4-1. Storage and Preparation Instructions

CSM products are stored and transported in either dry or wet conditions and are shipped in individual boxes. Toray Advanced Materials Korea Inc. aims to ensure that the delivered products are stored in optimal conditions to maximize their lifespan and to present the necessary checks and procedures during the initial stage of installing the products onto the equipment.

1. Storage Method Before Product Shipment and Use

Toray Advanced Materials supplies two types of RO/NF membrane elements

A. Dry Products: Both RO and NF elements are vacuum-sealed in transparent polypropylene packaging and finally packed in cardboard boxes for shipment.

B. For wet products, the RO product line is treated with a preservation solution (1.5 - 2.0% SBS; Sodium bisulfite), vacuum-sealed, and packed in cardboard boxes for shipment. The NF product line (excluding NE90) is vacuum-sealed with an oxygen absorber after being rinsed with RO water (TDS below 3 ppm) without preservation solution.

C. It is recommended to store the shipped products in their original packaging until they are installed in the vessel for system operation. If the packaging needs to be temporarily opened for inspection or if it is damaged during transport, reseal the products to prevent drying and contamination.

D. Store the packaged products indoors at temperatures between 7 - 32°C (45 - 90°F). Avoid storing them at freezing temperatures, above 35°C (95°F), or in direct sunlight.

E. When stacking products, it is possible to stack up to 8 layers or 40 boxes (standard 8-inch products) per pallet. Exceeding this limit may damage the products, so caution is required.

2. Preparation Before Installation

A. Wearing Safety Equipment and Preparation

CSM wet elements are packaged with a preservation solution (SBS) or RO water and an oxygen absorber, so caution is required when opening the packaging. Be especially careful not to ingest the solution, and avoid contact with eyes and skin as it can cause damage or irritation. Always use protective equipment.

The exterior material of the elements is made of Fiber Reinforced Plastic (FRP) which contains fiberglass, so it is essential to wear protective gloves. For safety, the following protective gear should be worn during work:

1. Safety goggles
2. Safety helmet
3. Safety shoes
4. Protective gloves

When installing the product, prepare a wrench, lubricant, and a dust-removing cloth. It is recommended to use glycerin as a lubricant to avoid affecting the product's performance.

B. Unpacking the Product

① Open the product box and take out the element and the vinyl-packaged parts. The parts consist of a brine seal and an interconnector. The surface of the vacuum-packaged element has the product name and an arrow indicating the direction of feed water flow marked in the center. Stand the element with the arrow pointing downwards. Be careful not to drop or tip over the element.

② Cut open the top part of the sealed packaging of the upright element, then pull the packaging downwards to completely remove it.

③ Verify the quantity and list of elements, and ensure that both wet and dry elements are installed within 24 hours after unpacking. During this process, wet elements may dry out, so RO water can be applied to the elements if necessary. However, for dry elements, do not allow any contact with water before installation, as exposure to water in an unpressurized state can lead to performance changes.

④ If the product needs to be preserved or transported later, keep the packaging materials and boxes for reuse.

C. Element Alignment

① Align the elements in the order of installation and record the barcodes.

② Attach the brine seal to the ATD at the top of the element. Ensure that the grooved side of the brine seal faces upward.

③ Attach the interconnector to the permeate tube at the top of the element. For the first element, do not attach the interconnector, as an adapter will be installed instead.

Caution
Store the product in its boxed packaging in a cool indoor environment. Avoid storing at freezing temperatures, above 35°C (95°F), or in direct sunlight. Always wear protective equipment before starting work. Install the element within 24 hours of removing the packaging. Especially for dry elements, do not allow any contact with water before installation, as exposure to water can lead to performance changes.

4-2. Opening the Vessel

1. Shut down the equipment operation.

Stop the operation of the equipment according to the recommendations of the system operator and completely release the residual pressure in the vessel. Ensure that all water inside the vessel is fully drained and confirm that there is no remaining water or pressure in the vessel before proceeding to the next step.

2. Disconnect the permeate and concentrate piping connections.

After removing dust and foreign substances from the exterior of the vessel, disconnect the permeate and concentrate piping from the vessel.

3. Inspect the end plate.

Inspect the vessel's end plate for any signs of corrosion. If any issues are found, proceed as follows:

A. Remove any foreign substances using a small wire brush.
B. Rinse off contaminants with clean water.

4. Remove the retaining ring.

Disassemble the retaining ring on the end plate using a wrench. If the screws do not turn easily due to excessive corrosion, proceed as follows:

A. Spray a penetrating fluid (such as WD-40® or LPS-1®) on the contact points of the retaining ring.
B. Use a screwdriver or a similar tool to gently tap the retaining ring to loosen the connection.
C. If the retaining ring does not come out smoothly, use a cushioned hammer or a regular hammer with a wooden block to tap the surface of the end plate to loosen it.

5. Remove the end plate.

Gently tap the end plate with a hammer, avoiding the use of metal tools. Hold the permeate port and carefully wiggle the end plate back and forth to separate it from the vessel. Be careful not to apply too much force to the permeate port.

6. Disconnect the connecting parts of the installed element.

A. When opening the concentrate side end plate of the vessel, remove the thrust ring if present. Refer to the vessel manufacturer's drawings if necessary.

B. Remove the adapters from both ends of the element.

4-3. Element Replacement

Do not proceed with the removal of the element until the pressure in the vessel has been relieved and all end plates have been removed. It is recommended that at least three workers perform the replacement procedure.

1. Remove the installed element.

A. Before removing the element from the vessel, wipe off any excess lubricant from the inner diameter of the vessel.

B. Push the element on the feed side of the vessel firmly, so that all elements inside the vessel are pushed towards the concentrate side (elements should be removed in the direction of the feed water flow). Ensure that the element on the concentrate side protrudes from the vessel enough for the worker to grasp and pull out the remaining parts.

C. Once the element on the concentrate side protrudes enough for the worker to grasp, carefully pull the element out horizontally. Ensure that the element remains level during removal. Vertical movement can damage the interconnector, rubber rings, piping, the element itself, and the brine seal.

D. Repeat steps B and C to remove all elements from the vessel. In long vessels, you may not be able to reach some elements that remain inside. In such cases, use a rod made of a material that will not damage the elements, such as PVC pipe, to slowly push the elements out.

E. Carefully store the adapters recovered during the element removal process. When reusing these parts, check for any scratches or cracks, and it is recommended to replace the O-rings before reuse.

F. Inspect the inside of the vessel and spray clean water to remove dust or residues. If necessary, use tools to wipe the interior. To prevent scratches and facilitate element installation, apply a glycerin solution inside the vessel using a soft cloth or similar tool. If the glycerin is too viscous, dilute it with water to a recommended concentration of about 50%. Do not use lubricants containing oil, as they can affect the performance of the elements.

2. Installing New Elements in the Equipment

A. After confirming that the number of elements matches the required quantity for each vessel, apply a thin layer of glycerin solution to the brine seal of each element.

B. Lift the first element horizontally and, following the direction indicated by the arrow on the product, push it about two-thirds of the way into the vessel from the feed side. Carefully lift the second element, verify the direction of the arrow, and connect it to the permeate connector of the first element. If necessary, use auxiliary tools to maintain the horizontal alignment of the element. Then, carefully push the element into the vessel, ensuring the brine seal and permeate connector are not damaged.

C. For subsequent elements, repeat the installation process used for the second element until the last element is installed. Once all elements are in place, push them towards the concentrate side so that the ATD face of the first element aligns with the designated position. Refer to the installation drawings provided by the equipment manufacturer for the correct positioning between the end plate and the first element.

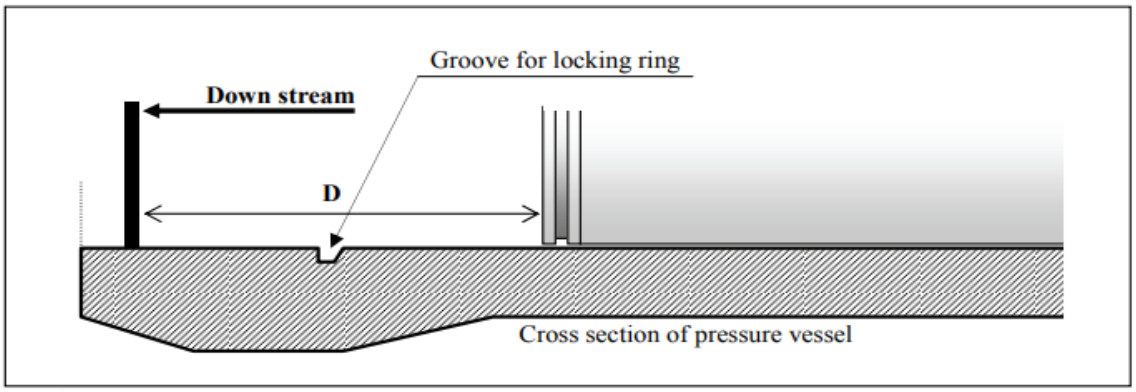

Figure 4-1. Element Positioning Inside the Vessel

Caution
Ensure the elements remain horizontal during installation so that the permeate adapter does not bear the weight of the elements. If the elements are not kept horizontal and alignment is disturbed, the adapter, permeate tube, and exterior of the elements may be damaged.

4-4. Closing the Vessel

After the elements and permeate adapters are installed inside the vessel, verify that the end plate is assembled with the correct components. If necessary, complete the installation of the shims before closing the vessel.

1. Install the thrust ring on the concentrate side end plate, and securely fasten the permeate adapter of the first installed element to the end plate.
2. After installing all the elements in the vessel, check the distance between the feed side end plate and the permeate adapter. If this distance exceeds the thickness of the shims provided by the vessel manufacturer, use the shims to fill the excess space. After using the shims, the remaining space should be less than the thickness of one shim.
3. It is recommended to install a closed adapter on the unused permeate port.
4. After installing and securing the feed side end plate of the vessel, connect the piping to the end plate. Ensure that all end plates on the vessels are secured with retaining rings.
5. Reconnect the main piping to the permeate and concentrate ports of the vessel. Using Teflon tape on the threads during connection will help prevent leaks after assembly.

Caution
Verify that the components of the retaining ring are correctly installed. Incorrect assembly or installation can damage the vessel lid.

4-5. Storage Method for Used Elements

When stopping the operation of the RO/NF system or removing elements from the vessel for replacement or inspection, follow these recommendations for storage:

1. When stopping the operation of the RO/NF system

A. Use flushing water of appropriate quality to rinse the vessel at low pressure, flushing out the concentrate from inside the vessel.

B. Suitable flushing water is pretreated feed water (refer to Table 4-1) or RO permeate water.

C. During the shutdown period, the elements must always be kept wet and managed to prevent microbial growth and freezing.

D. The back pressure on the permeate side should always remain below 5 psig, and the back pressure must be checked for each stage separately.

E. In situations where multiple trains are operating simultaneously and the operation of some trains is stopped, use check valves or isolation valves on the permeate piping to ensure that the permeate piping of the operating trains is not affected. If necessary, install pressure relief valves on the permeate piping of individual trains.

F. For short-term shutdowns (less than 7 days), flush the system with the recommended flushing water for 0.5 hours according to the feed water quality to expel air from the piping. Conduct train flushing daily.

G. For long-term shutdowns (7 days or more), for RO products, supply a 1 - 1.5% preservation solution (SBS) at low pressure to clean the elements and leave them soaked in this state. While circulating the preservation solution, expel any residual air from the system. The introduction of oxygen or air can oxidize the preservation solution. Check the pH of the preservation solution once a week. If the solution becomes oxidized, the pH will drop; if it falls below pH 3, replace the preservation solution with a fresh one.

H. Due to the characteristics of NF products, do not store them immersed in SBS preservation solution. Instead, flush the RO train with flushing water for 0.5 - 1 hour, fill the vessel with flushing water, and then close the valve that separates the train. Repeat the flushing process at least once daily.

I. Elements within the vessel must not be exposed to chlorine or oxidizing agents under any

circumstances. Exposure to these substances can damage the elements and negatively affect the salt rejection rate.

Types of Feed Water	Types of Flushing Water
Concentrated seawater High concentration water quality (over 70,000 ppm)	Pretreated RO permeate water
Seawater	Pretreated feed water
Brine	Pretreated feed water
River and wastewater	RO permeate water
High pH RO feed water (2 pass system)	Pretreated RO feed water (1-pass permeate) without pH adjustment

Table 4-1. Recommended Flushing Water Types Based on Feed Water Types

2. When Removing and Storing Elements

When storing used elements, the following recommendations should be followed:

A. Storage Method for RO Products

Prepare a 1% preservation solution (SBS) using RO water and sodium metabisulfite (SMBS). Soak the element in the solution for about 1 hour, then store it in a plastic bag.

B. Storage Method for NF Products (excluding NE90)

Store the flushed elements in a plastic bag, sealed with an oxygen absorber. Contact CSM to purchase the oxygen absorber and plastic bags.