# EVOQUA NSF CERTIFIED GENERATORS – 3 CHEMICAL T-VF SERIES FLOW PACED MILLENNIUM III™ CHLORINE DIOXIDE GENERATOR

The Millennium III™ Series generators are the next generation in chlorine dioxide technology combining high safety performance with durability, simplicity of use and ease to maintain. The generators are designed, built and certified in compliance to NSF 61, Section 8 standards.

The Millennium III™ Series T-VF generator produces chlorine dioxide in a two stage process under vacuum conditions to generate chlorine dioxide safely and efficiently. In the first stage, molecular chlorine gas is generated in situ as part of the generation process by the reaction of a 12.5% solution of sodium hypochlorite with a 15% solution of hydrochloric acid. In the second stage the chlorine gas is reacted with a 25% or 31% sodium chlorite solution to produce chlorine dioxide. The generator is available as a free-standing configuration with a flow-paced batch tank, level controls and multi-point distribution capability.

The Millennium III™ Series T-VF generators are available in a range of capacities from a few pounds per day to 12,000 pounds per day all utilizing a standard modular design.

## Options available include:

- Flow paced multi-port $ClO_2$ distribution panel (1-3 ports)
- Optical dual channel $ClO_2$ controller/sensor (0-4000 PPM) for real time monitoring of the aqueous chlorine dioxide dosing solution strength
- SFC / MFC series controller with Depolox® 5 Varisens flow cell, $ClO_2$ and chlorite ion residual probes, Micro/2000® real time ion specific chlorine dioxide residual (0.1-2.0 PPM) analyzer, ORP/pH monitors, and GMS Plus $ClO_2$ in-air monitor / leak detector.
- Chlorine dioxide vent gas air scrubber

## Equipment Description

**Generator:**

- The same basic process is used for all models, from simple manual units to the most complex automatic model.
- Simple design reduces operational difficulties. This three chemical process does not require pH control or excess chlorine addition. The result is lower operating costs, less maintenance, simplified operator control and precise calibration of the feed system. The pH of the chlorine dioxide exiting the generator is typically between 4-5.
- **Reaction Column:** The reaction column disperses the chemical reactants allowing for intimate contact and immediate reaction. The reaction column is designed to maximize generator yield of chlorine dioxide.
- **Reagent Flowmeters:** A metering tube design calibrated for each chemical reactant is available along with optional magnetic flow meters and auto metering control valves. All generators are supplied with custom feed rate charts correlating lbs/day (or kg/hr) of chlorine dioxide with flow meter and PLC settings.

- **Injector Requirements:** Water passing through the injector generates the vacuum required to pull the three feed chemicals into the reaction column of the chlorine dioxide generator assembly. A multi-stage centrifugal booster pump in conjunction with a pressure regulator valve ensures that the water supply is at the correct rate and pressure. A safety flow switch protects the pump in the event of water loss. Water temperature requirements are < 100°F/ 37°C. If high temperature water is used (>100°F/ 37°C), injector performance will be impaired due to decreased solubility of the chlorine dioxide gas.
- **Batch Tank:** The batch tank is constructed of FRP resin compatible with chlorine dioxide up to a concentration of 5,000 ppm. The batch tank is fitted with an ultrasonic level indicator that controls fluid levels in the tank preventing overflow conditions or low level conditions that can result in distribution pump failure. A redundant emergency mechanical kynar safety float switch, independent of the ultrasonic controller, protects the system from over-flow conditions in the event of a primary level control system failure.
- **Distribution Panel:** The generator is fitted with a single flow paced output as standard. Additional effluent flow pacing outlets are available upon request.
- **Power Requirements:** Each system is supplied with an electrical control box incorporating an ON/OFF control switch. Standard voltages are 110/220 VAC single phase. Other power supplies can be accommodated. Consult your Evoqua sales representative for more details.

**Assembly:**

- All components are securely mounted on specially designed stainless steel skid(s) with a small footprint allowing placement in space constricted areas. Split frames are also available as a custom option if door entry size should require such.
- The skid construction is heavy duty, allowing location in operating areas that are subject to severe service conditions.
- Each valve and flow meter is secured to the frame to minimize vibration and flow related stresses. Piping runs are designed to insure a simple and safe flow path.
- Components requiring maintenance are easily accessible.

## Typical Specifications

Chlorine dioxide feed equipment shall be manufactured by Evoqua and shall be comprised of a process or chlorine dioxide generation utilizing 25% sodium chlorite solution, 12.5% sodium hypochlorite solution and 15% hydrochloric acid solution from a two stage continuous reaction. The first stage combines the sodium hypochlorite solution with the hydrochloric acid solution under vacuum to produce molecular chlorine in-situ according to the reaction:

$$NaOCl + 2HCl \rightarrow Cl_2 + NaCl + H_2O$$

The subsequent reaction is between the sodium chlorite solution and the in-situ produced molecular chlorine under vacuum conditions according to the reaction:

$$2NaClO_2 + Cl_2 \rightarrow 2ClO_2 + 2NaCl$$

The feed system shall be arranged with equipment to suit plant requirements. The generator shall maintain a minimum yield efficiency of 95% chlorine dioxide from the reaction of sodium chlorite solution and chlorine gas. The yield efficiency shall be based on the above stoichiometric reaction.

The reaction of sodium chlorite solution and molecular chlorine shall take place under vacuum without the use of a separate mineral acid feed or the excess chlorine method (adding chlorine in excess of the stoichiometric chlorine requirements in order to lower the process pH). Excess chlorine shall be considered as any amount greater than 10% of the stoichiometric chlorine requirement that remains in the generator product stream as unreacted chlorine. Yield shall be defined as the maximum production of chlorine dioxide, compared to the theoretical maximum available, where;

$$\% \text{ Yield} = (ClO_2/(ClO_2 + ClO_2^- + (ClO_3^- * 67.45/83.45)))*100$$

The theoretical maximum shall be determined from the feed rates of the chemical reactants. They shall be confirmed by an Amperometric analysis capable of differentiating between chlorine, chlorine dioxide, chlorite and chlorate ions. Analysis shall be confirmed by the procedure as described in Standard Methods for the Examination of Water and Wastewater, APHA-AWWAWEF, 20th edition 1998, Amperometric Method II, 4500-ClO2E.

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