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# **Bekaert Progressive Composites PROTEC™ Pressure Vessels**

## **Users Manual**

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## Section 1 Intended Use

The **Pressure Vessel** is designed for continuous use as a housing for membrane elements. Vessel has been designed to meet the standards of the American Society of Mechanical Engineers (ASME), Boiler and Pressure Vessel Code, Section X. At an additional cost, vessels can be inspected during fabrication by an ASME Authorized Inspector and Code stamped. Vessel must be installed, operated and maintained using good industrial practice and following the precautions listed in order to help assure safe operation and a long service life. Misuse, improper installation or operation may result in severe bodily harm or property damage and will void the vessel warranty. Therefore, review and follow the safeguards listed below **before** placing the vessels into service. The filament-wound reinforced plastic shell of this vessel must be allowed to expand under pressure. Any undue restraint at the support points or piping connections can cause non-repairable leaks to develop in the shell. This vessel must not be subjected to excessive stress caused by bending moments acting at the side ports in the fiberglass shell. The end closures and side ports of the vessel must be kept dry and free of corrosion at all times. Failure to do so may result in deterioration that can lead to catastrophic failure of the vessel heads. When requested, Bekaert Progressive Composites will assist the purchaser in determining the suitability of this standard vessel design for their operating environment. However, the final determination including the evaluation of the materials of construction for use in the specific corrosive environment shall be the responsibility of the purchaser. Alternate materials of construction may be available on special order.

## Section 2 Precautions

**Follow all instructions.**

Failure to take every precaution listed will void the vessel warranty and may result in vessel failure.

**Mount shell using furnished hardware.**

Following the recommended span(s), mount the vessel on saddles provided. Tighten straps to 1 ft-lb (1.4 N-m) maximum.

**Align the side ports with the manifold.**

Center each vessel with the manifold and correct the causes of misalignment for each and every vessel.

**Use flexible type groove-end pipe couplings.**

Use Victaulic™ or similar flexible groove-end couplings adequate for the intended pressure following the manufacturer specifications. Allow the maximum possible gap permitted by the coupling device, in order to maximize flexibility.

**Maximize the connection flexibility.**

Position the vessel and the piping so that the vessel can grow in length and diameter under pressure without any undue restraint.  $\Delta\text{DIA} = 0.014''$  (0.4 mm) and  $\Delta\text{L} = 0.25''$  (6.4 mm) for a length code -7 vessel. This is especially true for Permeate piping where it is mandatory to maintain maximum flexibility.

**Provide overpressure protection.**

Set the safety device at not more than 105% design pressure.

**Inspect end closures and side ports regularly.**

Replace damaged or deteriorated components and correct the cause of any deviation.

**Relieve system pressure before working on the vessel.**

Working on vessels that are under pressure may result in bodily harm and/or property damage.

**Never support other components with the vessel.**

Hanging piping manifolds or supporting other components with the vessel may result in vessel damage. DO NOT allow the Feed / Concentrate ports or the Permeate ports to hold the weight of manifolds. Always use the frame to secure manifolds in a manner that does not pull on these ports.

**Do not over tighten the Permeate Port connection.**

Tightening the connection more than one turn past hand tight will damage the port. Avoid movement on the permeate piping not to produce stress on the permeate port.

**Ensure that the Thrust Ring is installed downstream.**

Operating without a thrust ring may cause membrane damage.

**Shim the membranes.**

Shim carefully the column of membranes to minimize movement of elements.

**Double check end closure installation.**

Ensure that retaining system is in place and fully seated.

**Never operate the vessel in excess of its ratings.**

This practice will void the vessel warranty, shorten vessel life and could lead to bodily harm or property damage.

**Do not operate the vessel permeate port over 125 psi (8.6 bar).**

Permeate pressure in excess of 125 psi (8.6 bar) must be approved by the factory prior to operation.

**Operate the vessel in only positive pressure applications.**

This vessel is not designed for vacuum conditions.

**Flush the vessel before system shut down.**

Some feed waters may cause corrosion under static conditions. Flushing with non-corrosive permeate is recommended.

**Operate the vessel within the recommended pH range.**

The vessel is designed for continuous use at a pH of 3-11 and for intermittent cleaning (less than 30 min. at a pH of 2-12). The use of chemical additives, such as sodium bisulphate or others, may impact the pH and must be continuously monitored and controlled. Please see **Section 15** for further precautions when using chemicals.

**Do not install the vessel in direct sunlight.**

*\*Please inform the factory when continuous operating temperature is less than 45°F (7°C).*

## Section 3

# PROTEC™ Pressure Vessels

## Vessel Installation

Proper vessel inspection, handling and installation are important to help ensure a long vessel life. This guide should be followed during vessel installation by the party responsible for the installation of the vessels into the system. However, following this guide does not relieve the purchaser from full responsibility for proper inspection, handling and installation of the vessel. Damage due to improper handling or installation shall be the sole responsibility of the purchaser.

Read this entire guide carefully. Vessel misuse, mishandling or corrosion damage can result in a mechanical failure that can cause property damage, personal injury or even death. Should any information provided in this guide not agree with the system suppliers recommendations, please call Bekaert Progressive Composites at +1 760-599-4800 (USA) or +34 94-674-03-12 (Spain) for clarification.

### Handling, Receiving and Inspection

Fiberglass pressure vessels are very rugged and are the choice of the industry for membrane applications. They are designed to operate safely over a long service life when they are handled and installed correctly. However, failure to do so may result in a malfunction or catastrophic failure while in service. To help prevent this possibility, please follow the precautions listed below:

- 1) Never lift or move a vessel by placing something inside the vessel bore. The inside surface is designed and intended only for membrane installation and removal. Lifting the vessel in this careless manner may permanently damage the vessel.
- 2) DO NOT scratch the inside surface of the vessel. This is especially true just inside the vessel bore where the head components must seal to the inside of the vessel.
- 3) DO NOT place tools or anything other than Membranes inside the vessel to avoid scratching the inside surface of the vessel.
- 4) DO NOT drop the vessel or allow it to hit other objects. If this happens, damage may be masked due to the durable polyurethane coating, thus hiding a potentially damaged vessel that may fail while in service.
- 5) DO NOT apply any undue stress at the shell. While the vessel can handle a small amount of misalignment, applying any undue stress may shorten the vessel life and lead to leakage while in service.
- 6) Before using a forklift or a crane to handle the vessels, either add padding to the forks or to the vessel wall to prevent any damage to the shell. Scratching or gouging the outside of the vessel can be prevented by proper handling.

## Impact Damage

Damage to the exterior of the vessel may lead to early failure. Any damage received in shipment must be reported to the shipping company immediately upon receipt. Minor damage that goes no deeper than the paint will be acceptable for adequate performance, however deep gouging should be inspected prior to the vessel being placed into service. When in doubt, please contact the Customer Service Department at Bekaert Progressive Composites at +1 760-599-4800 (USA) or +34 94-674-03-12 (Spain).

## Mounting the Shell

This section is written to address the mounting of all PROTEC pressure vessels. If you are mounting vessels for the first time, please refer to **Section 5** for piping recommendations.

## Installation

- 1) Before determining a final position for the vessel skid, make sure that adequate room is provided to access both ends of the vessel. Elements are installed from the feed end of the system and then removed from the opposite (downstream) end of the system.
- 2) Follow all the applicable guidelines on handling, receiving and inspection as noted earlier.
- 3) **NOTE:** It is important that each vessel is placed in a way to minimize any strain induced from the system piping that connects the vessel to a header or other system connection. Normally we suggest that each vessel be centered on the frame with the feed/concentrate ports located in such a way that the piping connections can be easily made without any undue stress. Plumbing components attached to the permeate port or head assembly must be independently supported.
- 4) Set the vessels on the urethane support saddles positioned directly on the system frame at the "S" dimension found on the Engineering Drawing. Ideally, the frame should already be drilled for mounting the vessels. The holes in the frame should be drilled to the dimension found on the Engineering Drawing. Bekaert always recommends for long vessels to use 3 saddles and only 2 straps to minimize shell stress.
- 5) Connect the vessels to the manifolds or to the next vessel while adjusting each shell and manifold for minimal misalignment at each end. The port to manifolds or port to port clearance should be set at the flexible connectors' Maximum recommendations. This dimension is usually 0.125 inches (3.175 mm). Double check with your coupling supplier for this value. The flexible connector should be able to be tightened without experiencing any binding. Secure the manifolds of the system and the vessels only after completing this important alignment procedure.

- 6) **WARNING:** Do not mount the vessels in any way that will restrict the growth of the vessel. Limiting expansion by rigidly mounting the vessels will not allow for proper vessel growth under pressure and affect vessel life. For expansion requirements, please see **Section 2**.
- 7) Connect the vessel straps to the system frame by positioning the screws through the frame and threading them into the bar nut located on the vessel strap. Tighten straps until finger tight.
- 8) Finish any piping and alignment that has not been completed following the alignment procedure noted above.
- 9) Using a wrench, tighten the strap screws one additional full turn. This should result in 0-1 ft-lb (0-1.4 N-m) of torque. If in question, repeat the procedure and measure the torque with an appropriate tool.
- 10) **CAUTION:** DO NOT over tighten straps to avoid vessel damage.
- 11) **NOTE:** PROTEC straps are designed to secure the vessel during operation. They have not been designed to handle any and all loads that may occur based on any unforeseen mounting condition. Appropriate evaluation should be employed to ensure that and factors such as transit, non-traditional mounting and system design. PROTEC straps are not designed to handle the weight of the vessel. For skid transportation the straps must be tightened to avoid any vessel movement but must be loosened for operation.
- 12) Strap assemblies are designed for horizontal positioning only.



## Section 4

# PROTEC™ Pressure Vessels

## Multiple Porting Recommendations

This guide is not intended in any way to replace good engineering judgment that is required for safe operation over a long service life. We recommend that only a qualified engineer or mechanic, experienced in servicing pressure vessels or high pressure equipment carry out the following tasks. If you have any questions concerning proper maintenance, please contact the factory at +1 760-599-4800 (USA) or +34 94-674-03-12 (Spain).

Multiple port vessels are those specified by the user to have more than one high-pressure port per end. This feature allows vessels to be directly connected together allowing water to flow through one vessel into another. This piping method has become an acceptable way to provide superior system designs while reducing system costs. While the thought of directly bolting vessels together is easily understood, there are several guidelines that must be followed in order to have a good long-term system design. These are as follows:

### **Flow-balance the system.**

When supplying feed water from one side of the vessels, take the concentrate from the opposite side. This will prevent more water from flowing through the first vessel and starving the second and third. This practice will help equalize feed flow to each vessel.

### **Minimize pressure drop.**

As water passes through each vessel, a pressure drop occurs. This will result in the last vessel in a connected pass receiving less pressure than the first. Increasing port size reduces this effect.

### **Optimize the water velocity through the ports.**

The speed of the water through the ports should be kept within a reasonable range to ensure proper long-term performance (typically 5-15 ft/sec. (1.5-4.5 m/sec.)) Speeds that are too fast will result in port erosion while speeds that are too slow will promote corrosion.

### **Avoid the temptation to use smaller ports.**

Even though the thought of adding on an extra vessel with small ports sounds reasonable, it can result in a pressure drop problem.

**Take caution when using more than one port size.**

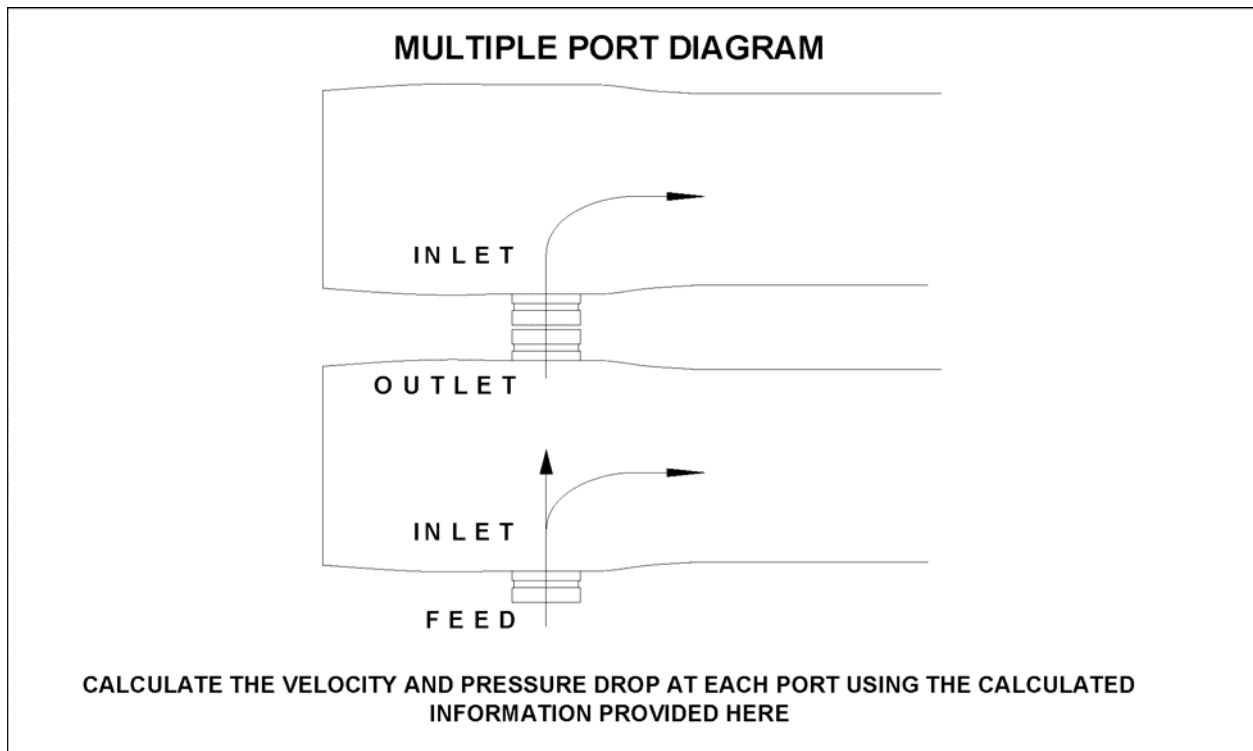
Changing ports sizes in a second or third pass requires careful evaluation of pressure drop that can affect system performance.

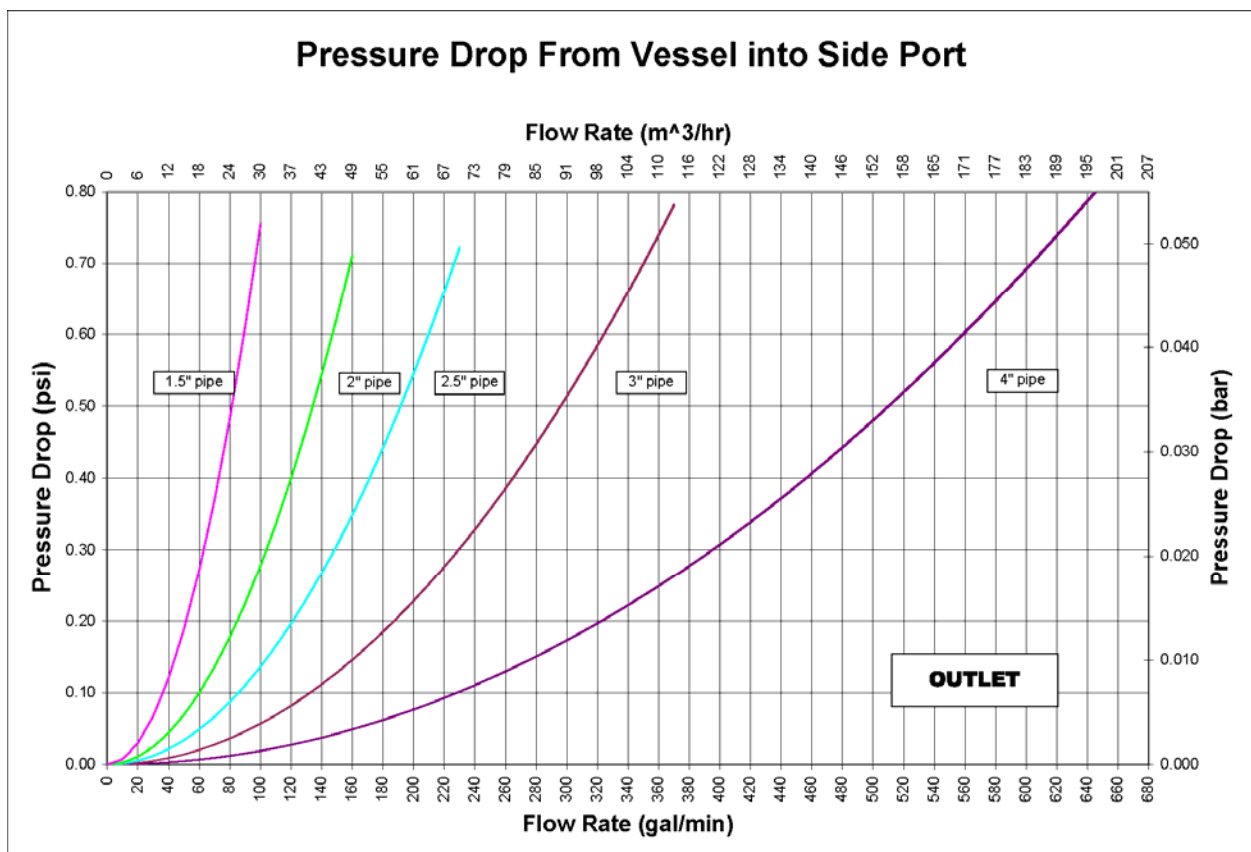
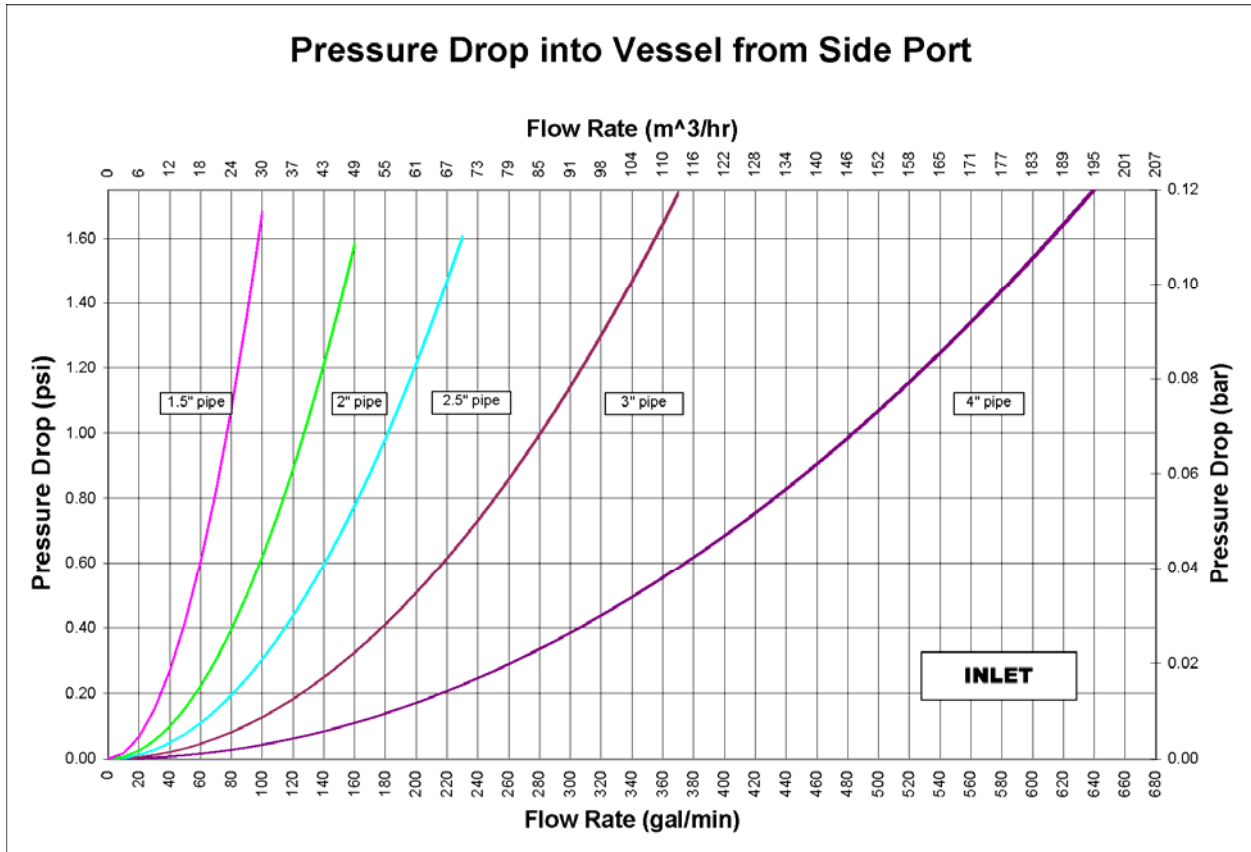
**Check with your membrane supplier.**

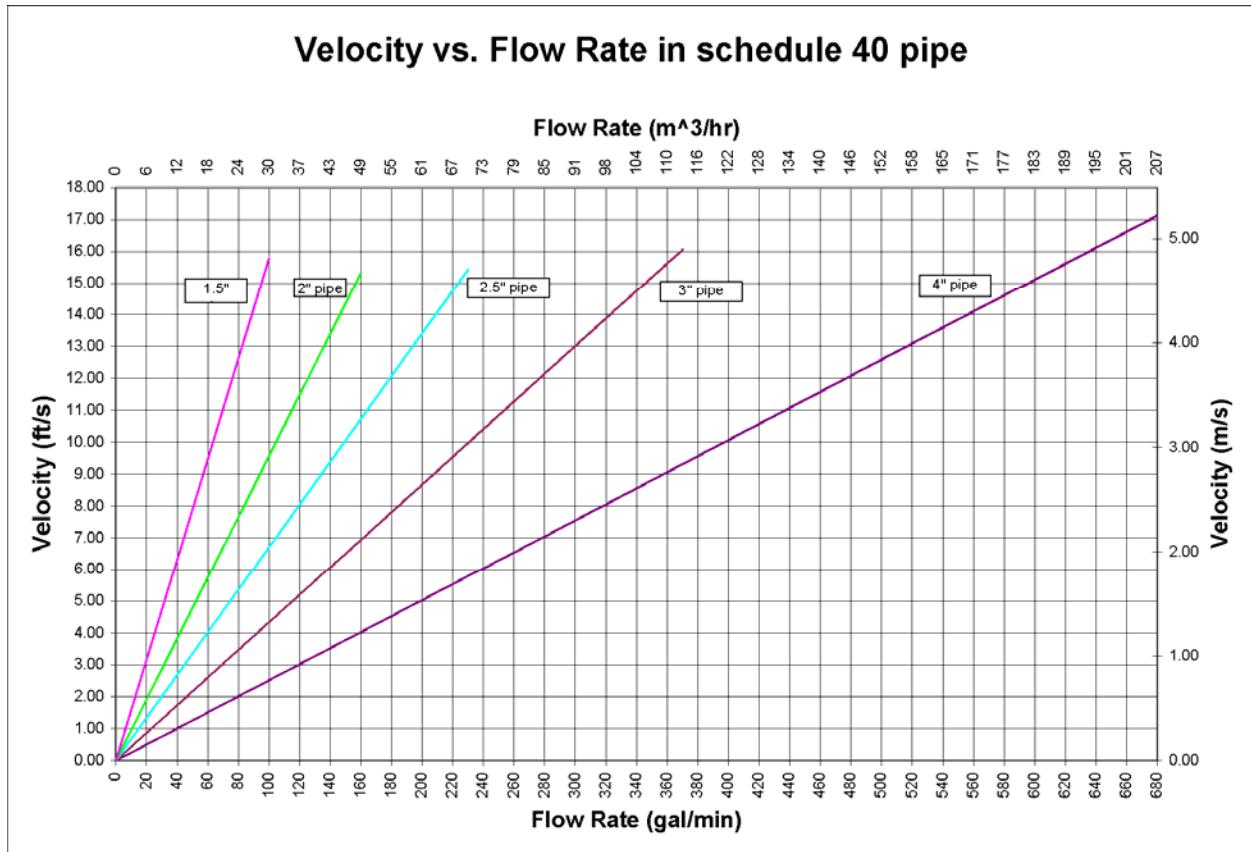
It is a good idea to let your membrane supplier evaluate the performance of your proposed system.

**Don't assume that we endorse the use of multiple ports for your system.**

Just because vessels can be ported together does not make them the best choice for your system. Bekaert Progressive Composites is not responsible for the misapplication of the multiple port option.







## Section 5

# PROTEC™ Pressure Vessels Piping Recommendations

This guide is not intended in any way to replace good engineering judgment that is required for safe operation over a long service life. We recommend that only a qualified engineer or mechanic, experienced in servicing pressure vessels or high pressure equipment carry out the following tasks. If you have any questions concerning proper maintenance, please contact the factory at +1 760-599-4800 (USA) or +34 94-674-03-12 (Spain).

PROTEC™ pressure vessels are the most durable side port vessel available today. Unlike vessels with less durable designs, connecting PROTEC side ported vessels to manifolds or to each other is easily done if some very basic rules are followed. These are as follows:

**Use two flexible Victaulic™ connections when manifold accuracy is questionable.**

The tolerance required for side-ported vessels should be a total per port of 0.030" (.76 mm). For retrofitting side-ported vessels into older systems or when manifold tolerances can simply not be guaranteed, the two-connection method is the safest approach.

**Use a single flexible Victaulic™ connection when manifold accuracy is not a problem.**

This is possible when manifold to vessel misalignment can be held to within 0.030" (0.76 mm) in any direction. However, it is important to note that these flexible connections allow angular but not lateral misalignment. Therefore, any misalignment must be kept to a minimum.

**Use intermediate Victaulic™ connections in the manifolds when required.**

This practice allows more flexibility in the system resulting in easier to install manifolds.

**Center the vessel between the manifolds.**

This is very basic but commonly overlooked. If the port on one end is directly aligned with the manifold and the opposite end is off by a small distance, centering the vessel so that the small distance is equally divided between each end before tightening the straps allows each end to handle half this distance rather than all at one end. Do this with each vessel to reduce stress on the ports.

**Allow one manifold to float.**

In some systems, the manifold can be connected to the vessels and supported by the floor but allowed to float in the axial direction to provide room for vessel growth under pressure.

**Let the manifold span be longer than the vessel span.**

Remember that the vessel will grow in length under pressure, see **Section 2**. Setting the manifold span to the maximum tolerance is another way to provide room for vessel growth under pressure.

**Check each connection for acceptable misalignment.**

By installing the Victaulic™ connection without the gasket and drawing the bolts snug, the connector should be able to rotate by hand. On some systems this test may not be practical. In these cases the Victaulic™ connections must be able to be tightened without the need of excessive force. Force would indicate a major misalignment that could damage the vessel. When in doubt, contact the factory.

**Ship skids without Victaulic™ couplings to prevent damage.**

We recommend that prior to the shipment of preassembled skids, the Victaulic™ couplings be removed and shipped in a separate box. The gasket should remain in place for easy assembly at the destination.

## Section 6

# PROTEC™ Pressure Vessels Pre-Pressurization Checklist

### **Danger – High Pressure Device**

The operation of this vessel may cause loss of life, severe bodily harm and/or property damage if not installed correctly and maintained throughout operation. Read, understand and apply all the guidelines given before attempting to open, close, service or in any way operate this vessel.

Failure to follow these guidelines, observe every precaution and use good engineering judgment may result in a malfunction that could result in the explosive failure of a vessel head or side port.

Misuse, incorrect assembly or the use of damaged or corroded components in the end closure or vessel side port can result in the components failure.

We recommend that only a highly qualified engineer or mechanic experienced in serving high pressure equipment open, close and service this vessel.

The checklist alone does not include all the details needed for safe vessel operation. Use the checklist each time any service operation is carried out to ensure that each step is completed before pressurizing the vessel.

# PROTEC™ Pressure Vessels Pre-Pressurization Checklist

## Membrane Elements

- Installed per manufacturers recommendations.
- Feed flow direction correctly noted and elements correctly oriented.

## Element Interface

- Adapters installed at both ends of element column.
- Thrust Cone installed downstream. (Concentrate or brine end) of the element column.

## Head

- All components in as-new condition clean and free of damage or corrosion.
- All components properly assembled with new freshly lubricated seals as required.
- Head stamped with proper rating for system.
- Head seal is free of dirt, grit, dust, etc.
- Head assemblies are properly shimmed to avoid membrane shifting.

## Head Assembly Interlock (PRO)

- Retaining ring groove at each end of shell clean, free of corrosion with insert ring in sound condition.
- All components in as-new condition; clean and free of damage or corrosion.
- Retaining Ring is fully seated in the retaining ring groove.

## Head Assembly Interlock (BPV)

- Locking segment groove at each end of shell clean, free of corrosion with locking segments in sound condition.
- All components in as-new condition; clean and free of damage or corrosion.
- Locking segments are fully seated in the locking segment groove and retaining screws are tight.

## Side Ports and Piping Connections

- Properly aligned (strain-free) and secured.
- Leak and corrosion free.



## Section 7

# PROTEC™ Pressure Vessels

## Preventative Maintenance

Preventative maintenance is essential to help ensure the safe operation of Bekaert Progressive Composites PROTEC™ pressure vessels.

Attention to each point listed below will enhance long-term use and provide a vessel that is easier to open, close and service. Please use the list below as well as sound engineering judgment when it comes to vessel maintenance. If you have any questions concerning proper maintenance, please contact the factory at +1 760-599-4800 (USA) or +34 94-674-03-12 (Spain).

For suggestions on cleaning corrosion deposits from the vessel or head, please refer to **Section 9**.

### Prevention Checklist

- ⇒ **End closures. Inspect for components that have deteriorated. Replace as needed.**
- ⇒ **Side Ports. Inspect for leakage or any signs that the locking system of the side port may have deteriorated. This may require the removal of the port or port seal to determine locking components condition. Replace as needed.**
- ⇒ **Keep external head assembly components as dry as possible.**
- ⇒ **Keep all side ports dry and free of leaks that can cause corrosion.**
- ⇒ **DO NOT TOLERATE LEAKS.**

#### **CAUTION:**

**Any leakage indicates a potentially dangerous condition. Failure to eliminate leakage may void the vessel warranty and could result in vessel failure.**

## Section 8

# PROTEC™ Pressure Vessels

## Recommended Spare Parts

Many system operators commonly request our input as the supplier when it comes to the amount of recommended spare parts required for our pressure vessels. This question is sometimes difficult to answer as we can not predict any abuse that the vessel may see during start-up and we have no information concerning the operating environment. However, we can provide a good faith estimate of what a supplier may want to have on hand to ensure proper system performance. The following spare parts / consumables list is for start up and the first two years of operation. These components are available for sale from Bekaert Progressive Composites. If you have any questions concerning spare parts / consumables, please contact the factory at +1 760-599-4800 (USA) or +34 94-674-03-12 (Spain).

### Spare Parts

Number of vessels	1-50	51-100	101-250	251-500	500 & up
<b>Part Name</b>					
Entire vessel head	2	3	4	5	6
Head Locking Ring (PRO)	2	4	6	8	10
Head Locking Segment sets (BPV)	2	4	6	8	10
Permeate Port	1	2	4	6	8
Adapter	2	3	4	5	6
Thrust Cone	1	2	4	6	8
Side port seal	6	8	10	10	10
Head Seal	10	10	20	20	25
Permeate Port Seal	10	10	20	20	30
Adapter Seal	10	10	20	20	30
PWT Seal	10	10	20	20	30

## Section 9

# PROTEC™ Pressure Vessels Troubleshooting

This section is written specifically for the troubleshooting of PROTEC™ pressure vessels.

This guide is not intended in any way to replace good engineering judgment that is required for safe operation over a long service life. We recommend that only a qualified engineer or mechanic, experienced in servicing pressure vessels or high pressure equipment carry out the following tasks. If you have any questions concerning proper maintenance, please contact the factory at +1 760-599-4800 (USA) or +34 94-674-03-12 (Spain).

### Vessel Inspection

Inspect the vessel at each end for corrosion which may interfere with the removal of the head. If corrosion is found or suspected, proceed as follows:

- 1) Loosen any deposits with a brush and or a medium piece of Scotchbrite™.
- 2) **CAUTION:** Do not use a wire brush on any components made from plastic, or fiberglass.
- 3) Flush away any loosened deposits with clean water.
- 4) Proceed with the instructions in **Section 10** to remove the vessel head.

### Difficulty in Opening the Vessel

**Note:** The recommendations listed below are intended only as a guide. If head assembly is still difficult to remove after the recommendations have been followed, call Bekaert Progressive Composites for technical assistance.

## Retaining Ring (PRO)

- 1) Will not release from the retaining ring groove:
  - a. Check that Head has been tapped inboard approximately 1/8" (3 mm). See **Section 10**, step 4.
  - b. Apply a penetrating fluid (such as WD-40 or LPS-1) to the interfacing areas of the retaining ring.
  - c. With a screwdriver handle or a similar tool, tap the retaining ring to release the bond.
  - d. Again attempt to remove the ring. A screw driver may be used to pry the finger pull from the shell.
  - e. Once the ring is removed, inspect the retaining ring groove and the ring for any corrosion damage. Renew all components to as-new standards.

## Head Assembly

- 1) Will not release from the shell.

**NOTE: If the Head is difficult to remove, remove a flexible port or manifold connection or take action to release any vacuum that may be holding the head in place.**

### a. Method A

- i. With a soft piece of wood and a plastic mallet, tap the face of the Bearing Plate of both sides to move the head inboard approximately 1/8" (3 mm).
- ii. Pull head out of shell by grasping the permeate port.

### b. Method B (Section 10 step 5)

- i. Thread two 5/16-18 or 8 mm (See order details) T-handles into the threaded holes on the Bearing Plate of the vessel.
- ii. Carefully pull on the T-handles while gently rocking the head back and forth to remove the head.

### c. Method C (Section 10 step 5)

- i. Drill a 14" (35 cm) long section of 1/4" (1 cm) steel bar stock with two holes that match the span of the threaded holes in the Bearing Plate.
- ii. Place the section of bar stock against the end bell of the vessel so that the metal is supported by the vessel bell.
- iii. Thread two 5/16-18 or 8 mm (See order details) threaded rods through the bar stock and into the bearing plate until they are threaded 1/4" (1 cm) into the Bearing Plate.
- iv. Put nuts on the threaded rods with washers between the nuts and the bar stock.
- v. Turn each nut 1/2 turn at a time, alternating between the two nuts until the head is released from the vessel.

## Seal Leakage

### Vessel Side Port

Follow the instruction for seal replacement found in **Section 13**.

**CAUTION:** Be careful to inspect for corrosion of the side port locking mechanism whenever a side port has been leaking. The use of corroded parts may lead to side port failure.

### Head Seal

**Warning:** Most head seal leaks are caused by improper membrane loading. Whenever a membrane or a vessel head is loaded, it must be flushed with clean water directly prior to installation to remove any grit or debris that may scratch the vessel bore. Scratches caused by improper loading or vessel abuse are not covered under warranty.

- 1) Remove seal from Sealing Plate.
- 2) Carefully inspect the seal gland on the Sealing Plate for any contamination or damage that may affect sealing properties.
- 3) Renew Seal Plate gland or replace to achieve as-new condition.
- 4) Install a new head seal that has been properly lubricated.
- 5) Inspect vessel bore for any damage such as scratches that may affect sealing.
- 6) If scratches are found, they may be carefully sanded with 600 grit sand paper dipped in a mild soap/water solution. If any scratches can not be removed in this manner, contact the factory for further instructions.

## Sudden Drop in Permeate Quality

Systems that are constantly started and stopped may develop problems with permeate quality. Usually this problem is found when the membrane column moves under pressure. Problems of this nature are typically sudden and indicate a seal problem. Changes that happen over time are typically not related to sealing problems and should be addressed by the membrane supplier.

If permeate quality drops suddenly and membrane performance is not in question, proceed as follows:

- 1) First check the membrane interconnectors and membranes by doing a probe following the membrane manufacturer guidelines.
- 2) Open the vessel head following the instruction in **Section 10**.
- 3) Remove the adapters from each end of the vessel.
- 4) Remove the PWT seals from the Adapter and the Adapter Seal from each Permeate Port.
- 5) Inspect all of these seals for any damage that may cause leakage. This may be noticeable as a tear, flat spot or gouge in the material.
- 6) If the seals have moved out of the groove in the Adapter or Permeate Port, this may indicate that the system is experiencing excessive membrane movement during start up and shut down. There are two ways to correct the problem. One is to install the PROTEC Auto-Shim device and the other is to shim the system.

## Installing the Auto-Shim

Contact the factory to enquire about the use of the Auto-Shim for your application. Please note that the Auto-Shim must be installed on the feed end of the vessel. If this is possible, we recommend the use of this device. If installing on the feed end is simply not possible or practical, we recommend that the vessel be shimmed.

## Installing Shims

Shimming is done by placing plastic spacers between the adapter and the hub of the Permeate Port on the upstream end of the vessel. When this is done correctly, it will help eliminate excessive movement of the membranes during start up and shut down. This will in turn prevent damage to the PWT and Adapter seals. The plastic spacers used for shimming are provided with each adapter and are .20 inches thick or 3 mm / 10 mm thick (See order details).

The suggested shimming procedure is as follows:

- 1) Before continuing, ensure that the Thrust Cone is installed on the down stream Head and the membranes are loaded and pushed down-stream as far as possible.
- 2) Remove the product water tube seals (PWT seals) from the upstream adapter and the Head Seal from the Sealing Plate.
- 3) Lubricate the Adapter Seal in the Permeate Port and also lightly lubricate the outside of the Adapter that engages into the Permeate Port.
- 4) Push the Adapter into the Permeate Port Hub until the Adapter passes the Adapter Seal.
- 5) Line the Adapter up with the product water tube on the upstream membrane element and install the head until the Bearing Plate passes the Retaining Ring groove in the shell.
- 6) Remove the head being careful to not disrupt the Adapter location in the Permeate Port.
- 7) Measure the distance between the Adapter hub and the Permeate Port. This area is where the Shims will be placed.
- 8) Determine how many Shims are required without needing more distance than measured minus 1/8" (3 mm) to allow for Head removal.
- 9) Install the Shims onto the Adapter.
- 10) Install the Head into the vessel a second time, to verify that there is still enough room to get the Head Retaining Ring into the groove in the shell. The Head should clear the Groove by about 1/8" (3 mm).
- 11) Now reinstall the seals removed in prior steps onto the Adapter and the Permeate Port.
- 12) The Head may now be installed following the directions in **Section 12** for the model used.

## Section 10

# PROTEC™ Pressure Vessels

## Head Removal Procedure

This guide is not intended in any way to replace good engineering judgment that is required for safe operation over a long service life. We recommend that only a qualified engineer or mechanic, experienced in servicing pressure vessels or high pressure equipment carry out the following tasks. If you have any questions concerning proper maintenance, please contact the factory at +1 760-599-4800 (USA) or +34 94-674-03-12 (Spain).

### Step 1 Shut Down System

Shut down system and take all steps necessary to relieve system pressure from the vessel.

### Step 2 Disconnect Permeate Piping

Carefully disconnect the permeate piping from the permeate port. Set this piping in a secure place for re-assembly.

### Step 3 Check End Closure

Examine the end closure for any corrosion or damage. Remove any corrosion with a brush and flush away the deposits with clean water. Order replacement components and seals as required.



#### Step 4 Remove Retaining Ring (PRO)

Never remove the two bolts. With a soft piece of wood and a plastic mallet, tap the face of the Bearing Plate on both sides to move the head inboard approximately 1/8" (3 mm). Pull the retaining ring out of the groove in the shell. After the ring is removed from the groove for 1/4 turn, stop pulling. Finish removing the ring by running your finger behind the ring and carefully pulling the ring from groove. It is best to follow the ring in a clockwise direction while removing to avoid stretching the ring.

#### Remove Locking Segments (BPV)

Remove the three retaining screws from the head that hold each segment in place. Push the head into the vessel until the locking segments can be removed.

#### Step 5 Remove Head (See figures below)

Use the two tapped 5/16-18 or 8 mm (See order details) holes in the bearing plate to pull the head out. It is recommended that you contact the factory for head removal tools.



## Section 11

# PROTEC™ Pressure Vessels Head Rebuilding Procedure

This guide is not intended in any way to replace good engineering judgment that is required for safe operation over a long service life. We recommend that only a qualified engineer or mechanic, experienced in servicing pressure vessels or high pressure equipment carry out the following tasks. If you have any questions concerning proper maintenance, please contact the factory at +1 760-599-4800 (USA) or +34 94-674-03-12 (Spain).

### Step 1 Remove Adapter

Pull the adapter from the permeate port by slowly pulling on the adapter body.

### Step 2 Remove Permeate Port

Carefully remove the metal retaining ring from the permeate port as to not damage the ring or the port. A new retaining ring may be required to assemble the head. After the ring is removed, carefully slip the bearing plate off the permeate port and set it aside. Then simply pull the permeate port from the sealing plate.

### Step 3 Remove Seals

Remove the seal from the permeate port and set aside. Using a small tool, such as a screwdriver or a paper clip, remove the seal from the inside of the permeate port and set aside.

### Step 4 Clean All Components

Using a mild soap solution, clean each component, rinse with fresh water and then dry with compressed air or a lint free towel.

### Step 5 Inspect Components

Examine each component for corrosion or damage that may affect the performance of the vessel. Replace any components that have corrosion or visual damage. In addition, carefully inspect each seal for damage or wear. It is recommended to replace each seal at this time. Please be aware that seal condition may affect system performance.

### Step 6 Lubricate Seals

Using extreme care, coat each seal with a thin layer of glycerin. Only a thin layer is required. Silicone lubricants can also be used; however, care should be taken to use as little as possible. Check with your membrane supplier before using these lubricants as they can foul membranes.

### Step 7 Reassemble Head

Reversing the removal procedure, reassemble the head. Please note that a new permeate port retaining ring may be required to ensure correct component performance.

## Section 12

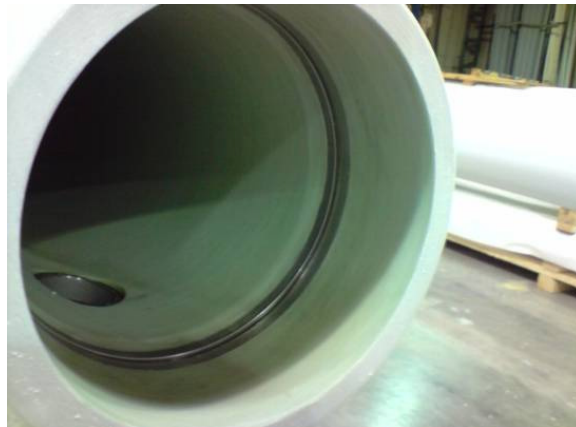
# PROTEC™ Pressure Vessels

## Head Loading Procedure

This guide is not intended in any way to replace good engineering judgment that is required for safe operation over a long service life. We recommend that only a qualified engineer or mechanic, experienced in servicing pressure vessels or high pressure equipment carry out the following tasks. If you have any questions concerning proper maintenance, please contact the factory at +1 760-599-4800 (USA) or +34 94-674-03-12 (Spain).

### Step 1 Inspect Vessel Shell

Before installing the head, check the inside surface of the shell for any imperfections or foreign matter. Remove all foreign matter using a mild soap solution and rinse with clean water. To remove imperfections, lightly sand the surface of the vessel with 600 grit sandpaper and soapy water and then rinse with water.



### Step 2 Head Seal and Shell Lubrication

Ensure that the head seal is covered with a thin layer of glycerin and is free from any dirt or dust contamination. Then lubricate the inside of the shell starting directly inboard of the retaining ring groove and up the energizing ramp into the vessel bore. Only a thin layer is required. Silicone lubricants can also be used; however, care should be taken to use as little as possible. Check with your membrane supplier before using these lubricants as they can foul membranes.

### Step 3 Install Head

Holding the head square to the axis of the shell, slowly push the head into the shell until the seal passes the retaining ring groove. As a resistance is felt, tap the head into the vessel using a 2-3 lb (1-1.5 kg) dead blow hammer until the head clears the retaining ring groove. Never tap on the Permeate Port or any other plastic parts.



### Step 4 Install Retaining Ring (PRO) or Install Locking Segments (BPV)

#### Install Retaining Ring (PRO)

Remove any moisture from the retaining groove before proceeding. Carefully place the end of the retaining ring into the groove on the shell. After the ring is started, slowly push the ring towards the groove. As the ring enters the groove, continue pushing as your hand slowly rotates counter-clockwise around the inside diameter of the shell. Be careful to prevent the ring from snapping against your finger as it enters the groove.





### Install Locking Segments (BPV)

Remove any moisture from the locking segment groove before proceeding. Carefully place the locking segments into the groove on the shell. After the locking segments are inserted, slowly pull the head outward into the locking segments.



After the head has stopped against the segments, install the three screws into the head and tighten no more than 1/4 turn past finger tight (preliminary thread). Be sure that each locking segment fits correctly on the bearing plate.



Don't thread the screws totally in this step. Repeat this operation for the 3 screws, twice.

Finally, push firmly each segment into the internal part of the groove with one hand, and use the other hand to thread the screws completely.



ENSURE THAT EACH SEGMENT IS PROPERLY SEATED ON THE BEARING PLATE.

**Step 5 Reconnect Permeate Port**

Reconnect the permeate manifold to the permeate port.

**Step 6 Pressurize System**

Before starting the system, double check that each head has been correctly installed and that all piping connections are in place. Follow the guidelines in the Pre-Pressurization Checklist, **Section 6**, of this manual before start up of the system. After ensuring that all required precautions have been taken, start the system.

**Step 7 Check For Leaks**

After system start up, verify that all connections are leak free. Fix any leaks at this time to prevent corrosion that may lead to component deterioration and possibly unsafe operation.

## Section 13

# PROTEC™ Pressure Vessels

## Side Port Seal Replacement Procedure

This guide is not intended in any way to replace good engineering judgment that is required for safe operation over a long service life. We recommend that only a qualified engineer or mechanic, experienced in servicing pressure vessels or high pressure equipment carry out the following tasks. If you have any questions concerning proper maintenance, please contact the factory at +1 760-599-4800 (USA) or +34 94-674-03-12 (Spain).

While it is possible to replace the side port seal without removing the port; port removal is the best way to ensure that the seal gland is not damaged and to inspect/recondition the gland as required. Before this procedure is started, it is strongly recommended that a replacement retaining ring and a new side port seal be purchased to ensure correct port installation. A side port/seal installation kit with instructions is available. Please contact the factory for ordering.

### Step 1 Remove Retaining Ring

Carefully remove the metal retaining ring from the side port as to not damage the ring or the port.

### Step 2 Remove Side Port

Rotate the vessel, until the port is in the 2 O'clock position. Place a soft towel into the vessel bore to prevent any possible damage. Using a rubber mallet, lightly tap on the port from the outside of the vessel while holding the port from inside the vessel. Continue to tap on the port until it is removed. For radius cut side ports only; carefully mark the port and the shell to indicate correct port location for reinstallation. Check with the factory if you are not sure which ports are in the vessel.

### Step 3 Inspect Port

Inspect inside the port for any corrosion and remove any deposits with a mild abrasive. Ports that have pitting or crevice corrosion should be replaced. Inspect the sealing area of the port for areas that may create sealing problems. Imperfections can be sanded with 600 grit sandpaper and soap solution. If any imperfections cannot be removed in this manner, port replacement is required.



**Step 4 Inspect Shell**

Inspect the sealing area of the shell for areas that may create sealing problems. Imperfections can be lightly sanded with 600 grit sandpaper and a mild soap solution. If any imperfections cannot be removed in this manner the port may leak. If this is found to be the case, the vessel will require a factory technician to repair the damaged area. Contact the factory for further information.

**Step 5 Install Port**

Install the port into the vessel wall by pushing it from the inside toward the outside of the vessel. Push the port into position until the retaining ring groove clears the outside of the shell. For radius cut side ports only; use the clocking marks made during port removal to orient the port in the vessel shell.

**Step 6 Install New Retaining Ring**

Carefully install the new retaining ring being very careful not to stretch it out of shape. Feed one end of the ring into the groove. Then walk the ring into the groove by pushing on the ring with a small tool such as a screwdriver until the ring is completely installed in the groove.

**Step 7 Lubricate New Seal**

In most cases lubrication is not necessary. Check with your membrane supplier before using lubricants as they can foul membranes. When necessary, lubricate the new seal with a thin layer of glycerin. Silicone lubricants can also be used; however, use as little as possible.

**Step 8 Install New Seal**

With the tongue depressor, push the seal all the way down at two points across from each other. Then repeat the process in the opposite direction. The seal should now be installed at four corners or more for larger seals. Carefully continue to push the seal into the gland by alternating sides until the entire seal is installed.

## Section 14

# PROTEC™ Pressure Vessels Paint Repair Procedure

This guide is not intended in any way to replace good engineering judgment that is required for safe operation over a long service life. We recommend that only a qualified engineer or mechanic, experienced in servicing pressure vessels or high pressure equipment carry out the following tasks. If you have any questions concerning proper maintenance, please contact the factory at +1 760-599-4800 (USA) or +34 94-674-03-12 (Spain).

### Step 1 Sanding

Sand the affected area with 220-600 grit sandpaper (depending on the repair) to smooth the surface of the vessel.

### Step 2 Apply Compound

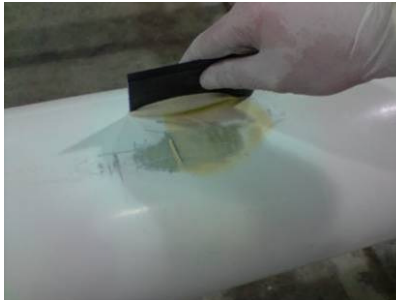
Apply a thin layer of repairing compound material with filler to cover all of the area.

### Step 3 Sand

Once the compound is cured, sand it again with the same sandpaper to smooth the area.

### Step 4 Clean and Paint

Finally clean the area and paint it with a two component polyurethane paint to cover the affected area.



## Section 15

### PROTEC™ Pressure Vessels

#### Precautions to be taken when using sodium bisulphite for membrane preservation (or any other chemical).

- ✓ Carefully and strictly monitoring the application of the membrane preservation procedure is mandatory.
- ✓ All variants in process must be carefully checked all during the preservation.
- ✓ Make a complete filling of the vessel, using a high enough filling pressure in order to get a turbulent flow.
- ✓ Avoid any air bubbles.
- ✓ Follow carefully the operation instructions of the preserving bisulphite or other chemical being used.
- ✓ Follow carefully the storage instructions of the preserving bisulphite or other chemical being used.
- ✓ Control and check strictly the solution pH.  
*If pH gets lower than 3, change the solution immediately.*
- ✓ Special precautions have to be taken in case of high temperatures.
- ✓ Proper use of chemicals is the responsibility of the end user.

**\*\* NOT FOLLOWING STRICTLY THESE GUIDELINES ABOVE COULD CAUSE SCC (Stress Corrosion Cracking) IN THE PRESSURE VESSELS \*\***

## Section 16

# PROTEC™ Pressure Vessels

## Factory Contact Information

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