

Siemens Water Technologies

Introduction to OSEC[®] *On-Site Electrolytic Chlorination*

0.8% sodium hypochlorite on-site and on-demand.

Clean and Safe Drinking Water Workshop – Gander Newfoundland
March 28, 2012

Overview of Contents



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- ◆ Introduction
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Introduction to OSEC®

- ◆ **OSEC® is a system for producing 0.8% sodium hypochlorite on-site, and on-demand, through the electrolysis of brine solution. It is available in various capacities depending on manufacturer from a few ppd to thousands of ppd of equivalent chlorine.**

- ◆ **OSEC® units eliminate dependence on commercial chemical supplies, and the safety concerns inherent in the transport, handling and storage of chlorine gas and commercial strength 12 - 15% hypochlorite.**

- ◆ **The OSEC® system was developed by Wallace & Tiernan in 1980**
 - US Patent 4,248,690 (1981)
 - UK Patent 2 068 016 A (1983)

Wallace & Tiernan was formerly part of US Filter Corporation

Siemens acquired US Filter in 2004

Introduction to OSEC®

Why use on-site hypochlorite generation methods?

- ◆ Effective disinfection, minimize health risks (as in all chlorination).
- ◆ No risk potential caused by gaseous chlorine.
- ◆ No handling of dangerous chemicals.
- ◆ Economic production based on actual demand.
- ◆ Hypochlorite produced at a definite concentration (always available).
- ◆ Economic off-peak production of bleach possible (Electrical Costs).
- ◆ Concentration of available chlorine is low (0.7 to 0.9%) compared to commercial bleach (12 – 15%), resulting in minimized decomposition of chlorine in feed stock.
- ◆ Storage of a low quantity of bleach for one – two day capacity
- ◆ OSEC® systems can produce hypochlorite at a cost that is significantly lower than purchased 12 – 15% hypochlorite.

Advantages of OSEC[®] Over Conventional Alternatives:

Chlorine Gas

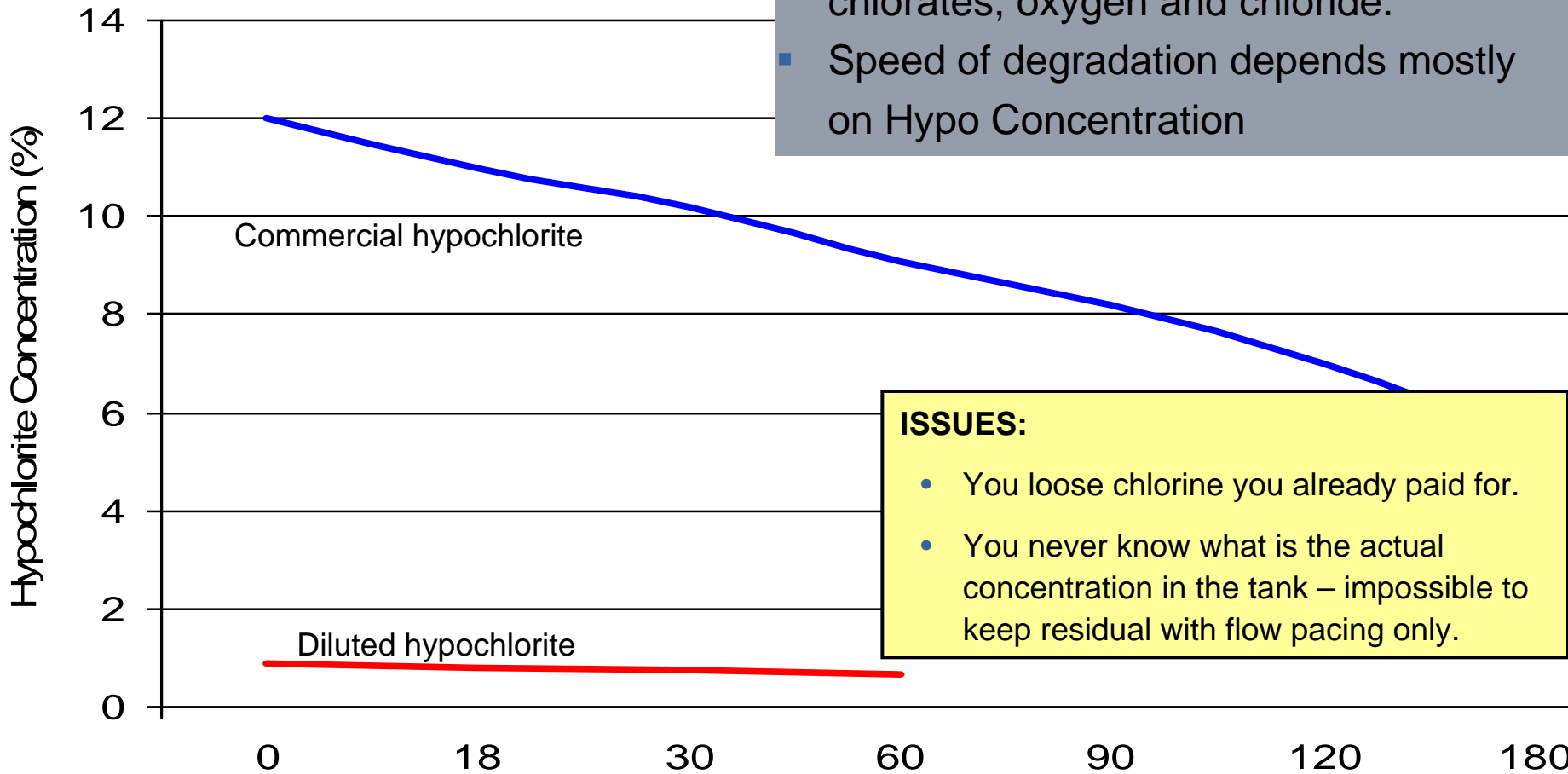
- ◆ Safety (danger of release of pressurized gas – highly toxic).
- ◆ Risk Management Program required in most provinces.
- ◆ Release Prevention Equipment required (scrubbers, shut-off systems, etc).

Commercial Sodium Hypochlorite (12 – 15%)

- ◆ High Operating Cost
 - ◆ In Newfoundland (up to \$3.85 per us gallon based on \$1.00 per liter) = 1 lb of equivalent chlorine at 12% concentration - (OSEC production costs approx \$0.55 to \$0.65 per lb CL₂ depending on prices of salt, power, and water).
- ◆ Stability
 - ◆ Off-gassing (difficult to pump) – Less off-gassing with lower concentrations.
 - ◆ Degradation (loss of available chlorine) – Less degradation with lower concentration (also with less storage time).

Degradation of Hypochlorite Solutions

- Degradation reactions convert Hypo into chlorates, oxygen and chloride.
- Speed of degradation depends mostly on Hypo Concentration



ISSUES:

- You loose chlorine you already paid for.
- You never know what is the actual concentration in the tank – impossible to keep residual with flow pacing only.

OSEC® Process Overview



Make Sodium Hypochlorite On-Site and On-Demand

Requirements:

- ◆ Salt
- ◆ Power
- ◆ Water
- ◆ On-Site Generation System

**Sodium hypochlorite solution
produced typically < 1.0wt%**

OSEC® Process Overview (Requirements)

Salt

NSF-Grade Solar Salt
99.5 wt% NaCl
(No additives)

30 day supply on hand

3.0 lb salt per lb Cl₂



Water

10 gpm per 1000 lb/day
10:1 water/brine ratio

Limits:

17 ppm (1 gpg) hardness
50 ppb Manganese



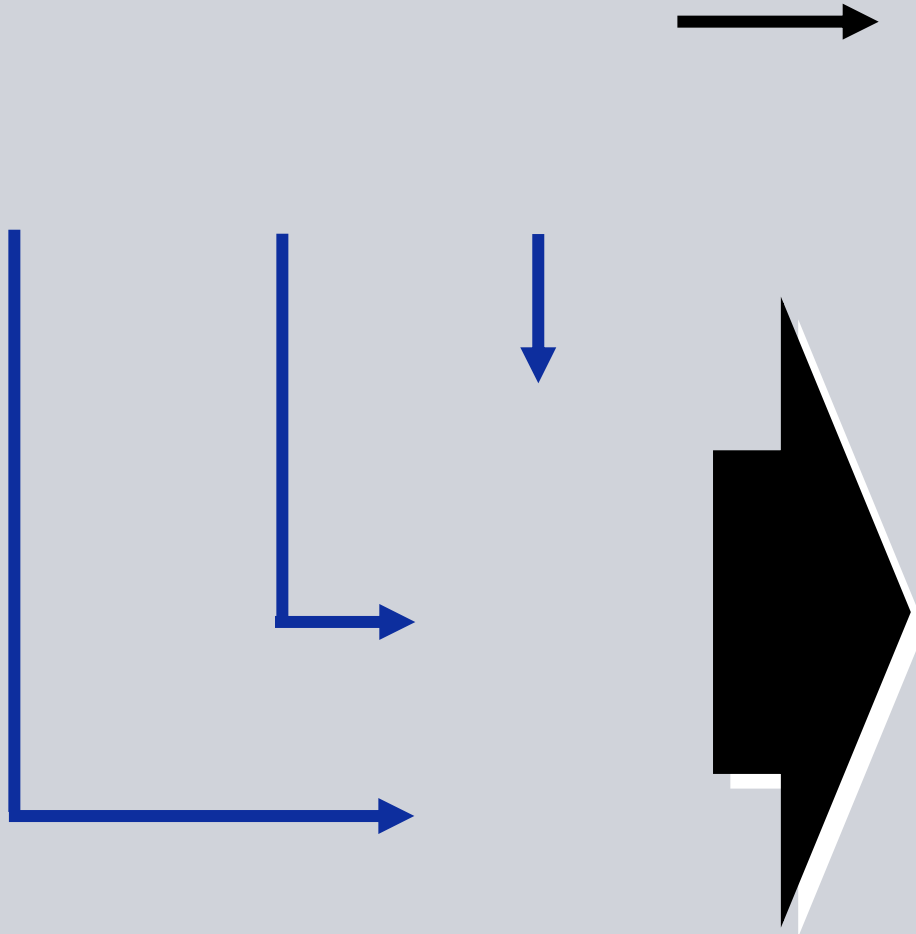
Power

2.0 kWh AC per lb Cl₂
(generator only)

Voltage Feed +/- 10%

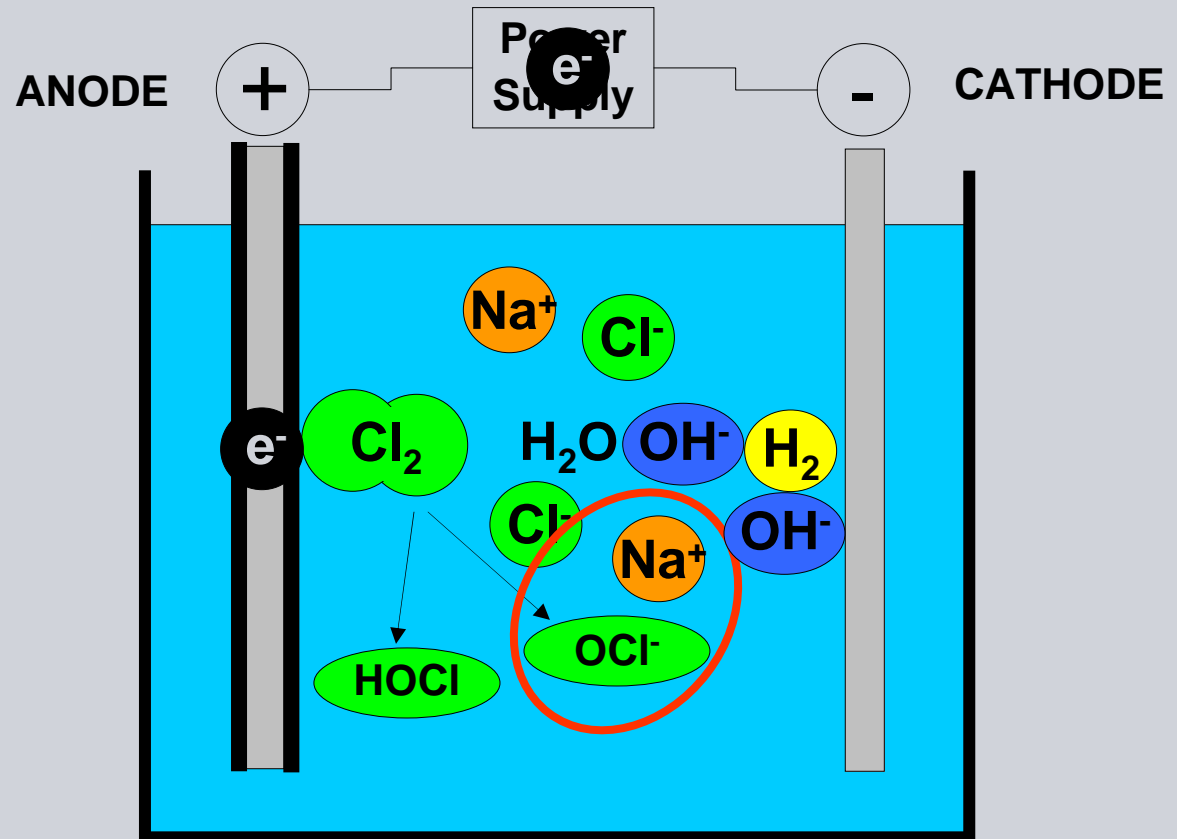


OSEC® Process Overview



OSEC® Electrolyzer Process Chemistry

~~ANODE: $2\text{Cl}^- \rightarrow \text{Cl}_2 + 2\text{e}^-$~~
~~CATHODE: $2\text{H}_2\text{O} + 2\text{e}^- \rightarrow \text{H}_2 + 2\text{OH}^-$~~
~~Overall: $2\text{Cl}^- + 2\text{H}_2\text{O} \rightarrow \text{Cl}_2 + \text{H}_2 + 2\text{OH}^-$~~
~~Primary Electrolysis (g) occurring in the electrolyzer cell~~



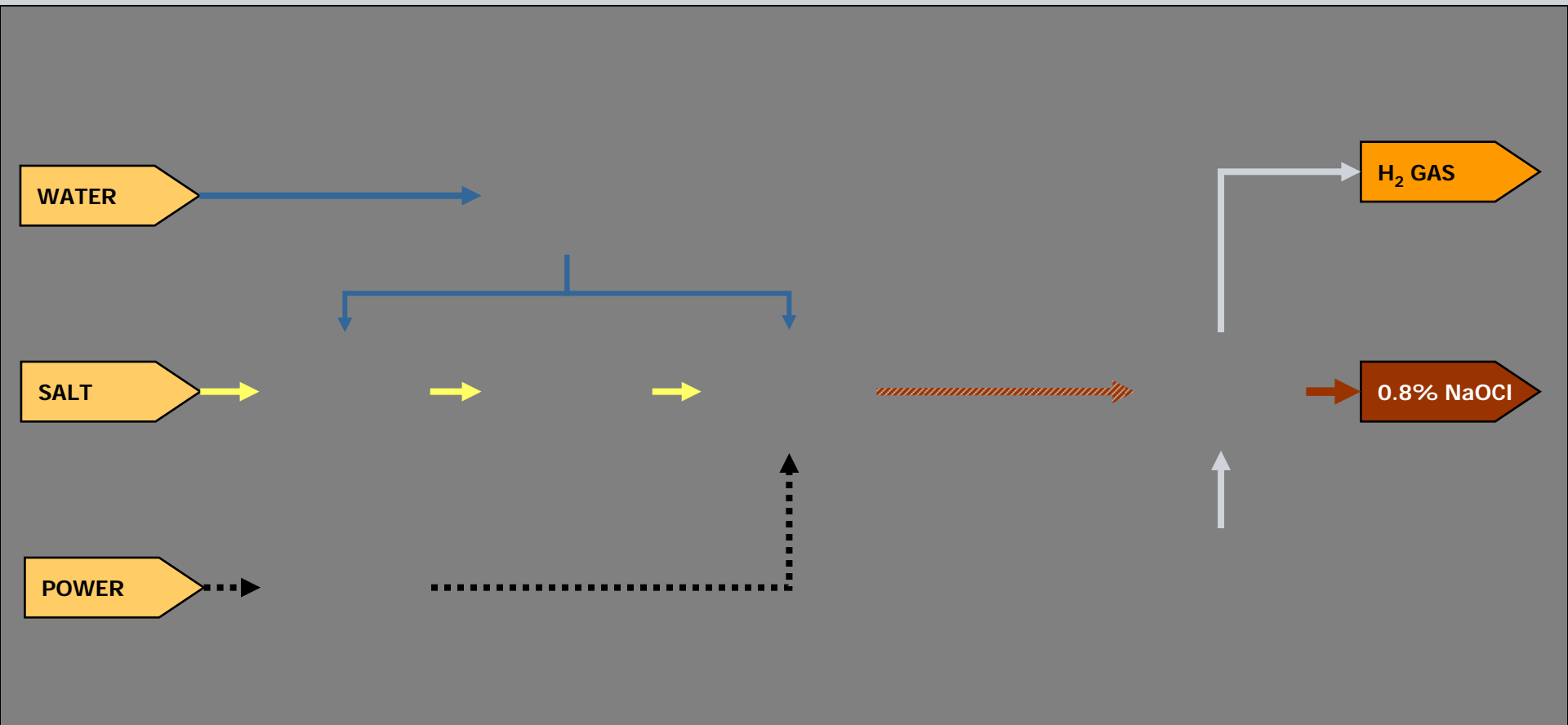
OSEC® Process Overview

The OSEC® system includes all the components required to generate a 0.8% hypochlorite solution from water, salt and power.

The hypochlorite generation system generally includes the following components:

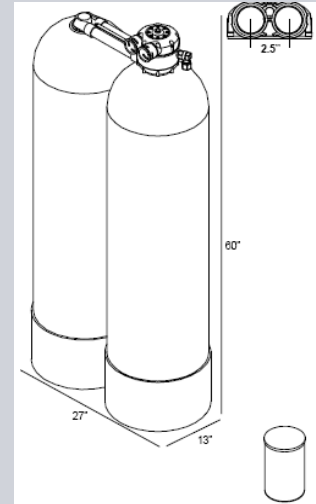
- 1. Water Softener**
- 2. Brine Saturator and Intermediate Brine Tanks (if required)**
- 3. Water Chiller and/or Water Heater (if required)**
- 4. Hypochlorite Generator with Brine Pump**
- 5. Transformer/ Rectifier**
- 6. Local Control Panel**
- 7. Product Tanks and Hydrogen Ventilation (Blower)**
- 8. Hydrogen Gas Detectors**
- 9. Dosing Pumps**

OSEC® Process Overview



1. Water Softeners

- ◆ Softened water is used to minimize the build up of deposits on the electrodes. Such deposits can seriously impair electrolyzer efficiency and reduce electrode life. The total hardness level must be 17 mg/L (1 grain) or less entering the electrolyzers. A level of 5 mg/L or less is preferred to minimize regular acid cleaning of the system.
- ◆ Standard softeners used are usually an automatic, multiple-tank softener system requiring no electrical connections. The control valve mechanism is driven by the flow of treated water. The softener sizing is based upon the customer's available water hardness.



**Kinetico CP213
Softener**



Kinetico Hydrus 436sOD

2. Brine Saturators

The Saturator provides saturated brine by dissolving salt in softened water. This is used by the electrolyzers for hypochlorite production and for water softener regeneration. It is usually a tank filled with a coarse form of softening-grade salt and containing some intermediate level of standing (soft) water in which the salt dissolves to make brine. The saturator is sized to contain the specified quantity of salt (based on acceptable frequency of refill) and produce the volume of brine required. Small saturators are often manually loaded with bagged salt, with pneumatic conveyance being the preferred method for large systems. Forced air delivery is generally via a metal chute, this chute must be grounded to prevent shock hazard by static charge. Delivery logistics and offload space requirements should be reviewed with the salt supplier.



- ◆ Heat tracing and insulation recommended if tank is to be mounted outdoors in Canada (Brine Freezes at -21 deg C).
- ◆ Most installations in Canada are indoors.
- ◆ Salt is supplied in bags, large bags, or bulk delivery (blown in).

3. Water Chiller and/or Water Heater (if required)

- ◆ **Water Chiller** - The OSEC® generator performs at the highest efficiencies when the dilution water temperature is lower than 70 F (21 deg C). It is common for surface water treatment plants in some regions of the country to see water temperatures consistently higher than 70 F (21 deg C) during the summer months. In those cases, a water chiller is required.
- ◆ **Water Heater** - The OSEC® generator should not be operated at water temperatures below 50 deg F (10 deg C). If the water temperature is lower than 50 deg F (10 deg C), an electrical water circulation heater must be furnished with the system.



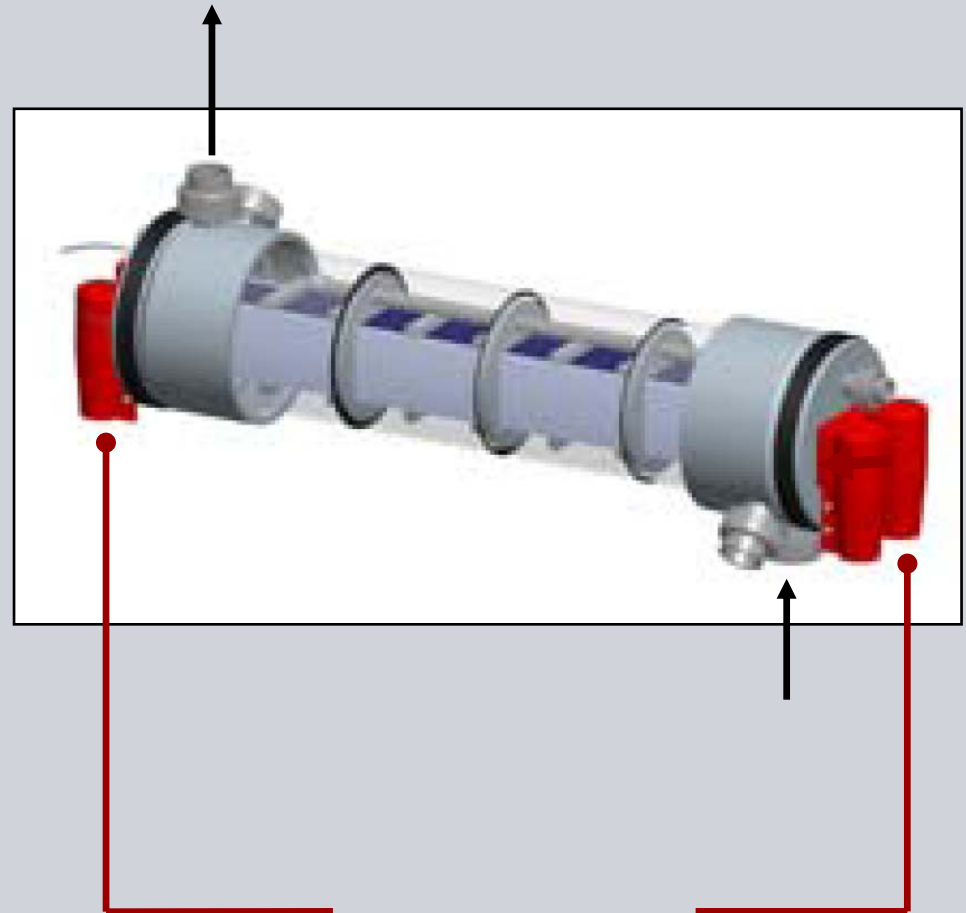
4. Hypochlorite Generator (Electrolyzer) with Brine Pump OSEC®

SIEMENS

Electrolyzer Type: Undivided Cell

- ◆ No Membrane
- ◆ Continuous Flow Path
- ◆ Bipolar electrodes acting Anode (+) and Cathode (-) in the same plate
- ◆ Removable chassis allows for inspection and repair
- ◆ Simple process connections

Latest Technology



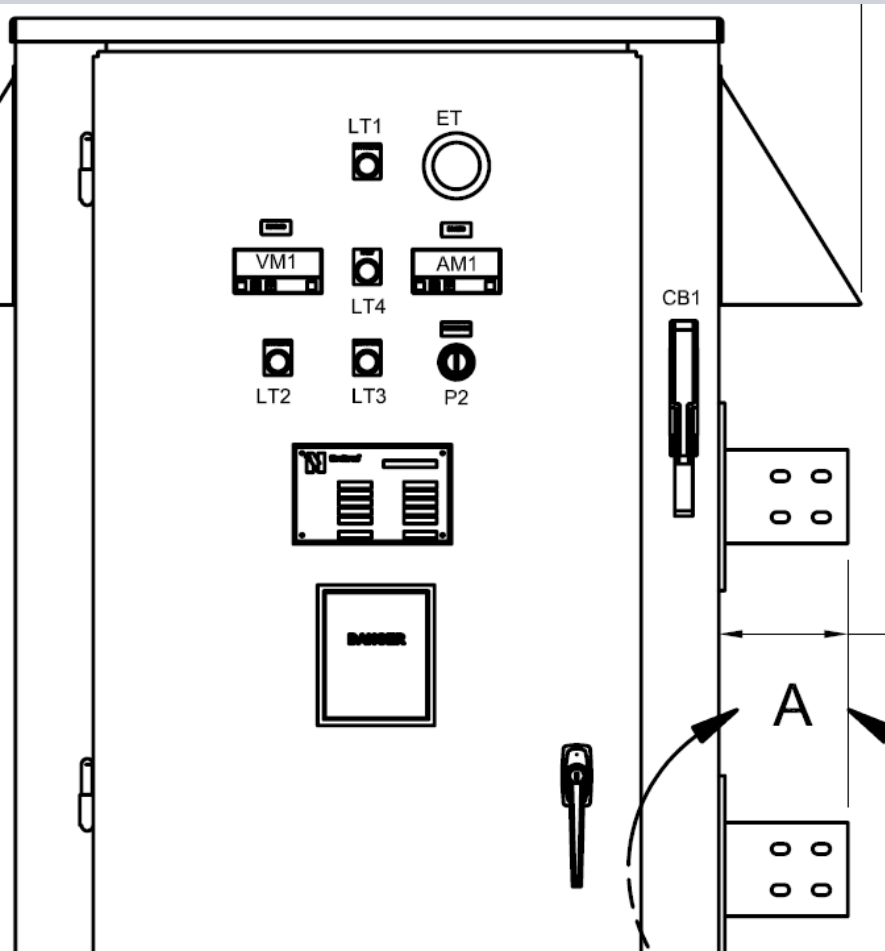
4. Hypochlorite Generator with Brine Pump OSEC®

- ◆ Brine Pumps depend on System Capacity
- ◆ Examples used in Siemens Systems:



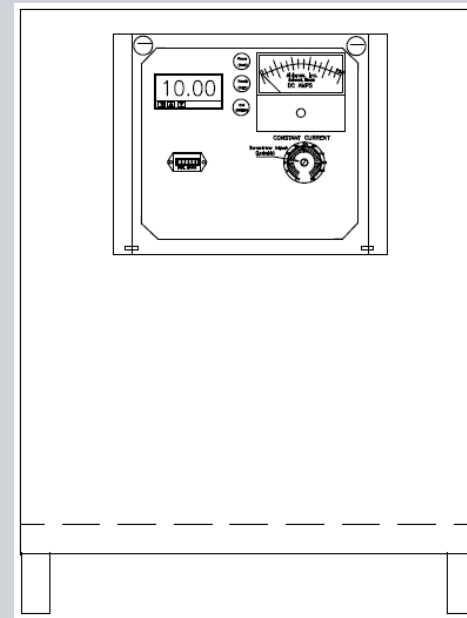
5. OSEC[®] Transformer/Rectifier

- ◆ Transformers may be needed to meet Rectifier Voltage Requirements. Rectifiers convert AC Voltage/Current to DC Voltage/Current.



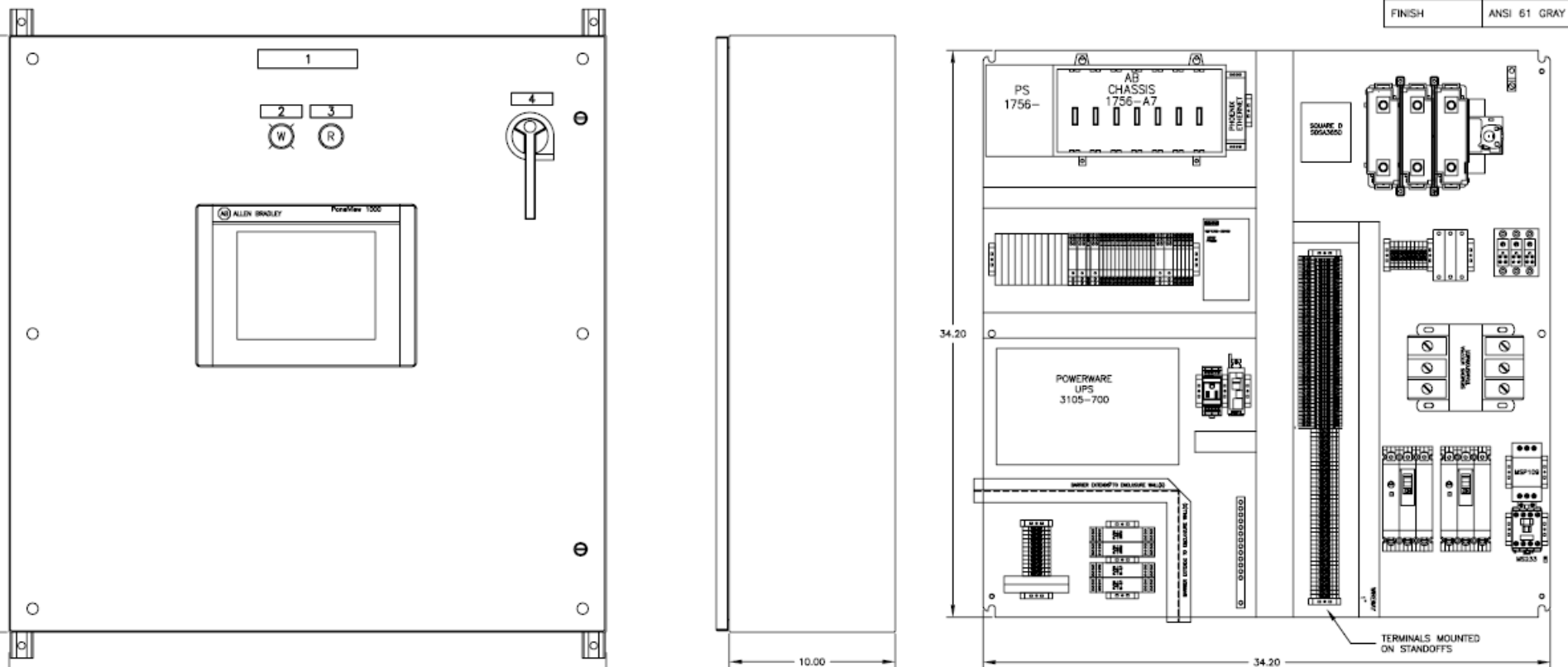
LEGEND

- AM1: DC AMMETER
- VM1: DC VOLTMETER
- P2: CURRENT ADJUST
- LT1: D.C. POWER ON
- LT2: A.C. POWER ON
- LT3: READY TO START
- LT4: FAULT LIGHT
- CB1: CIRCUIT BREAKER
- ET: ELAPSED TIMER



6. OSEC® Control Panel

◆ Control Panels are required to monitor and control every aspect of the system (e.g. of OSEC® B-Pak System).

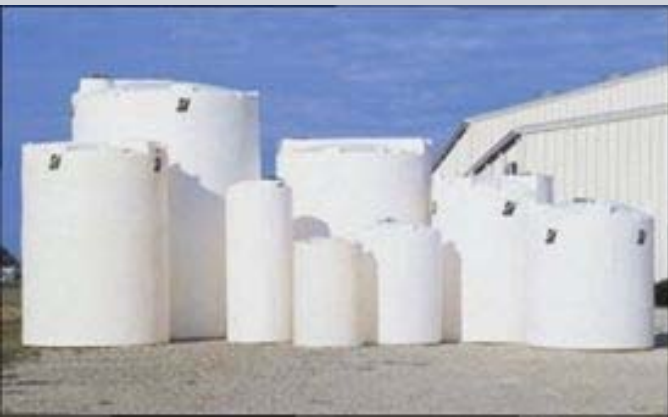


7. Product Tanks And H2 Ventilation

Above-ground atmospheric tanks are usually used for hypochlorite storage. Typical materials of construction include high-density polyethylene and fiberglass reinforced plastic (FRP).

Instrumentation –

- ◆ Level - Each hypochlorite tank should be furnished with a level sensor. Ultrasonic level sensors are typically used for hypochlorite storage tanks. Intrinsic safety barriers must be provided to avoid ignition sources in the tank.
- ◆ Air Flow - Each tank is ventilated with a blower. Proper air flow is confirmed by measuring the differential pressure across the orifice assembly with the differential pressure switch.

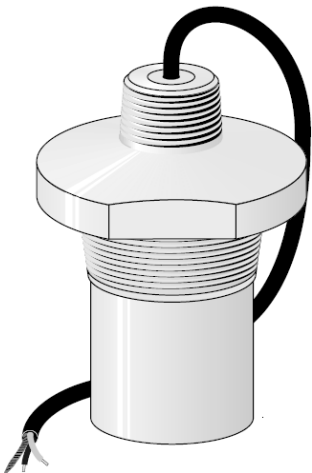


7. Product Tanks And H2 Ventilation Level Controllers (Ultrasonic or Pressure)

SIEMENS

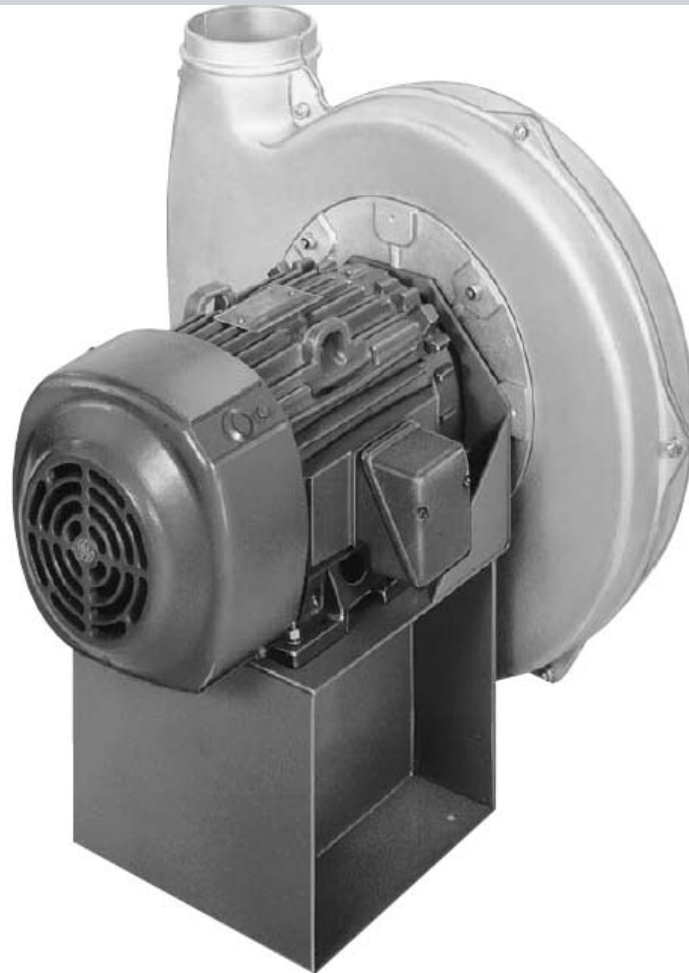


- ◆ Ultrasonic – Top of the tank
- ◆ Pressure (Head) – Bottom of Tank



7. Product Tanks And H2 Ventilation Hypochlorite Tank Blowers

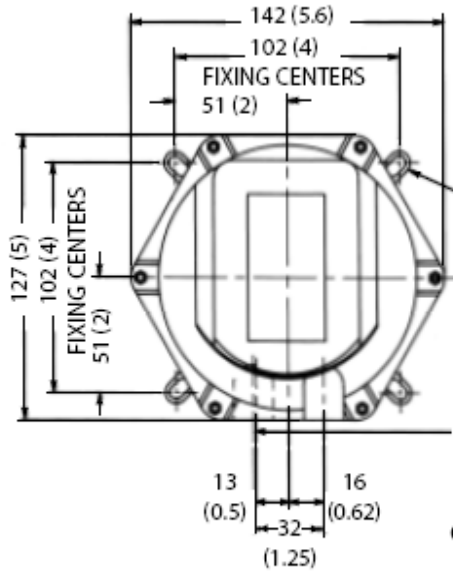
SIEMENS



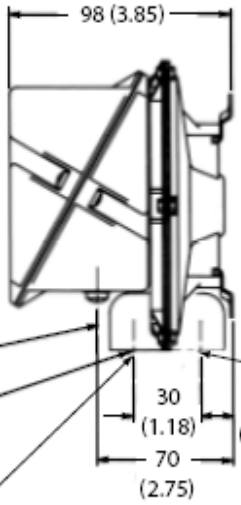
Arrangement 4
(Foot mounted motor)

7. Product Tanks And H2 Ventilation Differential Pressure Switch / Orifice Plate Assembly

Model 310

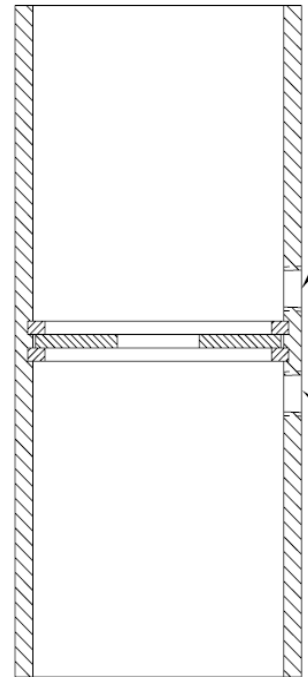


4 MOUNTING FEET WITH HOLES SUITABLE FOR 6mm (0.24) DIA. FIXING SCREWS



ELECTRICAL ENTRY CENTER LINE
 PROCESS CONNECTIONS
 HIGH PRESSURE PORT

LOW PRESSURE PORT



LOW PRESSURE PORT TO PRESSURE SWITCH 1/4 NPT

HIGH PRESSURE PORT TO PRESSURE SWITCH 1/4 NPT

8. Hydrogen Gas Detectors

- ◆ Mounted at Highest Point of Room
 - ◆ Over Tanks / Over Generators.
- ◆ Should be Explosion Proof Design.
- ◆ Various Manufacturers Available
 - ◆ ATI (Analytical Technologies)
 - ◆ MSA
 - ◆ etc.



9. Dosing Pumps (Siemens Examples)

- ◆ Chemtube PPS
- ◆ Chemtube 2000
- ◆ Encore 700
- ◆ ChemAd Series
- ◆ Premia 75

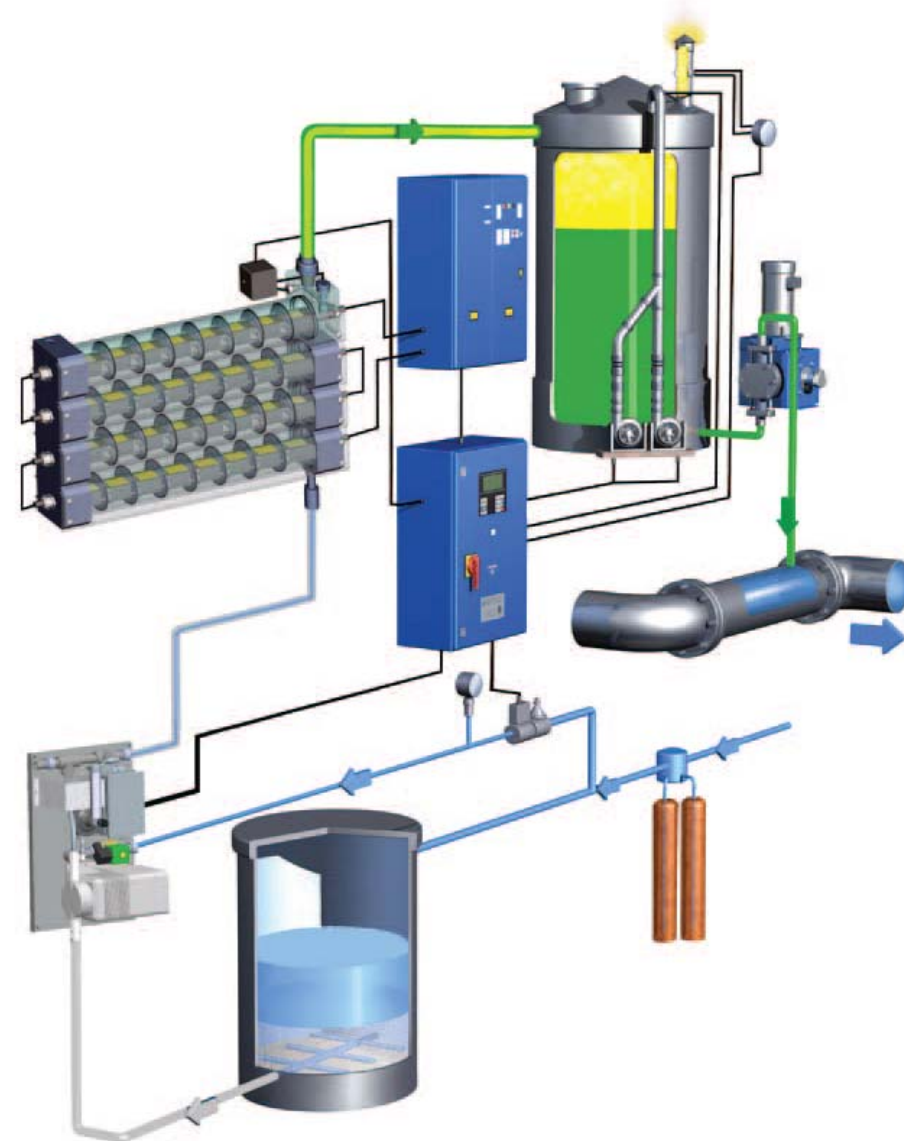


OSEC[®] in Operation

OSEC® Product Examples BP Series (Low Range System)

SIEMENS

- ◆ Manufactured 2000 – Present
 - ◆ Available in 4 Capacities
 - ◆ 12 ppd
 - ◆ 24 ppd
 - ◆ 36 ppd
 - ◆ 48 ppd
- ◆ Equipment Supplied “Loose” for installation by contractor or customer.



OSEC® Product Examples B-Pak Series (Mid Capacity)

◆ Manufactured 2011 - Present

◆ Available in 4 Capacities

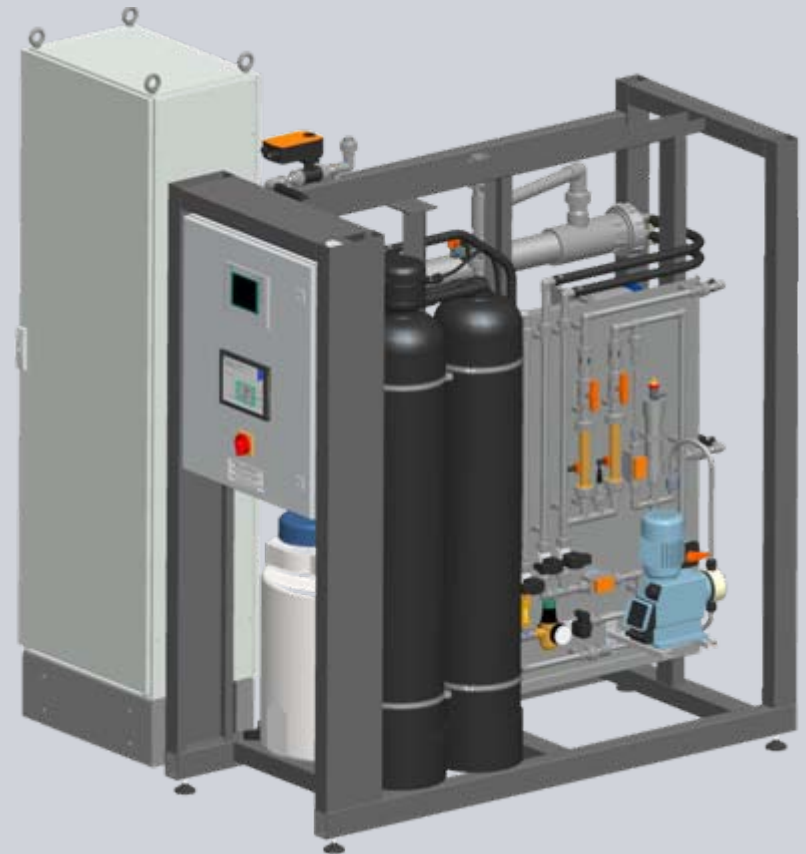
◆ 1.25 kg/h (65 lb/day)

◆ 2.50 kg/h (130 lb/day)

◆ 3.75 kg/h (195 lb/day)

◆ 5.00 kg/h (260 lb/day)

◆ Equipment Supplied Skid Mounted on majority of equipment (Rectifier and tankage separate).



OSEC® Product Examples B-Pak Series (Large Capacity)

SIEMENS

- ◆ Manufactured 2004 – Present
 - ◆ Available in 4 Capacities
 - ◆ 250 ppd
 - ◆ 500 ppd
 - ◆ 1000 ppd
 - ◆ 1500 ppd
- ◆ Equipment Supplied Skid Mounted on majority of equipment (Rectifier and tankage separate).



Thank you very much for your attention!

Taking care
of the world's water

A large water splash with a globe in the center, surrounded by smaller water droplets and bubbles. The globe is positioned in the upper center of the splash, and the water droplets are scattered around it. The background is a light blue gradient.