DuPont Water Solutions

DuPont™ Electrodeionization - EDI-310 Module Technical Manual

Version 1

August 2021

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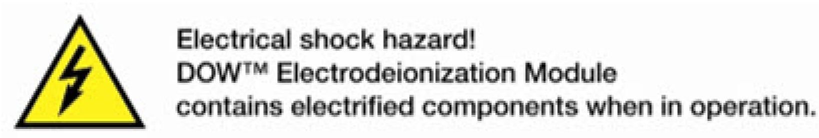

Caution:

To prevent DuPont™ Electrodeionization modules from being damaged, handle with reasonable care during transport, handling and operations and DO NOT:

- Operate module without adequate ventilation for electrode gases
- Operate module at more than 9 amps
- Operate module without adequate water flow through dilute, concentrate and electrode flush compartments
- Ship or store the module at a temperature below 4^0 C (40^0 F) or above 38^0 C (100^0 F)
- Operate module at feed water temperature above 38^0 C (100^0 F)
- Operate module at a peak feed pressure higher than 6.9 bars (100 psig) or continuously at a feed pressure higher than 5.5 bars (80 psig)
- Operate or clean module with unauthorized chemicals
- Open or disassemble module without the help of authorized personnel

1 DuPont™ EDI (Electrodeionization)

1.1 DuPont™ EDI Module Operating Principle

The DuPont™ EDI-310 module (hereinafter referred to as DuPont™ EDI unless specifically referred otherwise) utilizes spiral wound membrane technology which combines ion exchange resin, ion selective membranes, and direct current (DC) to deionize water.

1.1.1 Ion Exchange Resin Process

Ion exchange is a process that has been used in water purification for over 70 years. Ion exchange is a reversible chemical reaction wherein an ion (an atom or molecule that has lost or gained an electron and thus acquired an electrical charge) from solution is exchanged for a similarly charged ion attached to an immobile solid resin particle.

There are two basic types of resin - cation exchange and anion exchange resins. Cation exchange resins will release hydrogen (H^+) ions or other positively charged ions in exchange for impurity cations present in the water. Anion exchange resins will release hydroxide (OH^-) ions or other negatively charged ions in exchange for impurity anions present in the water. See Figure 1.

After the resins become exhausted, a regeneration sequence is used to remove the concentrated contaminants from the resin bed and regenerate the resin back to its original ionic form. Injection of hazardous chemicals such as sulfuric acid, hydrochloric acid, and sodium hydroxide are used to regenerate the resins back to the H^+ and OH^- form, which requires on-site bulk storage of these chemicals and operator's exposure to hazardous chemicals. Moreover, such batch regeneration process requires stand-by units to supply constant flow to the downstream equipment.

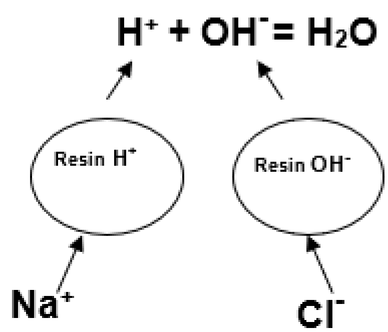

Figure 1. Ion Exchange Resin Diagram

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1.1.2 DuPont™ EDI Process

Electrodeionization (EDI) uses the water purification benefits of ion exchange resin while eliminating the disadvantages of chemical regeneration, which is done by combining ion exchange resin with electrodialysis. The elements required for the electrodialysis process consist of ion selective cation and anion membranes, electrodes, concentrate chambers, dilute chambers and DC current. See Figure 2.

The result is electrodeionization, which is a continuous, chemical-free system which generates high resistivity water of up to 18 meg-ohm-cm @ 25°C).

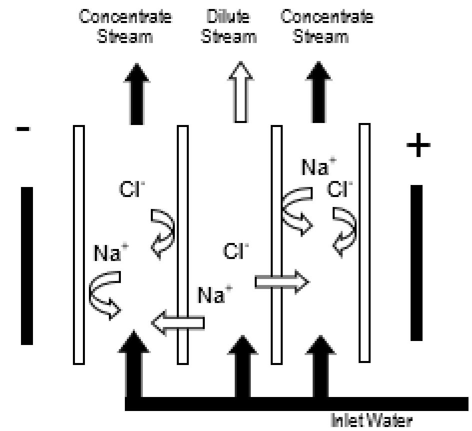

Figure 2. Electrodialysis Diagram

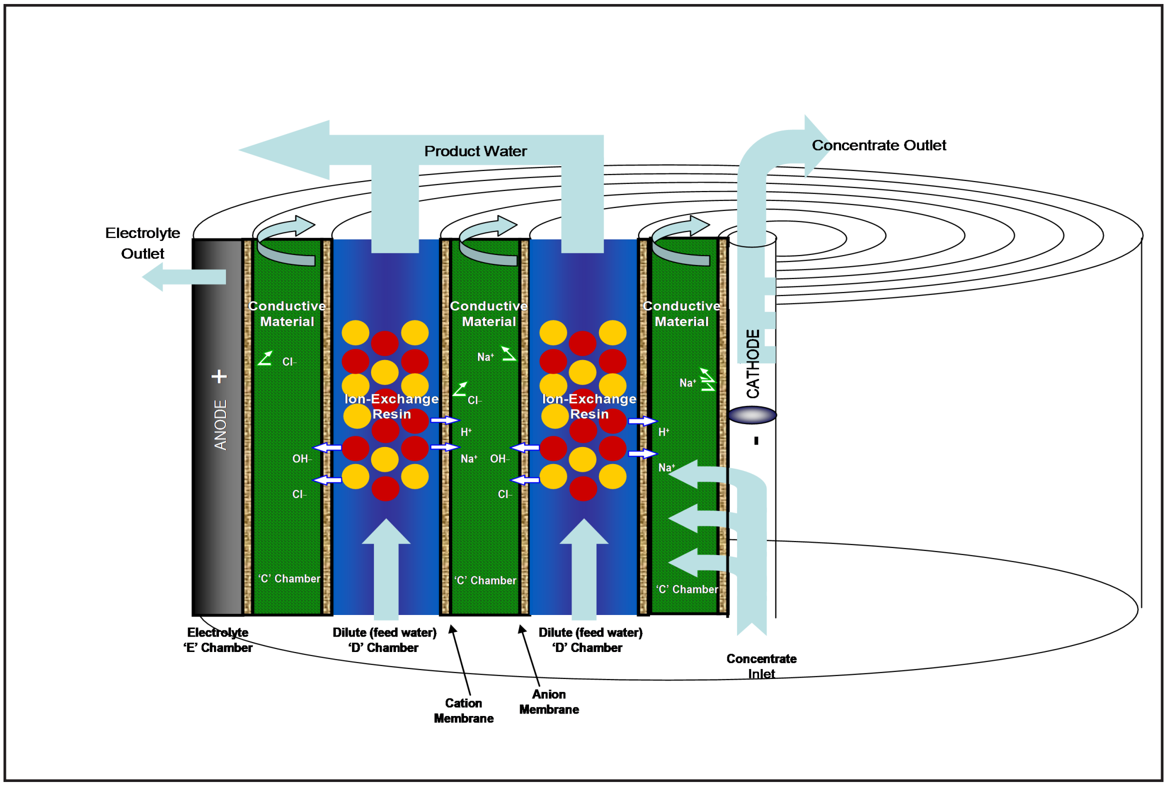

Figure 3. Schematic DuPont™ EDI Process

DuPont Water Solutions uses a patented spiral wound manufacturing process (US Patent number 6,190,528) to construct its modules. The spiral wound design results in a light weight, leak free module with lower maintenance requirements than earlier generation plate and frame style EDI products. Spiral wound DuPont™ EDI modules employ a fiberglass reinforced plastic (FRP) pressure vessel which is locked with end caps on both ends to prevent leaks.

1. Feed water (dilute stream) enters the DuPont™ EDI module from below and is diverted into vertically spiraled cells known as the 'D' (dilute) chambers. The dilute stream flows vertically through ion-exchange resins located between two membranes (an anion membrane specifically designed to allow migration of only anions and a cation membrane specifically designed to allow migration of only cations).

2. DC current is applied across the cells. The cathode applies negative DC charge and the anode applies positive DC charge. The DC electrical field splits a small percentage of water molecules (H_2O) into hydrogen (H^+) and hydroxide (OH^-) ions. The H^+ and OH^- ions attach themselves to the cation and anion resin sites, continuously regenerating the resin. The positively charged hydrogen ions will migrate through the cation resin, then through cation permeable membranes into the concentrate chamber due to its attraction to the cathode. Likewise, the negatively charged hydroxide ions will migrate through the anion resin, then through anion permeable membranes into the concentrate chamber due to its attraction to the anode. Cation membranes are permeable only to cations and will not allow anions or water to pass, and anion membranes are permeable only to anions and will not allow cations or water to pass. The H^+ and OH^- ions collect in the concentrate chamber to yield water.

3. Electrolytic conduction proceeds through the ion exchange resin beads in the diluting compartments. Ion exchange resins are typically 2–3 orders of magnitude more conductive than the deionized water. The resin bed is continuously regenerated by the current. Electrolytic splitting of water into H^+ and OH^- ions occur at the point of contact of ion exchange resin beads with the membranes of different types. For example, at the interface of anion exchange membrane and cation resin beads, the current will be carried partly by H^+ ions in the resin beads and by OH^- ions in the membrane when voltage exceeds 0.8 V (voltage requirement for dissociating water molecule into H^+ and OH^- ions). Contaminant ions, in the feed water, attach to their respective ion exchange resin displacing H^+ and OH^- ions and once within the resin bed, join in the migration of ions and permeate the membrane into the adjacent concentrate ('C') chambers on both sides. The contaminant ions are trapped in the 'C' chamber and are swept away in the concentrate stream as H^+ and OH^- ions combine to form water. The feed water continues to pass through the dilute chamber and is purified. It is collected on the outlet of the Dilute ("D") chambers and exits the DuPont™ EDI module. All DuPont™ EDI module product flows are collected and exit the system as purified water.

4. The concentrate flow, a separate stream from the RO feed water, enters the DuPont™ EDI modules through the center pipe from below and is diverted into vertically spiraled cells known as 'C' chambers. The helically flowing concentrate returns into the center pipe in the upper section of the module and exits as waste. The concentrate flow rate is determined by the EDI module recovery rate. However, the concentrate stream could also be recycled ahead of the reverse osmosis (RO) unit so as to maximize overall system recovery.

Note: Recycling the concentrate may increase the level of carbon dioxide loading to the RO. In addition, free chlorine generated at the anode and present in the concentrate will need to be removed.

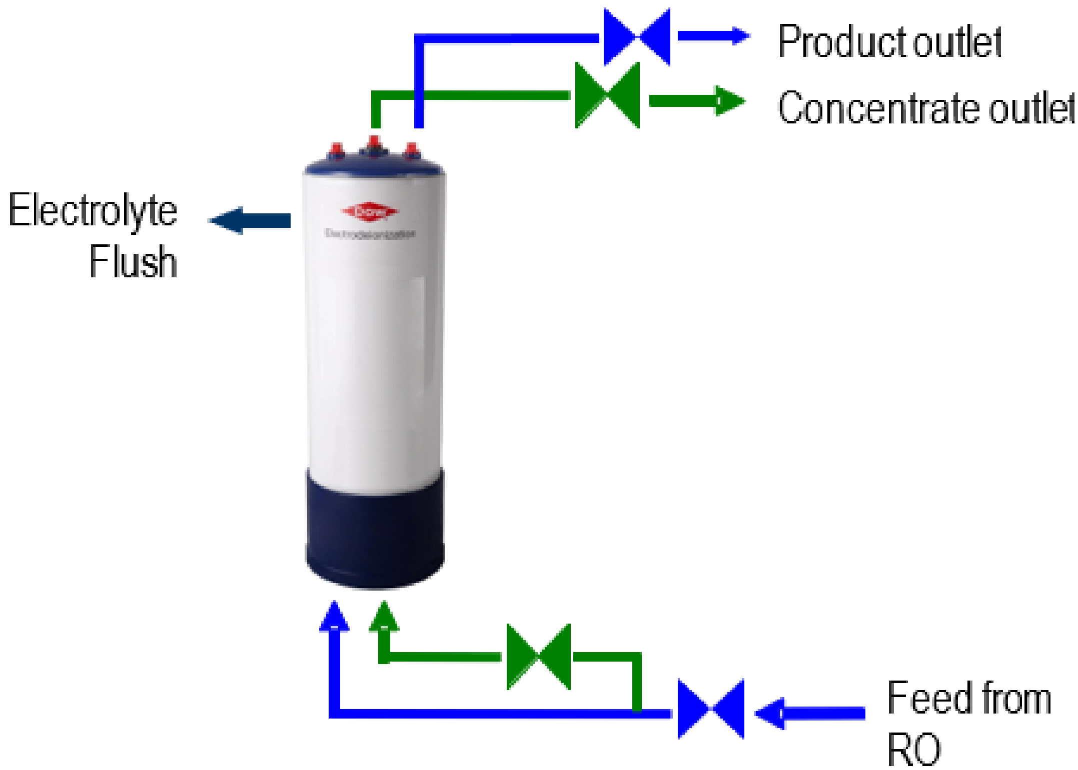

Figure 4. DuPont™ EDI Module Process Streams

Scaling is a problem that can occur in the concentrate chamber. Recovery rate and feed water quality must be controlled to avoid irreversible scaling. Recovery rate is determined by the feed water total hardness and is detailed in Section 1.3 under 'Module Operating Conditions'. The feed water specifications listed in Table 1 must be strictly adhered to, otherwise severe and irreversible module damage can occur.

Note: Gases (hydrogen, oxygen, chlorine) from water electrolysis are produced at the electrodes and are carried away in the electrode flush and concentrate stream. These gases must be vented to avoid buildup.

1.2 Feed Water Quality Specifications

Table 1. Feed Water Quality Specifications

Product Water Resistivity	Units	≥ 5 MΩ-cm	≥ 15 MΩ-cm
TEA (includes CO_2)	ppm as $CaCO_3$	≤ 25 ppm	≤ 8
TEC (includes NH_3)	ppm as $CaCO_3$	≤ 25 ppm	≤ 8
CO_2	ppm	≤ 5	≤ 3
pH		5.0-9.0	5.0-9.0
Hardness	ppm as $CaCO_3$	≤ 0.5	≤ 0.5
Dissolved silica	ppm	≤ 0.5	≤ 0.5
TOC	ppm	≤ 0.5	≤ 0.5
Free Cl_2	ppm	≤ 0.05	≤ 0.05
Oil & Grease	ppm	None	None
Fe, Mn, H_2S	ppm	≤ 0.01	≤ 0.01
Turbidity[1]	NTU	≤ 0.1	≤ 0.1
Other Oxidizer[2]	ppm	None	None

1. EDI devices are vulnerable to particulate fouling. Plugging of resin interstices increases the pressure drop across the module and immediately interferes with the desalination performance due to poor connectivity among ion exchange resins with similar functionality.
2. Oxidizers, for example chlorine, will attack ion exchange resin beads and cause de-crosslinking, which results in reduced ion exchange capacity.

Refer to Section 3.1 for additional feed water requirements.

1.3 Module Operating Conditions

Table 2. Module Operating Conditions

Item	**DuPont™ EDI-310**
Product Flow Rate	6.6 – 10 gpm (1.5 – 2.2 m^3/h)
Product Resistivity	≥15 MΩ .cm
Recovery Rate	up to 95 %
Working temperature	50 – 100° F (10 – 38° C)
Max. Inlet Pressure	100 psi (6.9 bar)
Max. Continuous Operating Pressure	80 psi (5.5 bar)
Dilute Pressure Drop	22 – 36 psi (1.5 – 2.5 bar)
Concentrate Outlet Pressure	7 – 10 psi (0.5 – 0.7 bar) less than dilute outlet pressure
Electrode Flush	0.18 – 0.26 gpm (40 – 60 l/h)
Maximum electrical current	9 A
Maximum working Voltage	160 V DC

Note: The recovery rate is inversely proportional to the feed water total hardness. Feed water total hardness and system recovery rates are described in Table 3 below:

Table 3. System Recovery Rates

Feed water total hardness, (ppm as $CaCO_3$)	**DuPont™ EDI recovery rate**
< 0.1	95%
0.1 – 0.5	90%

2 Shipping, Installation and Storage

2.1 Packaging and Shipping

Each DuPont™ EDI Module is packaged separately. The gross weight for each module is 47 Kgs (104 lbs). Temperature during shipment and storage should be maintained between 4 - 38° C (40 -100° F). The modules are shipped wet with all hydraulic connections, namely dilute inlet, dilute outlet, concentrate inlet, concentrate outlet, and electrode flush drained of free-standing water and properly capped.

2.2 Assembly of DuPont™ EDI Modules into an EDI system

DuPont™ EDI modules and systems are designed to deionize RO permeate and are subject to specific feed water requirements (as described in Section 1.2). Adherence to these feed water parameters is essential for successful system designs and warranties and it is the user's responsibility to ensure that the feed water and operating conditions satisfy all specifications.

Measuring Instrumentation shall measure the following parameters:

1. Dilute inlet pressure
2. Concentrate inlet pressure
3. Product water pressure
4. Concentrate outlet pressure
5. Product (Dilute outlet) water flow
6. Concentrate inlet water flow
7. Concentrate outlet water flow
8. Electrolyte flush water flow
9. Product water resistivity (MΩ.cm)
10. Feed water conductivity (µS/cm)
11. Concentrate outlet conductivity (µS/cm)
12. Feed water pH (optional)
13. Product Water Silica (optional)
14. Feed water hardness (required for single pass RO installations)

The rectifier which supplies DC power to the DuPont™ EDI modules must be rated at least for the operating current required to meet the product water specification as determined by DuPont™ EDI design software (XEDI). Once set, the output current should not fluctuate over +/-5% of the allowable range. DuPont Water Solutions recommends standard systems be equipped with rectifiers capable of providing the maximum allowable 9.0 amperes per module. Over-current protection sized up to 10 ampere is required.

The rectifier must be wired properly, by a qualified electrician and in accordance with all applicable regulatory requirements and local laws.

The system skid including pipe headers and all metal components must be properly grounded to safeguard operators from electrical shocks because of stray current in the system. All flow streams must also be grounded as they enter or leave the modules since the water in the EDI piping system may behave as an electrical conductor due to their exposure to high electrical potential inside the EDI modules.

Some O_2, H_2 and Cl_2 gases will be produced by the electrode reactions within each module and proper ventilation must be confirmed in the concentrate bleed and electrode flush waste stream discharge area. The H_2 gas generated at the cathode concentration must not be allowed to reach its lower explosion limit (LEL) of 4% (by volume). For safe operation, the level should not exceed 25% of the LEL or 1% (by volume). If H_2 gas is adequately ventilated then O_2 and Cl_2 gas concentrations will also meet requirements.

In order to protect the modules, the system must have proper safety switches installed as follows:

1. Install a high pressure switch to the feed, product, and concentrate lines to avoid leaks caused by excessive operating pressures.
2. Install a low flow switch on the product line to protect the modules from operating at lower than minimum recommended flow rate of 1.5 m^3/h (6.6 gpm) through each module.

CAUTION: EDI modules must be protected from overheating due to lower than minimum dilute flow of 1.5 m^3/h (6.6 gpm). Failure to do so may lead to irreversible module damage and create a safety hazard. If individual module dilute flow is less than 1.5 m^3/h (6.6 gpm) the flow switch should be programmed to initiate a system shutdown.

2.3 Operating Environment

The EDI system must be installed indoors. Polymeric components in the modules limit the maximum operating temperature to 38 ºC (100 ºF). Minimum operating temperatures should not go below 10 ºC (50 ºF) due to lower ionic transport mobility of ion exchange resins in the modules.

Table 4. Temperature Not to Exceed

Temperature not to exceed	38 ºC (100 ºF)
Temperature not to be below	10 ºC (50 ºF)
Maximum humidity	90%
Vibration	None

2.4 Storage and Shutdown Procedure

DuPont™ EDI modules must be stored indoors, protected from the environment, and not exposed to direct sunlight or freezing temperatures. Modules must always remain wet, or damage to the ion exchange resin and membranes will occur. If long term storage is required, drain residual water out of the each module. All inlet and outlet valves must be securely closed. Additionally, all the hydraulic connections should be firmly capped and modules should be stored in vertical position. DuPont™ EDI modules can be stored for six months at ex/work state.

If the system is shutdown for less than 12 hours, no special precautions need to be taken to protect the ion exchange resin. Turn off the rectifier, stop the concentrate and dilute flow. This will prevent exhaustion of the ion exchange resin that would otherwise necessitate regeneration during restart. To prevent damage to resin and membranes do not allow modules to drain.

Keep modules wet when the system is off-line for more than 3 days, electro-regeneration for 8-16 hours may be necessary to achieve the desired product water quality at restart. EDI modules do not allow the growth of microbes during regular operation due to biostatic condition created by pH polarization.

3 Module Operating Requirements

The following four factors must be considered in the system design to produce stable, high-purity product water:

- Feed water
- Power
- Flow rates
- Pressure differential between concentrate and dilute streams.

3.1 Feed Water Requirements

Water quality requirements are detailed in Section 1.2. Emphasis must be placed on:

1. TEA (Total Exchangeable Anion)
2. Carbon dioxide (CO_2)
3. Total hardness
4. Dissolved silica levels (if silica rejection is required)

3.1.1 TEA

The feed ionic impurity load limit is stated in Table 1 and must be pretreated to within acceptable feed water specifications in order to produce high-purity water. The ionic impurity load determines the current required for effective deionization. Due to the common presence of CO_2 in reverse osmosis permeate streams, TEA loading is generally higher than TEC loading. Therefore, the limiting factor for EDI process designs is usually TEA.

TEA represents the concentration of all the anions present in the feedwater in ppm as $CaCO_3$ including contributions from silica, carbon dioxide and hydroxide ion. In a similar manner, TEC represents the concentration of all the cations present in the feedwater in ppm as $CaCO_3$ including contributions from ammonia (NH_3) and hydrogen ion.

$$TEA\left(ppm\ as\ CaCO_3\right) = CO_3{}^{2-} as\ ppm\ CaCO_3 + 1.7 \times HCO_3{}^{-} as\ ppm\ CaCO_3 + 50000 \times 10^{(pH-14)}$$
$$+\left(SO_4{}^{2-} + F^{-} + Cl^{-} + NO_3{}^{-}\right) as\ ppm\ CaCO_3 + 0.83 \times SiO_2\ as\ ppm\ ion + \frac{1.7 \times 50}{44} \times CO_2\ as\ ppm\ ion$$

Feed water conductivity does not show a complete picture of the total ionic load to an EDI system. Conductivity measurement devices do not detect the full amount of weakly ionized species like CO_2, silica, and boron. Alternatively, feed water conductivity equivalent (FCE) includes both carbon dioxide and silica and can be used to determine the desalination current for a given feed flow and product water specifications.

3.1.2 CO_2 and Alkalinity

Maintaining correct feed water CO_2 levels is important for obtaining high product water quality. CO_2 in the feed water will combine with OH^- (created by electrolysis) when it enters the dilute chamber as follows:

$$CO_2 + OH = HCO_3^-$$
$$HCO_3^- + OH^- = CO_3^{2-} + H_2O$$

Therefore, CO_2 concentration must be accounted for when calculating TEA.

Carbon dioxide is typically present in significant concentrations in RO permeate water and is removed in the EDI module through a combination of anionic bicarbonate and carbonate forms as indicated above. Since CO_2 is nonionic it can diffuse back through the cation membrane into the diluting chamber and as such may need to be removed from the dilute chamber more than once. Consequently, occurrence of carbon dioxide and alkalinity at more than the recommended values can greatly degrade EDI product water quality.

CO_2 concentration is usually measured in mg/l. However, when designing an EDI system, CO_2 must be accounted as $CaCO_3$ equivalent mg/l. The recommended conversion factor of mg/l CO_2 to mg/l as $CaCO_3$ is 2.0. For example; 5mg/l CO_2 is approximately equal to 10 mg/l TEA ($CaCO_3$)

3.1.3 Total Hardness

To prevent scaling inside the EDI modules feed water hardness must be limited at ≤0.5 mg/l (as $CaCO_3$) at 90% recovery or ≤0.1 mg/l (as $CaCO_3$) at 95% recovery. The steady flux of regenerative OH^- ions in EDI maintain a high surface pH on the concentrate side of the anion membranes whereby Ca^{2+} and Mg^{2+} scale (carbonates, hydroxides) can form. The surface of the cathode is also a place of high pH due to the generation of OH^- ions associated with electrolysis of water. Temporary EDI pretreatment upsets can also result in scaling if the hardness/alkalinity feed specifications are exceeded.

CAUTION: Exceeding EDI feedwater specifications at any time may void module warranties.

3.1.4 Dissolved Silica

High influent silica levels can cause poor EDI performance and/or irreversible scaling in the concentrating chambers due to polymerization of silica. Scaling potential is dependent upon degree of super-saturation, pH, and temperature. Both calcium and magnesium can increase silica polymerization rates with magnesium appearing to be more active in accelerating polymerization.

Trace amounts of aluminum and iron can also accelerate silica fouling due to formation of insoluble metal silicates such as iron silicate, $Fe(OH)_3.SiO_2$.

EDI module silica rejection performance will vary depending upon inlet water silica levels, TEA, CO_2, pH, temperature and flow rate through each module.

3.2 Power Requirements

In order to meet high-purity water requirements, each module must be run with the proper amount of electrical current. The current is supplied by a power source capable of automatically increasing or decreasing voltage in response to a change in the electrical resistance of the EDI module to maintain constant current. Over time, the electrical resistance of all the modules increases resulting in a gradual increase in voltage at the desired current level. The limit for DuPont™ EDI modules is 160 VDC per module. Actual rectifier power consumption can be computed from the operating current and voltage.

In order to get a good estimate for the power consumption, DuPont can supply a XEDI projection software report to estimate the power consumption based on the feed quality and product water requirement.

During initial start up, regeneration of the resin in an EDI module may take 8 to 24 hours. To speed this process, the input current may be as high as 8 A for initial regeneration. THE INPUT VOLTAGE FOR CONTINUOUS OPERATION MAY NEVER EXCEED 160 VDC.

DuPont Water Solutions recommends electrically pairing EDI-310 modules in series, with each pair of modules wired in parallel. This approach reduces variation in resistance and current through each group of paired modules. Operating DC current for a multiple module system is therefore calculated by multiplying half the number of modules times the current requirement per module. The operating DC voltage of the system is twice that of each module operating voltage (maximum system operating voltage is 320 VDC).

3.3 Effects of Flow Rates

3.3.1 Dilute Flow Rate

Dilute product flow rate per DuPont™ EDI-310 module: 1.5 – 2.2 m^3/h (6.6 to 10 gpm). The combined effects of ionic load, feed flow rate, and applied current can be represented collectively by current efficiency. This is defined as the ratio of the theoretical current to the applied current. Desalination performance of an EDI module directly depends on the operating current efficiency. To achieve the product water specification in terms of water resistivity for a given feed water characteristics, flow rate in the dilute chamber must be maintained within the specified design range. If the flow rate is higher than 2.2 m^3/h (10 gpm), the corresponding current efficiency may increase beyond the desired value to achieve the desalination specification and the pressure drop in the dilute chamber may create a pressure imbalance causing impurities to move through the ion-exchange resins resulting in product water quality instability. EDI modules must also be protected from overheating due to lower than minimum product flow rate of 1.5 m^3/h (6.6 gpm) through each module.

3.3.2 Concentrate Flow Rate

The concentrate inlet flow comes from the EDI feed water manifold and passes the concentrate chamber once through. Unwanted ions from the dilute stream migrate into the concentrate stream and are removed. The concentrate inlet flow rate is determined by the feed water hardness, and thus by the recovery rate. Concentrate inlet flow rate per DuPont™ EDI-310 module is calculated as follows:

Concentrate inlet flow rate = Dilute inlet flow rate x (1 – Recovery, fraction) / Recovery, fraction

Note that the Reverse Osmosis system must be sized to provide permeate flow equal to EDI dilute inlet plus concentrate inlet flow.

The concentrate stream may be recycled back to the RO feed stream; however, care must be taken to ensure ventilation of hydrogen gas and additional carbon dioxide loading. The simplest process to purge hydrogen gas from the concentrate bleed stream is to provide a vented storage tank. In many situations, concentrate stream is purer than the RO feed water. However, when the EDI feed stream contains high level of CO_2, its concentration in the concentrate stream may prevent recycling without de-carbonation.

De-carbonation of the EDI feedwater using polypropylene hydrophobic gas transfer membranes (GTM) is one option. Alternatively, pH of the upstream RO feed water can be increased by the addition of a small amount of sodium hydroxide, which converts carbon dioxide to sodium bicarbonate which then can be rejected by conventional polyamide RO membrane. However, addition of caustic in the RO feed stream is only permitted if the LSI of the RO concentrate stream at the operating water recovery rate still remains negative after such chemical treatment.

3.3.3 Electrode Flush and Concentrate Outlet Flow Rate

Ions removed from the dilute stream are discharged by the concentrate stream. Part of the concentrate inlet flow is also used to provide the electrolyte flush stream.

- The flow rate of electrolyte flush is: 40 – 60 l/h (0.18 to 0.26 gpm) / module
- The amount of concentrate outlet stream is calculated as follows:

Concentrate outlet flow rate = Concentrate inlet flow rate – electrolyte flow rate

3.4 Operating Pressures

In order to avoid internal leakage, the dilute pressure must always be greater than the corresponding concentrate pressure to prevent back-leakage and hence deterioration of product water quality. It is important to maintain a concentrate outlet pressure that is 0.5 – 0.7 bar (7 – 10 psi) less than the dilute outlet pressure to achieve the desired internal pressure profile.

Note: System performance will not improve by increasing the pressure differential to more than 0.7 bar (10 psi).

The inlet pressure differential is determined by the module recovery rate. Since the concentrate flow passes the concentrate chamber once through, higher recovery rate means lower concentrate flow rate and thus higher inlet pressure differential. Usually, depending on module recovery rate, the inlet pressure differential is in the range of 0.5 – 1.5 bar (7 – 22 psi).

Concentrate inlet valve in the EDI skid is used to control the concentrate inlet flow rate depending on module recovery. By closing the valve, the pressure in the concentrate chamber will decrease, conversely increasing the pressure differential across the membrane. In addition, there is a back pressure valve located at the concentrate outlet. Adjusting this valve will increase or decrease the pressure in the concentrate chamber, thus negatively or positively affecting the differential pressure across the membrane. The maximum continuous design operation inlet pressure of the dilute stream is 5.5 bar (80 psi).

4 Operating Procedure

1. Remove blank fittings for Dilute (in/out), Concentrate (in/out), Electrode (out) and replace with standard fittings. The Dilute inlet and outlet each have 2 connections, one for feed/product and the others for sampling or cleaning. It is important that the Dilute Inlet is located at the bottom, and Dilute outlet is located at the top, and that they are connected on opposite sides when viewed from the front of module. For example if “dilute in” is “bottom left”, then the product out would be “top right”, and if “dilute in” is “bottom right”, then “product out” must be “top left”. Concentrate inlet is the center connection on the bottom of the module. Concentrate outlet is the center connection on the top side of the module. Electrode flush connection is on the side of the module.
2. Connect the modules into the system
    a. Open all module isolation valves
    b. Open all system outlet valves (product, concentrate outlet, electrode flush)
3. Test and start feed water pump, if any. Establish dilute outlet (product) flow. Adjust the dilute outlet (product) valve to obtain a minimum product pressure of 0.5 – 0.6 bar (7 – 9 psi). Maximum allowable inlet pressure is 6.9 bar (100 psi) for DuPont™ EDI-310 modules.

    Note: Maximum allowable continuous operating pressure is 5.5 bar (80 psi).
4. Open and adjust the concentrate inlet valve to obtain appropriate system recovery.
5. Adjust the concentrate outlet valve until the concentrate outlet pressure is 0.5 – 0.7 bar (7 – 10 psi) less than the dilute outlet (product) pressure.
6. Adjust the electrolyte outlet valve to obtain required electrode flush flow rate between 40 – 60 l/h (0.18 – 0.26 gpm) per DuPont™ EDI-310 module.
7. Confirm all flow rates and pressures. Adjust as needed.
8. Start the rectifier (ensure voltage is always set to 0 whenever starting the rectifier)

    CAUTION: the rectifier must not be started until dilute, concentrate, and electrode flush flow rates are fully established and maintained at constant values for several minutes.
9. Very slowly increase voltage to increase current through the modules.
10. Run the system until the standard dilute outlet (product) resistivity stabilizes for 1 hour. Continuously record the dilute outlet (product) flow rate, dilute outlet (product) resistivity, concentrate inlet flow rate, electrode flush flow rate, voltage and the current daily. Perform cleaning and maintenance as needed.

    CAUTION: Never run current through the module without adequate dilute, concentrate or electrode flows and pressures.

5 Cleaning Procedure

Cleaning is performed by recirculating a chemical solution through the modules at service flow rates. Selection of cleaning chemical is based on the anticipated type of scaling or fouling as indicated in the Table 5 below. Cleaning is done under following conditions:

- A decline in product quality
- A drop in flow rate or increase in pressure drop in either dilute or concentrate chamber.
- An increase in electrical resistance of the EDI module

Electrical resistance of the EDI modules is calculated by dividing the normal operation voltage drop per module by the current through each module. Overall resistance of an EDI module is equal to the sum of the resistance of the ion exchange membranes, resins, concentrate stream, anolyte, and catholyte at a particular feed water temperature and ionic composition.

Table 5. Cleaning procedures

Foulant	Cleaning Solution
Calcium carbonate scale	2% Hydrochloric acid
Bio-fouling or Silica Fouling	1% Caustic (NaOH)
Organic Fouling	5% Salt + 1% Caustic

Prior to cleaning, make sure rectifier power is off. De-pressurize all pipe lines before and after cleaning to avoid high pressure spray. Subsequent to chemical cleaning, modules must be rinsed and regenerated. Use only RO permeate water for preparing cleaning solutions and modules rinsing.

www.dupont.com/water/contact-us

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