On-site sodium Hypochlorite Generation System

ClorTec®

The market leading ClorTec® brine electrochlorination systems offer customers ease of operation, lower whole life costs and the peace of mind associated with more than 30 years of installations on a global scale.

De Nora Water Technologies has established itself as the undisputed technology leader in the field of electrochlorination disinfection.

With more than 35 years of electrochlorination experience, De Nora Water Technologies offers seawater and brine treatment solutions for water and wastewater applications to municipal and industrial operations.

ClorTec® brine on-site sodium hypochlorite generating systems have a strong reputation as the leading global technology provider with a proven track record of global installations. ClorTec® systems have been designed, manufactured, installed, operated and serviced since 1995. Over that time, more than 3,000 ClorTec® systems have been installed globally. The experience gained from these endeavors is unparalleled in the industry and our drive for product improvements and enhancements continues.
The Benefits of On-site Generation
On-site generation is a proven, cost-effective, reliable and safe alternative disinfection treatment method. The use of on-site generated sodium hypochlorite reduces the formation of disinfection byproducts and improves water quality. The process offers other advantages:

- Reduced operational costs
- Consistent solution strength
- Production of required volumes as needed
- Non-hazardous chemical (feed or product)
- Eliminates the need for OSHA risk management planning requirements surrounding chlorine gas

ClorTec® Systems are Serving to Enhance the World in Which We Live

- Ensures a lower carbon footprint
- Requires less salt, reducing salt levels in product water and discharge to the overall environment
- Requires less salt, reducing the number of delivery trucks on the road and lowering CO₂ emissions
- Increases efficiency, resulting in significant operational savings
- An easy to operate and maintain solution — clear cells enable simple visual inspection
Annual Carbon Footprint of OSHG vs Purchased Hypochlorite Delivered to Site

Annual Carbon Footprint ClorTec® vs Competitive OSHG Systems

- Hypochlorite Generation (lb/day)
- Carbon Footprint (tons)

- Industry OSHG Standard
- Bulk Hypochlorite

- ClorTec®
- Competitive OSHG
**ClorTec® System Offering**
The ClorTec® systems generate a 0.8% sodium hypochlorite disinfection solution, a chlorine equivalent, using three common consumables: salt, water and electricity. ClorTec® units range in capacity from 1 kg/day (2 lb/day) to 1,360+ kg/day (3000+ lb/day) and are engineered and offered to meet any specified application demand. To meet varying application specific conditions, the ClorTec® units are available as component-based or skid-based packaged systems. ClorTec® units are NSF Standard 61 and 50 certified.

**ClorTec® On-site Generating Process**
The operation of the ClorTec electrochlorination system is straightforward:
- Influent water is passed through a water softener to reduce hardness therefore reducing the scaling of electrodes and lengthening the intervals between cleanings
- Using softened water, salt is dissolved in a tank to form a concentrated brine solution
- The diluted brine solution is passed through an electrolytic cell that, using DC current from a rectifier, electrolyzes the diluted brine into a 0.8% solution of sodium hypochlorite
- The 0.8% hypochlorite solution flows into a storage tank
- Hydrogen, the only byproduct of the process, is safely vented to the atmosphere
**ClorTec® Enhanced Operation**

De Nora Water Technologies has significantly advanced on-site hypochlorite generation technology through an enhanced proprietary electrode coating. The coating, which the company has researched and developed since 2004, provides greater operational efficiency, significantly reducing the consumption of salt and electricity. A dedicated R&D staff is committed to further enhancing process efficiency.

The electrolytic cell consists of vertical titanium plates divided into arrays of cell packs consisting of an equal number of anodic and cathodic plates. The electrolytic cell packs are configured electrically and hydraulically in series.

The electrolytic cell is fed a DC current from a rectifier and electrolyzes the diluted brine into a sodium hypochlorite solution. Chlorine evolves at the anode surface, while hydrogen and hydroxide evolves at the cathode surface. The secondary reaction of chlorine, sodium and the hydroxyl ion nets sodium hypochlorite (chlorine bleach) at a 0.8% solution. (As a reference, bottled household bleach is typically delivered at a 5% to 6% solution.)

In simple terms, the process can be described as follows:

\[ \text{NaCl} + \text{H}_2\text{O} + \text{electricity} \rightarrow \text{NaClO} + \text{H}_2 \]

or

salt + water + electricity = sodium hypochlorite + hydrogen gas

The enhanced electrode coating reduces salt and energy consumption:

- Reduced salt consumption to as low as 2.8 kg/kg (2.8 lb/lb) of chlorine
- Reduced energy consumption to as low as 4.4 kW/kg (2.0 kWh/lb) of chlorine

**Capturing Hydrogen for Energy**

There is the potential to capture the hydrogen byproduct of large-scale on-site generation processes for use as an energy source. Work is being undertaken with industry experts to evaluate these potential hydrogen reuse scenarios:

- Vehicle fuel
- Heating fuel
- Electric power generation by a hydrogen-fueled Internal Combustion (ICE) Genset
- Combined heat and power (CHP) from a hydrogen-fueled High Temperature Fuel Cell (HTFC)
ClorTec® Enhanced Design

<table>
<thead>
<tr>
<th>State</th>
<th>Energy (Cost/kWh) x 2.0</th>
<th>Salt (Cost/lb) x 2.5</th>
<th>Misc. Maintenance (Cost/lb)</th>
<th>Chlorine Equivalent (Cost/lb)</th>
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</thead>
<tbody>
<tr>
<td>Pennsylvania</td>
<td>$0.07</td>
<td>$0.08</td>
<td>$0.03</td>
<td>$0.37</td>
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<tr>
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<td>Washington</td>
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<td>$0.09</td>
<td>$0.04</td>
<td>$0.365</td>
</tr>
</tbody>
</table>

*Regional sampling of estimated chlorine equivalent costs.
†Use of off-peak power rates can further reduce the cost per pound of chlorine equivalent.

Site-specific water quality and temperature are taken into account by the ClorTec® design team to ensure system operation at optimum conditions, maximizing electrode life and delivering the highest quality water. De Nora Water Technologies offers a performance guarantee on the enhanced efficiency ClorTec® systems for those clients procuring on a guaranteed whole life approach. De Nora Water Technologies maintains a strong commitment to safety in the design and operation of every ClorTec® on-site generation system. Every ClorTec® system employs multiple levels of safety controls.

De Nora Water Technologies is also leading the industry in hydrogen management. During the generation of sodium hypochlorite, hydrogen is formed as a byproduct. The ClorTec® hydrogen management system is designed to safely separate, contain and vent hydrogen directly into the atmosphere. A white paper detailing De Nora Water Technologies’s approach to hydrogen management is also available.

Annual Operational Salt Cost*

Salt Efficiency per lbs of Cl₂ Equivalent:
- 3.5 lbs
- 3.0 lbs
- 2.5 lbs

*based on $200/ton delivered salt cost

Increased efficiency offers significant savings the higher the disinfectant demand.

Disinfectant Demand (lbs of Cl₂ Equivalent)
ClorTec®
On-Site Sodium Hypochlorite Generation System

Key On-site Generation Facts
• More than 35 years of experience in seawater and brine electrochlorination
• Supplying over 65 percent of the worldwide installed base of on-site generated hypochlorite
• ClorTec® has the most established and largest brand name recognition of any on-site generation technology
• Guaranteed process efficiency
• Global service and warranty coverage
• Proven track record: installed more than 3,000 on-site generation systems producing over 56 thousand kg/day (3.2 million lb/day)
• Largest worldwide installed capacity system is 109 thousand kg/day (240 thousand lb/day) seawater and 9.5 thousand kg/day (21 thousand lb/day) brine

ClorTec® Services
• 24-hour service line (+1 800 524 6542)
• Overnight parts response with a local, regional and international support-network
• Factory-trained technical onsite assistance available if needed
• Global regional field service locations