, Shawcor Company Canusa-CPS, Canada, discuss the first intelligent technology developed to control the installation of heat shrinkable sleeves and outline the associated benefits.

FJC technology

Heat shrinkable sleeve technologies are the dominant field joint coating (FJC) selection in providing anti-corrosion and mechanical protection for oil and gas pipelines globally. From their early beginnings as 2-layer polyethylene-backed, asphalt-coated, fit-for-purpose systems, today's heat shrinkable sleeves offer few similarities. Through the focused development of newer, high performance hot-melt adhesives and engineered co-polymer outer layer backings, field-applied heat shrinkable sleeve technologies have broken down the boundaries of old to offer equivalent and, in some cases, enhanced coating protection compared to their factory-applied mainline coating counterparts. This comes as good news, since pipelines today are being constructed in more remote areas, in harsher operating environments, at greater depths and with higher fluid temperatures, all under increased regulatory and public scrutiny. Today's pipelines require seamless coating solutions along their entire length, with no compromise at the field joints. Factory grade heat shrinkable sleeve technologies are available for immediate use, and are up to the challenge.

As coating materials have improved, focus has more recently shifted to exert enhanced control over the coating process. Initially, this has come in the form of pre-project testing, to qualify the proposed coating materials and installation process well in advance of pipeline construction and coating activities. More attention is now being paid to the planning and preparation of project-specific coating application procedures, inspection and test plans, quality control programmes, comprehensive training programmes for coating applicators and pre-construction coating trials to confirm compliance to project specifications and demonstration of readiness to commence operations.

Combined implementation of these items has helped to create optimal conditions for quality and repeatability within the FJC process. However, within a demanding environment that necessitates the pursuit of continuous improvement, efforts to advance FJC materials and processes have not stopped there. In order to mitigate the potential risks involved in manually executed processes, further work has gone into the development of higher-level application solutions via smart automation.

Bringing automation to the field

IntelliCOAT™ was first introduced into the FJC market in early 2011, as the world's first fully automated system to control the application of heat-shrinkable sleeves. The field-friendly system provides a step-change enhancement in the quality, consistency and productivity of field-applied coatings by means of automation. Coupled with available 3-layer polyolefin heat shrinkable sleeve technologies offering the same level of protection as their factory coating counterparts, the system enables the application of a 'factory-grade' joint coating solution in a simple-to-operate format that is easily adaptable for an onshore pipeline right-of-way, spoolbase coating line or offshore construction pipelay vessel.

Figure 1. IntelliCOAT in use on large diameter pipes.

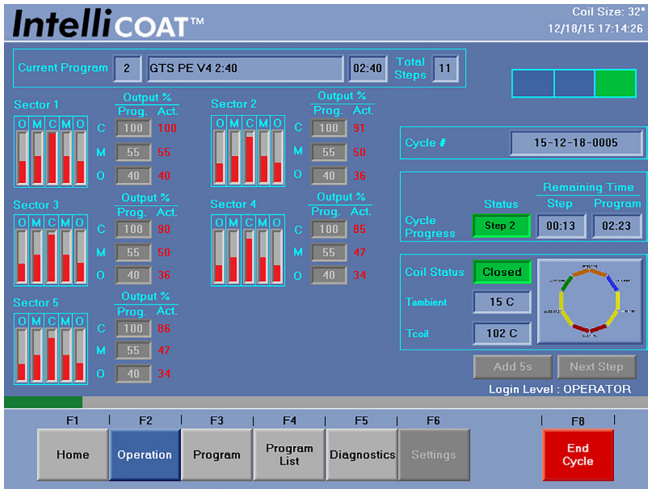

Figure 2. IntelliCOAT control screen.

Application process

Once the heating coil is lowered onto a pre-positioned heat shrinkable sleeve, best-practice application techniques are automated to fully-conform the sleeve to the joint surface while eliminating air entrapment and activating the adhesive onto the joint surface and factory coating overlaps. The closed-loop control system provides precise control of heat, intensity and time at each stage in the application process to vary energy delivery both across the width and around the circumference of the coil, thus, ensuring a consistent and high-quality application, each and every cycle. One button press is all that's required of the operator.

Because the system applies heat to the full surface area of the field joint during coating installation, application times are typically faster compared to manual methods and are independent of pipe diameter. Based on project requirements, coating thickness of up to 8 mm can be applied using IntelliCOAT. This proven technology is currently being employed on some of the largest and most complex global onshore and offshore projects under construction.

Key benefits

By design, IntelliCOAT automates best practice installation techniques to produce high quality FJC applications that are fully repeatable from joint to joint. Installation programmes are developed in advance of project deployment to meet specific project needs and can be qualified through comprehensive test programmes well in advance of pipeline construction activities. All installation parameters are tightly controlled and replicated throughout the duration of the project, just as they were during the qualification phase.

As a further enhancement to quality, Shawcor's technology can be set to retain a permanent digital record of installation data for every field joint, providing full digital traceability of the coating process. The coating conditions, system parameters, installation temperatures and quality assurance data can be tracked in real time to create a digital fingerprint of each

Figure 3. IntelliCOAT system used for onshore pipeline coating.

Figure 4. IntelliCOAT operating in extreme desert conditions.

installation. The information is correlated to the field joint number and geographical position using a GPS transmitter and can be accessed through a customer web interface for the display of coating summary reports or production statistics. Customers can access the smart data from the cloud to monitor coating productivity; to assess coating performance against key quality measures; to maintain permanent quality assurance records; or, to satisfy regulatory requirements – all improvements to prevailing pipeline coating operations.

The application process is precisely controlled by a PLC-based control system with closed-loop feedback. Once the application programme is qualified, operators simply lower the IntelliCOAT coil onto the pre-positioned sleeve, and the system takes care of the rest. That ensures that the same top quality result achieved during the first application of the day is the same as the result achieved at the end of the day. Every FJC installation on the pipeline will be performed in the same manner and will achieve the same result, thus minimising risks and uncertainty for the pipeline construction contractor and owner/operator.

By using the system, a contractor can precisely forecast the daily FJC productivity without reliance on operators to conduct any labour-intensive work steps. The application time per joint is pre-set at the qualification stage so production can proceed on schedule. Typical installation times are fast, and are achievable at the same rate for either a small diameter pipeline or for a large diameter pipeline; IntelliCOAT is able to proceed with installation on 100% of the surface area of the heat shrinkable sleeve at all times. The contractor can further benefit from manpower savings, as FJC installation on large diameter pipelines can be completed without the addition of extra labourers to install the coating over a larger surface area as would typically be required for manual applications.

Daily coating productivity can be maximised by balancing the cycle times for each of the coating application steps in line with the surface preparation and IntelliCOAT cycles. Rates of up to 15 - 20 joints per hour (per system) can be achieved for both onshore and offshore projects.

The system delivers enhanced operator safety through its enclosed heating design and rapid heat up and cool down times. When called into action, the heating coil's instantaneous response delivers intense heat to the centre of the joint to begin the FJC application cycle. At the end of the cycle, the heating coil quickly dissipates heat, making the system safe to lift off of the pipe surface to transport to the next joint or to prepare for the next installation sequence. Only standard personal protective equipment is required. The system also eliminates the need for the open gas torch flames typically associated with conventional FJC application methods, thereby increasing operator safety in the FJC station, especially in tight working quarters where space can be limited. Associated gas transport and handling and specialised storage facilities for bottled gas are also avoided as a result.

IntelliCOAT is designed to have few moving parts and few consumable/wear items to maintain or replace over the course of a project. The system is suitably equipped for operation in the harshest of environments with ambient temperatures ranging from below -30°C to 55°C and can withstand the rugged handling associated with onshore and offshore pipeline construction. Individual components are standardised across the IntelliCOAT family of equipment such that spare parts can be quickly substituted in a plug-and-play fashion in the unlikely event that repairs are required. A robust design ensures maximum uptime and productivity while minimising risk for the construction contractor.

Proven performance in extreme environments

Successful use of IntelliCOAT on onshore construction projects has largely been determined by the contractor's ability to balance the crew set-up, surface preparation and coating activities, and the equipment handling/transport process between successive field joints to achieve productivity goals. Quality has been guaranteed as a result of proper selection of FJC materials and correct use of the system, and applications have been consistent, joint-to-joint.

On a recently completed project in Western Canada, the pipeline construction contractor was able to exceed productivity requirements using IntelliCOAT to apply Canusa-CPS GTS-80 type 3-layer polyethylene-based heat shrinkable sleeves onto 36 in. OD pipe in a winter climate. With an application cycle set at just over 2 mins and the rest of the coating operations balanced to suit, the contractor was able to consistently achieve productivity rates of

Figure 5. Successful use of IntelliCOAT in Western Canada.

Figure 6. Production line operation of IntelliCOAT.

15 - 20 coated field joints per hour (including transport between joints), with all installations executed to the same high standard of quality.

Consistency in the coating rates and output quality allowed the contractor to effectively forecast and plan production activities and to minimise operational costs for FJC. Feedback from the contractor has been resoundingly positive and the pipeline owner has benefitted from the assurance that the FJCs have been applied correctly, consistently and to the highest standard.

In preparation for the offshore South Stream project spanning the shores of the Black Sea, the system was used to install Canusa-CPS's (6 mm thick) GTS-PP type 3-layer polypropylene-based system onto 32 in. OD pipe in a production line set-up. In this configuration, IntelliCOAT was able to deliver a new automated coating solution to the market that was previously only possible with expensive and more complicated injection molding equipment. In its first operational campaign, it easily delivered on all productivity targets during the planned 24 hours per day, seven days per week operation. Coating quality for this mega project was executed according to the demanding project specification, and was delivered in a uniform format with a permanent digital record of installation data for all joints coated. Both contractor and pipeline owner were impressed with the technology and expressed their full confidence in the system. IntelliCOAT has been employed on several other onshore and offshore projects for a total of more than 35 000 joints coated to date.

End-to-end coating implementation

It is not uncommon for the global pipeline construction industry to obtain protective coatings, for any particular project, from a variety of different suppliers. The mainline pipe coatings are typically procured from a factory or mill, while the field-applied coatings used on the girth weld joint areas are either selected from a list of approved materials issued by the pipeline owner, or in other cases, nominated by the construction contractor based on their own experience. When pipeline coating selection is allowed to progress through the aforementioned segregated channels, technical questions of compatibility and performance between the mainline and field-applied coatings naturally arise and can create uncertainty.

Today, due to increased scrutiny on asset management and cost for new pipeline projects, as well as a better technical awareness of the available coating options and performance characteristics, pipeline owners are empowered to consider the use of end-to-end pipeline coating systems. End-to-end refers to the implementation of an entire protective coating system designed with consistent material types, functional performance and full compatibility using a combination of both factory and field-applied application processes from a common manufacturer. With this approach, the integrity of the entire protective coating system can be better assured providing the user with enhanced asset protection through added value and risk mitigation strategies. This system solution approach is that of Shawcor, Pipeline Performance Group, where Canusa-CPS field-applied coating products and technologies like that of IntelliCOAT are developed, tested and deployed mutually with Shawcor's mainline coating operations.

Final word

As oil and gas exploration has pushed into more remote locations and deeper waters, additional demands have been placed on the industry to deliver technology-based solutions to address the complexities of today's pipeline construction projects. In the world of pipeline coatings, much work has gone into delivering enhanced anti-corrosion and mechanical performance in the face of extreme environmental conditions and increasing fluid temperatures.

FJCs have evolved to meet these same technical challenges, and field friendly options now readily exist to provide the same level of coating protection as compared to their factory-applied mainline coating counterparts. When coupled with automated technologies, the benefits to quality, data management, consistency, productivity and safety are distinct and real.