DeltaFlow* process

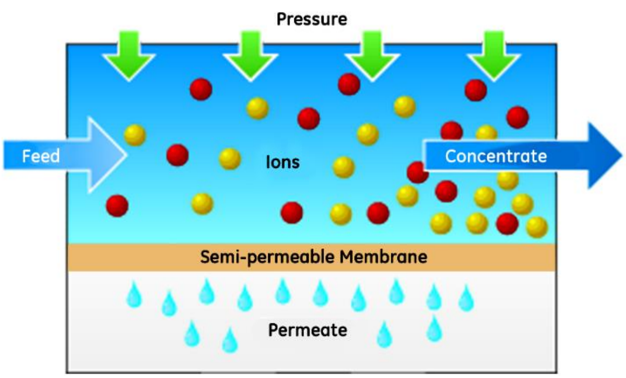

Figure 1: RO – Reverse Osmosis

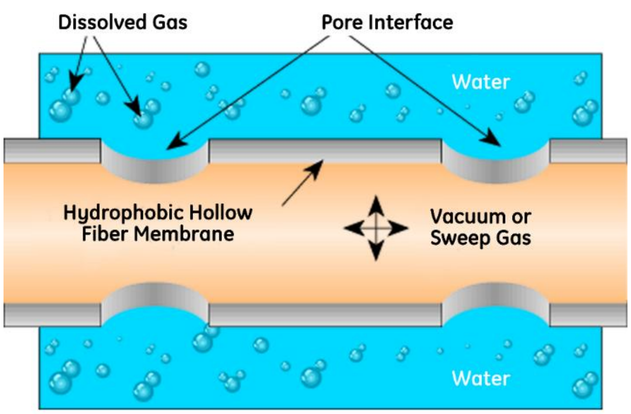

Figure 2: GTM – Gas Transfer Membrane

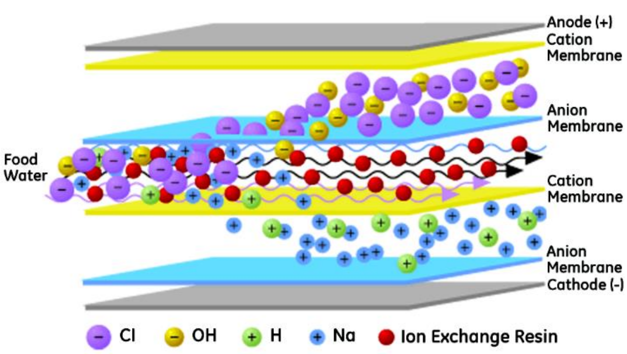

Figure 3: EDI - Electro deionization

typical application

To produce ultrapure water from brackish water using electrically driven membrane processes to achieve water quality theoretical purity (18.3 megohm/cm or 0.055 micromhos/cm).

general properties

Technology Advantage – SUEZ's DeltaFlow* three membrane separation system combines Reverse Osmosis (RO) Gas Transfer Membrane (GTM) and Electro deionization (EDI) into the most technologically advanced ultrapure water treatment system. It typically achieves water quality in the range of 10-18.3 megohms/cm resistivity (0.1-0.055 micromhos/cm conductivity.)

The DeltaFlow is an electrically-driven process that is proven and reliable, and it offers many advantages over chemically-regenerated ion exchange systems.

DeltaFlow Advantages

- Uses electricity to removed dissolved minerals and gases without bulk chemicals
- Engineered for continuous production, eliminating problems associated with batch processing
- Has low operating costs and low operating labor requirements
- Membranes provides a physical barrier to reduce colloidal and organic material
- Removes carbon dioxide and oxygen without chemicals
- Compact design with small footprint

Design Specifications

- 200 gpm (0.8 m^3/h) continuous product
- Typical Effluent Quality 10-18.3 megohms/cm or 0.1-0.055 micromhos/cm

Find a contact near you by visiting www.suezwatertechnologies.com and clicking on "Contact Us."

System Operating Conditions

- Temperature Range: 33°F to 100°F (1°C to 38°C) pH Range 4-9 S.U.
- Feed Pressure (Max.): 150 psig (10.5kg/cm^2)
- Feed Pressure (Min.): 50 psig (3.6 kg/cm^2)
- Feedwater Volume for 200 gpm (0.8 m^3/h)
- Effluent Pressure: (at 200 gpm [0.8 m^3/h]) 22-55 psig (1.7-3.5 kg/cm^2)
- Product: 275-320 gpm (62.4-72.6 m^3/hr)
- Effluent Pressure: (at 200 gpm [0.8 m^3/h]): 25-55 psig (1.7 - 3.5 kg/cm^2)
- Typical System Recovery: 65-75%
- Feedwater Requirements: Silt Density Index (SDI 15) <5
- Housing Material: RO - FRP, GTM - FRP, EDI - PVC
- Service Connections: 150# ANSI raised face flanges 4" influent and effluent; 2" waste
- Electrical Requirements: 480VAC/3ph/60Hz 300-500-amp service pending application, 150-350 amp running pending application

Space Requirements

- Containerized DeltaFlow for Outdoor Installation: 40'L x 8'W x 9.5'H (12.2 x 2.4 x 2.9 meters)
- Skid Configuration for Indoor Installation: 32'L x 14'W x 11'H (9.8 x 4.3 x 3.4 meters)

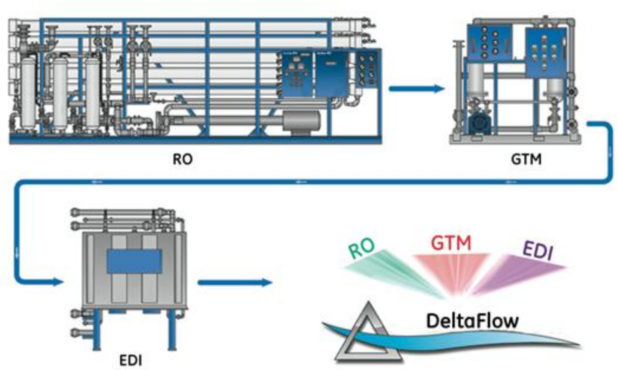

Figure 4: The DeltaFlow process uses three membrane separation technologies: RO, GTM and EDI.

DeltaFlow Operating Principles – Reverse Osmosis is a pressure driven process which reverses the natural tendency of liquid to flow through a semi-permeable membrane from the dilute to more concentrated solution. Reverse osmosis is a continuous process involving three streams – influent, concentrate, and permeate. The RO influent flows across the membrane surface and becomes more concentrated as the permeate (product) water passes through the membrane. The salts, colloids, and organics remain in the concentrate (reject) stream. The permeate stream is passed to the GTM process for further purification.

Gas Transfer Membranes remove carbon dioxide (CO_2) and oxygen (O_2) from water by using a membrane device and a sweep gas to separate the dissolved gases from the water. Liqui-Cel** membrane contactors employ hydrophobic hollow fiber membranes that allow the gaseous and liquid phases to interact without dispersing one into the other.

The partial pressure of the dissolved gas in the water phase is lowered by applying a strip gas on the inside of the hollow fiber membrane. A diffusive transfer of the CO_2 and O_2 occurs from the liquid phase to the inside of the hollow fiber where the gases are swept away.

Electro deionization is the high purity polishing step that uses ion exchange membranes, ion exchange resin, and direct current (dc) electricity to produce ultrapure water. Ion exchange membranes are located between two electrodes with alternating sheets of cation and anion permeable membranes that form an alternating series of dilute and concentrating compartments. Dilute compartments are filled with ion exchange resin that serves both as a medium for ion transfer and as a conductive pathway that increases electrical efficiency.

Under the influence of a dc electric field, positively charged ions (cations) are driven toward the negative charge of the cathode and pass through the cation exchange membrane into the concentration compartment. Negatively charged ions (anions) are driven toward the positive charge of the anode and pass through the anion exchange membrane into the concentrating compartment.

As the water becomes purer, the DC field splits water into regenerate the ion exchange resin with the acid (H+) and base (OH-) formed from the split water. The anion and cation resin are regenerated continuously with this mechanism, allowing the resin to remove weakly ionizable species such as silica, boron, and trace carbon dioxide. This ion transfer mechanism purifies the dilute steam and concentrates the ions in the small concentrate steam.