



*LENNTECH*

# **8" SIDE PORT PRESSURE VESSEL**

# **TECHNICAL MANUAL**

*LENNTECH*

info@lennotech.com Tel. +31-152-610-900

www.lennotech.com Fax. +31-152-616-289

## Introduction

BEL, founded in 1966, specializes in the design and manufacture of a variety of products made from advanced composite materials. With over 40 years of experience, the company has developed and mastered the innovative technologies necessary to manufacture the highest quality composite products. Combining innovation, technology, responsibility and dedication, our goal is to become the leader in providing commercial and industrial composite vessels for our clients needs.

BEL pressure vessels are manufactured from filament wound fiber reinforced plastic (FRP), wound over precision mandrels, using a superior epoxy resin, which results in the ultimate combination of physical strength and an ultra smooth inside surface. Vessels are tested according to the requirements of ASME code section X, the internationally recognized standard for pressure vessel construction.

BEL holds ISO 9001 quality systems certification, and its quality assurance is also approved for in-house final inspection by many of its customers.

The BEL family of pressure vessels is designed to be used as housings for all 4" ,8" ,9" and 16" spiral-wound Reverse Osmosis (RO), Nanofiltration (NF) and Ultra filtration (UF) membrane elements.

The pressure vessels are manufactured in different configurations, according to the required operating pressures, filtration type, and piping layout. In order to enhance interchangeability and facilitate the use and maintenance of the vessels, the utilization of identical parts and sub-assemblies has been maximized throughout the design of the vessel. For better performance and longer service life, each model is manufactured from the highest quality and highest performing materials of construction.

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## 1. Safety Precautions

- i. BEL pressure vessels are designed for high pressure operations. Improper installation, operation service or maintenance may cause severe damage to property, physical injury or death.
- ii. BEL pressure vessels are designed for water treatment only.
- iii. **PRESSURE AND TEMPERATURE DESIGN LIMITS** - Operation of a vessel outside the design limits will make void the warranty and may result in vessel fatigue with possible eventual explosive head failure. Although each vessel is tested at 110% of the design pressure **LONG-TERM OPERATION ABOVE DESIGN PRESSURE MUST BE PREVENTED**. Permeate port pressure **MUST NOT EXCEED 125 psi**. Vessels should **NOT BE CONTINUOUSLY OPERATED AT TEMPERATURES ABOVE 120°. (49° C)**.
- iv. The pressure vessel should not be use as a support. Piping manifolds and other fittings should be properly designed system framework. **OPERATING PERSONNEL SHOULD BE DISCOURAGED FROM APPLYING UNDUE FORCE TO ANY FITTINGS CONNECTED DIRECTLY TO A PRESSURE VESSEL.**
- v. Only qualified mechanics, experienced in working with high pressure hydraulic systems, should be allowed to disassemble or assemble the vessel.
- vi. Regularly inspect the system so as to ensure that the various components have not deteriorated or been damaged. Replace any faulty component, make sure the reason for the fault has been found and fixed as well.
- vii. Make sure that vessels and associated pipe systems are fully depressurized before attempting any service or maintenance operation.
- viii. Be careful not to scratch the inside wall of the shell, especially at the inner sealing area near the groove.
- ix. Corroded parts may cause difficulties in removing the head or other components. Do not try to force remove components before all visible signs of corrosion have been eliminated.
- x. Never attempt to repair or disassemble the feed/concentrate port in a side port vessel without consulting BEL.
- xi. Inspect end closures regularly; replace components that have deteriorated and correct causes of corrosion.
- xii. Do not tolerate Leaks, or allow end closures to be routinely wetted in any way.

## 2. Installation notes

- i. Provide adequate room for serving at both ends of vessel. Elements are installed from the upstream end, pushed through towards the downstream end and eventually removed from the downstream end.
- ii. Make sure that the vessel is horizontally installed on support saddles.
- iii. The vessels must not be rigidly clamped in place, mounting design must allow for both radial and axial expansion (typically up to 0.5 mm radial and up to 2-3 mm axial). Restriction can result in damage to the vessel and other system components.
- iv. Straps should be tightened enough to hold the vessel onto the support pads, but never so tightly as to restrict expansion.
- v. A flexible piping connection should be provided in order to prevent unwanted loads transfer from the manifolds to the permeate connection and to permit decoupling the header from the vessel.  
The recommended permeate port connection is a U-bend pipe with flexible connections at each end.
- vi. The piping system must be connected to the ports using flexible connectors in order to allow relative movement of the vessels and the piping system. (Victaulic or equivalent connections are recommended).

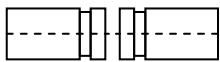
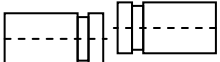

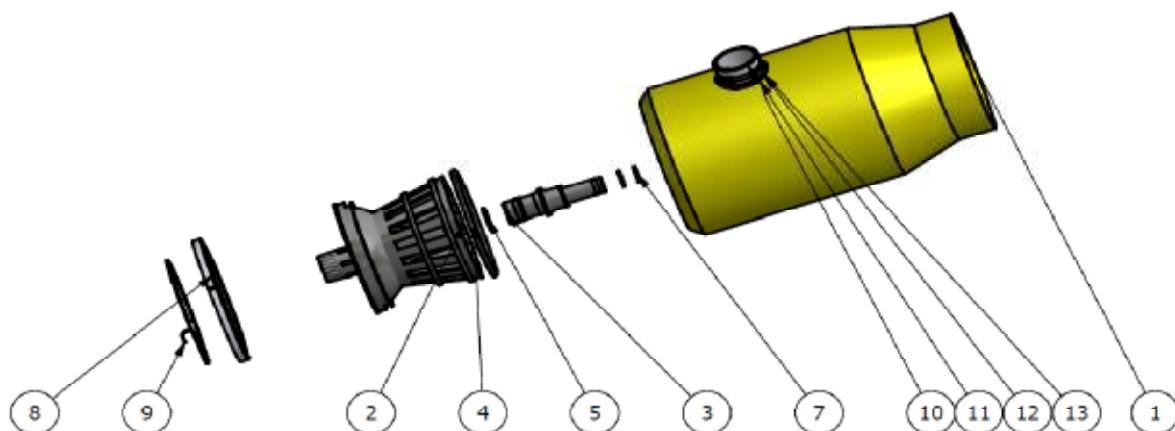
Side Port	 Spacing [mm]- X	 Max Offset* [mm]	 Max Angle [Deg]
1.5"	2 + 0.5	3	2.5
2"	2 + 0.5	3	2
2.5"	3 - 0.5	3	2
3"	3 - 0.5	3	1.5
4"	3 ± 0.5	3	1.5

Table 2.1

### 3. Component List

#### 3.1 BEL 8" PRESSURE VESSEL 300 PSI Side Port assembly



ITEM	QTY	DESCRIPTION	Material	Part Number
1	1	Body of Pressure Vessel	Glass/Epoxy, acc. F.I.227	8 / 1-5 / 450 / 1-8
2	2	End Cap	Engineering plastic	2857709010 / g / i / ig / iv / v
3	2	Adapter	Engineering plastic	See Table 3.2
4	2	O-Ring	EPDM	007-080-0092
5	2	Seal for Adapter	EPDM	285773918
7	2-4	Membrane seal	EPDM	55413912 / 55412357 (1.5")
8	2	Support ring	Engineering plastic	285034015
9	2	Retaining ring (finger hook)	Stainless steel	011-801-1202
10	1-4	Side port 1.5"/2"/2.5"/3"/4"	Stainless steel	See Table 2
11	4-8	Retaining ring	Stainless steel	See Table 3.1
12	1-4	Seal for side port	EPDM	See Table 3.1
13	1-4	Disk for side port	Metal plate	See Table 3.1
*14	2-3	Saddle	Engineering plastic	55410351
*15	2	Strap Assy.	Stainless steel	55410310
*16	0-3	Disk spacer - 1mm	Engineering plastic	285779231
*17	0-7	Disk spacer - 3mm	Engineering plastic	285779233

\*-These parts are not shown on the drawing assembly

Table 3.1

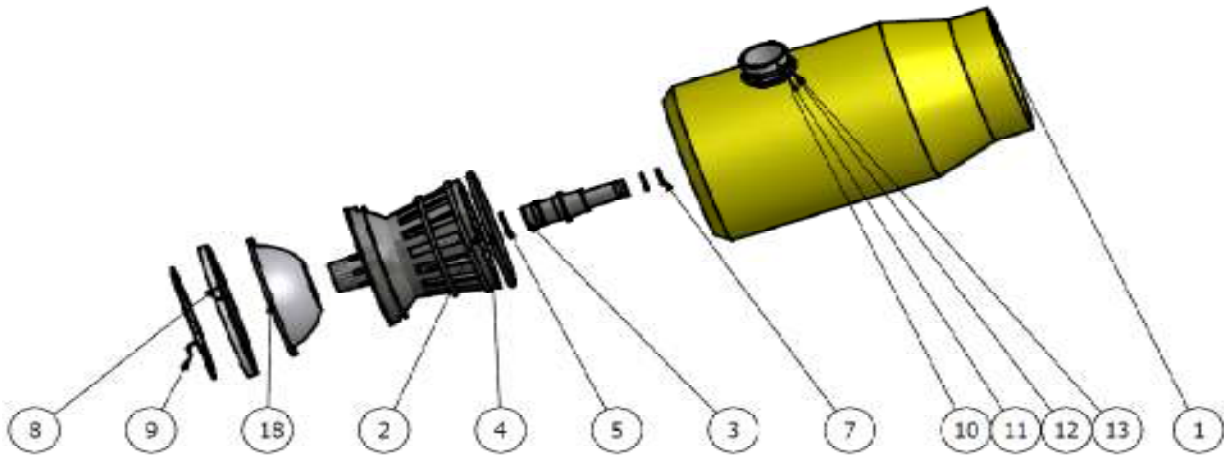
Diameter	Side port	Disk for side port	Seal	Retaining ring
1.5"	040-156-0458	006-156-0452	014-150-0506	011-150-1202
2"	041-206-0458	006-206-0452	014-200-0605	55412392
2.5"	042-256-0458	006-256-0452	014-250-0805	011-250-1212
3"	043-306-0450	006-306-0302	014-300-0807	011-300-1202
4"	044-406-0450	006-406-0302	014-400-0709	285772409

Table 3.2

Part description	Part number
Adapter 1.125" / Adapter 1.125" blind	001-112-0452 / 001-112-1228
Adapter 1.5" / Adapter 1.5" blind	285349324 / 001-150-0458

Table 3.3

### 3.2 BEL 8" PRESSURE VESSEL 450 PSI Side Port assembly



ITEM	QTY	DESCRIPTION	Material	Part Number
1	1	Body of Pressure Vessel	Glass/Epoxy, acc. F.I.227	8 / 1-5 / 450 / 1-8
2	2	End Cap	Engineering plastic	2857709010 / g / i / ig / iv / v
3	2	Adapter	Engineering plastic	See Table 3.6
4	2	O-Ring	EPDM	007-080-0092
5	2	Seal for Adapter	EPDM	285773918
7	2-4	Membrane seal	EPDM	55413912 / 55412357 (1.5")
8	2	Support ring	Aluminum	55410299
9	2	Retaining ring (finger hook)	Stainless steel	011-801-1202
10	1-4	Side port 1.5"/2"/2.5"/3"/4"	Stainless steel	See Table 3.5
11	4-8	Retaining ring	Stainless steel	See Table 3.5
12	1-4	Seal for side port	EPDM	See Table 3.5
13	1-4	Disk for side port	Metal plate	See Table 3.5
*14	2-3	Saddle	Engineering plastic	55410351
*15	2	Strap Assy.	Stainless steel	55410310
*16	0-3	Disk spacer - 1mm	Engineering plastic	285779231
*17	0-7	Disk spacer - 3mm	Engineering plastic	285779233
18	2	Metal cap	Stainless Steel	285453003

\*-These parts are not shown on the drawing assembly

Table 3.4

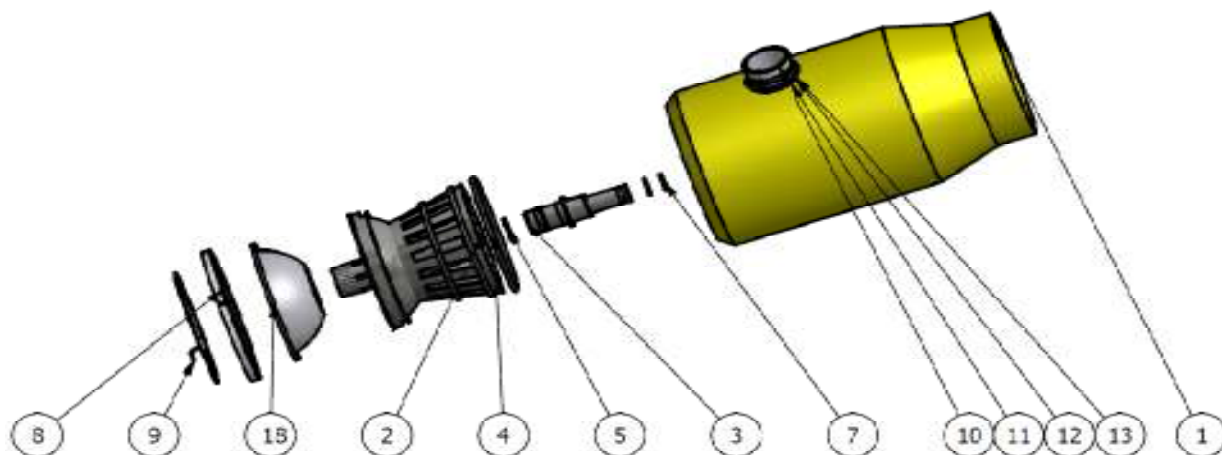
Diameter	Side port	Disk for side port	Seal	Retaining ring
1.5"	040-156-0458	006-156-0452	014-150-0506	011-150-1202
2"	041-206-0458	006-206-0452	014-200-0605	55412392
2.5"	042-256-0458	006-256-0452	014-250-0805	011-250-1212
3"	043-306-0450	006-306-1203	014-300-0807	011-300-1202
4"	044-406-0450	006-406-1203	014-400-0709	285772409

Table 3.5

Part description	Part number
Adapter 1.125" / Adapter 1.125" blind	001-112-0452 / 001-112-1228
Adapter 1.5" / Adapter 1.5" blind	285349324 / 001-150-0458

Table 3.6

### 3.3 BEL 8" PRESSURE VESSEL 600 PSI Side Port assembly



ITEM	QTY	DESCRIPTION	Material	Part Number
1	1	Body of Pressure Vessel	Glass/Epoxy, acc. F.I.227	8 / 1-5 / 600 / 1-8
2	2	End Cap	Engineering plastic	2857709010 / g / i / ig / iv / v
3	2	Adapter	Engineering plastic	See Table 3.9
4	2	O-Ring	EPDM	007-080-0092
5	2	Seal for Adapter	EPDM	285773918
7	4	Membrane seal	EPDM	55413912
8	2	Support ring	Aluminum	55410299
9	2	Retaining ring (finger hook)	Stainless steel	011-801-1202
10	1-4	Side port 1.5"/2"/2.5"/3"/4"	Stainless steel	See Table 3.8
11	4-8	Retaining ring	Stainless steel	See Table 3.8
12	1-4	Seal for side port	EPDM	See Table 3.8
13	1-4	Disk for side port	Metal plate	See Table 3.8
*14	2-3	Saddle	Engineering plastic	55410351
*15	2	Strap Assy.	Stainless steel	55410310
*16	0-3	Disk spacer - 1mm	Engineering plastic	285779231
*17	0-7	Disk spacer - 3mm	Engineering plastic	285779233
18	2	Metal cap	Stainless Steel	285453003

\*-These parts are not shown on the drawing assembly

Table 3.7

Diameter	Side port	Disk for side port	Seal	Retaining ring
1.5"	040-156-0600	006-156-1203	014-150-0506	011-150-1202
2"	041-206-0600	006-206-1203	014-200-0605	55412392
2.5"	042-256-0600	006-256-1203	014-250-0805	011-250-1212
3"	043-306-0600	006-306-1203	014-300-0807	011-300-1202
4"	044-406-0608	006-406-1203	014-400-0709	285772409

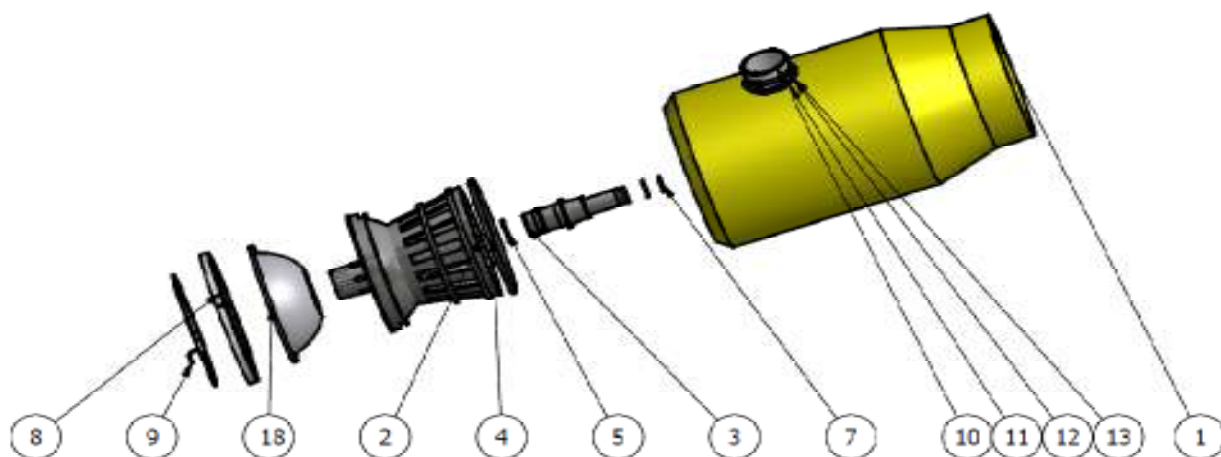
Table 3.8

Part description	Part number
Adapter 1.125" / Adapter 1.125" blind	001-112-1220 / 001-112-1228

Table 3.9



### 3.4 BEL 8" Pressure Vessel 1000/1200 PSI Side Port assembly



ITEM	QTY	DESCRIPTION	Material	Part Number
1	1	Body of Pressure Vessel	Glass/Epoxy, acc. F.I.227	8 / 1-5 / 1000-1200 /1-8
2	2	End Cap	Engineering plastic	2857709010 / g / i / ig / iv / v
3	2	Adapter	Engineering plastic	See Table 3.12
4	2	O-Ring	EPDM	007-080-0092
5	2	Seal for Adapter	EPDM	285773918
7	4	Membrane seal	EPDM	55413912
8	2	Support ring	Aluminum	005-861-1200
9	2	Retaining ring (finger hook)	Stainless steel	011-801-1202
10	1-4	Side port 1.5"/2"/2.5"/3"/4"	Super duplex Stainless steel	See Table 3.11
11	4-8	Retaining ring	Stainless steel	See Table 3.11
12	1-4	Seal for side port	EPDM	See Table 3.11
13	1-4	Disk for side port	Metal plate	See Table 3.11
*14	2-3	Saddle	Engineering plastic	55410351
*15	2	Strap Assy.	Stainless steel	55410310
*16	0-3	Disk spacer - 1mm	Engineering plastic	285779231
*17	0-7	Disk spacer - 3mm	Engineering plastic	285779233
18	2	Metal cap	Stainless Steel	285213006

\*-These parts are not shown on the drawing assembly

Table 3.10

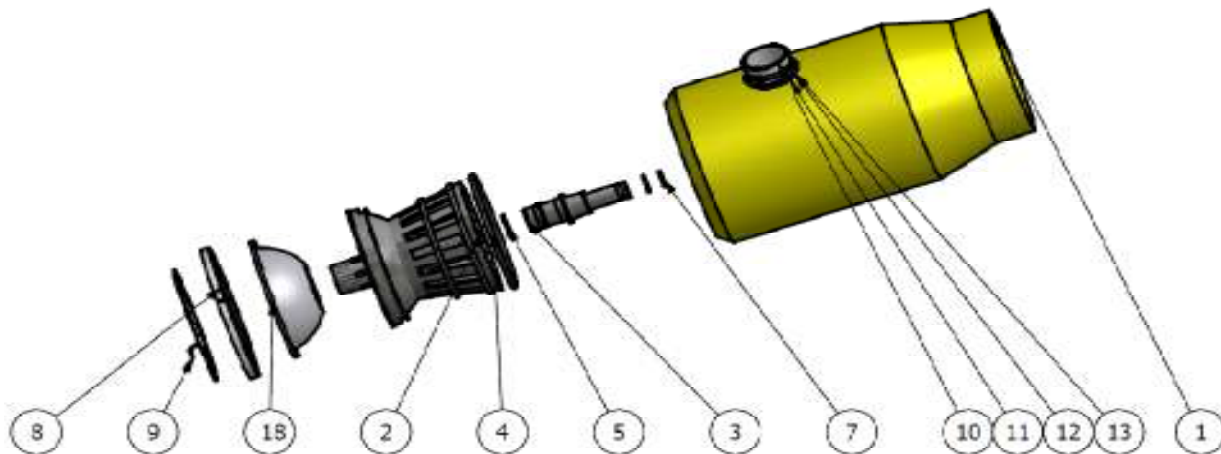
Diameter	Side port	Disk for side port	Seal	Retaining ring
1.5"	040-155-1200	006-156-1203	014-150-0506	011-150-1202
2"	041-205-1208	006-206-1203	014-200-0605	55412392
2.5"	042-255-1200	006-256-1203	014-250-0805	011-250-1212
3"	043-305-1200	006-306-1203	014-300-0807	011-300-1202
4"	044-405-1208	006-406-1203	014-400-0709	285772409

Table 3.11

Part description	Part number
Adapter 1.125" / Adapter 1.125" blind	001-112-1220 / 001-112-1228

Table 3.12

### 3.5 BEL 8" PRESSURE VESSEL 1500 PSI Side Port assembly



ITEM	QTY	DESCRIPTION	Material	Part Number
1	1	Body of Pressure Vessel	Glass/Epoxy, acc. F.I.227	8 / 1-5 / 1500 /1-8
2	2	End Cap	Engineering plastic	2857709010 / g / i / ig / iv / v
3	2	Adapter	Engineering plastic	See Table 3.15
4	2	O-Ring	EPDM	007-080-0092
5	2	Seal for Adapter	EPDM	285773918
7	4	Membrane seal	EPDM	55413912
8	2	Support ring	Aluminum	005-861-1200
9	2	Retaining ring (finger hook)	Stainless steel	011-801-1202
10	1-4	Side port 1.5"/2"/2.5"/3"/4"	Super duplex Stainless steel	See Table 3.14
11	4-8	Retaining ring	Stainless steel	See Table 3.14
12	1-4	Seal for side port	EPDM	See Table 3.14
13	1-4	Disk for side port	Metal plate	See Table 3.14
*14	2-3	Saddle	Engineering plastic	55410351
*15	2	Strap Assy.	Stainless steel	55410310
*16	0-3	Disk spacer - 1mm	Engineering plastic	285779231
*17	0-7	Disk spacer - 3mm	Engineering plastic	285779233
18	2	Metal cap	Stainless Steel	285213008

\*-These parts are not shown on the drawing assembly

Table 3.13

Diameter	Side port	Disk for side port	Seal	Retaining ring
1.5"	040-155-1200	006-156-1203	014-150-0506	011-150-1202
2"	041-205-1208	006-206-1203	014-200-0605	55412392
2.5"	042-255-1200	006-256-1203	014-250-0805	011-250-1212
3"	043-305-1200	006-306-1203	014-300-0807	011-300-1202
4"	044-405-1208	006-406-1203	014-400-0709	285772409

Table 3.14

Part description	Part number
Adapter 1.125" / Adapter 1.125" blind	001-112-1220 / 001-112-1228

Table 3.15

## 4. Maintenance

### 4.1 Head disassembly

- i. **Pressure relieve** - Stop all pumps and relieve pressure.
- ii. Disconnect all pipes from ports connecting the vessel's heads with the manifolds.
- iii. Engage your forefinger in the hook of the retaining ring, lift it up and out of the groove, by running your fingers behind the retaining ring as it continues to exit the groove. As shown in Fig 4-A



Fig 4-A

- iv. Move the three locker segments from the groove starting from the small segment.
- v. **NPT /Victaulic head extraction** -
  - a - Tight the puller legs (see annex 1) to the vessel wall as shown in Fig 4-B to support the puller to the vessel.

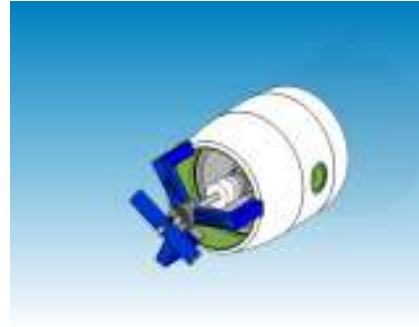


Fig 4-B

**b.1** - if **NPT connection** - Screw in fully the NPT cap (clockwise) to the back side of the puller.

**b.2** - if **Victaulic connection** - place the Victaulic puller cap carefully inside the End-Cap permeate port (rotate clockwise) and connect it to the End-Cap Victaulic port as shown in Fig 4-C.

**c.2** There after Screw out the Puller's handle (counterclockwise) until the End-cap is extracted,



Fig 4-C

## 4.2 Visual inspection

Once the head have been disassembled perform a visual inspection of the vessel head and fittings, to locate any signs of corrosion or salt concentrations if corrosion or salt concentrations are found, follow the following steps:

### Component inspection

- i. Use a small wire brush to loosen any large deposits.
- ii. Place components in a shallow container of soapy water and scrub their surfaces with medium-grade Scotch-Brite until all corrosion is removed.
- iii. Rinse components with clear water.
- iv. Blow components dry with compressed air.
- v. Examine components for damage that may affect structural strength or sealing properties.

### Vessel inspection

- i. If any case of deposit of foreign material has been discovered scrub surface with a fine Scotch-Brite and a mild detergent solution, clean both ends of the vessel, up to 20 cm into the vessel.
- ii. If during inspection scratches are found on the inner surface of the vessel up to 20 cm depth, grind the area carefully with sand paper until it is smooth

### 4.3 Head Reassembly

- i. Insert the O-ring seal into the groove of the End cap in the direction of the arrow as shown in Fig 4-D. Until it fits into the groove.



Fig 4-D

- ii. Apply a small amount of lubricant (Molykote 111 or equivalent, Glycerin can be used as well) on the Adapter seal thereafter insert the Adapter into the End cap as shown in Fig 3-E.



Fig 4-E

- iii. Apply a layer of lubricant (see 4.3.ii) on the O-ring (the amount of Glycerin should be just enough to give a lustre to the O-ring) and on the bell internal groove.
- iv. Place the NPT/ Victaulic pusher (see Annex 1) carefully inside End cap Permeate Port as shown in Fig 3-F. **To**

**avoid property damage do not bend the tool inside the End cap Permeate Port.**



Fig 4-F

- v. Push the sliding hammer quickly towards the NPT/ Victaulic pusher until it strikes the End cap to its place as shown in Fig 4-G. **To avoid personal injury, always grasp the pusher puller handle with both hands.**

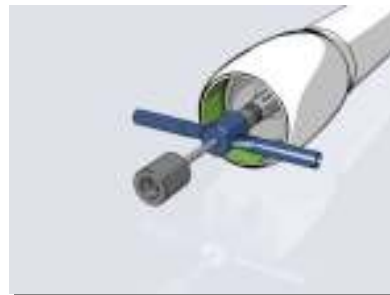


Fig 4-G

- vi. Insert the Metal cap into the outer side of the End Cap as shown in Fig 4-H.



Fig 4-H

- vii. With the head assembly inserted into the shell (once the head is in the correct position, the support ring groove is exposed) slide the three segments into the locking groove and insert the retaining ring as shown in Figs 4-I, 4-J, 3-K.
- viii. Insert the retaining ring into the groove of the Support ring and continue running your fingers behind the retaining ring as it continues to enter the groove. As shown in Figs 4-L, 4-M.



Figure 4-I



Figure 4-L



Figure 4-J



Figure 4-M



Fig 4-K

## 4.4 Loading the membrane element

- |   |  |
|---|--|
| <ul style="list-style-type: none"> <li>i. Flush the vessel with fresh water to remove dust and debris.</li> <li>ii. Insert Head assembly, <b>without the O-ring</b> into the downstream end of the vessel.</li> <li>iii. Install the segments of the support ring into the locking groove.</li> <li>iv. Inspect the membrane element surface to find any imperfections that could scratch the vessel bore element loading. If a defect is found, which cannot be easily corrected contact the element manufacturer.</li> <li>v. Apply a thin layer of lubricant (see 4.3.ii) to lubricate the inside of the vessel near the groove. <b>This will assist membrane element loading and reduce the risk of inadvertently scratching the vessel bore.</b></li> <li>vi. Install the brine seal on the upstream end of the membrane element so that the seal's open side faces upstream (if it is not already installed by the manufacturer).</li> <li>vii. Load the first element into the upstream of the vessel .Leave 10 cm of the element projecting out of the vessel to facilitate connection with the next element.</li> <li>viii. Apply a small amount of Lubricant (see 4.3.ii) onto the O-ring of the interconnector.</li> <li>ix. Connect the interconnector to the projected end of the loaded element.</li> </ul> | <ul style="list-style-type: none"> <li>x. Line up the next element and assemble it to the inter connector which is already on the first element. <b>Carefully maintain element alignment during assembly, misalignment may result damage to the membrane and vessel parts.</b></li> <li>xi. Line up the next element and assemble it to the interconnector which is already on the first element.</li> <li>xii. Carefully push the two elements into the vessel until the second element is projecting from the vessel approximately 10 cm. Repeat the above steps until all membrane elements have been assembled.</li> <li>xiii. Calculate the correct shimming distance (see Annex 2) in order to avoid impact damage on the membrane and head parts during pressure drop.</li> <li>xiv. Insert the shimming spacers on the upstream head assembly (Membrane adapter) so that the sum of their lengths will be equal to the shimming distance.</li> <li>xv. Install the upstream head assembly as described in section 3.3.</li> <li>xvi. Remove the downstream head assembly and reassemble it with the O-ring.</li> </ul> |
|---|--|



## ANNEX 1

### BEL Puller For 8" pressure vessels heads installation

This tool designated to extract BEL head assembly for 8" pressure vessels. Before disassemble any of the vessels parts ensure internal pressure has been unloaded.

**Note:**

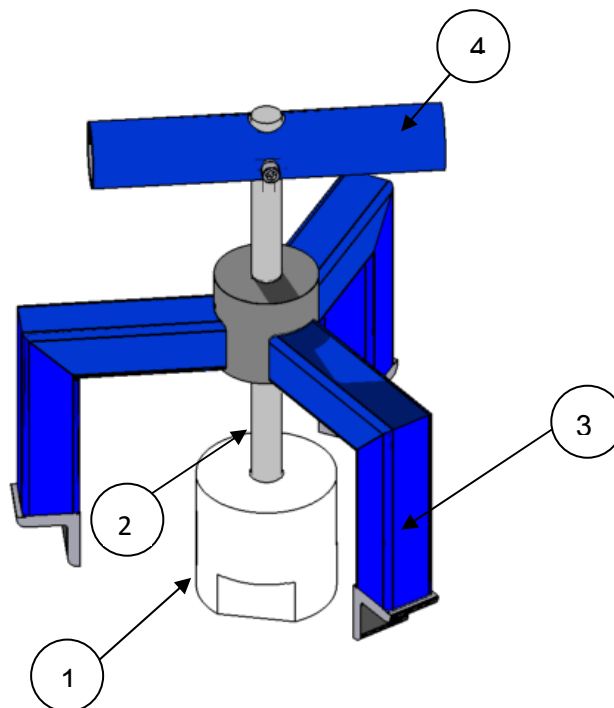
It is highly recommended to replace all seals each time the head is reassembled.  
A seal replacement kit is available from **BEL's** Customer Service.

**Part number:** 069-080-0101 +069-080-1000 (for 1"NPT adapter) or  
+ 069-080-1250 (for 1.25" NPT adapter) or  
+ 069-080-1500 (for 1.5"NPT adapter) or  
+ 069-080-1510 (for 1.5" Victaulic adapter).  
+ 069-080-2010 (for 2" Victaulic adapter for 9" PV)

#### **Kit assembly**

Tool must be assembled as shown on illustration 1.

Figure 1 –Puller assembly



(1) NPT/ Victaulic Puller cap, (2) Threaded Rod

(3) NPT/ Victaulic Puller (4) Handle



## BEL Pusher For 8" and pressure vessels heads installation

This tool designated to install BEL head assembly for 8" and pressure vessels.

***Note:***

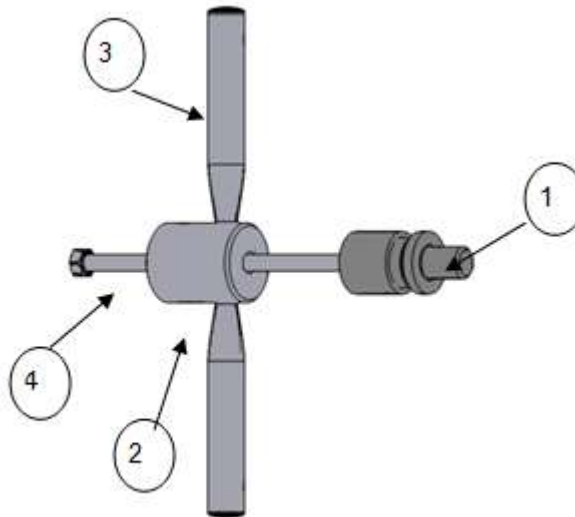
It is highly recommended to replace all seals each time the head is reassembled.  
A seal replacement kit is available from **BEL**'s Customer Service.

(**Part number:** 069-080-0100)

### **Kit assembly**

Tool must be assembled as shown on illustration 1. Ensure tool's handle is located far from the NPT/ Victaulic pusher (part 1).

Figure 2 – Pusher-Puller assembly



(1) NPT/ Victaulic pusher, (2) Sliding hammer (3) Handles (4) Rod



## ANNEX 2

### Shimming procedure

Correct shimming is needed in order to keep minimum Permeate Port movement at operation time, **shimming should be applied at the feed side only**.

For the shimming procedure make sure the membranes fully pressed to the End cap at the brine side (measure can be taken like the shimming procedure and it suppose to be like the sum of the parts), and the shimming at brine side is clearly making unified surface with the End cap and the adapter.

Correct shimming can be achieved by calculating the delta between the fixed dimensions of the End-Cap ( $t_{END-CAP}$ ) + the Metal Cap ( $t_{METAL\ CAP}$ ) and distance between the end of the groove and the membrane after pushing the membranes inside (call it X), this will bring you to the nominal shimming dimension:

- $X - t_{END-CAP} - t_{METAL\ CAP} - t_{LOCKER} - 2 = \textit{Shimming dimnsion(mm)}$

Or without the LOCKER thickness if you'll take the measures from the inside of the LOCKER (put the locker in the groove and take the measure):

- $X - t_{END-CAP} - t_{METAL\ CAP} - 2 = \textit{Shimming dimnsion(mm)}$



## ANNEX 3

### O-Ring replacement and scratches treatment procedure

#### **1. Preparations**

Please prepare the following items before procedure:

- i. New intact O-Ring seal suitable with End-Cap type.
- ii. BEL End-Cap. Ensure O-Ring groove is clean and free of scratches.
- iii. Clean cloth.
- iv. Lubricant.
- v. BEL Pusher-Puller (optional).

#### **2. O-Ring Replacement procedure**

- i. Clean vessel internal surface at sealing area (O-Ring area) with clean damp cloth after the disassembling of the head assembly from the vessel.
- ii. Ensure vessel sealing area is smooth and free of scratches. See next procedure for scratch treating.
- iii. Assemble End-Cap parts (e.g. End-Cap, Adapter, O-Rings and Shims) and apply full and reach layer of lubricant on seals, vessel's groove and vessel's sealing area.
- iv. Install End-Cap using BEL's pusher-puller.

#### **3. Scratches treatment procedure**

- i. Clean vessel internal surface at sealing area (O-Ring area) with clean damp cloth.
- ii. Locate the scratch at the O-Ring sealing area. Scratches out of this area will not cause leaks, therefore will not be treated.
- iii. Grind out the scratch using Extra-Fine sand paper (P400) until scratch is flat and smooth. DO NOT grind deep into the vessel, this might cause permanent damage to the vessel.

Note: In case of deep scratches or layers delamination please consult BEL engineering department.