Tank bottoms repair

Introduction

After some years in service tank bottoms may experience pit corrosion, in particular crude oil tanks. This means a reduction in steel thickness and thus specific repair and maintenance operations are needed to extend the service life of the tank.



Omega pitting | Conventional pit

The presence of pits in the steel calls for special procedures utilising thick film solvent free epoxy linings, in many cases as part of a reinforced system. This applies to light, moderately and severely pitted bottoms which are structurally sound. If steel thickness is too low or with holes the weak areas must have the steel replaced; no reinforced scheme can be substitute of this.

According to API Standard RP 653, maximum first inspection interval for newly constructed tanks or existing tanks with newly installed bottom cannot exceed 10 years. Installation of fibreglass-reinforced lining systems means an additional extension of 5 years to this initial 10 years interval, so the first inspection interval can be carried out after 15 years.

There are two ways of building fibreglass-reinforced tank lining systems:

- using fibreglass mats which are hand-laid out on an already applied wet lining film and compacted in with a roller. Subsequent lining and/or mat layers may be applied depending on the specification
- using a fibreglass chopper gun, so the fibre strand is cut and filaments are projected to the surface at the same time as the liquid paint. This is less manpower intensive and thus more efficient in terms of operating cost and time

Safety

Use adequate personal safety equipment and follow sound procedures. Apply only in well ventilated areas. Observe safety labels on packaging and paint containers and consult Hempel's Safety Data Sheets for the products to be applied.

Scope

The purpose of this Technical Guideline is to provide specific advice on working procedures for repair of pit-corroded tank bottoms with solvent free epoxy tank linings including fibreglass-reinforced systems. Refer to relevant product data sheets (PDS) of the paint(s) and fibre mat/strand being used as part of the scheme for further information.

Typical Hempel products for this usage include:
- Hempaline Defend 400
- Hempaline Defend 430
- Hempaline Defend 630

Rigging of work site and considerations prior to steel work and surface preparation

Please refer to section "Rigging of work site and considerations prior to steel work and surface preparation" in the Hempel's Tank Linings Work Technical Guideline.

Additionally the following shall also be observed:
- approx. 2 metres adjacent to the surface to be repaired must be cleaned from all contaminants (sludge, water, fat, oil, grease)

- in order to avoid contamination from the upper part of the tank the area to be repaired should be sealed off with a tent. In case of floating roof tanks, the internal floating roof can be used as a cover
- In floating roof tanks, the underside of the roof shall also be cleaned or sweep blasted to remove loose corrosion and other contaminants that may fall down and contaminate the area to be repaired. For protection against rain water the gap between the floating roof seal and the tank shell shall be water-proof

Surface preparation

Please refer to section “Surface preparation” in the Hempel’s Tank Linings Work Technical Guideline.

Additionally the following shall also be observed:
- after removing oil and grease with suitable detergents and salts and other contaminants by high pressure fresh water hosing, let some water remain in the tank, so all pit-corroded areas are covered by approx. 5 cm (2”) of water)
- after 24 hours, remove water by vacuum cleaning and dry the tank. If salt contamination is still found in the pits, repeat washing treatment
- continue the procedure as indicated in the above mentioned Section 5 in the HEMPEL’s Tank Linings Work Guideline

Paint mixing and application

Please refer to section “Paint mixing and application” in the Hempel’s Tank Linings Work Technical Guideline.

Additionally the information in the following sections shall be observed:

Pit filling
After application of holding/blast primer (if needed) and in order to ensure pits are completely filled in with the selected lining, please observe the following procedure:
- spray apply the solvent free epoxy on the pitted area. There should be enough paint to fill all pits completely
- wait approx. 5 min to allow the paint to properly flow and fill in the pits
- use the squeegee to force the lining inside the pits to ensure they are properly wetted and filled in with paint
- this first application of lining on the pitted areas does not contribute to the specified Dry Film Thickness (DFT) – it is merely to ensure the pits are properly filled and sharp edges covered to provide a smooth, even surface for the subsequent regular coating application

Caulking
After pit filling and before the application of stripe coating and the subsequent repair lining system, uneven surfaces must be properly filled in to obtain a smooth, continuous surface. This includes steel plate overlaps, seams and welds in tank bottoms and walls, as well as the chime area (the joint area between wall and floor plates). Caulking materials are used for this purpose.

This step is especially important when applying reinforced systems (with fibreglass mat and chopped glass fibres), as if the surface is not even it is very difficult to obtain a regular, smooth application, particularly in the chimes. It is also important to allow the caulking material to dry hard before proceeding with the application of the fibreglass reinforced system.

The caulking material should be sealed with a thin coat of the solvent free epoxy prior to application of the first coat of the specified coating system in order to avoid entrapped air.

Please refer to Hempel’s Technical Guideline “Caulking of tank bottoms and walls”.

Application of the coating system
After caulking and subsequent stripe coating, one of the three following coating system is applied according to the relevant specification:
- non reinforced, thick film lining system
- reinforced thick film lining system with fibreglass mat (single or double layer hand-lay laminate)
- reinforced thick film lining system with chopped glass fibres

Non reinforced thick lining system
Spray apply the lining scheme as detailed in the relevant specification (number of coats, DFT).

Single layer fibreglass mat reinforced system/hand-lay laminate
- Spray apply a first layer of the specified solvent free epoxy at 400 microns WFT.
- Hand-lay out the fibreglass mat on the wet lining coat. Recommended nominal weight for this fibreglass mat is 450 g/m^2 E-glass type. This will nominally contribute approximately 600 microns to the total film thickness of the final laminate system.
- Spray a light coat of solvent-free epoxy on top of the fibreglass mat (equivalent to 200 mics WFT)

- Ensure 10 cm overlap between mats.
- Use a serrated or split-washer aluminium or stainless steel roller to work out all wrinkles, folds and entrapped air by compacting the fibreglass mat in the wet lining, so it is fully saturated with paint. To ensure this, application of additional solvent free epoxy may be needed but pooling of excess coating on top of the mat shall be prevented.



- Pressure will be needed to expel entrapped air and to saturate the fibreglass mat. Surface shall be smooth.
- Visually inspect the laminate after initial hardening has occurred. Projecting fibre glass strands shall be sanded.
- In some specifications a 'veil coat' is applied. The purpose of the veil coat is to reduce the surface texture of the main laminate layer. It consists of a spray applied coat of around 300 microns of solvent-free epoxy into which fibre glass surfacing tissue (30 g/m^2) is hand-laid into the wet lining coat. A light coat of solvent-free epoxy (equivalent to 100 microns) sprayed on top of the surfacing tissue. The same as with the fibreglass mat, use the serrated or split-washer aluminium or stainless-steel rollers to work out all wrinkles, folds and entrapped air. Ensure that the fibreglass surfacing tissue is fully saturated with paint and that pooling of excess coating on top is prevented.
- Examine the surface closely to locate any folds, wrinkles and entrapped air pockets. If found, cut and grind out such defects and repair with stripe coating, fibreglass mat and additional coat of the solvent free epoxy.
- In case fibre glass surfacing tissue is used and if dry areas are observed, apply additional solvent free epoxy and work thoroughly into the surface to fully saturate the fibres.
- After curing inspect the repairs for holidays, repair if they are found.
- Check DFT; if low, correct by applying an additional coat. Do not allow coating to pool on top of the glass fibre mat. Remove excess DFT by sanding or grinding to the correct range.
- Random check for adhesion by "ringing" (lightly tapping the laminate to ensure there is no hollow between the laminate and substrate indicating a disbondment).
- Allow to dry for at least 24 hours and spray apply the gel coat according to the specification (generally, the same solvent free epoxy at 400 microns DFT).
- Typical system:

Painting step	Product	DFT (microns)
Primer (if specified)	Hempaline Prepare 130	50
Pit filling	Hempaline Defend 400, 430 or 630	n.a.
Caulking	Hempaline Defend 400, 430 or 630 + washed, fire dried silica sand with average particle size 200 micron (sieved at 300 micron)	n.a.
Laminate layer	Hempaline Defend 400, 430 or 630 with saturated fibreglass mat	1200*
(Optional) Surface tissue layer	Hempaline Defend 400, 430 or 630 with saturated surface tissue	400
Gel coat	Hempaline Defend 400, 430 or 630	400

*Note: DFT indicated above is representative of the complete coat including glass mat. For paint consumption calculations a figure of 50% is recommended for the laminate layer (before normal loss factor is applied).

Double layer glassfibre mat reinforced system/hand-lay laminate

- Spray apply a first layer of the specified solvent free epoxy at 400 microns DFT.
- Hand-lay out the fibreglass mat on the wet lining coat. Recommended nominal weight for this fibreglass mat is 450 g/m^2 E-glass type. This will nominally contribute approximately 600 microns to the total film thickness of the final laminate system.
- Spray a light coat of solvent-free epoxy on top of the fibreglass mat (equivalent to 200 mics WFT)
- Ensure 10 cm overlap between mats.

- Use a serrated or split-washer aluminium or stainless steel roller to work out all wrinkles, folds and entrapped air by compacting the fibreglass mat in the wet lining, so it is fully saturated with paint. To ensure this, application of additional solvent free epoxy may be needed but pooling of excess coating on top of the mat shall be prevented. Pressure will be needed to expel entrapped air and to saturate the fibreglass mat. Surface shall be smooth.
- Visually inspect the laminate after initial hardening has occurred. Projecting fibre glass strands shall be sanded.
- Spray apply a second layer of the specified solvent free epoxy at 400 microns DFT.
- Hand-lay out the fibreglass mat on the wet lining coat. Recommended nominal weight for this fibreglass mat is 450 g/m^2 E-glass type. This will nominally contribute approximately 600 microns to the total film thickness of the final laminate system.
- Spray a light coat of solvent-free epoxy on top of the fibreglass mat (equivalent to 200 mics WFT)
- Ensure 10 cm overlap between mats.
- Use a serrated or split-washer aluminium or stainless steel roller to work out all wrinkles, folds and entrapped air by compacting the fibreglass mat in the wet lining, so it is fully saturated with paint. To ensure this, application of additional solvent free epoxy may be needed but pooling of excess coating on top of the mat shall be prevented.
- Pressure will be needed to expel entrapped air and to saturate the fibreglass mat. Surface shall be smooth.
- Visually inspect the laminate after initial hardening has occurred. Projecting fibre glass strands shall be sanded.
- In some specifications a ‘veil coat’ is applied. The purpose of the veil coat is to reduce the surface texture of the main laminate layer. It consists of a spray applied coat of around 300 microns of solvent-free epoxy into which fibre glass surfacing tissue (30 g/m^2) is hand-laid into the wet lining coat. A light coat of solvent-free epoxy (equivalent to 100 microns) sprayed on top of the surfacing tissue. The same as with the fibreglass mat, use the serrated or split-washer aluminium or stainless-steel rollers to work out all wrinkles, folds and entrapped air. Ensure that the fibreglass surfacing tissue is fully saturated with paint and that pooling of excess coating on top is prevented.
- Examine the surface closely to locate any folds, wrinkles and entrapped air pockets. If found, Cut and grind out such defects and repair with stripe coating, fibreglass mat and additional coat of the solvent free epoxy.
- In case fibre glass surfacing tissue is used and if dry areas are observed, apply additional solvent free epoxy and work thoroughly into the surface to fully saturate the fibres.
- After curing inspect the repairs for holidays, repair if holidays are found.
- Check DFT; if low, correct by applying an additional coat. Do not allow coating to pool on top of the glass fibre mat. Remove excess DFT by sanding or grinding to the correct range.
- Random check for adhesion by "ringing" (lightly tapping the laminate to ensure there is no hollow between the laminate and substrate indicating a disbondment).
- Allow to dry for at least 24 hours and spray apply the gel coat according to the specification (generally, the same solvent free epoxy at 400 microns DFT).
- Typical system:

Painting step	Product	DFT (microns)
Primer (if specified)	Hempaline Prepare 130	50
Pit filling	Hempaline Defend 400, 430 or 630	n.a.
Caulking	Hempaline Defend 400, 430 or 630 + washed, fire dried silica sand with average particle size 200 micron (sieved at 300 micron)	n.a.
First Laminate layer	Hempaline Defend 400, 430 or 630 with saturated fibreglass mat	1200*
Second Laminate layer	Hempaline Defend 400, 430 or 630 with saturated fibreglass mat	1200*
(Optional) Surface tissue layer	Hempaline Defend 400, 430 or 630 with saturated surface tissue	400
Gel coat	Hempaline Defend 400, 430 or 630	400

*Note: DFT indicated above is representative of the complete coat including glass mat. For paint consumption calculations a figure of 50% is recommended for each laminate layer (before normal loss factor is applied).

Reinforced thick film lining system with chopped glass fibres

- Application can be done with a standard airless pump with ratio 1:60 and sufficient capacity to feed 2 nozzles. A glass fibre chopper gun must be used. It consists of a spray gun and a set of blades on top of it to cut fibre strand in such a way that cut filaments are projected to the surface at the same time as the liquid paint. The fibres are cut to a length of approximately 50mm (2in).



- Recommended chopped fibre is E-glass type with filament diameter 12 µm. The recommended spreading rate is 450 g fibres pr. m^2. For a film with dry film thickness 800µm this can be achieved with a mixing ratio of the chopped fibre to paint of approximately 30% to 70% by weight.
- Insert the fibreglass strand in the knife set on top of the chopper spray gun as per instructions of the spray gun supplier.
- Spray the lining on the surface and the cut fibreglass filaments will be simultaneously projected towards the surface. Follow the instructions of the spray gun supplier.
- Use a serrated or split-washer aluminium or stainless steel roller for compacting the fibres. Surface shall be smooth.
- Remove protruding glass fibres by light sanding in order to ensure minimum perforation of the coat on top.
- After curing inspect the repairs for holidays, repair if holidays are found.
- Check DFT; if low, correct by applying an additional coat.
- Allow to dry for at least 24 hours and spray apply the topcoat according to the specification (generally, the same solvent free epoxy at 400 microns DFT).
- Typical system:

Painting step	Product	DFT (microns)
Primer (if specified)	Hempaline Prepare 130	50
Pit filling	Hempaline Defend 400, 430 or 630	n.a.
Caulking	Hempaline Defend 400, 430 or 630 + washed, fire dried silica sand with average particle size 200 micron (sieved at 300 micron)	n.a.
First layer	Hempaline Defend 400, 430 or 630 with chopped glass fibres	800
Topcoat	Hempaline Defend 400, 430 or 630	400

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