# MDI Manual – UX series

.

## INSTRUCTION MANUAL FOR OPERATION AND MAINTENANCE OF MDI

### Table of Contents

# MDI Manual – UX series

## Ⅰ. MDI Overview

### 1.1. MDI Introduction

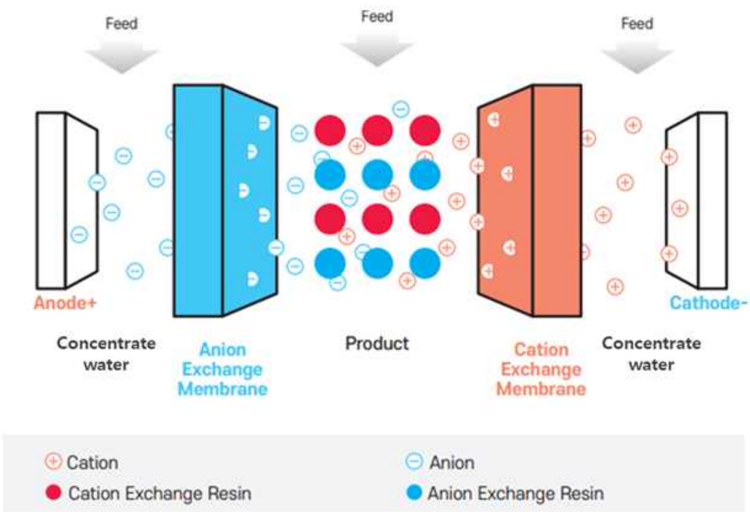
MDI is a continuous electrodeionization system that produces high-purity water using direct current electricity. MDI is comprised of components such as ion exchange membranes, ion exchange resin, and spacers. The replacement and regeneration of ion exchange resin are not required, preventing the generation of regeneration waste, and allowing for the continuous production of ultrapure water without operational interruptions.


[Figure 1. MDI DX Series]

### 1.2. MDI Principle

Feed water is introduced into the spacer located between the membranes. Upon applying an electric current, electrostatic forces cause cations in the water to move toward the (-) electrode and anions to move toward the (+) electrode. During this process, the cations (Na+, Ca2+, etc.) present in the dilute spacer pass through the cation exchange membrane, while the anions (Cl-, OH-, etc.) pass through the anion exchange membrane and move to the concentrate spacer. This is similar to the principle of a traditional Electrodialysis (ED/EDR) system. Water that has had ions removed as it passes through the dilute spacer becomes produced water (ultrapure and demi. water). On the other hand, the concentrate water discharged after passing through the concentrate spacer contains numerous ions and is either discharged or recirculated.

1) FCE (Feed Conductivity Equivalent)



# MDI Manual – UX series

While the typical removal rate of salts by RO membranes is around 99%, dissolved carbon dioxide ($CO_2$) in water is hardly removed. When a high concentration of $CO_2$ is introduced into MDI, it acts as a load and causes the device's processing performance to deteriorate. Consequently, in MDI design, it is essential to consider CO2 concentration.

| | |
|---|---|
| FCE Calculation Formula | FCE = Conductivity(㎲/㎝) + ($CO_2$×2.66)㎲/㎝ + ($SiO_2$ × 1.94)㎲/㎝ |

FCE (Feed Conductivity Equivalent) refers to electrical conductivity, which includes the concentration of dissolved $CO_2$ and dissolved $SiO_2$. It is obtained by converting the ppm concentrations into electrical conductivity (µS/cm). In this case, 1 ppm of $CO_2$ is equivalent to 2.66 µS/cm, and 1 ppm of $SiO_2$ is equivalent to 1.94 µS/cm. For example, if the conductivity measurement of RO-treated water is 2 µS/cm, with 1 ppm dissolved $CO_2$ and 0.1 ppm dissolved $SiO_2$, the FCE is calculated as 2 µS/cm + (1 × 2.66 µS/cm) + (0.1 × 1.94 µS/cm) = 4.85 µS/cm.

2) Regeneration of ion exchange resin
The application of direct current electricity initiates water splitting within the ion exchange resin in the ion exchange membrane and spacer, disintegrating $H_2O$ into $H^+$ and $OH^-$. $H^+$ and $OH^-$ ions regenerate the cation and anion exchange resins within the dilute spacer through the following reaction equation.
The electro-regeneration reaction occurs continuously without the need for separate regeneration processes, allowing for continuous operation without the generation of waste solution. Regenerated ion exchange resin increases the desalination (ion removal) rate and efficiently removes weakly ionized compounds ($CO^{3-}$, $SiO_2$, etc.).

| Cation Exchange Resin Regeneration Reaction Equation | Anion Exchange Resin Regeneration Reaction Equation |
|---|---|
| $R\text{-}Na^+ + H^+ \rightarrow R\text{-}H^+ + Na^+$ | $R\text{-}Cl^- + OH^- \rightarrow R\text{-}OH + Cl^-$ |

3) Removal of weakly ionized compounds
Weakly ionized compounds such as $CO_2$, Silica, and Boron are removed as follows. The weakly ionized compounds in the dilute spacer combine with ions ($H^+$, $OH^-$) generated by water splitting, acquiring an electric charge. The cations are attracted to the cathode and pass through the cation exchange membrane, while the anions are attracted to the anode and pass through the anion exchange membrane and are removed to the concentrate spacer.

| | | |
|---|---|---|
| Ionization Reaction Equations of Weakly Ionized Compounds | $CO_2 + OH^- \rightarrow HCO_3^-$ | $H_3BO_3 + OH^- \rightarrow B(OH)_4^-$ |
| | $HCO_3^- + OH^- \rightarrow CO_3^{2-} + H_2O$ | $NH_3 + H^+ \rightarrow NH_4^+$ |
| | $SiO_2 + OH^- \rightarrow HSiO_3^-$ | |

# MDI Manual – UX series

## Ⅱ. MDI Technical Information

### 2.1. MDI Module Specifications

| Model | UX-5005 | UX-5010 |
|---|---|---|
| **Maximum Feed Water Specifications** | | |
| Feed Water Conductivity Equivalent including $CO_2$ and Silica | < 10㎲/㎝ ($CO_2$<1.25ppm, Silica<0.2ppm) | |
| Inlet Pressure | Max. 10㎏f/㎠ | |
| Inlet Temperature / pH | 20~45℃ (Nor. 25℃) / 4~11 | |
| **Typical Module Performance** | | |
| Recovery | ≧ 95% | |
| Capacity | 4-6㎥/hr | 10-13㎥/hr |
| Pressure Drop | < 2.5㎏f/㎠ | |
| DC Voltage / Current | 0-500V / 0-6A | |
| Product Resistivity | > 17.5㏁·㎝ (<5㎲/㎝ : 2Pass RO)<br>> 18.0㏁·㎝ (<1㎲/㎝ : DI Water) | |
| Silica / Boron Removal | ≧ 99% | |
| Sodium / Chloride Removal | ≧ 99.9% | |
| **Physical Specifications** | | |
| Size | 470ID㎜×1,095㎜L | 470ID㎜×2,110㎜L |
| Empty / Oper. Weight | 250㎏ / 260㎏ | 480㎏ / 500㎏ |

### 2.2. MDI Installation

**A. Disassembly and Transportation**

1) Disassemble the existing product's connecting pipes to separate them from the skid.
2) Transfer the module, which is packaged in a box or packaging material, to the installation site.
3) After unpacking, inspect the condition of the module and verify its components.
4) Safely move the MDI onto the skid using transportation equipment (such as forklifts or cranes).

※ Ensure that each nozzle of the MDI, sealed with plugs, is not disassembled to prevent the MDI modules from drying out.

**B. Piping Connection**

1) Thoroughly clean the pre-treatment equipment and related piping with clean water that has been treated by RO or is free from particles.
2) Establish connections between all interface points of the MDI to the system (piping).
3) Inspect the leakage condition of the electrode water, feed water, concentrate water, and produced water piping.

※ This procedure must be carried out before supplying feed water to the MDI module. If any residual substances from the MDI pre-treatment equipment and associated piping, such as PVC and SUS welding residues, particles, etc., are introduced to the MDI module, it could result in severe damage.

**C. Electrical Connection**

1) Connect the anode (+) and cathode (-) electrical wires.
2) Ground the MDI module itself by connecting it to the grounding wire.

※ Before applying DC power, it is essential to ensure that all electrical wires are correctly connected. Operating in a state where the anode (+) and cathode (-) directions are reversed can deteriorate the treated water quality and cause damage to the electrode plates. In the electrical cable, the red wire indicates the anode (+), and the blue wire indicates the cathode (-).

※ Grounding is crucial in MDI installation. To ensure effective grounding, it's imperative to connect the grounding wire to the MDI module, rectifier, and skid components. If the MDI is not grounded and some of the current supplied to the MDI escapes through the grounding wire, it can affect the performance and pose a risk of electric shock in the event of abnormal currents.

# MDI Manual – UX series

## Ⅲ. MDI Operation

### 3.1. Operation Preparation

Before beginning the operation, the quality of the feed water should be regularly checked to ensure the following conditions are met: The feed water conditions may vary depending on the site conditions and the produced water guarantee levels

| Model | UX Series |
|---|---|
| Temperature | 20 ~ 45 ℃ |
| pH | 4 ~ 11 |
| Conductivity, FCE | < 10 ㎲/㎝ (2-Pass RO Permeate) ($CO_2$ < 1.25ppm, Silica < 0.2 ppm) |
| Fe, Mn, $H_2S$ | < 0.01 ppm |
| TOC | < 0.5 ppm |
| Total Hardness | < 0.1 ppm as $CaCO_3$ (Recovery 90%) |
| Free Chlorine | < 0.01 ppm |

### 3.2. Normal Operating Conditions of MDI System

※ Recovery 95%

| Model | UX-5005 | UX-5010 |
|---|---|---|
| Feed pressure | 4.0 ~ 4.5 kgf/㎠ | |
| Conc. In pressure | 3.0 ~ 3.5 kgf/㎠ | |
| Product pressure | 2.5 ~ 3.0 kgf/㎠ | |
| Conc. Out pressure | 1.5 ~ 2.0 kgf/㎠ | |
| Operating voltage | Nor. 300 ~ 500 V / Max. 600 V | |
| Operating current | Nor. 1 ~ 4A / Max. 6A | |
| Product flow rate | Nor. 5 $m^3$/hr | Nor. 11.5 $m^3$/hr |
| Conc. Out flow rate | Nor. 0.6 $m^3$/hr | Nor. 1.3 $m^3$/hr |
| Electrode water flow rate | Min. 60 L/hrstack | |

During constant-voltage operation, the voltage remains constant while the current automatically adjusts depending on the MDI stack load (feed water quality, temperature, treated water flow rate). On the other hand, during constant-current operation, the current remains constant while the voltage automatically adjusts depending on the MDI stack load. Typically, the operating current is maintained at 0.3 to 4A per stack, and voltage and current limits are set to prevent abrupt increases in operating voltage.

### 3.3. MDI Operation

It consists of two stages: The Make-up process and the Service process (Normal operation), and the details are as follows.

# MDI Manual – UX series

**1) Make-up**
This process involves filling the dilute spacer and concentrate spacer within the module with feed water (R/O treated water) using the MDI feed pump. The water filled in the dilute spacer is discharged through the produced water piping, while the water filled in the concentrate spacer is discharged through the concentrate water outlet and electrode water outlet piping. Check if the specified flow rate is being properly discharged from the outlet piping of produced water, concentrate water, and electrode water.
The water used in the Make-up process is recycled for reuse. The water discharged through the produced water outlet piping is directed to the MDI feed tank, while the water discharged from the concentrate water outlet and electrode water piping is sent to the inlet-side of the R/O.

**2) Service**
A. Supply of Direct Current Power within the Stack
Direct current power within the stack is supplied through the operation of the rectifier. Be cautious when the rectifier is activated while the feed water and produced water valves are closed or while the supply of feed water to the MDI stack is interrupted due to the trip of the MDI feed pump. In such conditions, critical damage to the electrode plates within the MDI can occur.

B. Current and Voltage Adjustment
Depending on the quality of feed water and desired water, the current is adjusted to an appropriate level to achieve economical operation. In most cases, the operation is carried out using either constant-voltage or constant-current mode. During constant-voltage operation, the voltage remains constant while the current automatically adjusts depending on the MDI stack load (feed water quality, temperature, treated water flow rate). On the other hand, during constant-current operation, the current remains constant while the voltage automatically adjusts depending on the MDI stack load. Typically, the operating current is maintained at 0.3 to 4A per stack, and voltage and current limits are set to prevent abrupt increases in operating voltage.

C. Adjustment of concentrate water discharge flow rate and pressure.
Adjust the discharge flow rate and discharge pressure of the concentrate water by adjusting the Make-up flow control valve for the concentrate chamber and the discharge flow control valve for the concentrate water. To minimize concentrate spacer contamination, the discharge flow rate of concentrate water is set to about 10% of the feed water. If the pressure in the concentrate spacer is high, there is a risk of concentrate water flowing into the dilute spacer, leading to contamination of the treated water quality. Therefore, the pressure in the dilute spacer (Product) must be maintained at 1.0~1.5kgf/cm² higher than the outlet pressure of the concentrate spacer (Conc. Out) to prevent such contamination.

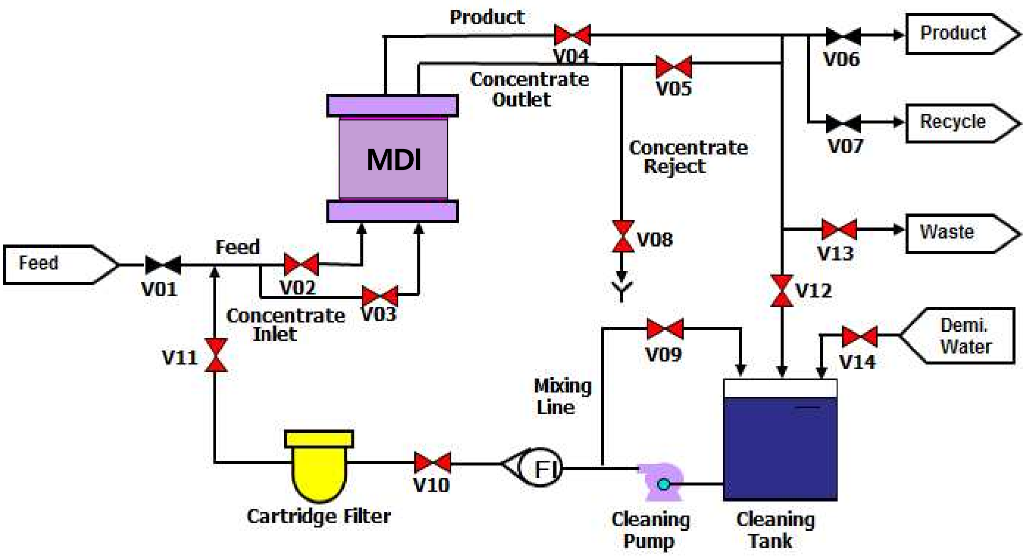
## Ⅳ. MDI Maintenance

### 4.1. MDI Chemical Cleaning
During prolonged operation of MDI under normal conditions, the MDI stack can become contaminated by colloidal suspended solids (Colloid, Clay, Silt, etc.), organic or inorganic particulates, microbials, and inorganic compounds such as Silica, $CaCO3$, $CaSO4$, and metal hydroxides that remain in the feed water. Also, periodically removing these contaminants through a cleaning process is called CIP (Cleaning In Place).
If contamination occurs within the MDI stack, it can lead to reduced treated water quantity, lower salt permeability, degradation in treated water quality, and increased differential pressure within the MDI module. Additionally, if the cleaning process is delayed and the system operates for an extended period, the efficiency of contaminant removal through cleaning decreases. Hence, timely cleaning is crucial. Moreover, if performance recovery is insufficient after cleaning, proactive actions like analyzing contaminants and then pursuing steps such as choosing suitable chemicals and adjusting the cleaning frequency should be taken. If scheduled chemical cleaning is delayed, severe contamination that is difficult to recover even through chemical cleaning can occur in the MDI system. Therefore, chemical cleaning should be performed as early as possible in the event of initial contamination.

1) Typical timing for chemical cleaning
- When the treated water quantity decreases by more than 10% (without changes in temperature

# MDI Manual – UX series

and pressure)
- When the treated water conductivity decreases by more than 10% (without changes in temperature, feed water quality, and pressure)
- When the pressure difference between produced water and concentrate water increases by about 15% (without changes in temperature and pressure)
- When the operating current decreases by more than 20 to 25% (without changes in feed water quality, treated water flow rate, temperature, and pressure)
- When the electrode water flow rate decreases by more than 20 to 25% (without changes in feed water quality, treated water flow rate, temperature, and pressure)




[Figure 1. CIP Flow Diagram]

2) Chemical cleaning procedure
- Before performing MDI chemical cleaning, be sure to replace the used cleaning cartridge filter with a new one. Using a contaminated cleaning cartridge filter can lead to severe contamination during the MDI chemical cleaning process.
- Fill the cleaning tank with MDI produced water and verify the agitator and temperature settings before dissolving chemicals according to the intention of the cleaning process.
- Mix and circulate the cleaning solution using the agitator and cleaning pump, adjusting the pH. All cleaning processes are performed manually.
- Depending on the source of contamination, choose the type of cleaning. If the source of contamination is complex or unclear, conduct inorganic cleaning first, followed by organic cleaning.
- Depending on the level of contamination, cleaning of the dilute chamber and concentrate chamber can be conducted together. Generally, conducting separate cleaning for the dilute chamber and concentrate chamber is more effective. In this case, perform dilute chamber cleaning first, followed by concentrate chamber cleaning. During cleaning, the cleaning pressure is maintained below 3 $kgf/cm^2$.
- In the event of chemicals splashing or spilling onto the body, immediately rinse the affected area with a large volume of flowing water for at least 15 minutes. Respond as quickly as possible and seek immediate medical attention after completing emergency measures for treatment and prescription.

3) Common types of contaminants and removal methods
Alkaline cleaning agents are used to remove contamination caused by microbials, organic substances, and silica, while acidic cleaning agents are used to remove contamination caused by inorganic substances such as iron and hardness scale. Depending on the type of common contaminants, the following methods are applied, and if necessary, seek cooperation from TSK ENGINEERING.

# MDI Manual – UX series

■ **2.5% HCl Cleaning**
Cleaning to remove contamination from $Ca^{2+}$, $Mg^{2+}$scale, and metal oxides occurs mainly in the concentrate chamber. If the effects of cleaning are not satisfactory, repeat cleaning or gradually increase the concentration of HCl to a range of 2.5~3.0% for effective cleaning.

① Chemical input amount for acid cleaning (per unit)

| Chemical | Input amount |
| --- | --- |
| 99% NaCl | 30kg |
| 35% HCl | 37L |
| Demi. Water | 0.6㎥ |

② HCl cleaning procedure

| [Step 1] Start flushing |
| --- |
| ✓ To rinse out the contaminants present in the stack, pipelines, and cleaning tank before chemical cleaning, a flushing process with demi water is conducted at a rate of about 14㎥/hr for approximately 2 to 5 minutes.<br>- Open V/V : V02, V03, V04, V05, V10, V11, V13, V14<br>- Activate pump: Cleaning Pump |
| [Step 2.1] Dilution chamber HCl recycle |
| ✓ Add 2.5% HCl (0.6㎥ pure water, 37L of 35% HCl) to the cleaning tank and dissolve it. (Activate agitator)<br>- Open V/V : V09<br>- Activate pump: Cleaning Pump<br>- Activate the electric heater and agitator<br>✓ Open the cleaning line valve of the dilution chamber. Circulate the dilution chamber through the cleaning tank for 1 hour using the cleaning process of Ca2+, Mg2+, and hardness scale. Adjust the chemical inflow rate to approximately 12㎥/hr.<br>✓ Maintain the pH value at approximately 0.5 to 1.0 during the cleaning process. If the pH value rises above 1.0 during the circulation process, add HCl solution to adjust it back to the range of 0.5 to 1.0.<br>- Open V/V : V02, V04, V10, V11, V12<br>- Activate pump: Cleaning Pump<br>- Activate the electric heater |
| [Step 2.2] Concentrate chamber HCl recycle |
| ✓ After the dilute chamber HCl recycle process is completed, close the valve on the dilute chamber side and open the valve on the concentrate chamber cleaning line. Contaminated stacks are cleaned using the cleaning process of Ca, Mg, and hardness scale, circulating the concentrate chamber through the cleaning tank for 1 hour. Adjust the chemical inflow rate to approximately 2㎥/hr.<br>✓ Maintain the pH value at approximately 0.5 to 1.0 during the cleaning process. If the pH value rises above 1.0 during the circulation process, add HCl solution to adjust it back to the range of 0.5 to 1.0.<br>- Open V/V : V03, V05, V10, V11, V12<br>- Activate pump: Cleaning Pump<br>- Activate the electric heater |

# MDI Manual – UX series

| |
|---|
| [Step 3] Soaking (Optional) |
| ✓ In cases of severe MDI contamination, this procedure is carried out where the cleaning agent is filled in the stack. Inlet and outlet valves are closed, and the process is conducted for 1 hour. If the cleaning is not effective, the procedure can be extended for a longer period. |
| [Step 4] Cleaning tank drain & water flushing |
| ✓ After fully draining the cleaning solution in the cleaning tank, the remaining cleaning solution in the stack, pipes, and cleaning tank is removed by flushing with demi. water and discharging to the trench drains for about 14 to 20 minutes.<br>- Open V/V : V02, V03, V04, V05, V10, V11, V13<br>- Activate pump: Cleaning Pump |
| [Step 5] Start flushing |
| ✓ Add 5% NaCl (demi. water: 0.6 m³, 99% NaCl: 30 kg) to the cleaning tank, and ensure complete dissolution of NaCl by activating the agitator. Return the 5% NaCl solution to the cleaning tank via the cleaning pump while the agitator is in operation. To convert the ion exchange resin filled in the cell to R-Na and R-Cl forms, the process is carried out by discharging a salt solution for about 3 minutes or more to the trench drains. The inflow rate is adjusted to be at least 3 minutes by manipulating the cleaning inlet valve at a rate of approximately 12 m³/hr.<br>- Open V/V : V02, V03, V04, V05, V10, V11, V13, V14<br>- Activate pump: Cleaning Pump |
| [Step 6] Final water flushing |
| ✓ To rinse out any remaining salt and cleaning solution in the stack, pipes, and cleaning tank, perform a flushing process using demi. water for approximately 1 hour until the pH becomes neutral. Adjust the inflow rate to approximately 14㎥/hr.<br>- Open V/V : V02, V03, V04, V05, V10, V11, V13, V14<br>- Activate pump: Cleaning Pump |
| [Step 7] Blow-down & Service |
| ✓ After opening or closing all valves in the operational state, operate the MDI while circulating the treated water to the filtered water reservoir under the designed flow rates and pressure conditions until the desired treated water quality is achieved (Blow-down). Once the desired treated water quality is attained, conduct the service process to the demi. water tank. The duration of the blow-down takes at least 6 hours or more, depending on the residual amount of chemicals and the degree of regeneration after the final flushing.<br>- Open V/V : V01, V02, V03, V04, V05, V07, V08 [Blow-down]<br>V01, V02, V03, V04, V05, V06, V08 [Service]<br>- Activate pump: MDI Feed Pump<br>- Rectifier Run |

# MDI Manual – UX series

## ■ 5% Brine & 1% NaOH Cleaning

This cleaning is carried out to remove typical organic and silica contaminants. Organic contaminants are commonly found in the dilute chamber, while silica is commonly found in the concentrate chamber.

① Chemical input amount for Brine & NaOH cleaning (per unit)

| Chemical | Input amount |
|---|---|
| 99% NaCl | 30kg |
| 45% NaOH | 9L |
| Demi. Water | 0.6㎥ |

② Brine & NaOH cleaning procedure

| [Step 1] Start flushing |
|---|
| ✓ To rinse out the contaminants present in the stack, pipelines, and cleaning tank before chemical cleaning, a flushing process with demi water is conducted at a rate of about 14㎥/hr for approximately 2 to 5 minutes.<br>- Open V/V : V02, V03, V04, V05, V10, V11, V13, V14<br>- Activate pump: Cleaning Pump |
| [Step 2.1] Dilution chamber brine & NaOH recycle |
| ✓ Add 5% NaCl (demi. water: 0.6 m³, 99% NaCl: 30 kg) to the cleaning tank, and ensure complete dissolution of NaCl by activating the agitator. Return the 5% NaCl solution to the cleaning tank via the cleaning pump while the agitator is in operation.<br>- Open V/V : V09<br>- Activate pump: Cleaning Pump<br>- Activate the electric heater and agitator<br>✓ Add 1% NaOH (45% NaOH: 9 L) to the dissolved 5% NaCl solution and mix until fully dissolved. Open the cleaning line valve of the dilution chamber. Contaminated stacks are cleaned using the cleaning process of organic and silica, circulating the dilution chamber through the cleaning tank for 1 hour. Adjust the chemical inflow rate to approximately 12㎥/hr using the cleaning inlet valve. Maintain the pH value at approximately 11 to 12. In the case of heavy contamination, perform the cleaning at around 35°C.<br>- Open V/V : V02, V04, V10, V11, V12<br>- Activate pump: Cleaning Pump<br>- Activate the electric heater |
| [Step 2.2] Concentrate chamber brine & NaOH recycle |
| ✓ After the brine & NaOH recycle process of the concentrate chamber is completed, close the valve on the dilute chamber side and open the valve on the concentrate chamber cleaning line. Contaminated stacks are cleaned using the cleaning process of organic and silica, circulating the concentrate chamber through the cleaning tank for 1 hour. Adjust the chemical inflow rate to approximately 2㎥/hr using the cleaning inlet valve. Maintain the pH value at approximately 11 to 12. In the case of heavy contamination, perform the cleaning at around 35°C.<br>- Open V/V : V03, V05, V10, V11, V12<br>- Activate pump: Cleaning Pump<br>- Activate the electric heater |

# MDI Manual – UX series

| [Step 3] Soaking (Optional) |
| --- |
| ✓ In cases of severe MDI contamination, this procedure is carried out where the cleaning agent is filled in the stack. Inlet and outlet valves are closed, and the process is conducted for 1 hour. If the cleaning is not effective, the procedure can be extended for a longer period. |
| [Step 4] Cleaning tank drain & water flushing |
| ✓ After fully draining the cleaning solution in the cleaning tank, the remaining cleaning solution in the stack, pipes, and cleaning tank is removed by flushing with demi. water and discharge to the trench drain for approximately 1 hour until the pH becomes neutral. Adjust the inflow rate to approximately 14㎥/hr using the cleaning inlet valve.<br>- Open V/V : V02, V03, V04, V05, V10, V11, V13<br>- Activate pump: Cleaning Pump |
| [Step 5] Blow-down & Service |
| ✓ After opening or closing all valves in the operational state, operate the MDI while circulating the treated water to the filtered water reservoir under the designed flow rates and pressure conditions until the desired treated water quality is achieved (Blow-down). Once the desired treated water quality is attained, conduct the service process to the demi.water tank. The duration of the blow-down takes at least 6 hours or more, depending on the residual amount of chemicals and the degree of regeneration after the final flushing.<br>- Open V/V : V01, V02, V03, V04, V05, V07, V08 [Blow-down]<br>V01, V02, V03, V04, V05, V06, V08 [Service]<br>- Activate pump: MDI Feed Pump<br>- Rectifier Run |

## 4.2. Handling, Storage, and Shutdown of MDI

### A. Precautions for handling and storage

1) Maintaining appropriate temperature
All new MDI systems undergo performance testing, and after completion, they are filled with demi. water and sealed. Bacteria reproduce rapidly at temperatures of 25~35℃ in ultrapure water, while their reproduction slows down at temperatures below 15~18℃. Therefore, it is advisable to store it at lower temperatures under air conditioner conditions.
However, excessively low temperatures should be approached with caution. When MDI is frozen, irreparable damage can occur to the membranes or the module exterior can crack, so it is important to store inside a building to protect it from freezing. It's advisable to keep it within the temperature range of 5 to 30℃.

2) Prevention of drying out
All new MDI systems undergo performance testing, and after completion, they are packaged while filled with demi.water to prevent drying inside the MDI. When storing the MDI, if the plugs are removed, the sealed demi. water inside may leak out, causing the ion exchange resin and membrane within the module to dry out, resulting in critical damage to the MDI. Therefore, ensure that the plugs attached to each nozzle of the MDI are securely connected and sealed.

3) Prevention of direct sunlight and UV exposure
MDI should not be exposed to direct sunlight or UV radiation for prolonged periods. It should be stored indoors or in a suitable storage area with the humidity being maintained at around 40~60%, preferably with air conditioning.

4) Handling and storage in terms of appearance

# MDI Manual – UX series

MDI must be protected from physical impacts such as vibration, twisting, and dropping. Prior to installation, store the MDI in its packaging to protect it from physical impacts and potential damage.

**B. Caution When Shutting Down (Shutdown)**
The MDI system's regeneration efficiency of ion exchange resin improves with continuous operation, leading to better processing performance. Therefore, it is advisable to avoid stopping operation for more than 3 days whenever possible. If the operation is halted for over 3 days, more operating time may be required and extended electrical regeneration may be required to achieve the initially satisfactory treated water quality upon restart.

1) Short-term storage within the MDI stack
When the MDI system is temporarily halted for 5 to 30 days while installed, follow these steps for storage. Whenever possible, alternate operations should be conducted within a week to prevent microbial growth.
A. Flushing: While flushing with demi. water, perform venting to ensure there is no air inside the MDI stack.
B. Block Valve Close: After filling the MDI stack with demi. water, close all valves to prevent the entry of air.

2) Long-term storage within the MDI stack: When the MDI is shut down for a period of 30 days or more while installed, the storage procedure is similar to short-term storage, but it is recommended to repeat the procedure on a monthly basis.

## 4.3. MDI Troubleshooting and Countermeasures

1. In Case of Deterioration in Treated Water Quality

| Probable cause | Action |
|---|---|
| Increase in feed water TDS (Including $CO_2$, silica) | Constant-voltage operation – Sequentially increase the operating voltage by around 20~30V.<br>Constant-current operation – Sequentially increase the operating current by around 0.1~0.2A.<br>※ Adjust within the range that meets the treated water guarantee levels. |
| Decrease in feed water temperature | |
| Increase in feed water temperature | Constant-voltage operation - Sequentially decrease the operating voltage by about 20~30V.<br>Constant-current operation - Sequentially decrease the operating current by around 0.1~0.2A.<br>※ Adjust within the range that meets the treated water guarantee levels. |
| Increase in feed water hardness | Reduce the recovery rate.<br>Cleaning or replacement of R/O membrane in MDI inlet-side (to lower feed water hardness and silica concentration) |
| Treated water / Concentrate outlet pressure change | Keep the treated water pressure (Product) higher than the concentrate water outlet pressure (Conc. out) at all times.<br>※ Sequentially adjust the pressure difference within the range that satisfies the treated water guarantee levels; typically, this difference is around 0.5~1.5 bar. |
| Electrical wiring condition | Check if the (+) and (-) electrode wires of the electrode connection are properly connected. |
| Contamination inside the MDI module | Chemical cleaning (CIP) is required. |
| Others | Adjust the feed water flow rate of the MDI module with deteriorated treated water quality to a lower level, and adjust the feed water flow rate of the MDI module with better-treated water quality to a higher level.<br>※ Adjust within the range that meets the treated water guarantee levels. |

# MDI Manual – UX series

2. Decrease in Treated Water Flow Rate

| Probable cause | Action |
|---|---|
| Valve operation error | Adjust feed water inlet valves (Feed-in) and treated water outlet valves (Product-out) → Increase in treated water flow rate |
| | Adjust concentrate water inlet and outlet valves → Adjust according to the design recovery rate |
| MDI module oxidation | Check for oxidation - Analyze the ORP and $Cl_2$ of the feed water |
| Contamination inside the MDI module | Check for organic and microbial contamination - Analyze TOC/COD and microbial of feed water<br>If contamination occurs within the module, chemical cleaning (CIP) is required |

3. In Case the Rectifier Power is not Supplied

| Phenomenon | Action |
|---|---|
| INP lamp indicator on | Check AC input power |
| Fuse and OT lamp indicators on | Replace the rectifier fuse, Replace the rectifier and external fan |
| Treated water flow rate is below low | Turn off the rectifier |
| Concentrate water flow rate is below low | Turn off the rectifier |
| Treated water flow rate is above the set limit | Turn on the rectifier |

4. Decrease in Concentrate Water Flow Rate

| Probable cause | Action |
|---|---|
| Valve operation error | Conc. Adjust concentrate water inlet and outlet valves → Adjust to design concentrate water flow rate |
| Contamination inside the MDI module | Chemical cleaning (CIP) is required. |

5. Decrease in Electrode water flow rate

| Probable cause | Action |
|---|---|
| Valve operation error | Check if the electrode water inlet valve and electrode water flow meter valve are in an open state |
| Contamination inside the MDI module | Chemical cleaning (CIP) is required. |

### 4.4. MDI Replacement

During operation, fouling or scaling can damage the ion exchange membranes and ion exchange resins of the MDI membrane, causing a decrease in treatment performance. Therefore, it is necessary to restore performance by proper chemical cleaning. Furthermore, the usage lifespan is approximately 5 to 7 years, but it can vary depending on the feed water quality and operational conditions of the MDI. If the cleaning cycle is shortened and recovery is not achieved despite being cleaned, a complete replacement with a new MDI or partial replacement of the problematic stack is performed.

# MDI Manual – UX series


GEUMHWA WTS

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