



# Chlor Generators

Innovating electrochlorination technologies

- **ANTI-FOULING**
- **DISINFECTION**



## Applications:

- Power stations
- Oil & gas installations
- Off-shore platforms
- Desalination plants
- Waste water plants
- Potable water plants



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## INTRODUCTION

*CHLOR GENERATORS LTD* is a UK based design and manufacturing company of on-site electrochlorinators. Our systems are used for light and heavy industrial applications all over the world

We offer in-house technical innovation with practical experience for any custom design to meet the exact needs of our client's specifications and application

### Our systems can be either:

- Local or remote controlled
- Plate or tubular electrolyzers
- Safe or hazardous areas systems (full certification optional)
- Unlimited chlorine capacities (from a few kilograms to several tons of Cl<sub>2</sub>/day)
- Manual or automatic acid cleaning systems
- Acid-free self-cleaning electrochlorination systems, e.g. tubular or reverse polarity automatic self-cleaning electrolyzers

All our systems are fail-safe, interlocked controlled systems where actual electrochlorination is only possible after all the safety interlocks are confirmed to be in a healthy and positive state

Our electrochlorinators are designed to generate hypo with the highest chlorine concentration that is economically possible, for example: 2,000 PPM in seawater systems and 8,000 PPM in fresh water + salt systems. This ensures all relevant hypo generation equipment (piping, fittings, hypo storage tanks, hypo dosing pumps) is of a minimum size, thus saving running and maintenance cost as well as requiring the minimum installation space

*CHLOR GENERATORS LTD* design and manufacture according to a strict QA plan and control procedures. All our systems are fully shop tested and inspected before shipment. Our systems come with a comprehensive warranty and all related documentation and manuals

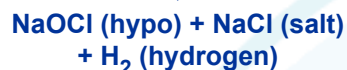
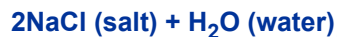
*CHLOR GENERATORS LTD* also offer a commissioning service and operator training

## WHAT IS ELECTROCHLORINATION?

Electrochlorination is an electrolysis process where either: natural seawater, or, an artificial brine solution (fresh water + salt) is converted into sodium hypochlorite solution

Salt is composed of sodium and chloride. When in solution and DC (direct current) is passed through titanium electrodes, the chlorides will disassociate to form chlorine. The process is basically as follows:

- Electrolysis occur in an undivided cell when a DC current is passed through a saline water solution (e.g. seawater or brine solution)
- At the anode: Oxidation of chloride ions to produce chlorine (Cl<sub>2</sub>)
- At the cathode: Reduction of water to produce sodium hydroxide (NaOH) and hydrogen (H<sub>2</sub>)
- Liberated chlorine reacts with the sodium hydroxide to produce sodium hypochlorite (NaOCl) instantaneously
- The overall reaction, sustained by electrical energy, is as follows:



## WHAT IS SODIUM HYPOCHLORITE?

Sodium hypochlorite, "NaOCl" (also known as "hypo", "bleach", or "liquid chlorine"), is a powerful oxidant that is used world-wide for the chlorination of water for:

- **anti-biofouling** (e.g. to prevent sliming, mussel/barnacle growth, etc)
- **disinfection** (e.g. for drinking water, general anti-bacterial purposes in process water, etc)
- **chemical treatment** (e.g. bleaching, removal of iron, manganese, etc)

## Typical applications are at:

- Power stations
- Oil & gas installations
- Off-shore platforms
- Desalination plants
- Waste water plants
- Potable water plants
- Marine vessels



## ADVANTAGES OF ELECTROCHLORINATION:

Electrochlorination is the only 100% safe chlorine technology as Cl<sub>2</sub>, in the form of a low concentrated hypo solution, is generated:

- **on-site** (at the point of application)
- **on demand** (only when required and always "fresh")
- **no bulk storage** (because it is generated on demand)
- **only basic/safe inputs are used** (seawater + electricity, or, fresh water + salt + electricity)

When using an electrochlorinator, there is no need for any commercial chlorine products. It is a safe, economical and independent chlorine alternative to hazardous, high concentrated commercial chlorine products e.g. gaseous chlorine, commercial hypo and dry chlorine (granular calcium hypochlorite)

It is also safe for the environment:

- no heavy metal pollution (e.g. copper or lead), and,
- chlorine decomposes back into common salt (sodium chloride) again

## CONSUMPTION

The generation of sodium hypochlorite requires only:

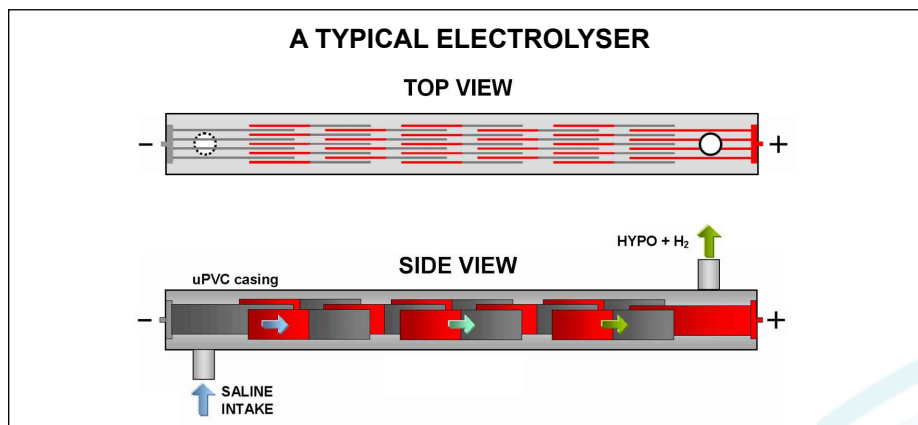
**seawater + electricity**  
or  
**fresh water + salt + electricity**

The following table shows the consumption of a typical plate electrolyser

CONSUMPTION WHEN GENERATING HYPO CONTAINING 1kg chlorine	
<b>SEA WATER SYSTEM</b> (2,000 PPM) <ul style="list-style-type: none"> <li>• 4.2 kWh (AC)</li> <li>• 500 litres seawater</li> <li>• no salt required</li> </ul>	<b>FRESH WATER + SALT SYSTEM</b> (8,000 PPM) <ul style="list-style-type: none"> <li>• 5.5 kWh (AC)</li> <li>• 125 litres fresh water</li> <li>• 3.5 kg salt</li> </ul>

## THE ELECTROLYSER

The electrolyser consist of bi-polar anodes and cathodes that are arranged to form multiple cells. The number of cells depends on the specific design parameters and will vary from case to case



All anodes and cathodes are made of titanium. Anodes require a coating of mixed metal oxides (MMO) of the platinum group of metals. This coating is essential for the generation of chlorine and can last between 5 to 8 years (All our anodes are guaranteed for 5 years continuous duty)

*CHLOR GENERATORS LTD* offer two types of electrolysers:

### Plate electrolysers:

Anodes and cathodes of solid titanium sheets are arranged to form multiple cells inside a horizontal PVC casing. This is the most popular and efficient design. It also offers the highest possible Cl<sub>2</sub> concentration e.g. 2,000 PPM in seawater systems and 8,000 PPM in fresh water + salt systems. This ensure all relevant hypo generation

equipment (piping, fittings, hypo storage tanks, hypo dosing pumps) is of a minimum size, thus saving running and maintenance cost as well as requiring the minimum installation space. Plate electrolysers require frequent cleaning (de-scaling), This is done by either: acid washing (manual or automatic) or reverse polarity auto-self cleaning

### Tubular electrolysers:

(Only for seawater applications) Anodes and cathodes of solid titanium tubes are arranged in a concentric tubular assembly where seawater is passed in the annular space between the outer and inner tubes. High velocity seawater will reduce scaling and thus acts as a continuous self-cleaning mechanism. These systems can't offer the same efficiency and high Cl<sub>2</sub> concentration as plate electrolysers

level of the supply water and salt supply (NOTE: If soft water and high purity salt is used, de-scaling may be required only once every 1 or 2 years)

The consumption of hydrochloric acid is very low and it is always re-used several times before additional acid is required to restore the acid concentration

*CHLOR GENERATORS LTD* is offering manual and automatic acid washing systems. There is also a range of acid-free self-cleaning electrochlorination systems e.g. tubular, and, reverse polarity automatic self-cleaning plate electrolysers

## HYDROGEN AND HYPO DE-GASSING TANK

Hydrogen is always generated during electrochlorination and is directly proportional to the amount of generated chlorine. Hydrogen is an inert by-product and does not participate in the overall chemical reaction. It is discharged along with the hypo into the de-gassing tank where it will disengage. This is the primary function of the hypo de-gassing tank. Hydrogen is then safely diluted and removed with blower air from blower fans. There are usually 2x 100% blower fans, a duty and standby fan

In order to ensure 100% safety, hydrogen is diluted 4 times below the LEL (lower explosion limit) of H<sub>2</sub>. A failsafe operation is also employed where dilution air is continuously measured with an air flow sensor and, only after the set flow rate is achieved, is a signal send to the control panel to enable the electrochlorination process. Any dilution air low-flow condition will activate a system emergency shut down

The second purpose of the hypo de-gassing tank is to act as a retention tank for the dosing system to offer a steady supply of hypo and to prevent pump dry-running

The third purpose of the hypo de-gassing tank is to control the start/stop of the hypo generation process. During hypo dosing the hypo level will drop and as it reaches the low level (LSL) the electrochlorination process will start and the hypo de-gassing tank will refill again. As the level reaches the high level (LSH), hypo generation will stop

## SCALING AND DE-SCALING

All water contains dissolved calcium and magnesium. During electrolysis, calcium carbonate and magnesium hydroxide will deposit on the cathode, a process commonly referred to as "scaling". It is a universal phenomenon with all electrochlorinators, without exception

Scale is easily removed by flushing the electrolyser with 5% diluted hydrochloric acid. The process takes approx. 1 hour and is required as follows:

- Seawater systems: After approx 10 days of continuous electrochlorination. The average down-time is therefore only about 0.4% of the running time
- Artificial brine systems: between 10 to 50+ days, depending on the hardness

Hypo dosing and hypo generation are therefore two completely independent processes that are only interphased with the hypo tank's low and high level switches

## HYPO DOSING

The dosing of chlorine in the form of hypo is always expressed in:

- **PPM** (parts per million) or mg/litre chlorine. Both represent exactly the value e.g. 2 PPM = 2 mg/litre chlorine, and,
- **total and residual chlorine**, where total chlorine is the dosing at the point of application, and, residual chlorine is the remaining chlorine level after a certain time period of oxidation

The level of chlorine dosing depends on the client's needs and will vary according to specific conditions and objectives

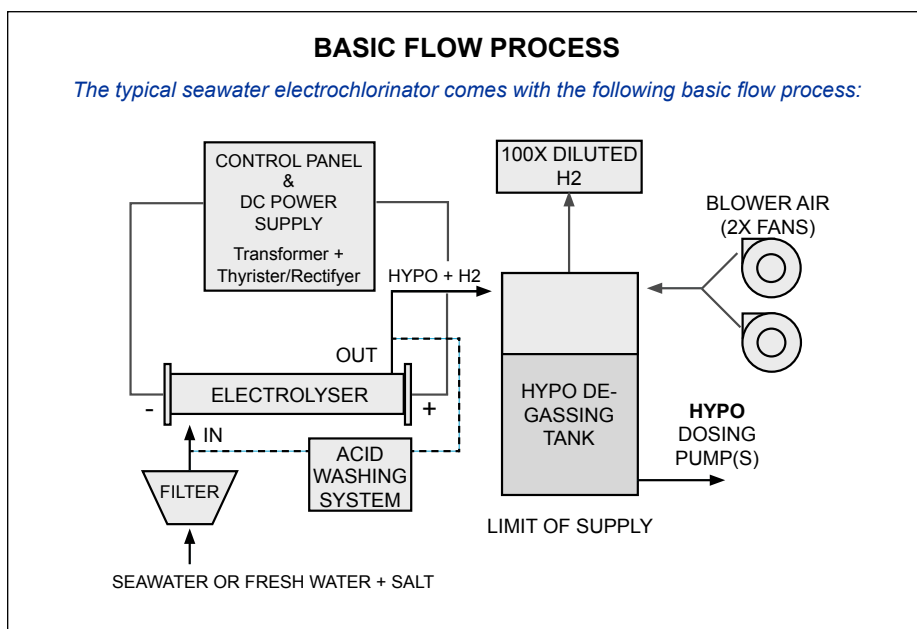
### Typical hypo dosing and control methods:

- **pump types:** metering (piston or diaphragm), or, centrifugal magdrive dosing pumps
- **quantity of dosing pumps:** 1x 100%, or, 2x 100% hypo (a duty and standby pump)
- **dosing control:** proportional flow, or, programmable on-line residual Cl<sub>2</sub> control
- **continuous and shock dosing** (required for anti-biofouling i.e. in sea water applications)

## BIO-FOULING, CONTINUOUS AND SHOCK DOSING

### Micro-fouling:

Comes in the form of a layer of slime over the surface of heat exchanger plates and tubes and can reduce heat transfer efficiency by as much as 25%. It can also accelerate corrosion and result in a situation where maintenance is required more often than usual with subsequent increases in running costs



### Macro-fouling:

Barnacle and mussel growth inside seawater pipes and cooling systems can gradually restrict seawater flow and reduce the flow and heat transfer efficiencies. In extreme cases, pipes and valves can become completely blocked, resulting in shut-down of systems, damage to equipment, and, consequent loss of production time

### Continuous and shock dosing:

Continuous and shock dosing are usually considered for the effective control of micro and macro-fouling in seawater applications. During continuous dosing, a low chlorine dosing is maintained. It provides protection against the majority of biofouling. Unfortunately macro organisms can become resistant to this low chlorine dosing and require a much higher chlorine dosing. During shock dosing, a much higher chlorine dosing is applied only for a short time and repeated at certain fixed intervals. This will ensure complete protection against all micro and macro-fouling

*CHLOR GENERATORS LTD* offer a complete range of dosing strategies to ensure optimum anti-biofouling protection at the lowest chlorine usage

### MAIN COMPONENTS

A typical seawater electrochlorinator is made up of the following main components and usually comes as a complete self-contained skid-mounted package:

- control panel with PLC (optional)
- DC power supply with thyristor/rectifier controller
- inlet seawater controller with filter, pressure/flow regulators, etc
- general field instruments, sensors and control interlocks
- electrolyser
- hypo dosing pumps
- acid washing system
- blower fans
- hypo tank



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