IN FOCUS: Process Vessels

Issue 105

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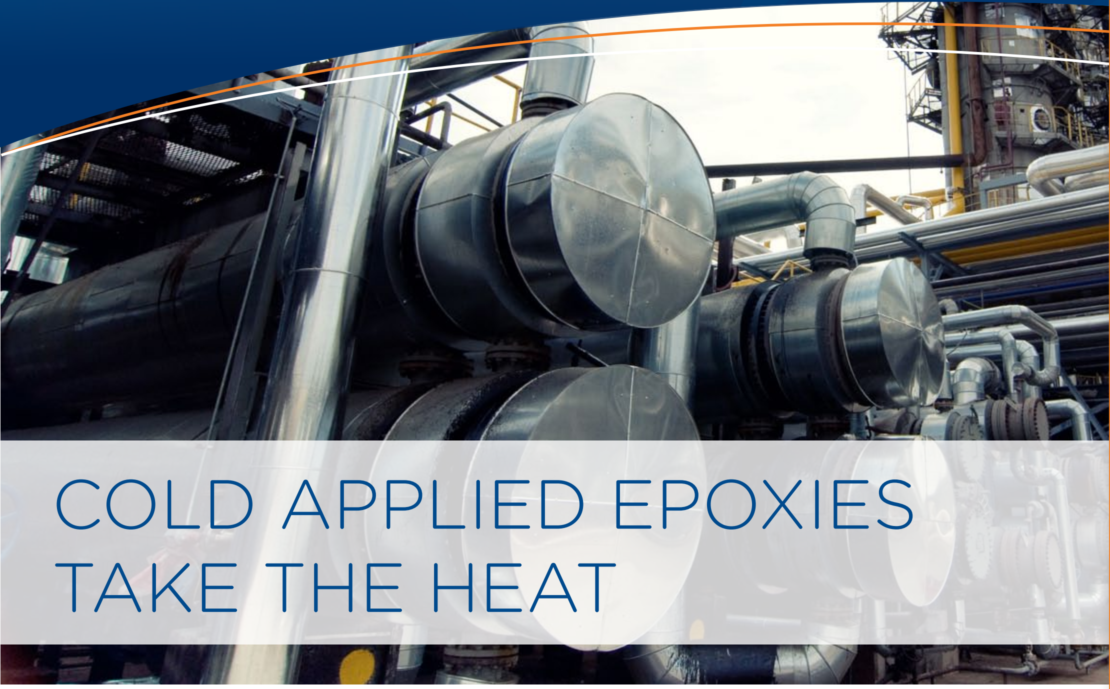


COLD APPLIED EPOXIES TAKE THE HEAT

Process vessels operating at elevated temperatures and pressures represent one of the most arduous service environments and major challenges for the asset owners and operators. These vessels, and in particular those involved in the separation of oil/water and gas as it enters the process stream, are constantly subjected to a wide variety of aggressive conditions which can ultimately lead to severe internal corrosion.

Why conventional coatings fail

When designing systems that are resistant to high temperature immersion, it is important to consider the reasons why conventional coatings fail. Many such materials are solvent-based, and in these instances, quite apart from other limitations, problems are experienced due to solvent retention within the film. This retained solvent will then increase in volume as it is exposed to higher temperatures, which in turn leads to blistering. Furthermore, in some cases, exchange takes place between the retained solvent and the process fluid leading to swelling and premature failure.

Systems with low cross-link density are susceptible to a high degree of permeation of both water and gases leading to corrosion.

This phenomenon increases dramatically as the polymer system reaches its softening point, whereby distances between the polymer molecules' cross-link sites increase and permeation occurs more readily. Even conventional epoxy resins, which typically display good resistance to permeation at ambient temperatures, can only offer limited protection at elevated temperatures.

Novel solution to high temperature immersion

Belzona has developed a range of organic epoxy vessel linings that provide long-term corrosion protection at elevated pressures and temperatures. A unique binary cure system allows the rapid development of immersion resistance during post cure in service. The resulting system displays a very high glass transition temperature, which means it is more highly cross-linked at elevated operating temperatures than conventional systems.

By utilisation of a polymer matrix with a high cross-link density coupled with reinforcing fillers, which give barrier protection, the tendency for water and gas permeation can be dramatically reduced, thus leading to immersion resistance at higher water temperatures. Extensive in-house

Corroded separator

Blistering of coating with low cross-link density

COLD BONDING – A SAFE ALTERNATIVE TO WELDING

Vessel internal fittings and externals can be cold bonded with Belzona. Cold bonding composites offer equal corrosion and chemical resistance to vessel lining materials. Several independent tests have also confirmed adequate adhesion and mechanical properties with results superior to welding.

Belzona commissioned tests with Lloyd's register to measure tensile shear adhesion, tensile adhesion and cleavage adhesion of Belzona 1511 (Super HT-Metal) in March 2004. Tests were conducted using Schenk/Instron servo hydraulic test machine at 50% humidity and 23°C (73°F).

Adhesion test	Max Load (kN)
Tensile shear adhesion	51.31
Tensile adhesion	20.62
Cleavage adhesion	22.32

For external bonding Belzona 1111 (Super Metal) cold bonded patch repair was tested by Lehigh Testing Laboratories where repair withstood pressures up to 3,400psi (23 N/m^2).

and independent testing, including over 150 elevated temperature/pressure immersion tests using autoclaves revealed:

- Heat Distortion Temperature in excess of 250°C (482°F).
- Immersion resistance in water/ hydrocarbon service up to 180°C (356°F).
- Rapid post cure in service, eliminating the need for extensive stoving periods, and reducing the risk of permeation during the initial post cure in service.
- Physical properties that show only moderate change across a temperature range from 0-200°C (32-392°F).
- Limited reduction in adhesive strength across the same temperature range, a contributory factor to the coatings excellent high temperature immersion characteristics.

Belzona linings have been thoroughly tested in laboratory environment and the field for resistance to high pressures, erosion, steam-out, decompression and cathodic disbondment. Upon reviewing the vessel spec, appropriate solution can be specified.

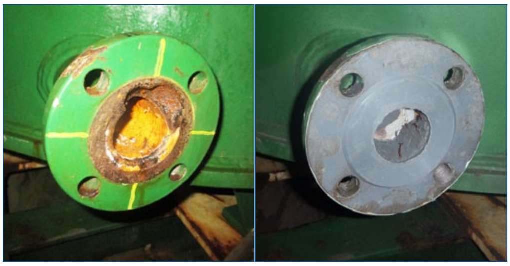
How Belzona technology works – internal lining

Over the years Belzona has formulated a range of organic process vessel linings that withstand various harsh in-service conditions. Belzona linings can be spray or hand applied to repair corrosion damage and existing linings including glass flake systems or at the design stage as a preventative measure.

Lining material specification is influenced by the physical design, process fluids and operating conditions of the vessels, where these are matched with the product spec compiled by Belzona utilising in-house and external testing data. Field experience of said materials is also taken into account and assists with estimating the lining design life.

Surface preparation is carried out following set guidelines: typically after testing for internal contaminants the surface is cleaned, degreased and grit blasted achieving the cleanliness of "near white metal" ISO Sa 2.5 and minimum profile of 75um (3 mils). Application environment is also controlled. The substrate and environmental temperatures as well as humidity are measured and reduced to appropriate levels. To reduce the risk of inadequate application standards, applicators and coating inspectors are trained and validated by Belzona.

Flange face forming technology



Flange face corrosion is a common problem affecting pressure vessels, where the face must be isolated to prevent oxidation. Belzona composite materials do not corrode and bond strongly to the flange face, where prefabricated formers are used to shape specified Belzona material on the flange face.

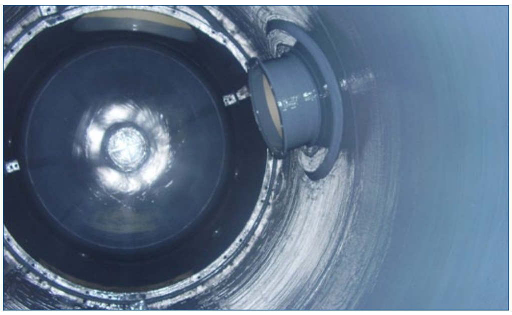
Small bore nozzle inserts

In order to protect small bore nozzles, a conventional coating would not be sufficient due to the risk of pinholes or holidays when coating a narrow nozzle. This issue is rectified by introducing prefabricated nozzles made from Belzona composites that do not corrode. The inserts and the nozzle are wetted out with a Belzona coating grade material, before being installed and bonded together to ensure corrosion protection.

Cold bonding of vessel fittings

Welding vessel internals necessitates post weld heat treatment, additionally in some cases hot work is not permissible. Cold bonding technique has been utilised in many industries and in recent years, laboratory and field testing have confirmed that Belzona cold bonding solution for process vessels is preferable to allow modification to meet changes in feed make-up.

Spray applied Belzona lining



Process vessel lined for corrosion protection

FPSO P57 PRESSURE VESSEL CORROSION PREVENTION SOLUTION

Inspected after four years in service, result - flawless

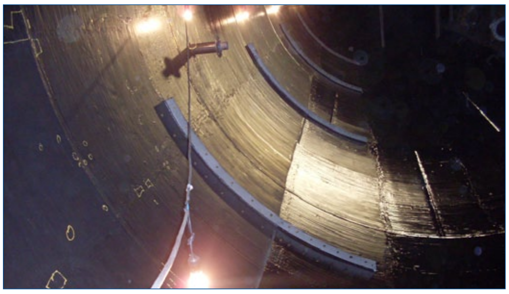
In February 2008, a major Oil and Gas company signed a contract for the supply of the P57 FPSO with delivery of the unit planned 33 months later. Construction took place in Singapore and Brazil and the contractual requirement of 65% Brazilian content was exceeded.

The facility was operated for the first three years of production at the Jubarte field. The FPSO, capable of processing up to 180,000 barrels of oil and 2,000,000 cubic metres of gas per day, facilitated production from 22 interconnected wells.

Four pressure vessels - two desalters, a dehydrator and a separator, for handling liquid hydrocarbons at high temperatures, V-T6205A, V-T6205B, V-T6204 and V-T6206 respectively required internal corrosion protection.

Temperature, pressure and chemical resistance requirements were carefully evaluated before specifying Belzona 1591 (Ceramic XHT), capable of withstanding immersion temperatures of up to 180°C (356°F), to line the vessels. Other areas that commonly suffer from corrosion, such as small bore nozzles and flange faces, were also to be isolated from the environment with the use of Belzona materials.

The work was carried out in September 2009 and in February 2013 V-T6205A was opened for inspection. The condition was described as “flawless”; lining, flange faces and nozzles all showed no signs of deterioration.



Application in 2009

Flange and small bore nozzle protected

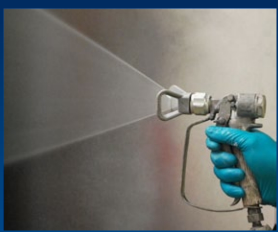
Inspection in 2013 - Flawless

Vessel name	V-T6205A/B	V-T6204	V-T6206
Type	Desalters	pre Dehydrator	Separator
Fluid handled	Crude oil	Crude oil	Crude oil
Design temperature	160°C (320°F)	160°C (320°F)	160°C (320°F)
Operating temperature	120°C (248°F)	120°C (248°F)	120°C (248°F)
Design pressure	1451.3 kPa g	1451.3 kPa g	1451.3 kPa g
Operating pressure	598.2 kPa g	696.2 kPa g	882.6 kPa g

INTRODUCING NEXT GENERATION HIGH TEMPERATURE VESSEL LININGS

Spray applied Belzona 1523 and Brush applied Belzona 1593

Novel formulation offers simplified application and inspection. Crack inhibiting rubbery domains provide better impact resistance and flexibility.



PROTECTING THE WEAKEST LINK

Erosion-corrosion of small bore nozzles and flange faces can be detrimental to the vessel’s operation. Nozzles in particular can deteriorate very quickly and are in turn difficult to repair using a conventional coating system due to their length and narrowness.

Belzona prefabricated composite nozzle inserts are “glued” into the small bore nozzle, thus eliminating the risks of pinholes and holidays. Composite insert can also act as a sacrificial erosion resistant layer in extreme abrasive conditions.

In conjunction with the flange face forming technology, vessels’ weak points are effectively isolated from corrosive media.

A kit has now been made available that consists of necessary accessories to carry out flange face forming applications. Currently available #300 pressure class kits include formers for 2”, 3” and 4” NB diameters covering all range of pipe schedules.

PROTECTING VESSELS AT THE DESIGN STAGE

European Engineering Design house compared economic gain over the lifetime of the slug catcher. Using a traditional 625 stainless steel cladded carbon steel, they assume that it would be maintenance free over the lifetime of the asset. As part of a cost reduction exercise they considered a carbon steel base metal protected with Belzona lining for which they integrated the cost of touch-up repair every 5 years. Adding up CAPEX and OPEX the Belzona option was 3.5 times more cost-effective.

Belzona recommends applying a complete corrosion protection solution at the design stage to prevent corrosion, including:

» Vessel lining
» Small bore nozzle protection
» Flange face protection
» Cold bonding of fittings

Belzona strives to provide a complete supply and apply package through its Global Distribution network. This network was specifically created to provide clients with direct access to materials, specialist application services, inspection services and supervision. It is Belzona's mission to meet specialist repair and maintenance needs in its target industries and markets worldwide.

BELZONA®
Repair • Protect • Improve

Issue No. 105

UPGRADE OF MULTIPHASE SEPARATORS

Cold bonded fittings inspected a decade later – all in excellent condition

In 2003 Opus was awarded a contract to review and recommend cost effective upgrade measures to improve the performance and operability as well as maximise the throughput of a 1st Stage Production Separator. As with the majority of upgrades, there was not an option to weld to the existing vessel. A test program confirmed Belzona cold bonding solution to be ideal from both an adhesion point of view as well as being mechanically sound.

The lower edges of the new baffles were supported on beams which were mounted within the vessel using new clips bonded to the vessel wall with Belzona and some intermediary brackets tied back to existing clips. This had the effect of creating a solid structure right through the centre section of the vessel. The plate packs were supported on new beams similarly supported with Belzona. The weir extensions were bolted in two pieces to the top of the existing weirs and the sealing to the side walls of the vessel achieved by bonding new clips using Belzona.

Cold bonded beams

Due to the high future water content, the existing water outlet nozzle was of insufficient diameter. To solve this, a decision was taken to switch the existing oil and water outlet nozzles through the weir. A new concept consisted of manufactured short elbow sections and a modified weir plate to accept the new arrangement. Interface sections were then machined to slide into the bore of the existing nozzles and sealed with Belzona.

The droplet separator housings were supported from below, through new support frames. These were mounted to the webs remaining from removal of the existing droplet separator. A sealing coat of Belzona was inserted between its top flange and the vessel shell. Vertical load was then applied, via jacking screws, to ensure that the sealing medium was compressed whilst curing.

The coalescing plate packs were designed and fabricated in a modular cell form and supported within the vessel on cross beams, mounted on new clips bonded to the vessel wall. The lower rows of cells were fixed to the beams at the time of bonding and remained there while curing to ensure the beams were fixed squarely and positioned correctly.

Eight and 10 years after the application, the separator was inspected and Belzona bonded fittings were found to be in excellent condition.

Overhead fittings bonded

Inspection eight years later

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