



Technical Brochure

ELECTROCHEMICALLY ACTIVATED WATER



Experience



Knowledge



Flexibility





What is ECA?

What is Electrochemical Activation (ECA Technology)

Radical Waters is the market leader in Electrochemical Activation ECA Technology. We sell and install Electrochemical Activation hygiene management systems for food and beverage plants, water treatment facilities and the hospitality industry, worldwide. ECA Technology is a replacement for traditional chemical cleaning and disinfection processes.

The Electrochemical Activation of water, better known as ECA solutions are created by mixing readily available food grade salt with water, and feeding it through the reactors which are the core of the ECA device. Once inside the reactor, the dilute brine solution is activated by way of an electrical charge, transfer of electrons takes place across the membrane and two distinct solutions are produced:

- Anolyte which is used as a disinfectant
(replacing chlorine based and other traditional disinfectant chemicals.)
- Catholyte which is used as a detergent
(replacing caustic-based chemicals and other traditional detergents)

Water savings of up to 60%

Reduction of Toxic Effluent

ECA does NOT affect the taste, colour and appearance of the products



How does it work?

ECA is a scientific process that mimics the body's own natural defence process.

When the body comes under attack from invading bacteria and viruses, the body's immune system immediately responds by sending increased numbers of a specific white blood cell called a Neutrophil to the invasion site. Once activated, these cells produce substantial quantities of a mixed oxidant solution which is highly effective in eliminating all invading microbes and pathogens. The oxidant that the white blood cells produce is acknowledged to be amongst the most potent natural disinfectants, yet it remains non-toxic to humans, and is highly effective as an antimicrobial agent with rapid action. It is called Hypochlorous acid or HOCl.

HOCl is generated under highly specific electrochemical activation conditions using a combination of water, salt (NaCl) and electricity. By utilising the specially designed and highly controlled production systems Radical Waters is able to consistently and repeatedly produce HOCl of the highest quality and efficacy, litre after litre.

HOCl is extremely effective at eliminating all pathogens and food spoilage microbes including spores.

The Radical Waters Anolyte also complies with the specifications of SABS SANS 1828 – Cleaning chemicals for use in the food industry in respect of corrosiveness to corrosion – resistant steel. The change in mass of an undiluted sample of Anolyte on corrosion resistant steel was less than 0.01mg/100mm². Results from recent studies and real time use, also confirm that Radical Waters ECA solutions will have no adverse impact on good quality SS304 and SS316 when used in accordance with the recommended usage protocols. The dilute solutions also comply with beverage manufacturers' OEM specifications.

ECA GENERATORS

Radical Waters currently have 2 Ranges of ECA Generator Products that fall under the umbrella of the **N.O.W ECA Generator Range**.

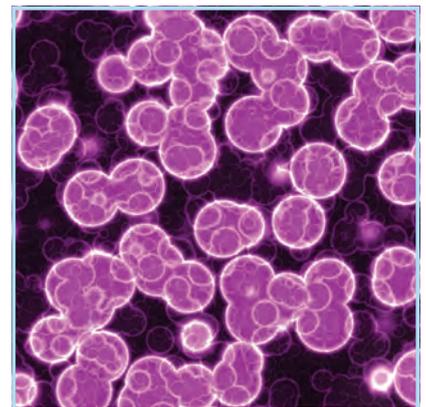
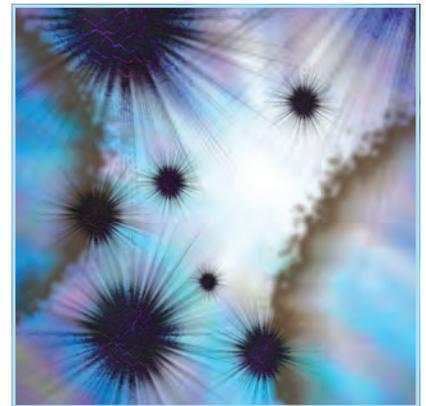
N.O.W or Neutral Oxidant Water can be used in a variety of markets formally dependent on chemical disinfection and cleaning.

The N.O.W range has two sub-categories:

- **N.O.W Impact** – For larger volumes of ECA
- **N.O.W Compact** – For smaller volumes of ECA

The Radical Waters N.O.W Impact & Compact range of devices are specific to core market segments and application areas within the Food and Beverage, Hospitality, Legionella & Water Treatment and the Animal Husbandry industry.

The N.O.W ECA product range can be supplied as dual stream generators or single stream generators as well as with Low salt options. These are supplied in various sizes Impact and Compact, dependent upon the application and customer requirement.



safe • fast • effective

ECA Anti-Microbial efficacy

Table 1. Electrolyzed water (pH 6.5, FAC 500-700ppm) efficacy against some bacteria strains

	Time (minutes)	Dilution rate					
		1/1	1/2	1/10	1/20	1/50	1/100
<i>Acinetobacter baumannii</i>	1	-	-	-	+	+	+
	2	-	-	-	+	+	+
	5	-	-	-	-	+	+
	10	-	-	-	-	+	+
	30	-	-	-	-	+	+
<i>E. coli</i>	1	-	-	-	+	+	+
	2	-	-	-	+	+	+
	5	-	-	-	+	+	+
	10	-	-	-	-	+	+
	30	-	-	-	-	+	+
<i>Enterococcus faecalis</i>	1	-	-	-	+	+	+
	2	-	-	-	+	+	+
	5	-	-	-	-	+	+
	10	-	-	-	-	+	+
	30	-	-	-	-	+	+
<i>Klebsiella pneumoniae</i>	1	-	-	-	+	+	+
	2	-	-	-	+	+	+
	5	-	-	-	-	+	+
	10	-	-	-	-	+	+
	30	-	-	-	-	+	+
<i>Pseudomonas aeruginosa</i>	1	-	-	-	+	+	+
	2	-	-	-	+	+	+
	5	-	-	-	-	+	+
	10	-	-	-	-	+	+
	30	-	-	-	-	+	+
<i>Staphylococcus aureus</i>	1	-	-	-	+	+	+
	2	-	-	-	+	+	+
	5	-	-	-	-	+	+
	10	-	-	-	-	+	+
	30	-	-	-	-	+	+

(-): no growth on culture, (+): bacteria growth on culture.

Electrolyzed water was effective against all bacteria used in the study at concentrations of 1/1, 1/2, 1/5, 1/10 for all contact times tested.

“The System is automated to ensure CIP integrity and requires little manual intervention.”

RW customer quote



Table 2. Effects of electrolyzed water on the growth of some yeast and mold species

	Time (minutes)	Dilution rate					
		1/1	1/2	1/10	1/20	1/50	1/100
<i>Candida albicans</i>	1	-	-	-	-	+	+
	2	-	-	-	-	+	+
	5	-	-	-	-	+	+
	10	-	-	-	-	+	+
	30	-	-	-	-	+	+
<i>Candida tropicalis</i>	1	-	-	-	+	+	+
	2	-	-	-	+	+	+
	5	-	-	-	+	+	+
	10	-	-	-	+	+	+
	30	-	-	-	-	+	+
<i>Candida parapsilosis</i>	1	-	-	-	+	+	+
	2	-	-	-	+	+	+
	5	-	-	-	+	+	+
	10	-	-	-	-	+	+
	30	-	-	-	-	+	+
<i>Aspergillus fumigatus</i>	1	-	-	-	+	+	+
	2	-	-	-	-	+	+
	5	-	-	-	-	-	+
	10	-	-	-	-	-	+
	30	-	-	-	-	-	+
<i>Aspergillus flavus</i>	1	-	-	-	+	+	+
	2	-	-	-	-	+	+
	5	-	-	-	-	-	+
	10	-	-	-	-	-	-
	30	-	-	-	-	-	-
<i>Aspergillus niger</i>	1	-	-	-	+	+	+
	2	-	-	-	+	+	+
	5	-	-	-	-	+	+
	10	-	-	-	-	+	+
	30	-	-	-	-	+	+

CIP time savings of up to 70%

Chemical Cost Saving up to 90%

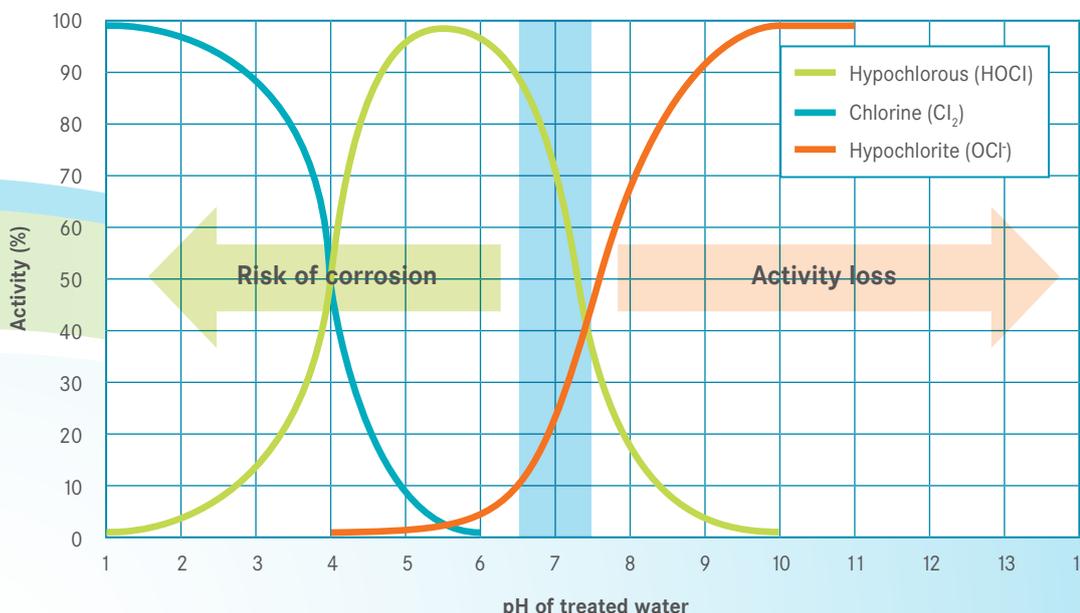
Water savings of up to 60%

Energy Savings

(-): no growth on culture, (+): yeast/mold growth on culture.

Electrolyzed water was effective against all yeasts and molds used in the study at concentrations of 1/1, 1/2, 1/5, 1/10 for all contact times tested.

Reduction of Toxic Effluent



ECA does NOT affect the taste, colour and appearance of the products

CIP time savings of up to 70%

Chemical Cost Saving up to 90%

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Alkaline Analyte:

There are ECA manufacturers that use plate reactors without a membrane, and thus produce an alkaline Analyte with a pH of ± 9 . In this instance, the predominant active ingredient of this type of Analyte is sodium hypochlorite (bleach). Although hypochlorite is relatively safe during storage and use when diluted, it is less effective in eliminating certain microbial species and might require longer contact times or higher concentrations in order to achieve the equivalent antimicrobial activity as TRUE ECA solutions.

Table 3. Effect of pH on Hypochlorous and Hypochlorite concentration.

pH	HOCl (%)	OCl ⁻ (%)
6.5	92	8
7.0	79	21
7.5	55	45
8.0	28	73
8.5	11	90
9.0	4	96

Hypochlorous acid is a weak acid (pKa of about 7.5), meaning it dissociates slightly into hydrogen and hypochlorite ions as noted in the below equation:



Between a pH of 6.5 and 8.5 this dissociation is incomplete and both HOCl and OCl⁻ species are present to some extent. Below a pH of 6.5, no dissociation of HOCl occurs, while above a pH of 8.5, complete dissociation to OCl⁻ occurs. As the germicidal effects of HOCl is much higher than that of OCl⁻, chlorination at a lower pH is preferred.

Acidic Analyte

Other suppliers of on-site chlorine generators produce a gaseous mixture of oxidants with a low pH of ± 2.0 . Therefore, gaseous chlorine is the predominant specie in this type of Analyte and it has to be dissolved into water to create an aqueous chlorine solution.

Chlorine gas is extremely harmful when inhaled, therefore strict requirements for handling and storage need to be adhered to. Although this type of Analyte is an efficient oxidant and disinfectant, the possible formation of THM's (trihalomethanes) when organic material is present, and the hazard aspect, pose a risk to both the manufacturer and end user of this Analyte. Analyte produced at such a low pH is also much more corrosive.

Neutral Analyte

The Radical Waters devices produce Analyte with a pH of 6.0 – 7.0. The neutral pH makes the solutions safe and effective because hypochlorous acid is the predominant oxidant in Analyte with a near-neutral pH. It is scientifically proven that hypochlorous acid is much more effective against a wider range of microorganisms than the standard sodium hypochlorite solution produced at an alkaline pH. As a consequence, hypochlorous acid requires shorter contact time compared to hypochlorite and other equivalent conventional chemicals.

This pH neutral Analyte is also highly effective as a sporicidal agent and it has a superior ability to remove biofilm when compared to other ECA or chlorine solution types. Additionally there is a significantly reduced risk for the formation of toxic by-products such as THM's due to the presence of both hydroperoxy- as well as chloroxy- radicals which is the distinctive feature of the mixed oxidant analyte solutions produced by Radical Waters.

Comparison between ECA and other traditional chemicals used

	ECA	Chlorine Gas
Disinfection	<p>300x more effective than Hypochlorite.</p> <p>More rapid disinfection.</p> <p>Broader inactivation range.</p> <p>Oxidants generated on-site - fresh solutions with constant potency.</p>	<p>Effective kill on certain organisms.</p> <p>Slower disinfection.</p> <p>Cannot kill some resistant organisms.</p>
Residual and stability	<p>More stable - Solution shelf life up to 6 months under optimal conditions.</p> <p>Residual effect without affecting taste and odour.</p> <p>Less disinfectant required to maintain residual.</p> <p>No need for Ammonia.</p> <p>Low levels of THM formation.</p> <p>Doesn't produce chlorites/chlorates.</p>	<p>Can vary widely throughout system.</p> <p>Must often be boosted or combined with ammonia to last throughout the system.</p> <p>A higher dosage is required to maintain equal residual.</p> <p>Production of THM's is much greater.</p>
Safety	<p>Uses only salt, water and electricity.</p> <p>Reduction in liability exposure.</p> <p>Avoids special equipment and training for worker safety.</p> <p>Reduced equipment corrosion problems.</p> <p>Avoids fire hazards from chlorine concentrates.</p>	<p>Packed Cl₂ gas is under pressure - potential for explosion or fire.</p> <p>Liability exposure.</p> <p>Poses hazards to surrounding community and to system operator.</p> <p>Potential for chlorine burns and highly corrosive to equipment.</p> <p>Safety equipment and training is necessary.</p>
Generation	<p>Oxidants generated on-site - fresh solutions with constant potency.</p> <p>No hazardous materials to transport or store.</p>	<p>Transportation of hazardous materials requires permits, EISs, etc.</p> <p>Storage of hazardous materials often requires gas scrubber to remove fumes.</p>
Cost Considerations	<p>Higher capital cost is offset by lower lifecycle cost when compare to other chemicals.</p>	<p>Lower installation cost when gas scrubber is not considered but higher lifecycle cost.</p>
Simplicity & Reliability	<p>Fully automated unit requires minimal training and maintenance - periodically add salt and check system.</p> <p>Safety gear is unnecessary.</p> <p>Reactor is easily replaced and only requires replacement every 1 or 5 years (depending on device acquired).</p>	<p>Regular change-out of cylinders requires complicated safety training and gear.</p> <p>Periodic cleaning required.</p> <p>Cylinders is changed frequently - up to 2x per month.</p>
Taste & Odour	<p>Excellent taste - does not react with ammonia and phenols to produce compounds that normally impart chemical taste and odours.</p> <p>Removes H₂S to improve water quality.</p>	<p>Often imparts a chlorine taste and odour especially when combined with ammonia.</p> <p>Cannot eliminate H₂S taste or odour.</p>
Multiple Uses	<p>Can be used for a wider range of disinfection purposes than Cl₂.</p> <p>Can be used for heavy metal removal - iron and manganese.</p> <p>Used for H₂s removal.</p> <p>Improve filter runs.</p> <p>Improves turbidity - enhancing prefilter flocculation.</p>	<p>Mainly used for disinfection purposes.</p>

Chlorine Dioxide	Ozone	Sodium Hypochlorite
Inactivates most microorganisms. More effective than chlorine less than ozone. Biocidal properties not influenced by pH. Effective against <i>Cryptosporidium</i> and <i>Giardia</i> .	Strong disinfectant and oxidation agent. More effective than chlorine and chlorine dioxide. Requires very short contact time. Very effective against <i>Cryptosporidium</i> and <i>Giardia</i> . Biocidal activity not influenced by pH.	At high pH, OCl ⁻ dominates, which causes a decrease in disinfection efficiency. Requires higher concentrations. Requires longer contact times. Not effective against <i>Cryptosporidium</i> and <i>Giardia</i> .
Reacts with many organic and inorganics. Chlorites and chlorates are produced - cause of health effects. Does not produce THM's - ClO ₂ aids in reducing the formation of THM's. Residual in system can cause taste/odour problems. It decomposes in sunlight.	Ozone provides no residual. Ozone decays rapidly at high pH and temperatures. Forms DBP's including aldehydes, ketones, organic acids, bromine containing THM's and bromates. Upon decomposition the only residual is dissolved oxygen.	Formation of THM's and other DBP's as well as chlorites and chlorates. The stability of sodium hypochlorite solution depends on the hypochlorite concentration, the storage temperature, the length of storage (time), the impurities of the solution and exposure to light. Sodium hypochlorite solutions degrade over time. Sodium hypochlorite solution is typically not diluted prior to mixing to reduce scaling problems.
ClO ₂ gas is explosive at levels >10% in air. ClO ₂ dosage cannot exceed 1.4mg/L to limit formations of Chlorites and Chlorates. Measuring ClO ₂ gas is explosive. Chlorine dioxide also highly corrosive.	High levels of ozone is toxic when inhaled. Ozone, when correctly applied, has been proven to maintain uniformly low corrosion rates, similar to and frequently better than systems treated with traditional chemicals.	Sodium hypochlorite solution is a corrosive liquid with an approximate pH of 12. Therefore, typical precautions for handling corrosive materials such as avoiding contact with metals, including stainless steel, should be used. Chlorates may be formed, avoid by limiting storage time, high temp and reduce light exposure. Spill containment must be provided for. Safety equipment and training is essential.
Must be generated on-site, easy to do this. Generated as needed and directly injected into diluting stream. Variety of feedstock used like sodium chlorite, Cl ₂ gas, NaOCl, HCL or H ₂ SO ₄ . Only small samples up to 1% can be stored if solutions are protected from light, chilled, has no unventilated head space.	Generation of Ozone requires high energy and should be generated on-site.	Sodium hypochlorite is produced when chlorine gas is dissolved in a sodium hydroxide solution. Alkaline solution produced with lower biocidal effect. Dilute sodium hypochlorite solutions can be generated electrochemically on-site from salt brine solution.
Equipment is typically rented and costs of sodium chlorite are high. Costs associated with training, sampling and testing for chlorates/chlorites are high.	Initial cost of ozonation equipment is very high. Considerable expenses for operators' training and installation support.	Least expensive when bought in containers, But can be expensive when on-site generators are used. Typically, sodium and calcium hypochlorite are more expensive than chlorine gas.
Oxidant demand study should be completed to determine approx ClO ₂ dosage to obtain required CT value for disinfection. Decomposes in sunlight. Generator efficiency and optimization difficulty can cause excess chlorine to be fed into system - can potentially form halogen based DBP's.	Biologically activated filters are needed for removing organic carbon biodegradable DBP's. Maintenance on generators requires skilled technicians. The process is highly automated and very reliable, requiring only a modest degree of operator skill and time to operate an ozone system.	Easiest and least expensive disinfection method. No maintenance required. Easier to use, are safer, and need less equipment compared to chlorine gas.
Concerns about possible taste and odour complaints have limited the use of ClO ₂ to provide a residual in the system.	Ozone controls colour, taste and odours.	Finished water could have taste and odour problems, depending on the water quality and dosage.
Primary and secondary disinfectant, for taste and odour control. TTHM/HAA reduction, Fe and Mn control, colour removal. Sulphide and phenol destruction. Zebra mussel control. Enhance clarification process.	Ozone can sometimes enhance the clarification process and turbidity removal. Ozone oxidises iron, Manganese and sulphides.	Oxidises iron, Manganese and sulphides.

Material Compatibility

One concern is that use of ECA water will oxidize equipment and facilities, and this can happen if the materials are incompatible with ECA water. Most materials used in food processing are compatible with ECA water at the concentrations normally used. Stainless Steel (e.g. 316L) is corroded less and common plastics used in food processing are generally resistant, including ECTFE (Halar®), PTFE (Teflon®), PVDF (Kynar®), PVC (rigid, schedule 80 or 40), and silicon tubing and gaskets. Natural rubber will readily degrade; however FPM (Viton®) and Teflon gaskets are very stable.

Table 4. Material compatibility with ECA water.

NOTE: The highlighted materials will perform satisfactorily under most ECA water uses
 NOTE: Some materials rated as excellent in contact with ECA perform poorly in heat treatment (e.g. PVDF or Kynar ®)

Material	Compatibility
304 Stainless Steel	C - Fair
316 Stainless Steel	A - Excellent
ABS Plastic	B - Good
Acetal (Delrin ®)	C - Fair
Buna N (Nitrile ®)	D - Severe Effect
Carbon Steel	C - Fair
ChemRaz (FFKM)	B - Good
CPVC	A - Excellent
EPDM	A - Excellent
Fluorocarbon (FKM)	A - Excellent
Hypalon ®	A - Excellent
Hytrel ®	C - Fair
Kalrez	A - Excellent
Kel-F ®	A - Excellent
LDPE	C - Fair
LLDPE	A - Excellent
Natural Rubber	D - Severe Effect
Neoprene	C - Fair
Nylon	D - Severe Effect
Polycarbonate	A - Excellent
Polyether ether Ketone (PEEK)	A - Excellent
Polypropylene	D - Severe Effect
Polyurethane	A - Excellent
PTFE (Teflon ®)	A - Excellent
PVC	B - Good
PVDF (Kynar ®)	A - Excellent
Silicone	A - Excellent
Viton ®	A - Excellent

- Ratings: A - Excellent
 B - Good: Minor effect, slight corrosion or discoloration.
 C - Fair: Moderate effect, not recommended for continuous use.
 Softening, loss of strength, swelling may occur.
 D - Severe effect: Not recommended for ANY use.
 * Using recommended concentrations and contact times.

“We have not challenged this technology enough to know its limitations.”

RW beverage customer quote



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