El-Ion –
the new dimension

Ultra pure water production by electro-deionization

The deionization cell El-Ion

The reinvention of ultra pure water production

Progress through research

Electro-deionizing systems have been on the market for some years now, but there are consistent differences regarding the methods. Conventional mixed-bed facilities can achieve a water quality of up to < 0.06 µS/cm from reverse osmosis permeate, but have little effect on germ reduction and organic carbone decomposition (TOC). Intensive research has made a technological breakthrough possible. An electro-deionizing method developed by the german research center Forschungszentrum Jülich has made it possible to produce ulta pure water from reverse osmosis permeate which achieves the ionogenic purity of water produced by a mixed-bed ion exchanger but without the high germ loading that these facilities often carry. This advantage is due to the fact that anodes and cathodes are positioned close to the ion exchange chambers. This new method developed in Jülich has been further developed by SG as licensee and introduced into the market under the name of “El-Ion”.

Environmental benefits

The most convincing advantage of electro-deionization is the continuous operation without any consumption of caustic and acid regeneration chemicals. The resins are regenerated through electricity only, no chemicals needed. Power consumption is distinctively lower compared to reverse osmosis systems, which makes another environmental benefit.

Leading edge technology at its best

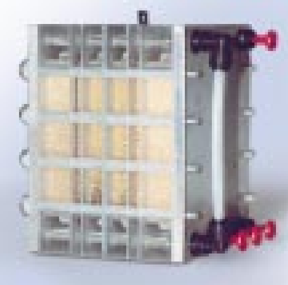
The modern way of electro-deionizing

What makes the difference

The Jülich method was introduced in 1994 on the ACHEMA and 1996 in Amsterdam on the Ultrapure Water Conference. Its essential characteristics are

- the electrodes are in close contact to the resin beds. This has been the first application where ions react directly in the space between electrodes and resin;
- the resin beds are designed as single beds.

All electro-deionizing methods have in common that the ions in the electric field are being transported through the resin fraction, even if the salt content, i.e. the electric conductivity, is very low. The specific resistance of the resins varies between 100 and 1000 Ω · cm, depending on their charge, while the water's specific resistance ranges from 0.1 · MΩ cm at the cell's entrance up to 18.2 · MΩ cm at the cell's exit.



Advantages of the El-Ion compared to ion exchangers with chemical regeneration

Continuous operation:

- No outages due to the electro-chemical regeneration of the resin during operation.
- No double-systems needed for passing over the regeneration periods as well as no switching of any standby cartridges.
- Maintenance-free operation for more than 22,000 operating hours possible (just demonstrated by a long-time test made by Forschungszentrum Jülich)

No chemicals:

- No treatment of waste water needed.
- No transport and no handling of chemicals.
- No tanks, pipes or control instruments for regeneration chemicals needed.

Construction:

- Required floor space is considerably smaller in comparison with conventional systems.
- Simple construction and less components increase operational safety.
- Less time needed for maintenance.

Water quality:

- Resistance up to 18.2 Megohm (0.055 µS/cm) for input < 30 µS/cm.
- TOC approx. 3 – 5 ppb for feed water < 100 ppb.
- Germ reduction > 99 %.

The clean solution

Presenting a top class method

The construction of the El-Ion cell

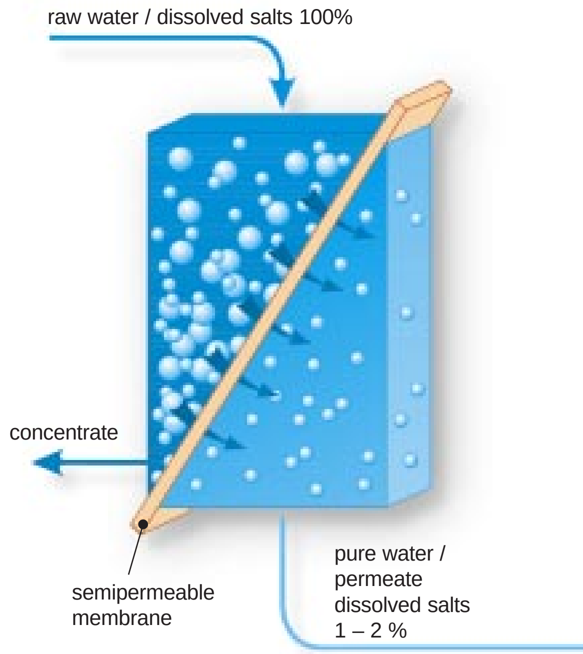
A single El-Ion cell consists of three chambers: the cation exchanger chamber, the anion exchanger chamber and the concentrate chamber. The feed water – permeate from a reverse osmosis system – flows into the cation exchanger chamber which is filled with cation exchanger resin. A cation exchanger membrane forms the boundary of the cation exchanger chamber. The water cations are exchanged against protones from the resin. There is an anode with a platinum surface placed in direct contact with the resin bed. This anode works electrochemically and produces the protones needed for the regeneration of the resin; it also keeps the resin in a permanent state of partial charge. Picked-up cations and surplus protones move through the resin bed in the electric field and pass through the cation exchanger membrane into the concentrate chamber. The water with the remaining anions flows through the anion exchanger chamber which is filled with anion exchanger resin. An anion exchanger membrane forms the boundary of this chamber. The hydroxyl ions needed for the resin regeneration are produced at a high-grade stainless steel cathode. Anions and surplus hydroxyl ions move through the resin bed in the electric field and pass through the anion exchanger membrane into the concentrate chamber. The order of operation – the anion exchanger before the cation exchanger or vice versa – depends on individual needs.

Conductivity in long term test

The salt in the concentrate chamber is continuously rinsed with small amounts of permeate and either flow back to the reverse osmosis system or drain together with the reverse osmosis system's concentrate.

The El-Ion cells are constructed as dual cells so that two at the time are connected in series. 90 % of the salts are already split off in the first stage.

This method is very similar to the electro-dialysis method, but there is an important difference. The disadvantage of the electro-dialysis method is its limited salt reduction. The lower the salt concentration in the solution, the higher the electric resistance between the electrodes. Consequently, less ions are transported. By using ultraclean ion exchanger resin, this problem can be solved neatly. Their electric charge lowers the electric resistance so that the ion transportation is continued steadily.



Little expense – huge output

With the feed conductivity of the reverse osmosis permeate at 5 – 30 µS/cm, the first cell achieves a water quality of 0.1 to 1 µS/cm. This is sufficient for most applications. In order to produce ultra pure water, two cells have to be connected in series. The result is saltfree, ultra pure water up to the theoretic conductivity limitation of 0.055 µS/cm = 18.2 MΩ · cm.

Microbiologic analysis of the ultra pure water showed a striking decrease in germination, even if the permeate germination had been high. This pleasant effect is partly due to the direct contact of resin and electrodes. The positive pH shift is also realized by using single resin beds. Consequently, germ reduction and also the severance of SiO_2 and CO_2 is much improved. A clear advantage of the single resin bed compared to the mixed resin bed is demonstrated here.

Analytic Data

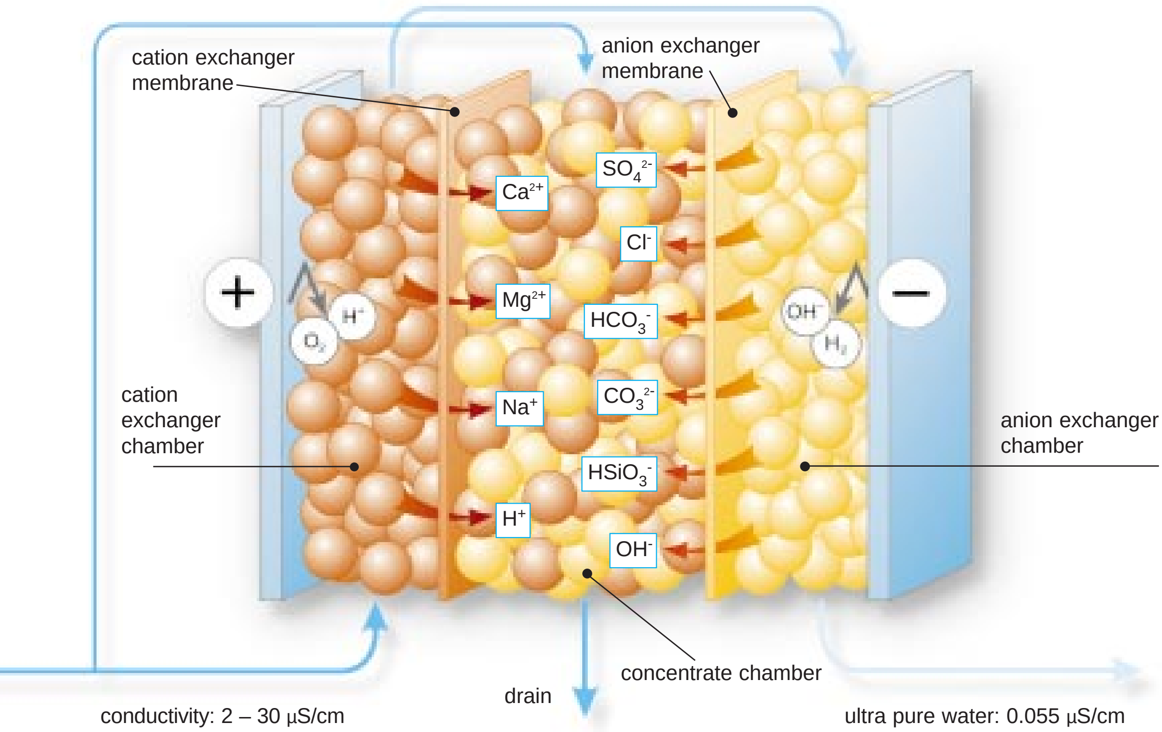
		entrance stage 1	exit stage 1	exit stage 2	tracing limit/ notes
Cl^-	µg/l	600	0.91	0.280	0.005
NO_3^-	µg/l	1190	0.38	0.194	0.005
SO_4^{2-}	µg/l	150	0.34	0.186	0.010
Na^+	µg/l	1250	26.00	0.069	0.005
NH_4^+	µg/l	120	< 3.00	0.036	0.010
K^+	µg/l	60	8.00	0.030	0.020
Mg^{2+}	µg/l	70	7.55	0.038	0.010
Ca^{2+}	µg/l	120	4.00	0.033	0.013
TOC	ppb	40 – 100	---	≤ 3 – 5	Anatel A 1000/C 80
SiO_2	ppb	300	20	≤ 10	Spectoquant 14794E
Number of germs	KbE/ml	10 – 20	---	≤ 0 – 0,5	R2A-Test

Operation data of the El-Ion cell

		stage 1	stage 2	concentrate
Flow	l/h	110 – 220	110 – 220	5 – 10
Inductivity entrance	µS/cm	5 – 20	---	5 – 20
Inductivity exit	µS/cm	0.1 – 1	0.055 – 0.07	50 – 300*
Total electricity	A	2 x 2 – 3	2 x 1	---
Cell voltage	V	10 – 15	6 – 10	---

** can be lead back to the reverse osmosis system*

The principle of the ***El-Ion*** cell



Meets all requirements

The suitable model for every need

Small footprint, high performance

Modern design, economical, user-friendly handling, reasonable purchase price and low cost of ownership – just a few attributes of the small reverse osmosis system euRO…plus. Above all, the “plus” means a strikingly improved quality of the ultra pure water by adding the El-Ion single bed cell. A further advantage compared to conventional system is that the euRO…plus requires extremely little floor space. The typical ultra pure water quality amounts below 0.06 µS/cm at an output of up to 80 l/h, depending on the type.

The compact solution

Laboratories, hospitals, institutes and industry require high amounts of ultra pure water. Cabinet systems in a wide variety of types and sizes are available – all equipped with El-Ion, of course. Ultra pure water output ranges from 70 – 750 l/h, with a granted water quality of < 0.2 µS/cm.

Optimal on a large scale

The biggest El-Ion cell is used, when enormous amounts of ultra pure water are needed. One of these cells is able to produce up to 13 gpm ultra pure water per hour. For semiconductor and electronic production, up to 400 m^3 ultra pure water are required per hour. To meet such needs, several cells can be connected in series. Thus, tailored production of the exact amount that a customer might require is no problem and can be easily obtained.

Advantages of the El-Ion compared to mixed bed electro-deionizing (CEDI, Elix, EDI)

Construction:

- Fewer, but stronger resin beds.
- Less membrane surfaces.
- Fewer seals required.
- Less expense for resin regeneration and membrane changing needed.
- Resin exchange without disassembly of the cell possible.
- Fewer loss of pressure through thicker resin beds.
- Increased flow speed induces better ion transport from water to resin.

Adjustment and control:

- The production of protones and hydroxyl-ions is regulated by the amount of amprage applied instead of being controlled by the dissociation of water at the contact to resin or membranes. Thus, the regeneration can be adjusted depending on the entrance conductivity of the feed water.
- Our system offers a higher silica severance and is less sensitive to carbon dioxide in the feed water.

Water quality:

- Resistance up to 18.2 Megohm (0.055 µS/cm) for input < 30 µS/cm.
- TOC approx. 3 – 5 ppb for feed water < 100 ppb.
- Germ reduction > 99 %.

Technical data:

Compact solution: reverse osmosis system with El-Ion

Type		RO 70 plus	– 140 plus	– 220 plus	– 310 plus	– 500 plus	– 750 plus
Pure water output at 15°C	l/h	70	140	220	310	500	750
Pure water quality	µS/cm	< 0,2	< 0,2	< 0,2	< 0,2	< 0,2	< 0,2
Yield	%	50 – 75	50 – 75	50 – 75	50 – 75	50 – 75	50 – 75
Required raw water pressure	bar	3 – 6	3 – 6	3 – 6	3 – 6	3 – 6	3 – 6
Power consumption	kW/h	0,5	0,55	0,65	0,65	1,4	1,5
Power supply	V/Hz	230/50	230/50	230/50	230/50	3 x 400/50	3 x 400/50
Dimensions (h/w/d)	mm			1600 / 600 / 550			
Weight	kg	260	270	280	290	–	–
Item no.		**3050**	**3055**	**3060**	**3065**	**3070**	**3075**

Type		euRO 5 plus	–10 plus	–20 plus	–40 plus
Pure water output at 15°C	l/h	5	10	20	40
Weight	kg	39	40	41	45
Dimensions (h/w/d)	mm		520 / 340 / 420		
Item no.		**3401**	**3402**	**3403**	**3404**
Power supply 115 V/60 Hz					
Item no.		**3501**	**3502**	**3503**	**3504**

El-Ion cells

Type*		E-20	E-60	E-250	E-750	E-1500	E-3000
Pure water output at 15°C	l/h	10 – 20	30 – 60	100 – 250	400 – 750	1000 – 1500	2000 – 3000
Power consumption	$W/m^3/h$			ca. 300 – 500			
Height	mm	140	140	325	400	570	640
Width	mm	95	95	240	400	520	950
Depth	mm	110	135	155	220	440	440
Item no.		**16200**	**16201**	**16250**	**16600**	**16650**	**16700**

** Further sizes available soon*

We reserve the right to make technical changes!

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