PRESS INFORMATION

The flange protection challenge

The integrity of flanged connections is critical to the containment of fluids in a piping system. Loss of containment, whether in chemical lines such as hydrocarbons and gas systems or water distribution lines, will have significant environmental, operational and commercial impact, and could pose a serious safety risk.

Flanges present a unique corrosion protection challenge because solutions must not only prevent corrosion, but also allow future access to fastenings in the event that maintenance or disassembly is required. Exposure to corrosive environments or polluted industrial atmospheres leads to high corrosion rates of unprotected flanges. In addition, due to the complex geometry of a flanged connection, problems such as crevice corrosion found within the void between the two flange faces and galvanic corrosion found where dissimilar metals are used are common and can prove severely detrimental to the integrity of the piping system.

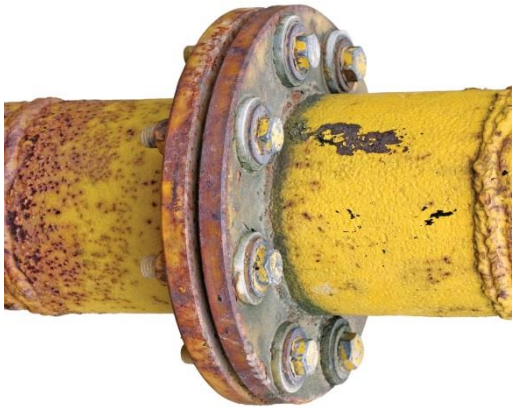

Figure 1. corroded flange

Corrosion issues and inspection of flanges

As flanged connections are a critical component within the piping system, effective monitoring and inspection techniques are required to minimise unscheduled shutdowns due to leakage in order to meet ever demanding production requirements. Usually, leakages occurring between the flange faces are the primary

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concern, leaving fastenings and pipe external protection unaddressed, which can lead to serious problems especially when external environmental conditions are severe.

Insufficient external protection can lead to rapid and more extensive damage to the flanges and fastenings which will in turn accelerate the deterioration of the sealing system as a whole. The consequences of such a situation are not easy to predict since they are dependent upon prevailing conditions. Depending upon the severity of the environmental conditions there may, at best, be a slow continuous degradation of the substrate, however, under extreme conditions, the external corrosion process may rapidly reach a point where the structural integrity of the system is adversely affected and could result in a catastrophic loss of containment.

Since visual inspection of the sealing faces of flanged connections can only be accomplished during a shutdown of the system, it is vital that this process is made as simple as possible and therefore elimination of external corrosion must be a high priority. If shut down is not an option, then an alternative method of inspection would be to use ultrasonic techniques but again this process can be made much more complex and inaccurate if external corrosion is not controlled.

Therefore, external corrosion protection of flanges and fastenings is critical in order to be able to both monitor the system and provide more effective and realistic quality control and inspection procedures.

Existing solutions to answer the corrosion protection dilemma of flanges

Due to the complexity of the flange geometry, it has become a challenge to design efficient solutions to protect flanges against corrosion. The ideal solution would be a system that combines excellent corrosion protection along with a simple installation procedure and is suitable for all flange sizes and shapes, in conjunction with easy bolt access for inspection purposes.

The most common solutions available on the market are maintenance paints and mechanical solutions. Maintenance paints are hard coatings that are bonded directly to the substrate, commonly epoxy or urethane based. As flanges involve lots of

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angles and edges, paint systems will struggle to coat effectively due to the thinning effect when paints are applied over an edge. Applying thicker layers may address the issue of edge protection, but it may also lead to seizing of fastenings which prevents subsequent access. In addition, accessing the bolt will be difficult without cracking the coating and it will therefore be necessary to re-apply the coating after the inspection.

Mechanical solutions such as covers and clamps encapsulate the flange or the void between the flange faces and they are usually constructed from stainless steel or plastic and incorporate a rubber seal. This protection is rigid, not flexible and requires having the correct cover or clamp size in stock to cater for each size of flange.

Another commercially available solution are tapes or semi-solid tapes. These come in various forms such as Petrolatum tape, wax or visco-elastic polymers embedded into fabric for wrapping. Tapes are supplied on a roll and are wrapped around the surface to be protected. They provide reliable corrosion protection, thanks to the water-repellent nature of these semi-solid polymers. However, these materials can be time-consuming and difficult to apply on complex shapes. If access to bolts is required, these relatively soft materials can be readily cut away, but cannot be easily resealed afterwards to reinstate the protection, and normally must be replaced with new.

Hot-melt thermoplastics are relatively new on the market. They are essentially a wax-like meltable polymer which is heated to high temperatures and then spray applied onto the surface with specialist hot-melt equipment. The main advantage of using this solution is the fact that it can be re-melted and recycled, which offers a cost-effective solution for flange protection. However, it requires hot work as well as specialist equipment and contract application service, and while the coating can be reused it cannot be easily opened up and resealed to facilitate inspection.

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Another relatively new form of flange protection are polymer bags containing Vapour Corrosion Inhibitors (VCI), which entirely cover the flanges. The sealed bag is composed of a low permeability polymer with internal VCI film (and drying agents). They are quick and easy to install but the ends of the bag are sealed using normal adhesive tape – not the most durable or effective of bonding mechanisms. The large vapour space inside the bag means that a relatively large amount of moisture may be trapped inside the system and the VCI's are consumed over a period of time.

Peelable coating for flange corrosion protection

To offer an alternative answer to flange corrosion issues, Belzona has formulated a new peelable coating concept, Belzona 3411 (Encapsulating Membrane), specifically designed for the protection of flanges, fastenings and associated pipework.

Belzona's R&D Chemist, Ruckseeta Patel, describes the new technology, "With the use of clever polymer chemistry, we have created a flange protection system strong and flexible enough to be peeled back without tearing. This solution features the flexibility of elastomers but is based on a completely new technology excluding the use of isocyanates and toxic metal catalysts. The system bonds to manually prepared surfaces and does not involve hot work, making it safe and easy to use."

The coating offers full corrosion protection due to its use with a corrosion-inhibiting base layer, Belzona 8411, and its high adhesive properties that exclude any moisture.

Figure 2. Belzona flange encapsulation system

The corrosion resistance of the system has been proved by the salt spray test, used to assess a coating's ability to resist attack from a continuous salt fog. The salt chamber converts a 5% sodium chloride solution into a hot fog at 35°C (95°F). The test piece consisted of an assembled flange joint, one side being bare steel and the other an existing paint system.

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After 1000 hours of exposure to the salt-fog atmosphere, no corrosion was reported under the encapsulated system. In comparison, the exposed steel part at the end of the flange showed a high level of corrosion.

Figure 3. Salt spray test showing no corrosion under the encapsulating system

Figure 4. Salt spray test showing no corrosion under the encapsulating system - close up

In order to provide a durable seal at the application extremities and exclude any moisture, the system requires a good adhesion, particularly to manually prepared surfaces. Adhesion testing has been performed on three manually prepared substrates according to ASTM D429/ISO8510-1 St 2. The results have shown a cohesive mode of failure on all substrates.

Substrate	Preparation	Adhesion	Failure Mode
Rusty carbon steel	Manual abrasion	6.6 pli 1.16 MPa	Cohesive
Epoxy paint	Manual abrasion	6.4 pli 1.12 MPa	Cohesive
Polyurethane paint	Manual abrasion	6.4 pli 1.12 MPa	Cohesive

Table 1. Adhesion testing results on three different substrates

Release properties and flexibility

Another property of this new system is the ease of access to the fastenings. When maintenance is required, the system can be simply cut open by using a sharp knife to cut through the membrane in the gap between the flange faces around the circumference of the flange. The membrane will be then be peeled back with the bolt caps, exposing bolts and flanges. Once the required maintenance has been completed, the membrane will fold back to its original position.

Figure 5. Encapsulating system being cut for inspection

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In order to be peelable, the system requires being tough and flexible. Tensile strength, elongation and tear strength were determined according to ASTM D412/D624.

	Belzona 3411 Unreinforced	+Belzona 9311 Reinforcement
Tensile Strength	410 psi 2.8 MPa	670 psi 4.6 MPa
Elongation	66%	24%
Tear Strength	21 pli 380 kg/m	100 pli 1830kg/m

Table 2. Tensile strength, elongation and tear strength results

To reseal the repair, the surface of the system has to be cleaned around the flange circumference to remove all dirt, grease and surface contaminants. Then a further quantity of Belzona 3411 will be brush applied onto the cut around the circumference of the flange for a quick and simple reinstatement of the flange protection.

This encapsulating system can be used not just to provide a complete corrosion protection for flanges, fastenings and associated pipes, but also as a preventive system which helps improving and facilitating further monitoring and inspection of flange faces.

Ensuring asset reliability has become one of the major challenges faced within many industries today. As a result of this, a growing demand for new and more effective corrosion protective systems can be identified. The corrosion protection challenge presented by flanges has led to the development of a number of solutions. However, most of them fail to meet all the requirements of providing excellent corrosion protection, a simple installation, are suitable for all flange sizes and shapes, and allow easy access for inspection purposes. Made available in 2014, Belzona's innovative encapsulating membrane system has been specifically developed to meet all of these requirements. Its unique design ensures that further monitoring and inspection of flanged connections can be easily carried out.

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Notes to Editor;

About Belzona:

- Established in 1952, Belzona has pioneered innovative polymer technology that has revolutionised industrial repair and maintenance procedures.
- Belzona is a leading company in the design and manufacture of polymer repair composites and industrial protective coatings for the repair, protection and improvement of machinery, equipment, buildings and structures.
- At Harrogate, the full Belzona product range is manufactured to stringent quality and environmental control guidelines complying with the requirements of ISO 9001:2008 and ISO 14001:2004.
- Belzona has over 140 Distributors in more than 120 countries ensuring not only the availability of Belzona materials, but also specification support, project management, application and supervision services. Distributorships and their teams are supported by Belzona Corporate offices in Europe, North America and Asia.

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