GENERAL INFORMATION

Product Description:
Two component, hand or spray applied, high temperature coating, suitable for continuous immersion in aqueous/hydrocarbon systems up to 320°F/160°C. Also suitable for steaming out up to 410°F/210°C. Exhibits excellent corrosion resistance at elevated temperatures and is resistant to a wide range of chemicals.

Application Areas:
When mixed and applied as detailed in the Belzona Instructions for Use (IFU), the system is ideally suited for application to the following:

- Absorbers
- Boiler Feed Water Systems
- Condensate Tanks
- Condensers
- De-aerators
- Evaporators
- Heat Exchangers
- Hot Water Vessels
- LP & HP Knock-Out Drums
- Scrubbers
- Separators
- Slug Catchers
- Storage Tanks

APPLICATION INFORMATION

Application Methods
Brush
Applicator
Spray

Application Temperature
Application should occur in the following ambient temperature range: 50°F/10°C to 104°F/40°C

Coverage Rate
Belzona 1593 shall be applied in two coats to give a minimum thickness of 20 mils (500 microns).

At a thickness of 20 mils/500 μm, the theoretical coverage rate will be 1.10 m²/kg.

Cure Time
Cure times will vary depending on the ambient conditions; consult the Belzona IFU for specific details.

Mixed Properties
Color: Light Green or Light Grey
Density: 1.81 g/cm³
Gel Time (BS 5350-B5): 70-110 minutes (68°F/20°C)
Sag Resistance (BS 5350-B9): >30 mils / >750 μm
60° Specular Gloss (ASTM D2457): 60 - 70 Gloss Units
VOC content (ASTM D2369 / EPA ref. 24): 0.62% / 11.14 g/L

Mix Ratio (base : solidifier) 11 : 1 (parts by weight)

Overcoat Window
Overcoat times will vary depending on the ambient conditions; consult the Belzona IFU for specific details.
At 68°F/20°C, the maximum overcoat time will typically be 24 hours.

Working Life
The working life will vary according to the temperature. At 68°F/20°C, the usable life of mixed material will typically be 45 minutes, consult the Belzona IFU for specific details.

The above application information serves as introductory guide only. For full application details including the recommended application procedure/technique, refer to the Belzona IFU which is enclosed with each packaged product.
# ABRASION

**Taber**

Dry sliding abrasion resistance, when determined in accordance with ASTM D4060 using CS17 wheels, will typically result in:

- 17.4 mm³ loss per 1000 cycles (212°F/100°C cure & 68°F/20°C test)

Wet sliding abrasion resistance, when determined in accordance with ASTM D4060 using H10 wheels, will typically result in:

- 1042 mm³ loss per 1000 cycles (212°F/100°C cure & 68°F/20°C test)

# ADHESION

**Cleavage Adhesion**

The Cleavage Strength when applied to grit blasted mild steel, as determined in accordance with ASTM D1062, will typically be:

- 1830 pli / 320 N/mm (68°F/20°C cure & test)
- 980 pli / 172 N/mm (212°F/100°C cure & 68°F/20°C test)
- 770 pli / 134 N/mm (320°F/160°C cure & 68°F/20°C test)
- 760 pli / 132 N/mm (212°F/100°C cure & test)
- 400 pli / 70 N/mm (320°F/160°C cure & test)

**Pull Off Adhesion**

The PosiTest Dolly Pull Off Strength on 10mm thick grit blasted mild steel, as determined in accordance with ASTM D4541 and ISO 4624, will typically be:

- 4350 psi / 30.0 MPa (68°F/20°C cure)
- 3430 psi / 23.7 MPa (212°F/100°C cure)
- 2770 psi / 19.1 MPa (284°F/140°C cure)
- 2290 psi / 15.8 MPa (320°F/160°C cure)

**Tensile Shear Adhesion**

The Tensile Shear Adhesion on grit blasted mild steel, as determined in accordance with ASTM D1002, will typically be:

- 2900 psi / 20.0 MPa (68°F/20°C cure & test)
- 2110 psi / 14.6 MPa (212°F/100°C cure & 68°F/20°C test)
- 2400 psi / 16.6 MPa (320°F/160°C cure & 68°F/20°C test)
- 1530 psi / 10.6 MPa (212°F/100°C cure & test)
- 1790 psi / 12.3 MPa (320°F/160°C cure & test)

# CHEMICAL ANALYSIS

The mixed *Belzona 1593* has been independently analyzed for halogens, heavy metals, and other corrosion-causing impurities in accordance with ASTM E165, ASTM D4327 and ASTM E1479. Typical results are displayed as follows:

<table>
<thead>
<tr>
<th>Analyte</th>
<th>Total Concentration (ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fluoride</td>
<td>68</td>
</tr>
<tr>
<td>Chloride</td>
<td>300</td>
</tr>
<tr>
<td>Bromide</td>
<td>ND (&lt;10)</td>
</tr>
<tr>
<td>Sulfur</td>
<td>57</td>
</tr>
<tr>
<td>Nitrite</td>
<td>ND (&lt;7)</td>
</tr>
<tr>
<td>Nitrate</td>
<td>7</td>
</tr>
<tr>
<td>Zinc</td>
<td>5.4</td>
</tr>
<tr>
<td>Antimony, Arsenic, Bismuth, Cadmium, Lead, Tin, Silver, Mercury, Gallium and Indium</td>
<td>ND (&lt;5.0)</td>
</tr>
<tr>
<td></td>
<td>ND : Not Detected</td>
</tr>
</tbody>
</table>

# CHEMICAL RESISTANCE

When tested in accordance with ISO 2812 and ISO 4628, the coating demonstrates excellent resistance to a wide range of chemicals. For full details, see the *Belzona 1593* Chemical Resistance Chart

# COMPRESSION PROPERTIES

When determined in accordance with ASTM D695, typical values will be:

**Compressive Yield Strength**

- 8280 psi / 57.1 MPa (68°F/20°C cure & test)
- 11460 psi / 79.0 MPa (212°F/100°C cure & 68°F/20°C test)
- 13200 psi / 91.0 MPa (320°F/160°C cure & 68°F/20°C test)
- 5510 psi / 38.0 MPa (212°F/100°C cure & test)
- 5010 psi / 34.6 MPa (320°F/160°C cure & test)

**Compressive Modulus**

- 1.81x10⁶ psi / 12500 MPa (68°F/20°C cure & test)
- 1.66x10⁶ psi / 11400 MPa (212°F/100°C cure & 68°F/20°C test)
- 1.68x10⁶ psi / 1170 MPa (320°F/160°C cure & 68°F/20°C test)
- 1.20x10⁶ psi / 830 MPa (212°F/100°C cure & test)
- 0.99x10⁶ psi / 680 MPa (320°F/160°C cure & test)

# CORROSION PROTECTION

**Cathodic Disbondment**

When tested in accordance with ASTM G42 at 194°F/90°C, the average disbondment radius will typically be: 0.209 in./5.3 mm

**Salt Spray**

When tested in accordance with ASTM B117, the coating will show no signs of failure after 1000 hours continuous exposure.
**PRODUCT SPECIFICATION SHEET**  
**BELZONA 1593**  
**FN10151**

**ELECTRICAL PROPERTIES**

When tested in accordance with ASTM D4149, method A, with voltage rise of 2kV/s, typical value will be:

- **Dielectric strength**: 27.5 kV/mm

**ELONGATION & TENSILE PROPERTIES**

When determined in accordance with ASTM D638, typical values will be:

- **Tensile Strength**
  - 2750 psi / 19.0 MPa (68°F/20°C cure & test)
  - 2610 psi / 18.0 MPa (212°F/100°C cure & 68°F/20°C test)
  - 2570 psi / 17.7 MPa (320°F/160°C cure & 68°F/20°C test)
  - 2070 psi / 14.3 MPa (212°F/100°C cure & test)
  - 1620 psi / 11.2 MPa (320°F/160°C cure & test)

- **Elongation**
  - 0.27% (68°F/20°C cure & test)
  - 0.29% (212°F/100°C cure & 68°F/20°C test)
  - 0.30% (320°F/160°C cure & 68°F/20°C test)
  - 0.31% (212°F/100°C cure & test)

- **Young's Modulus**
  - 9.30x10^6 psi / 6410 MPa (68°F/20°C cure & test)
  - 8.68x10^6 psi / 5960 MPa (212°F/100°C cure & 68°F/20°C test)
  - 9.26x10^6 psi / 6380 MPa (320°F/160°C cure & 68°F/20°C test)
  - 6.27x10^6 psi / 4320 MPa (212°F/100°C cure & test)
  - 2.40x10^6 psi / 1650 MPa (320°F/160°C cure & test)

**EXPLOSIVE DECOMPRESSION**

When tested in accordance with NACE TM0185 using a seawater/crude oil test fluid over-pressured with 10% carbon dioxide/90% methane, the coating exhibits no breakdown after a 21 day immersion period at 248°F/120°C and 70 bar pressure followed by rapid decompression over 15 minutes.

**FLEXURAL PROPERTIES**

When determined in accordance with ASTM D790, typical values will be:

- **Flexural Strength**
  - 7500 psi / 51.7 MPa (68°F/20°C cure & test)
  - 7810 psi / 53.8 MPa (212°F/100°C cure & 68°F/20°C test)
  - 6880 psi / 47.4 MPa (320°F/160°C cure & 68°F/20°C test)
  - 4600 psi / 31.7 MPa (212°F/100°C cure & test)
  - 4660 psi / 32.1 MPa (320°F/160°C cure & test)

- **Flexural Modulus**
  - 8.99x10^6 psi / 6200 MPa (68°F/20°C cure & test)
  - 8.42x10^6 psi / 5810 MPa (212°F/100°C cure & 68°F/20°C test)
  - 9.15x10^6 psi / 6310 MPa (320°F/160°C cure & 68°F/20°C test)
  - 5.19x10^6 psi / 3580 MPa (212°F/100°C cure & test)
  - 4.31x10^6 psi / 2970 MPa (320°F/160°C cure & test)

**HARDNESS**

The Shore D and Barcol hardness, when determined in accordance with ASTM D2240 and ASTM D2583, will typically be:

<table>
<thead>
<tr>
<th></th>
<th>68°F/20°C cure</th>
<th>212°F/100°C cure</th>
<th>320°F/160°C cure</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Shore D</strong></td>
<td>88</td>
<td>89</td>
<td>91</td>
</tr>
<tr>
<td><strong>Barcol</strong></td>
<td>87</td>
<td>88</td>
<td>90</td>
</tr>
</tbody>
</table>

**HEAT RESISTANCE**

**Heat Distortion & Glass Transition Temperature (HDT & T<sub>g</sub>)**

The HDT and T<sub>g</sub> when determined in accordance with ASTM D648 and ISO 11357-2 respectively, following a 7 day cure period, will typically be:

<table>
<thead>
<tr>
<th>Cure temperature</th>
<th>HDT</th>
<th>T&lt;sub&gt;g&lt;/sub&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>68°F/20°C</td>
<td>120°F/49°C</td>
<td>127°F/53°C</td>
</tr>
<tr>
<td>212°F/100°C</td>
<td>334°F/168°C</td>
<td>291°F/144°C</td>
</tr>
<tr>
<td>284°F/140°C</td>
<td>448°F/231°C</td>
<td>347°F/175°C</td>
</tr>
<tr>
<td>320°F/160°C</td>
<td>453°F/234°C</td>
<td>383°F/195°C</td>
</tr>
</tbody>
</table>

**Atlas Cell Cold Wall Immersion Test**

When tested in accordance with NACE TM 0174 procedure A, the coating will exhibit no blistering or rusting (ASTM D714 rating 10; ASTM D610 rating 10) after 6 months immersion in water at 320°F (160°C).

**Electrochemical Impedance Spectroscopy (EIS)**

The EIS results (lo<sub>1/2</sub>[Z<sub>1/2</sub>]) determined in accordance with ISO 16773 following Atlas cell testing at 320°F/160°C will be typically:

- a) Unexposed: 11.0 Ω cm<sup>2</sup>
- b) Liquid Phase: 10.8 Ω cm<sup>2</sup>
- c) Vapor Phase: 10.5 Ω cm<sup>2</sup>

**Immersion Resistance**

Suitable for service at temperatures up to 320°F (160°C) but refer to chemical resistance data for chemical contact limitations.

**Steam-out Resistance**

The coating will exhibit no failure after 96 hours exposure to pressurized steam at 410°F/210°C.

**Dry Heat Resistance**

The indicated degradation temperature in air based on Differential Scanning Calorimetry (DSC) operated in accordance with ISO11357 is typically 428°F (220°C).
## IMPACT RESISTANCE

**Izod Pendulum**
Izod impact strength, when determined in accordance with ASTM D256, will typically be:

<table>
<thead>
<tr>
<th>Type</th>
<th>Value 1</th>
<th>Value 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Notched</td>
<td>4.9 KJ/m²</td>
<td>(68°F/20°C cure &amp; test)</td>
</tr>
<tr>
<td></td>
<td>3.2 KJ/m²</td>
<td>(212°F/100°C cure &amp; 68°F/20°C test)</td>
</tr>
<tr>
<td></td>
<td>3.0 KJ/m²</td>
<td>(320°F/160°C cure &amp; 68°F/20°C test)</td>
</tr>
<tr>
<td>Un-notched</td>
<td>5.7 KJ/m²</td>
<td>(68°F/20°C cure &amp; test)</td>
</tr>
<tr>
<td></td>
<td>5.3 KJ/m²</td>
<td>(212°F/100°C cure &amp; 68°F/20°C test)</td>
</tr>
<tr>
<td></td>
<td>3.8 KJ/m²</td>
<td>(320°F/160°C cure &amp; 68°F/20°C test)</td>
</tr>
</tbody>
</table>

## THERMAL PROPERTIES

**Thermal Cycling**
When tested in accordance with NACE TM0304 the coating exhibited no cracking after 252 cycles between +140°F and -22°F (+60°C and -30°C).

**Low Temperature Thermal Shock**
Coated steel panels will exhibit no blistering, cracking or delamination after multiple cycles of rapid cooling from 212°F (100°C) to -76°F (-60°C).

**Thermal Conductivity**
Thermal conductivity over a range of temperatures has been determined.

<table>
<thead>
<tr>
<th>Temperature</th>
<th>25°C</th>
<th>100°C</th>
<th>200°C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thermal conductivity (W/m.K)</td>
<td>0.6258</td>
<td>0.6773</td>
<td>0.6710</td>
</tr>
</tbody>
</table>

**Specific Heat Capacity**
Using DSC in accordance with ASTM E1269 the Specific heat capacity has been determined over a range of temperatures.

<table>
<thead>
<tr>
<th>Temperature</th>
<th>25°C</th>
<th>100°C</th>
<th>200°C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specific heat capacity (J/g.K)</td>
<td>1108</td>
<td>1299</td>
<td>1412</td>
</tr>
</tbody>
</table>

## THICK FILM CRACKING RESISTANCE

When tested in accordance with NACE TM0104 no cracking was experienced when applied at three times recommended thickness and exposed for 12 weeks in sea water at 104°F (40°C).

## SHELF LIFE

Separate base and solidifier components shall have a shelf life of 3 years from date of manufacture when stored in their original unopened containers between 32°F (0°C) and 86°F (30°C).
Belzona products are manufactured under an ISO 9001 Registered Quality Management System

Belzona 1593 is available from a network of Belzona Distributors throughout the world for prompt delivery to the application site. For information, consult the Belzona Distributor in your area.

Prior to using this material, please consult the relevant Safety Data Sheets.

Complete technical assistance is available and includes fully trained Technical Consultants, technical service personnel and fully staffed research, development and quality control laboratories.

The technical data contained herein is based on the results of long term tests carried out in our laboratories and to the best of our knowledge is true and accurate on the date of publication. It is however subject to change without prior notice and the user should contact Belzona to verify the technical data is correct before specifying or ordering. No guarantee of accuracy is given or implied. We assume no responsibility for rates of coverage, performance or injury resulting from use. Liability, if any, is limited to the replacement of products. No other warranty or guarantee of any kind is made by Belzona, express or implied, whether statutory, by operation of law or otherwise, including merchantability or fitness for a particular purpose.

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