VEOLIA

E-Cell* Electrodeionization (EDI) Stack

WATER TECHNOLOGIES

Evolution Of Demineralization

Electrodeionization (EDI) For Industrial Use

For many years, operators of pure water production systems were trying to find a technology to replace mixed bed ion exchange for final demineralization. The operating cost as well as the complexity and risks associated with acid and caustic regeneration were frustrations to these operators. EDI became established as the innovative alternative solution by reducing operating costs, improving site environmental, health, and safety risk profiles, and producing a continuous and steady supply of pure and ultrapure water.

Production of pure water has evolved from conventional pretreatment with multiple stages of ion exchange in initial and final demineralization to the following membrane based operations, including EDI, that are now considered to be best practice by many customers around the world:

Pre-treatment – (MF)/ (UF) → Reverse osmosis → EDI

EDI utilizes both traditional ion exchange resin and ion exchange membrane to remove contaminants, including those that are uncharged or lightly charged in the feed water such as silica and boron. The biggest advantage lies in the fact that EDI technology employs direct current to drive contaminants out of the feed water and through the ion exchange membranes into the concentrate channels. The direct current also splits water into hydrogen and hydroxyl ions which act as continuous regenerating agents so that contaminants do not accumulate on the ion exchange resin. Therefore, EDI can continuously and predictably produce high-purity and ultrapure water with equal or better quality than mixed bed ion exchange.

Advantages Of EDI Compared To Mixed Bed

- More advanced technology
- No regeneration chemicals or neutralization systems needed
- Much lower operating cost
- Continuous and simplified operation
- A smaller footprint and reduced building height requirement

Typical EDI Applications

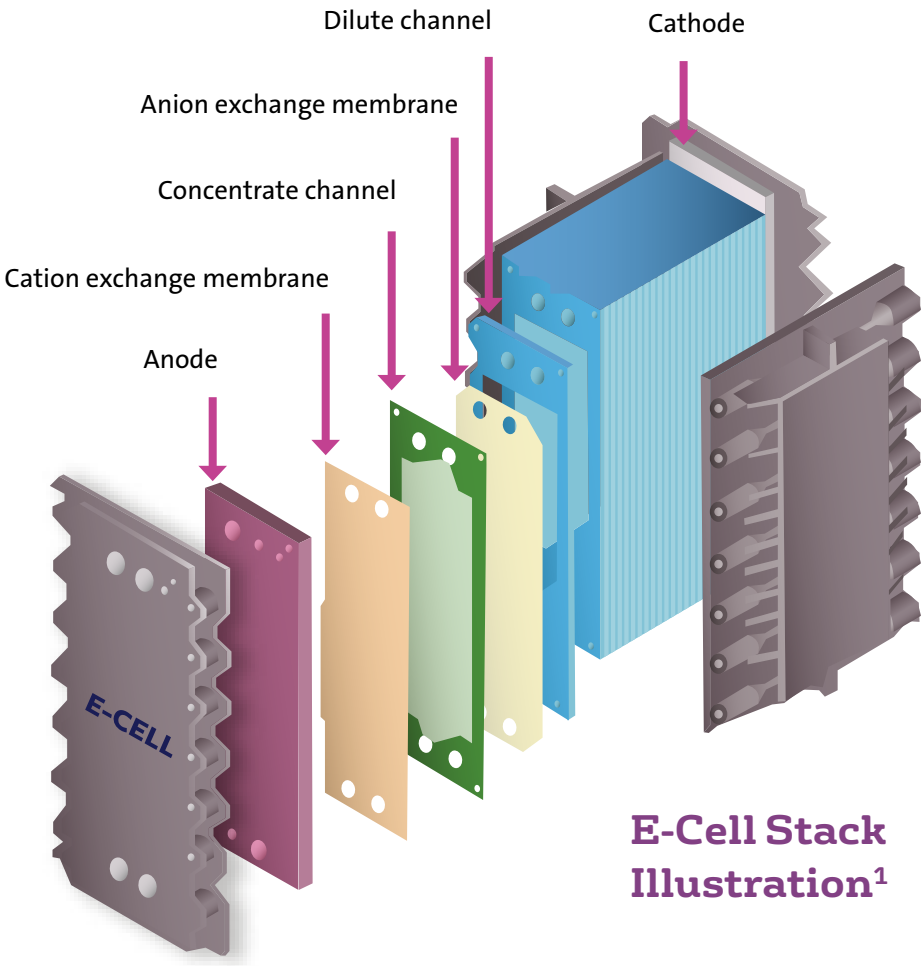
- Semiconductor, microelectronic and solar panel production rinse water
- Boiler feed water for power generation or the chemical, steel, and metallurgical industries
- Various pharmaceutical industry waters
- Laboratory water

EDI System

E-Cell EDI Stack

E-Cell EDI technology provides industry leading product water quality, energy consumption, and reliability from time-tested manufacturing practices. Veolia reputation for performance has enabled a leading market share and deep experience in EDI applications globally.

E-Cell EDI technology employs a modular stack-and-rack design that can adapt to project requirements with varying capacity. Veolia is also willing to offer performance guarantees when extra confidence in the quality of the pure and ultrapure water is desired.



E-Cell Stack Illustration[1]

[1] **Details modified for simplicity**

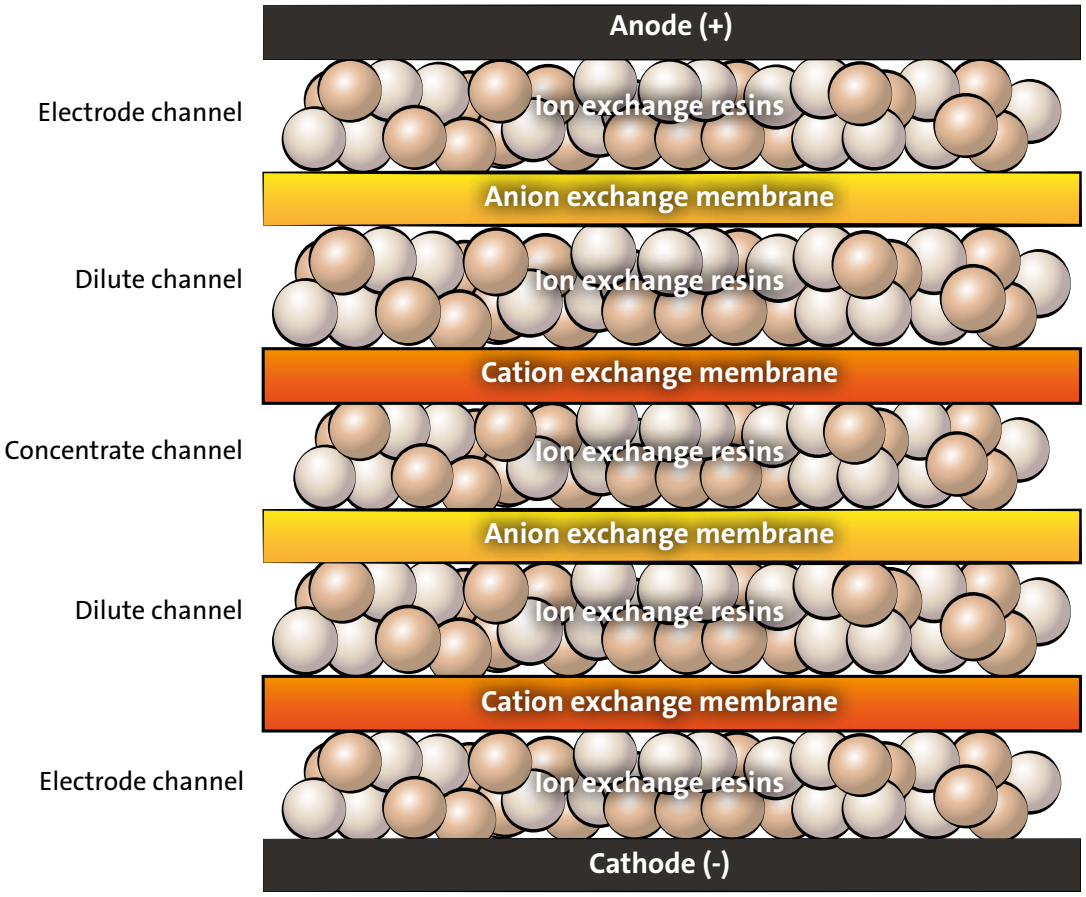
E-Cell EDI Stack Features And Benefits

- Low energy consumption
- Leading product water quality, in part due to ion exchange resin filled concentrate and dilute channels as well as a patented ion exchange resin arrangement
- Counter-current operation reduces the possibility of scale formation
- Strong reputation for reliable operation
- Simplified system design does not require degassing the concentrate, a concentrate recirculation loop, or added salts

Quality Assurance

- CE, RoHS, and CSA marked
- FDA compliant (pharmaceutical modules)
- Manufactured in an ISO 9001 and ISO 14001 certified facility
- Halal certified. E-Cell stacks are manufactured in accordance with the Islamic Food and Nutrition Council of America (IFANCA) standards

Simplified E-Cell Stack Design



General Industrial Stacks†

	Stack Name	MK-7	E-Cell-3X	MK-3
Weight	Shipping weight (kg)	136	135	92
Dimensions	Dimensions (cm as width x height x depth)	30 x 61 x 74	30 x 61 x 72	30 x 61 x 54
Feed Water Quality Specifications	Total exchangeable anions (ppm as $CaCO_3$)	< 14	< 25	< 25
	Conductivity (µS/cm)	< 24	< 43	< 43
	pH	4-11	4-11	4-11
	Temperature (°C)	4.4-40	4.4-40	4.4-40
	Hardness (ppm as $CaCO_3$)	< 1.0	< 1.0	< 1.0
	Silica (ppm as SiO_2)	< 1.0	< 1.0	< 1.0
	TOC (ppm)	< 0.5	< 0.5	< 0.5
	Turbidity (NTU)	< 1.0	< 1.0	< 1.0
	Color (APHA)	< 5	< 5	< 5
	Chlorine (ppm)	< 0.05	< 0.05	< 0.05
	Fe, Mn, H_2S (ppm)	< 0.01	< 0.01	< 0.01
	Oxidant	Not detected	Not detected	Not detected
	Oil and grease	Not detected	Not detected	Not detected
	SDI_{15}	< 1.0	< 1.0	< 1.0
Product Water Quality	Resistivity (MOhm-cm)	> 10	> 16	> 16
	Silica (SiO_2) removal	Up to 99%	Up to 99% / < 5 ppb	Up to 99% / < 5 ppb
Operating Parameters	Maximum water production (m^3/hr)	7.8	6.4	4.5
	Minimum water production (m^3/hr)	4.2	2.3	1.7
	Typical designed water production (m^3/hr)	6.0-7.8	4.0-6.4	2.0-4.5
	Recovery	Up to 97%	Up to 97%	Up to 96%
	Voltage (VDC)	0-400	0-400	0-300
	Amperage (ADC)	0-5.2	0-5.2	0-5.2
	Inlet pressure (bar)	Counter-current: 4.1-6.9 Co-current: 3.1-6.9	Counter-current: 4.1-6.9 Co-current: 3.1-6.9	Counter-current: 4.1-6.9 Co-current: 3.1-6.9
	Dilute inlet/outlet standard pressure drop (bar)	1.0-3.1	1.4-2.8	1.4-2.8
	Minimum pressure difference between dilute outlet and concentrate inlet (bar)	0.34	0.34	0.34

†Actual feed water quality specifications and performance may vary depending on flow rate through each stack and site conditions. Entries here based on nominal flow. Reference fact sheets and Winflows projection software to verify actual performance.

Hot Water Sanitizable Stacks‡

	Stack Name	MK-3PharmHT	MK-3MiniHT
Weight	Shipping weight (kg)	92	52
Dimensions	Dimensions (cm as width x height x depth)	30 x 61 x 54	30 x 61 x 29
Feed Water Quality Specifications	Total exchangeable anions (ppm as $CaCO_3$)	< 25	< 25
	Conductivity (µS/cm)	< 43	< 43
	pH	4-11	4-11
	Temperature (°C)	4.4-40	4.4-40
	Hardness (ppm as $CaCO_3$)	< 1.0	< 1.0
	Silica (ppm as SiO_2)	< 1.0	< 1.0
	TOC (ppm)	< 0.5	< 0.5
	Turbidity (NTU)	< 1.0	< 1.0
	Color (APHA)	< 5	< 5
	Chlorine (ppm)	< 0.05	< 0.05
	Fe, Mn, H_2S (ppm)	< 0.01	< 0.01
	Oxidant	Not detected	Not detected
	Oil and grease	Not detected	Not detected
	SDI_{15}	< 1.0	< 1.0
Product Water Quality	Resistivity (MOhm-cm)	> 10	> 10
	TOC (ppb)	< 500	< 500
Operating Parameters	Maximum water production (m^3/hr)	4.5	1.5
	Minimum water production (m^3/hr)	1.6	0.5
	Typical designed water production (m^3/hr)	2.0-4.5	0.5-1.5
	Recovery	Up to 96%	Up to 93%
	Voltage (VDC)	0-300	0-150
	Amperage (ADC)	0-5.2	0-5.2
	Inlet pressure (bar)	Counter-current: 4.1-6.9 Co-current: 3.1-6.9	Counter-current: 4.1-6.9 Co-current: 3.1-6.9
	Dilute inlet/outlet standard pressure drop (bar)	1.4-2.8	1.4-2.8
	Minimum pressure difference between dilute outlet and concentrate inlet (bar)	0.34	0.34
	Number of 1 hour sanitization cycles	160	160
	Maximum sanitization temperature (°C)	85	85

‡Actual feed water quality specifications and performance may vary depending on flow rate through each stack and site conditions. Entries here based on nominal flow. Reference fact sheets and Winflows projection software to verify actual performance.

E-Cell EDI Technology Performance Examples

E-Cell EDI technology has been successfully applied in various industries such as power, petroleum, chemical, steel, pharmaceutical, and electronics.

Location: Singapore

Industry: Semiconductor

Capacity: 1000 m^3/h

Application: Ultrapure water

Location: China

Industry: Power

Capacity: 360 m^3/h

Application: Boiler feed water

Location: Australia

Industry: LNG

Capacity: 84 m^3/h

Application: Boiler feed water

Location: China

Industry: Coal chemical

Capacity: 480 m^3/h

Application: Boiler feed water

Location: USA

Industry: Pharmaceutical

Capacity: 6.8 m^3/h

Application: USP purified water

Location: China

Industry: Solar energy

Capacity: 300 m^3/h

Application: Ultrapure water

Location: Canada

Industry: Steel

Capacity: 100 m^3/h

Application: Boiler feed water

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