Internal Linings for Vessels and Tanks

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Internal Linings for Vessels and Tanks

Presented By : Mr Ron Campbell
Belzona Polymerics Ltd

18th May 2014 WORKSHOP
COATING AND LINING
for Industrial Application

NACE JUBAIL

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What are the vessel deteriorating factors that need to be overcome :

Corrosion

Galvanic

Pitting

Crevice

SCC

Bacterial

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What are the options ?

Materials of Construction

- Carbon Steel
- Corrosion Resistant Alloys
- Overlaid Carbon Steel
- Non Metallic Materials

Internal Linings

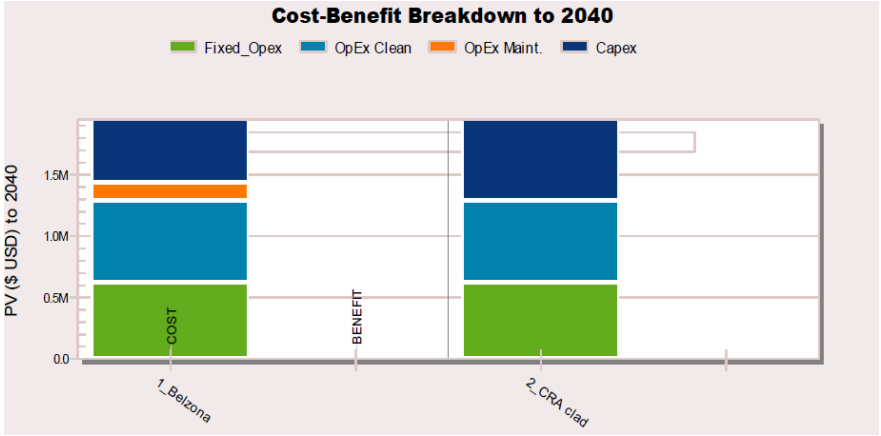
- Epoxy Paint
- Glass Flake Coatings
- “ Ceramic Coatings “
- Hybrid Epoxy Novolac Linings

What are the considerations

- **Metal Cladding / Weld Overlay**
  Weight, Cost, Availability ,
  Chemical Resistance
- **Corrosion Allowance**
  Weight, Design Life, Root Cause
- **Cathodic / Anodic Protection**
  Cost, Effectiveness, Reliability
- **Internal Lining**
  Reliability, Application Quality,
  Resilience

Internal lining – cost effective solution

Cost Benefit Study carried out by major Engineering Contractor for a Middle East Oil and Gas new construction project



Component	Option 1	Option 2
CapEx	USD 57.1 million	USD 211.6 million
OpEx (External inspection)	USD 2.0 million	USD 2.0 million
OpEx (Clean out)	USD 3.0 million	USD 3.0 million
OpEx (Maintenance)	USD 0.75 million	-
Total	**USD 62.9 million**	**USD 216.6 million**
	Hybrid Epoxy Novolac Lining Option	**CRA Option**

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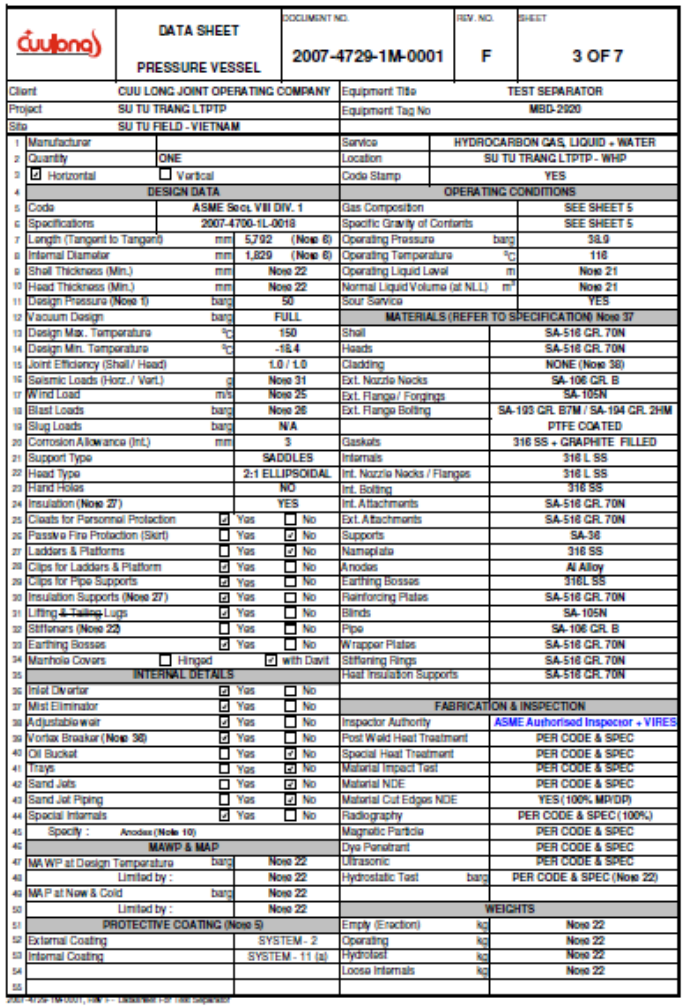
Selecting a suitable internal lining

Determine the following :

- Design and operating temperature
- Design and Operating pressure
- Operating Fluids
- Levels of corrosive gases (H_2S / CO_2)
- Levels of solids entrainment (eg. Sand)
- Chemical Additives (eg. : Well stimulation)
- Decompression Cycling
- Microbiological Activity
- Chemical Cleaning
- Steam Cleaning
- Vessel Configuration (for “ coatability”)
- Nozzle Sizes
- Flange Face Configuration



cuulong	DATA SHEET PRESSURE VESSEL	DOCUMENT NO. 2007-4729-1M-0001	REV. NO. F	SHEET 3 OF 7

Client	CUU LONG JOINT OPERATING COMPANY			Equipment Title	TEST SEPARATOR		
Project	SU TU TRANG LTPTP			Equipment Tag No	MBD-2920		
Site	SU TU FIELD - VIETNAM						
1	Manufacturer			Service	HYDROCARBON GAS, LIQUID + WATER		
2	Quantity	ONE		Location	SU TU TRANG LTPTP - WHP		
3	☑ Horizontal	☐ Vertical		Code Stamp	YES		
4	DESIGN DATA			OPERATING CONDITIONS			
5	Code	ASME Sect. VIII DIV. 1		Gas Composition	SEE SHEET 5		
6	Specifications	2007-4700-1L-0018		Specific Gravity of Contents	SEE SHEET 5		
7	Length (Tangent to Tangent)	mm	5,792 (Note 6)	Operating Pressure	barg	38.9	
8	Internal Diameter	mm	1,829 (Note 6)	Operating Temperature	°C	116	
9	Shell Thickness (Min.)	mm	Note 22	Operating Liquid Level	m	Note 21	
10	Head Thickness (Min.)	mm	Note 22	Normal Liquid Volume (at N.L.L)	m^3	Note 21	
11	Design Pressure (Note 1)	barg	50	Sour Service		YES	
12	Vacuum Design	barg	FULL	MATERIALS (REFER TO SPECIFICATION) Note 37			
13	Design Max. Temperature	°C	150	Shell		SA-516 GR. 70N	
14	Design Min. Temperature	°C	-18.4	Heads		SA-516 GR. 70N	
15	Joint Efficiency (Shell / Head)		1.0 / 1.0	Cladding		NONE (Note 36)	
16	Seismic Loads (Horz. / Vert.)	g	Note 31	Ext. Nozzle Necks		SA-106 GR. B	
17	Wind Load	m/s	Note 25	Ext. Flange / Forgings		SA-105N	
18	Blast Loads	barg	Note 26	Ext. Flange Bolting		SA-193 GR. B7M / SA-194 GR. 2HM	
19	Slug Loads	barg	N/A			PTFE COATED	
20	Corrosion Allowance (Int.)	mm	3	Gaskets		316 SS + GRAPHITE FILLED	
21	Support Type		SADDLES	Internals		316 L SS	
22	Head Type		2:1 ELLIPSOIDAL	Int. Nozzle Necks / Flanges		316 L SS	
23	Hand Holes		NO	Int. Bolting		316 SS	
24	Insulation (Note 27)		YES	Int. Attachments		SA-516 GR. 70N	
25	Cleats for Personnel Protection	☑ Yes ☐ No		Ext. Attachments		SA-516 GR. 70N	
26	Passive Fire Protection (Skirt)	☐ Yes ☑ No		Supports		SA-36	
27	Ladders & Platforms	☐ Yes ☑ No		Nameplate		316 SS	
28	Clips for Ladders & Platform	☑ Yes ☐ No		Anodes		Al Alloy	
29	Clips for Pipe Supports	☑ Yes ☐ No		Earthing Bosses		316L SS	
30	Insulation Supports (Note 27)	☑ Yes ☐ No		Reinforcing Plates		SA-516 GR. 70N	
31	Lifting ~~& Tailing~~ Lugs	☑ Yes ☐ No		Blinds		SA-105N	
32	Stiffeners (Note 22)	☐ Yes ☐ No		Pipe		SA-106 GR. B	
33	Earthing Bosses	☑ Yes ☐ No		Wrapper Plates		SA-516 GR. 70N	
34	Manhole Covers	☐ Hinged ☑ with Davit		Stiffening Rings		SA-516 GR. 70N	
35	INTERNAL DETAILS			Heat Insulation Supports		SA-516 GR. 70N	
36	Inlet Diverter	☑ Yes ☐ No					
37	Mist Eliminator	☑ Yes ☐ No		FABRICATION & INSPECTION			
38	Adjustable weir	☑ Yes ☐ No		Inspector Authority		ASME Authorised Inspector + VIRES	
39	Vortex Breaker (Note 38)	☑ Yes ☐ No		Post Weld Heat Treatment		PER CODE & SPEC	
40	Oil Bucket	☐ Yes ☑ No		Special Heat Treatment		PER CODE & SPEC	
41	Trays	☐ Yes ☑ No		Material Impact Test		PER CODE & SPEC	
42	Sand Jets	☐ Yes ☑ No		Material NDE		PER CODE & SPEC	
43	Sand Jet Piping	☐ Yes ☑ No		Material Cut Edges NDE		YES (100% MP/DP)	
44	Special Internals	☑ Yes ☐ No		Radiography		PER CODE & SPEC (100%)	
45	Specify : Anodes (Note 10)			Magnetic Particle		PER CODE & SPEC	
46	MAWP & MAP			Dye Penetrant		PER CODE & SPEC	
47	MAWP at Design Temperature	barg	Note 22	Ultrasonic		PER CODE & SPEC	
48	Limited by :		Note 22	Hydrostatic Test	barg	PER CODE & SPEC (Note 22)	
49	MAP at New & Cold	barg	Note 22				
50	Limited by :		Note 22	WEIGHTS			
51	PROTECTIVE COATING (Note 5)			Empty (Erection)	kg	Note 22	
52	External Coating		SYSTEM - 2	Operating	kg	Note 22	
53	Internal Coating		SYSTEM - 11 (a)	Hydrotest	kg	Note 22	
54				Loose Internals	kg	Note 22	
55							

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Performance Testing – Immersion Temperature Resistance

- NACE TM0174: Atlas Cell Immersion

  - Glass cells up to 95ºC / 203ºF
  - Steel pressure cells up to 180ºC / 356ºF
  - Minimum 6 months test

Performance Testing – Steam out resistance

- Resistance To Steam-Out
  - Autoclave
  - 96 hours
  - Up to **210ºC** / **410ºF**

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Performance Testing – Depressurisation Resistance

- NACE TM0185 Rapid Decompression

Typical Test Program:
100 bar (1450 psi)
Reduced to 50 bar (725 psi) in 5 minutes
Then reduced to atmospheric in a further 10 minutes

Recommended 5 bar/min

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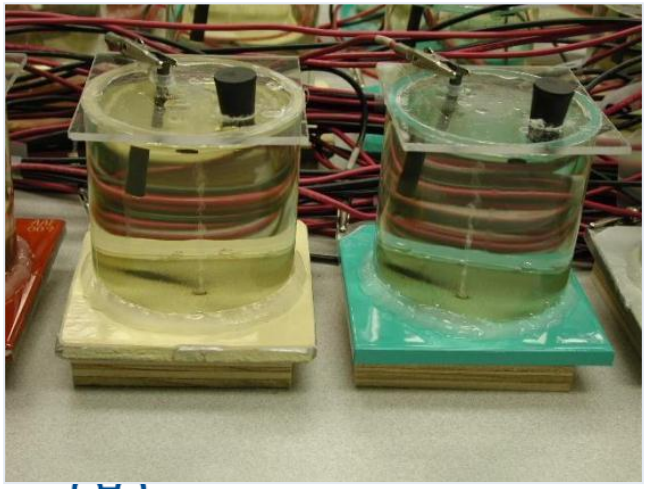
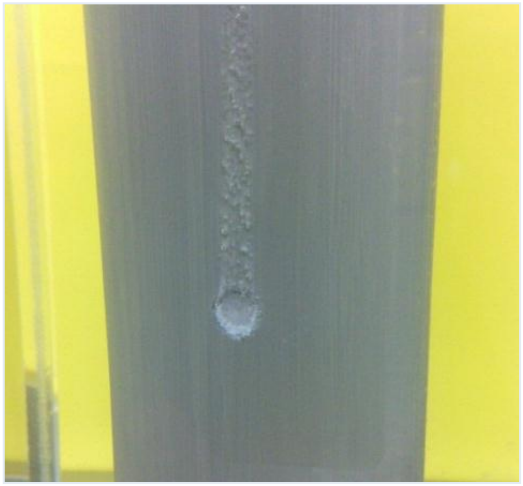
Performance Testing – Cathodic Disbondment Resistance

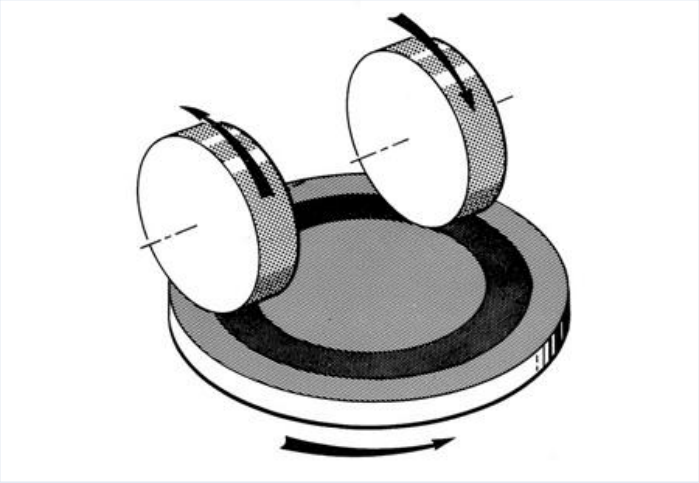
- ASTM G8, G42 or G95
  - 28 day test
  - Elevated temperature ASTM G42 / G95 tests run at temperatures up to 90ºC
- Radii as low as **2.5 mm at 80ºC / 176ºF**





Performance Testing – Erosion Resistance

- ASTM D4060: Taber Abrader
  - Sliding abrasion
  - 1 kg load, 1000 cycles
  - Wet or dry test



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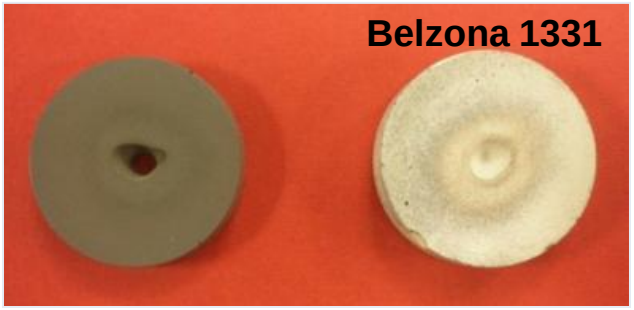
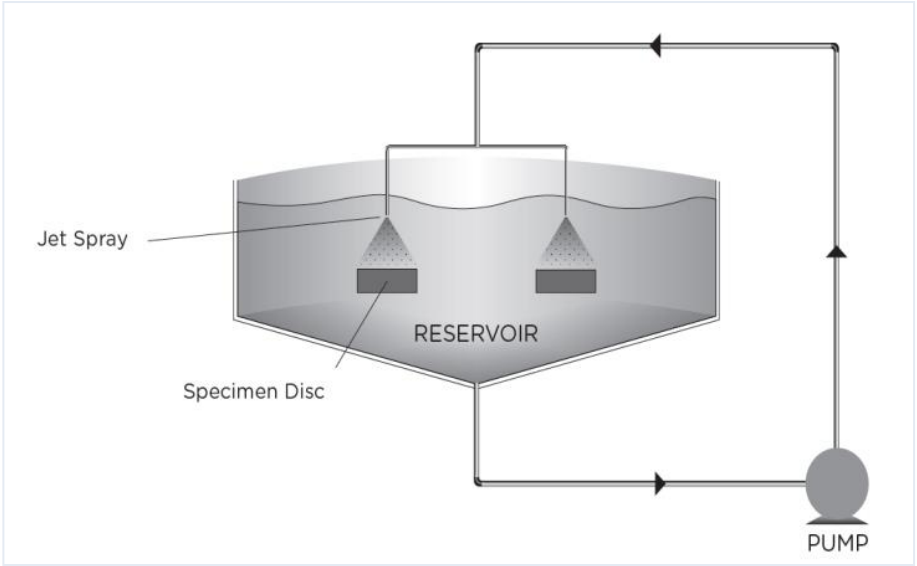
Performance Testing – Erosion Resistance

- Leeds University Slurry Jet
  - Impact abrasion
  - Silica sand in water
  - 100 hours at 20 m/s flow rate
  - 90º impact angle
  - Up to 70ºC

UNIVERSITY OF LEEDS





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Performance Testing – Chemical Resistance

- ISO 2812-1
  - Coated steel rods
  - Ambient and elevated temperatures
  - Reagents including ethanolamines and other process additives (e.g. Nalco)
  - **12 months immersion**

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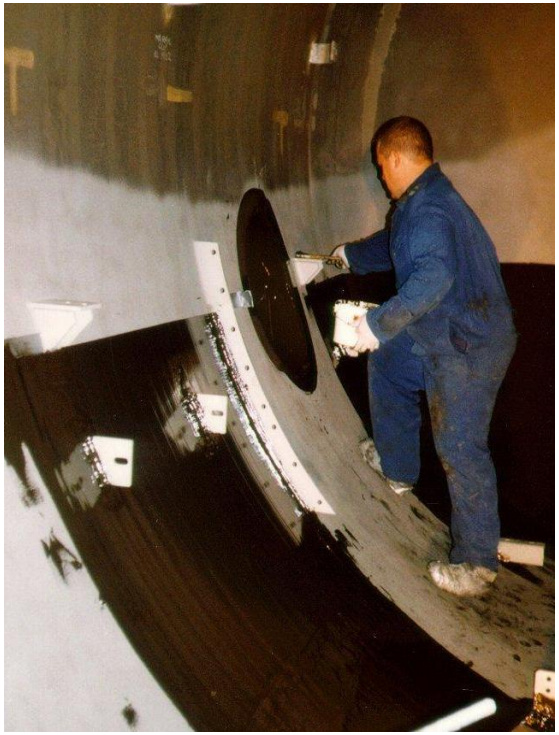
Hybrid Epoxy Novolac - Lining Performance Parameters

- Suitable for Immersion Temperatures up to 180C
- Tested up to 120bar decompression resistance
- Steam out resistance over 210C
- Resistant to H2s and CO2 in saturated solution
- Excellent resistance to entrained solids
- Resistant to SRB / MIC



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Hybrid Epoxy Novolac lining – System Properties

- Brush Applied Products with immersion temperature resistance up to 180C
- Spray applied products with immersion temperature resistance up to 150C
- Repair grade products with immersion temperature resistance up to 150C

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Application Case Histories

	A	B	C	D	E	F	G
204	Kuwait Oil Company	SA	Kuwait Oil Company		1391	Oil and Gas Separator	
205	Kuwait Oil Company	SA	Kuwait Oil Company		1391	Oil and Gas Separator	
206	Kuwait Oil Company	SA	Kuwait Oil Company		1391	Oil and Gas Separator	
207	Kuwait Oil Company	SA	Kuwait Oil Company		1391	Oil and Gas Separator	
208	Kuwait Oil Company	SA	Kuwait Oil Company		1391	Oil and Gas Separator	
209	Kuwait Oil Company	SA	Kuwait Oil Company		1391	Oil and Gas Separator	
210	Kuwait Oil Company	SA	Kuwait Oil Company		1391	Oil and Gas Separator	
211	Rabigh Refinery	SA	Saudi Aramco		1391	Vent Gas Tower	
212	Rabigh Refinery	SA	Saudi Aramco		1391	Gas Cooler	
213	SWCC-Khobar	SA	Al-Khobar Power Plant		5891	Seawater Intake Pipes	
214	Ras Tanura Refinery	SA	Saudi Aramco		1391	Multi-Effect Condenser Unit	
215	Ras Tanura Refinery	SA	Saudi Aramco		1391	Multi-Effect Condenser Unit	
216	Saudi Pet. Co. Sadaf	SA	Saudi Petroleum			MTBE Heat Exchanger	
217	Saudi Pet. Co. Sadaf	SA	Saudi Petroleum		1391	MTBE Heat Exchanger	
218	Rabigh Refinery	SA	Saudi Aramco		1391	Deaerator	
219	Rabigh Refinery	SA	Saudi Aramco		1391	Deaerator	
220	Rabigh Refinery	SA	Saudi Aramco		1391	Deaerator	
221	Berri Gas Plant	SA	Saudi Aramco		5891	DGA Amine Concrete Sump Pit	
222	Berri Gas Plant	SA	Saudi Aramco		1591	98% Sulfuric Acid Containment Area	
223	National Methanol, Jubail	SA	National Methanol Co		1591	98% Sulfuric Acid Containment Area	
224	Al Shaheen	KP	Maersk Oil Qatar	2007	1391	Test Separator / Sand Collection Drum / Slug Catcher / Closed Drains Drum / Inlet Separator /	Internal Lining of Ve
225	Bein Dong 1 Project	VT	PetroVT	2011	1391 / 1591 / 5891	Instrument Air Receiver / Cooling Medium Expansion Vessel / Heating Medium Expansion Vessel / Methanol Storage Tank / Open Drains Tank / Fuel Gas Receiver	Internal Lining of Ve
226	Su Tu Den North East Project	MY	Cuulong (Conoco Phillips JV)	2007	1521	Flare Scrubber / Instrument Air Reciver / Test Separator	Internal Lining of Ve
227	Su Tu Den Nau Project	ID	Cuulong (Conoco Phillips JV)	2012	1521 / 5891	Allocation Separator / Flare Scrubber / Hazerdous Open Drains Tank / Fuel Gas Scrubber /	Internal Lining of Ve
228	Su Tu Trang	VT	Cuulong (Conoco Phillips JV)	2011	5891 / 1521 / 1591 / 1391	Hazerdous Open Drains Tank / Flare Scrubber / Instrument Air Receiver	Internal Lining of Ve
229	Dan FG Project	SG	Maersk Denmark	2003	1391 / 1521	IP Suction Scrubber / HP Suction Scrubber / H2S Scavenger Separator / HP Flash Drum / LP Flare Drum / Closed Drain Vessel / Drain Separator / Induced Gas Flotation Vessel / HP Separator / Open Drains Tank / IP Flash Drum	Internal Lining of Ve
230	Dung Quat Refinery	VT	PetroVT	2011	1591	Amine Flash Drum	Internal Lining of Ve
231	Al Shaheen Block 5	KP	Maersk Oil Qatar	2012	1391	Gas Flotation Vessel	Internal Lining of Ve
232	South Pars 6-7 -8	KP	National Iranian Oil Company	2005	1521	KO Drum / Flash Drum / MEG Sump Drum / Separators	Internal Lining of Vess

main info | detailed info | Sheet1

PROJECT DATABASE 1994 TO 2014

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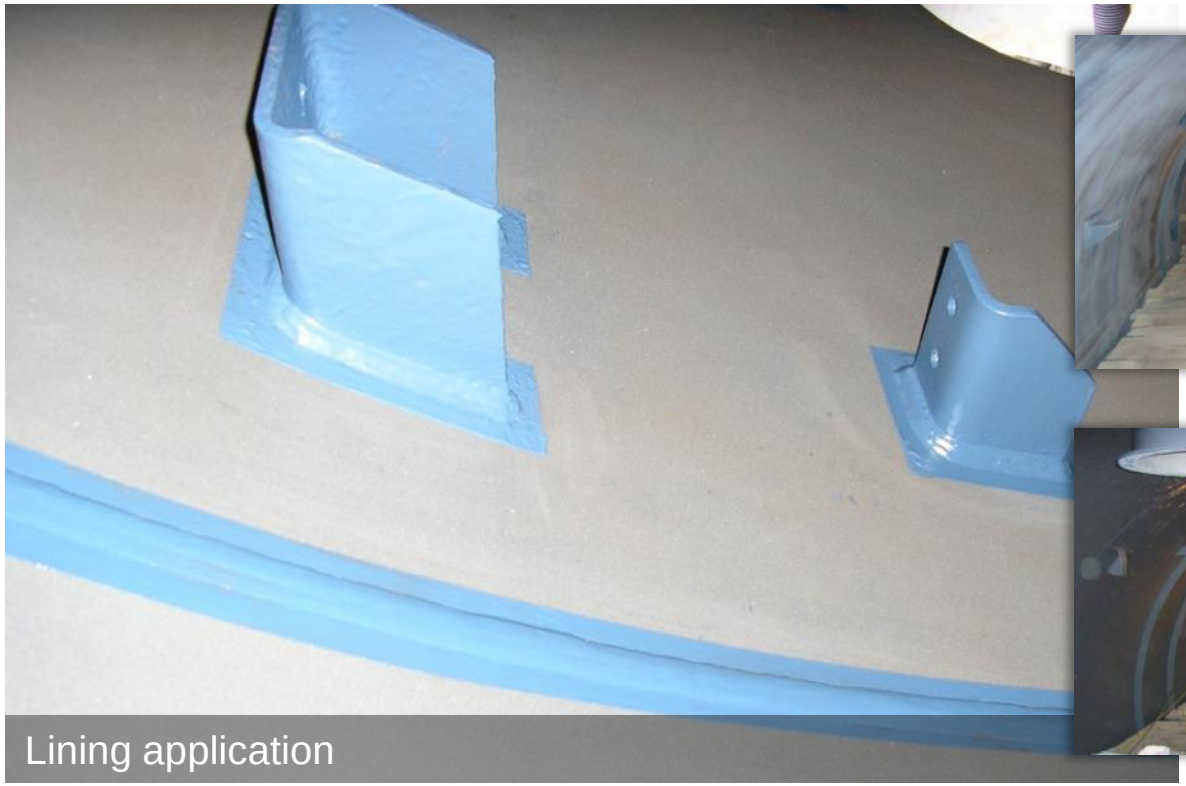
Correcting Lining Failures - North Sea

August, 2006



Lining application

The original glass flake coating had failed in service leading to substrate pitting and corrosion.

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Flash Drum Lining - Argentina

June, 2007

Inspection in 2010

Flash drum to be exposed to diglycolamine, wet H_2S and CO_2 at 80°C.

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Amine Still Column - Turkey

August, 2012

Completed application

Vessel needed protection from hydrogen sulphide and carbon dioxide at operating temperatures of 93°C (200°F)

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32 Feed Gas Liquid Separators - China

September, 2011

High H_2S presence in the gas field called for high performance corrosion protection to 32 new build carbon steel vessels.

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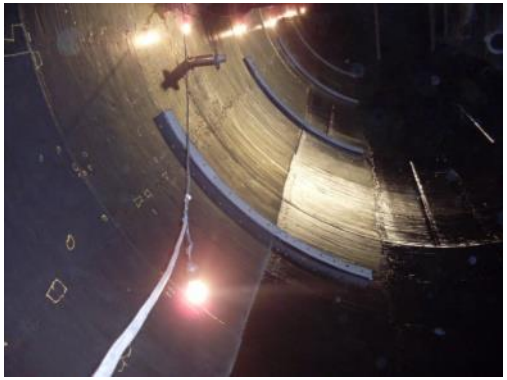
SBM And Petrobras, Brazil

September, 2009

Inspection in 2013



4 pressure vessels - in-service temperatures of up to 180°C. Adjacent flange faces and nozzles also required corrosion protection. Inspected in 2013, all in perfect condition.

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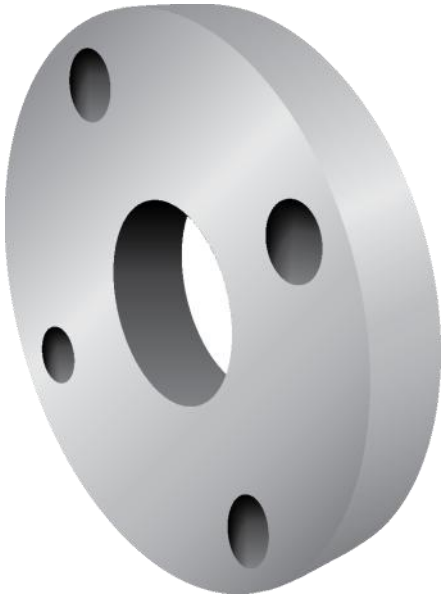
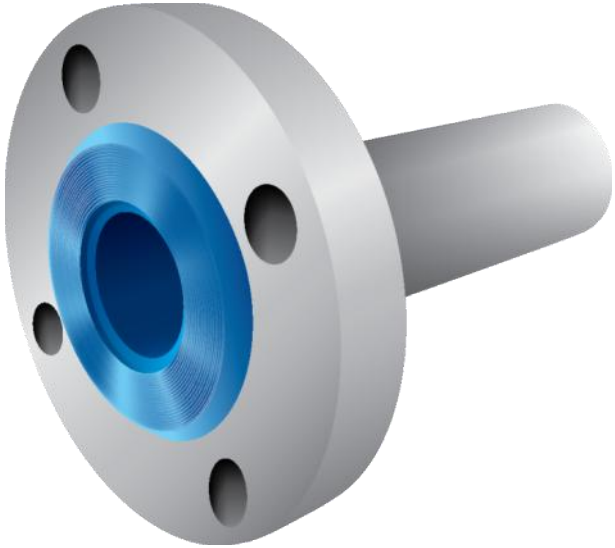
Chevron Richmond Refinery - USA

Protection of weld areas subject to stress corrosion cracking at elevated temperatures due to the presence of H2S. Weld areas only protected using high temperature Hybrid Epoxy Novolac lining system with operating temperature in excess of 150C

Flange Face Repair and Protection





Flange Face Repair Kit

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Flange Face Forming

Flange faces formed using Belzona materials to prevent corrosion and leaks

Suitable for : ANSI 150, 300, 600 and 900 Flanges.

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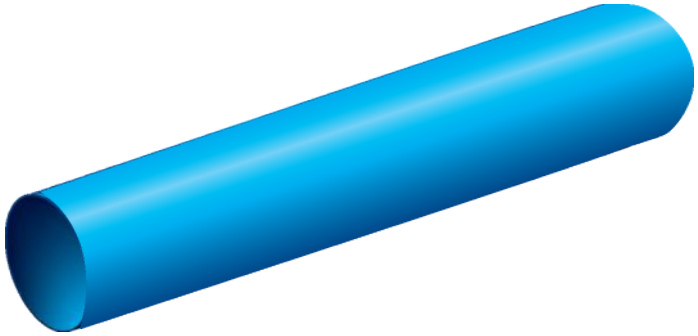
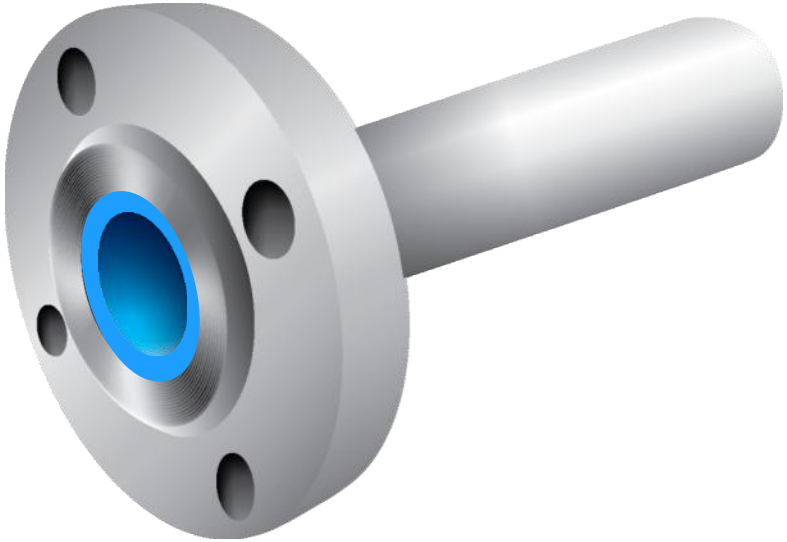
Small Bore Nozzle Protection





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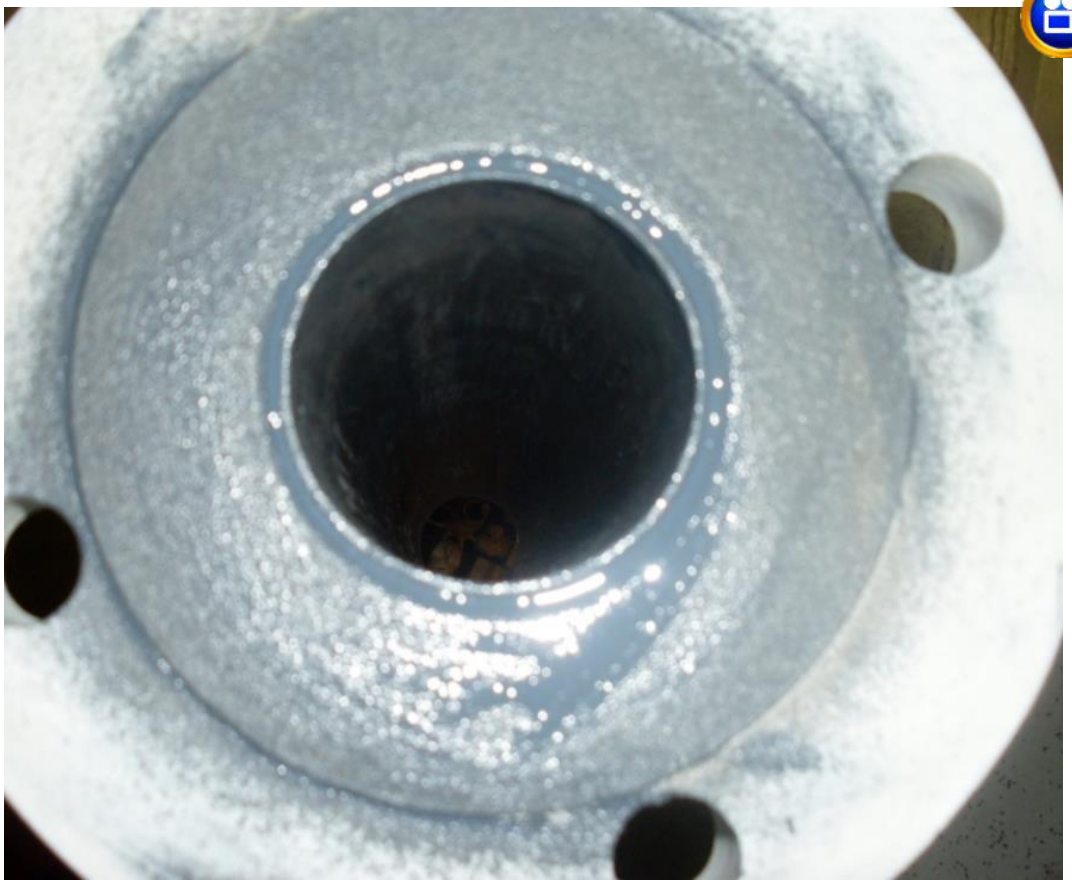
Small Bore Nozzle Protection



Belzona nozzle inserts bonded into small bore nozzles, protect against corrosion and erosion

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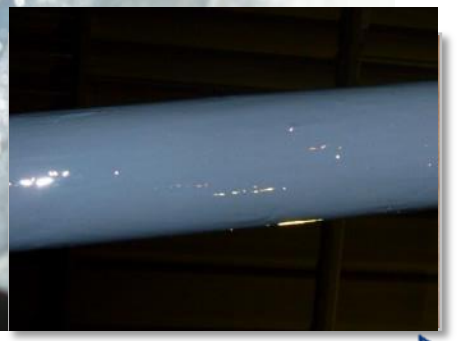
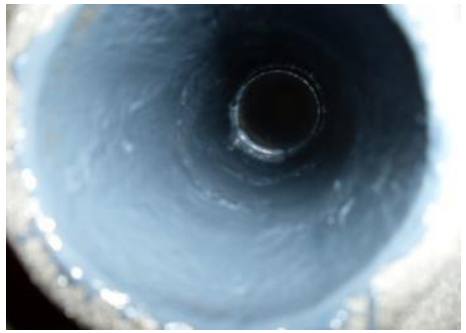
Small Bore Nozzle Protection

Salamis Application



Maersk Application

RBG Application



Validated Training:

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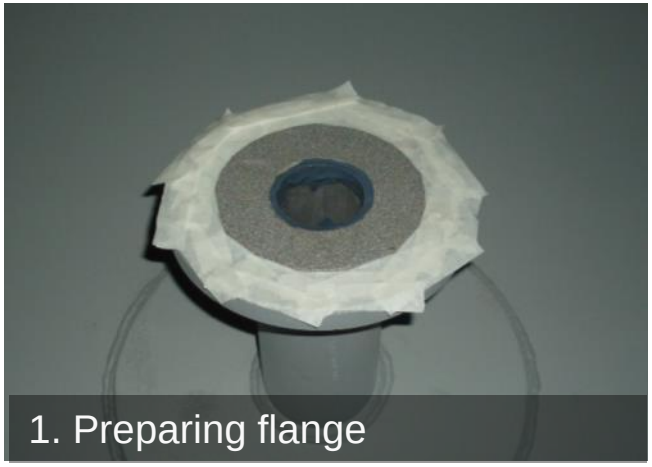
SBM and Petrobras

Brazil, 2009



1. Preparing flange

2. Face formed

Flange face forming and small bore nozzle protection, applied in 2009, inspected in 2013.

3. Bonding nozzle insert

4. Completed application

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UK Gas Terminal Methanol Still

The acid washing process at elevated temperature led to severe pitting within the tower and significant loss of wall thickness adjacent to tray support rings. High Temperature repair compound used to restore wall thickness then acid resistant lining applied to resist operating conditions at 95C - Inspected in Year 2011 and in good condition.

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Chemical Tank Protection

Equipment

Chemical Process Tank

Problem

Severe corrosion due to chemical attack to tank resulted in costly replacement

Solution

High Temperature Epoxy Novolac internal lining selected for its excellent chemical resistance

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Repair and Protection of Effluent Treatment Tank

Equipment

Large Steel tank used for the treatment of effluent

Problem

Corrosion pitting and loss of wall thickness due to previous coating failures

Solution

Repair compound used to repair pitting and bond plates to damaged areas then coating system applied

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Repair and Protection of Storage Tank

Equipment

Hydrocarbon Storage Tank

Problem

Corrosion pitting and loss of thickness in the base of the tank due to previous coating failures

Solution

Repair compound used to fill pitting and bond plates to damages area of the tank then internal coating system Applied.

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Repair and Protection of Produced Water Tank – Occidental Oman Year 2011 Ongoing

Equipment

Produced Water Storage Tank operating up to 115C

Problem

Corrosion pitting and loss of thickness in the base due to previous coating failures

Solution

Repair system used to fill pitting / and then High Temperature Coating System applied.

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Internal Linings for Vessels and Tanks

BELZONA HYBRID EPOXY NOVOLAC SOLUTIONS

- Proven to provide solutions for pressure vessels operating at elevated temperatures and pressures
- Novel solutions for flanges and small bore nozzles
- Cold bonding Solutions for Internal Furniture
- Proven to outperform traditional conventional paints and coatings
- Accepted and specified by many major Oil and Gas companies
- Proven to provide a cost effective through life alternative to traditional materials of construction

ONGOING INVESTMENT IN RESEARCH AND DEVELOPMENT

NEW ! ***Belzona 1500 Series High Temperature Coating Systems***

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Internal Corrosion Management of Pressure Vessels

ANY QUESTIONS ?

Presented By : Mr Ron Campbell
Belzona Polymerics Ltd

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