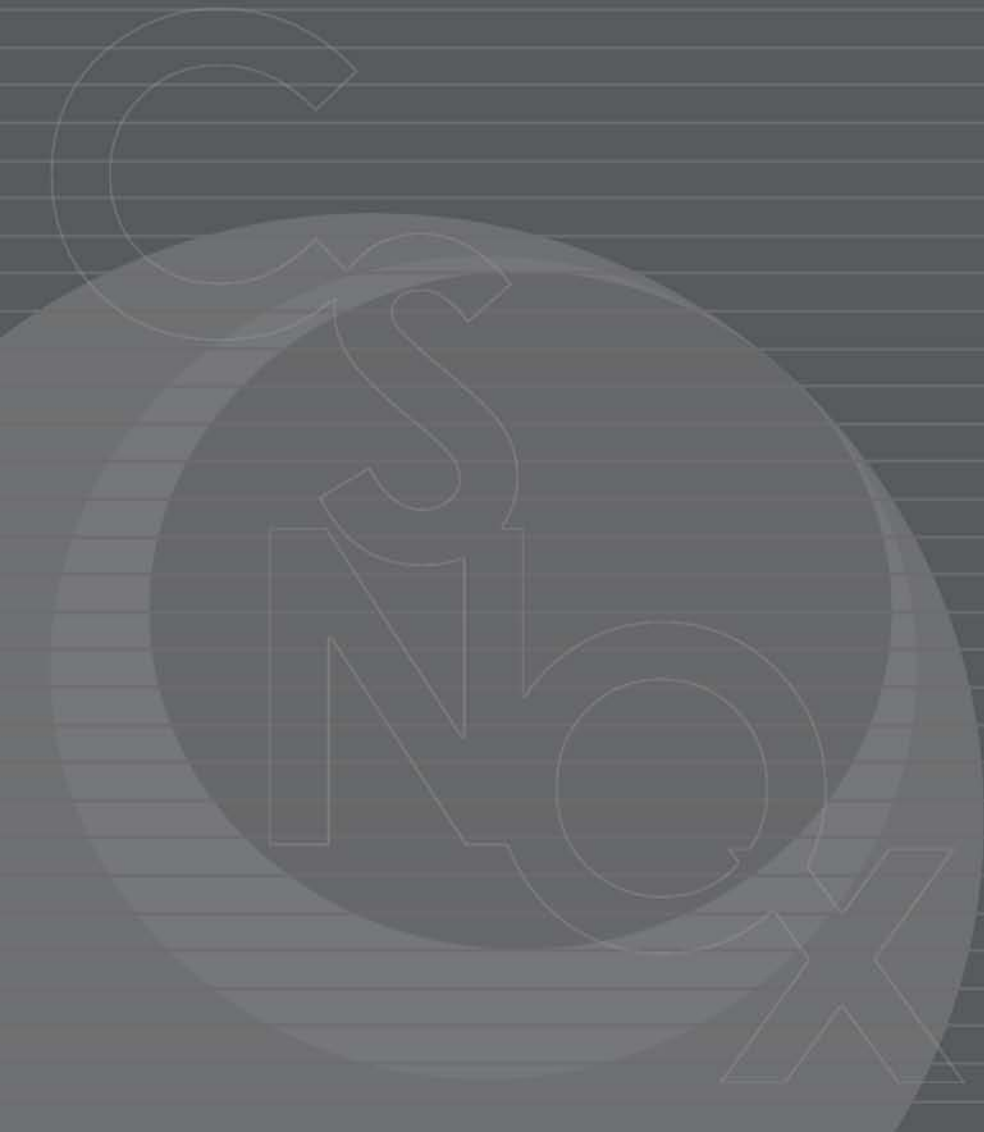


**CSNOx**



# The World's First 3-in-1 Emission Abatement Technology



## Emission Control and Our Environment

Since the dawn of industrial revolution, the world has seen a marked acceleration in global warming. In recent years, dealing with climate change has become an increasingly pressing concern for governments and organizations alike.

Fortunately, reversing global warming is possible and one major step to achieving this is reducing Green House Gas (GHG) emissions. Today, various international regulatory bodies have enforced stringent controls on the emission of Sulfur Dioxide ( $\text{SO}_2$ ), Oxides of Nitrogen ( $\text{NO}_x$ ) and Carbon Dioxide ( $\text{CO}_2$ ) across a broad group of industries - from marine vessels to onshore plants. With a concerted effort from all clusters, it is possible to minimize and manage the negative impact of GHGs on the world's climate.

## Why CSNOx?

Introduced to address rising global demand for GHG emission control, CSNOx is a revolutionary breakthrough in emission technology, set to redefine the convention of emission treatment. Innovated with the mindset of cost economy and eco-efficiency, CSNOx requires minimal system maintenance and does not release harmful by-products that pollute the ecosystem. More notably, CSNOx is the world's first 3-in-1 gas emission abatement technology with unparalleled capabilities to remove  $\text{SO}_2$ ,  $\text{NO}_x$  and  $\text{CO}_2$  generated from fuel engines or boilers, all in a single eco-friendly process.

In Ecospec, our systems are conceptualized with keen awareness of actual working conditions. Hence, each CSNOx system is intelligently designed and custom produced to fit into constrained spaces, be it on vessels or in industrial plants.

# CSNOx

## Abatement Results on Marine Vessels

a 100,000 ton oil tanker

Gas removal efficiency at 33 ton/hr gas load	
SO <sub>2</sub>	99%
NOx	66%
CO <sub>2</sub>	77%

Wash water quality	CSNOx	IMO limit MEPC 184(59)
pH	6.7	> 6.5
PAH	< 1 ppb	< 50 ppb
Nitrates	< 0.066 ppm	< 60 ppm
Turbidity	Δ8.7 NTU	< 25 NTU

Gas removal efficiency at 70 ton/hr gas load	
SO <sub>2</sub>	100%
NOx	42%
CO <sub>2</sub>	46%

Wash water quality	CSNOx	IMO limit MEPC 184(59)
pH	7.02	> 6.5
PAH	3.85 ppb	< 50 ppb
Nitrates	< 0.39 ppm	< 60 ppm
Turbidity	Δ2.14 NTU	< 25 NTU



### Meeting The Legislative Requirement

The removal efficiencies of CSNOx allows vessels to continue using normal heavy fuel and still meet the 0.1% sulfur content as required by EU Directive (effective 2010) and ECA (effective 2015). In other words, there is no need for vessel owners to convert to distillate fuel, or to modify the fuel system.

# CSNOx

## Open Loop

### G1 System (with electrodes)

#### System Components

**BFC**  
**Bio-Fouling Control**  
 for marine growth control

**SAE**  
**SOx Absorption Enhancer**  
 for improving the absorption ability of water

**PHx**  
**pH Exciter**  
 for preconditioning water before treatment

**ULFELS**  
**Ultra Low Frequency Electrodes**  
 for treating the water in G1 system

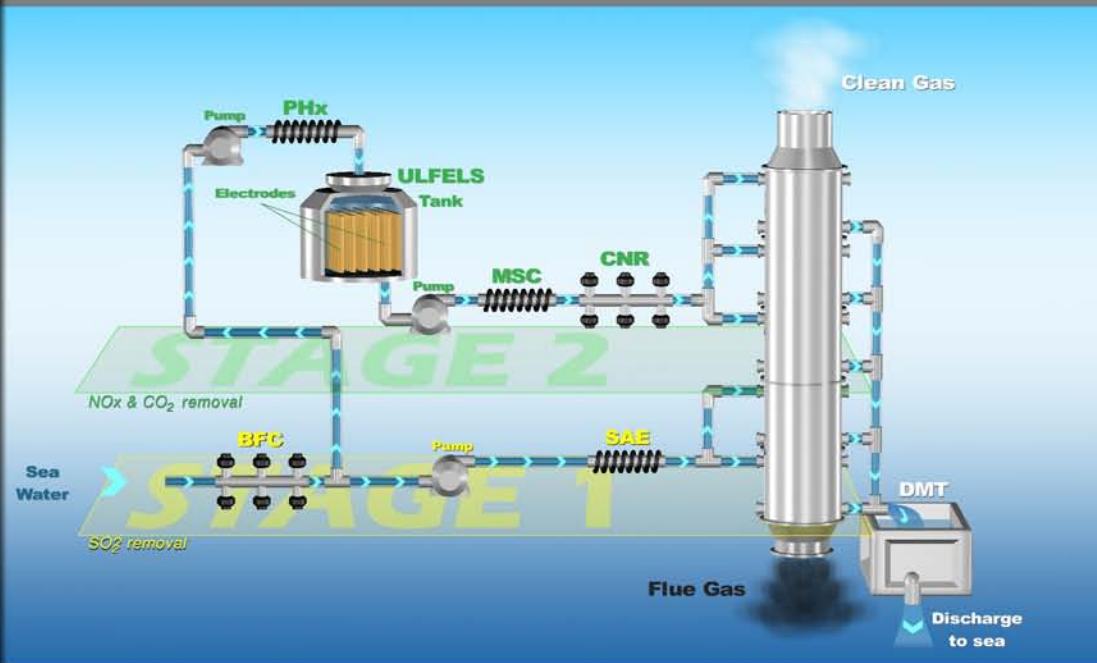
**ULFED**  
**Ultra Low Frequency Energy Dissipation**  
 for G2 system only

**MSC**  
**Mineral Scale Control**  
 for preventing scales/deposits from forming on the pipes surfaces

**CNR**  
**CO<sub>2</sub>, NOx Reducer**  
 for improving the removal ability of water

**DMT**  
 Discharge Mixing Tank

The CSNOx Open Loop System with electrodes (G1 System) makes use of the Ultra Low Frequency (ULF) waves to treat water and the treated water is used to react with the exhaust gas to remove the SO<sub>2</sub>, CO<sub>2</sub>, and NOx.



The CSNOx process is divided into 2 stages: Stage 1 for removing Sulfur Dioxide (SO<sub>2</sub>), and Stage 2 for removing Carbon Dioxide (CO<sub>2</sub>) & Nitrogen Oxides (NOx).

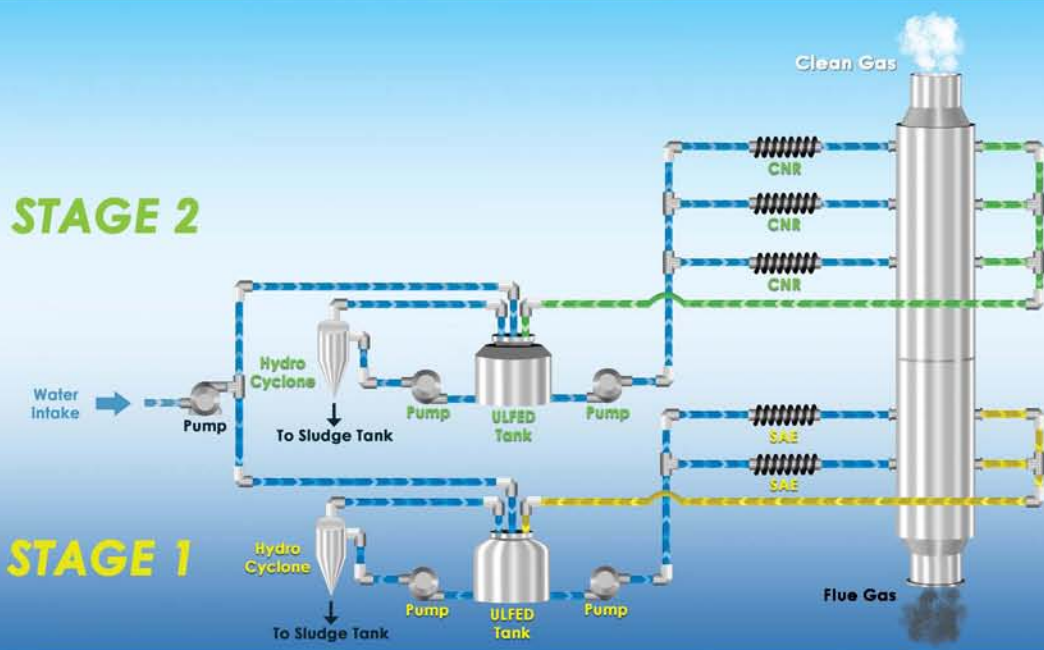
In Stage 1, water is pumped up from the sea chest, passed through the BFC and treated by the SAE before it is sprayed into the 1st two sections of the abator tower to remove the SO<sub>2</sub>.

Similarly, in Stage 2, water is pumped up from the sea chest and passed through the BFC. However, in this stage the water is treated in a series of the CSNOx components; the PHx, ULFELS electrodes, MSC, CNR before it is sprayed into the top 3 sections of the abator tower. SO<sub>2</sub> removal rate ranges from 98%-100%. The removal rates for CO<sub>2</sub> and NOx can be as high as 77% and 66% respectively. Please refer to the Test Result on the previous page.

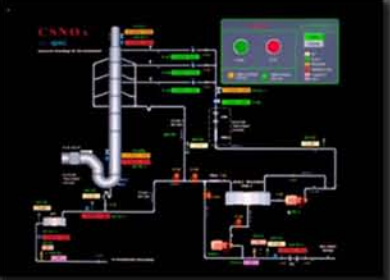
With such removal efficiencies, ships using fuel with sulfur content as high as 3.5% is able to comply with the emission limit of 0.1% as required by the European Union ports and also the requirement by 2015 in the Emission Control Areas. The newly implemented Energy Efficiency Design Index (EEDI) intends to reduce CO<sub>2</sub> emission by 20%-30%. It is therefore possible to meet the EEDI target using the CSNOx system. It is also possible to replace the Selective Catalytic Reduction (SCR) for NOx reduction.

# CSNOx Closed Loop G2 System (without electrodes)

This closed Loop System is without electrodes (G2 system). Similar to the G1 system, it also makes use of the Ultra Low Frequency (ULF) waves to treat water and entails 2 stages.



## System Components



Main differences from G1:

- No electrodes
- Water (with buffering solution) is re-circulated
- Side stream filtration is required to filter large particles

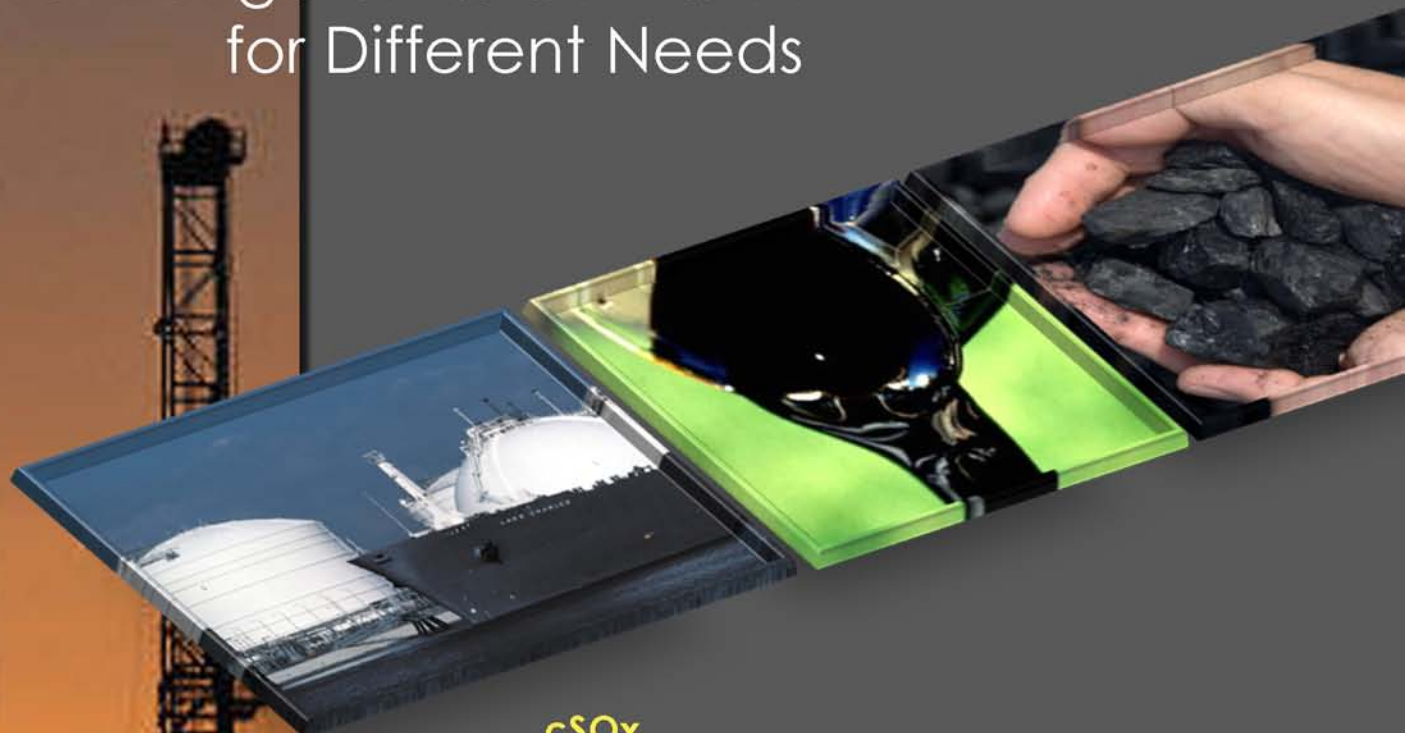
Hence, the G2 system offers these advantages:

- Eliminates cost related to electrodes, eg. replacement, maintenance
- No necessity to pump water from sea chest, only top-up water is needed

This electrodeless system and reduced pumping capacity significantly lowers the amount of power needed to operate the G2 system.

As with any emission abatement system, the authorities are utmost concerned about the quality of emission and discharge water. With this closed loop system, operators and owners no longer need to worry about the quality of discharge water, hence having one less area to deal with.

# Full Range of CSNOx for Different Needs



## **cSOx**

for ship/plant owners whose primary objective is to have SO<sub>2</sub> removed. cSOx is able to remove a relative small amount of CO<sub>2</sub> such that a net carbon neutral position can still be achieved when running this emission abatement system.

## **CNOx**

for ship/plant owners who are using diesel oil with very low or zero sulphur in their fuel to run their generators/boilers but wish to remove the CO<sub>2</sub> and NOx in their emission.

## **CSNOx**

the full system where all 3 gases (SO<sub>2</sub>, CO<sub>2</sub> and NOx) are removed simultaneously in one system, one process.

## **CSNOx Benefits**

- ✓ Revolutionary technology that abates 3 gases (SO<sub>2</sub>, CO<sub>2</sub> and NOx) in a single system
- ✓ Significant CO<sub>2</sub> removal, at a rate unrivalled by any system in the world
- ✓ Surpasses all prevailing IMO emission requirements
- ✓ Minimal system maintenance required
- ✓ Low power consumption, high energy efficiency
- ✓ Simple operational procedures
- ✓ Ease of system monitoring
- ✓ Compact size of system and equipment
- ✓ Zero harmful output to the ecosystem
- ✓ Make it possible to continue using high sulfur heavy fuel, rather than switching to expensive distillate fuel

# CSNOx Applications

- ✓ Shipping / Marine
- ✓ Offshore propulsion
- ✓ Power plants using coal or heavy fuel
- ✓ LNG and waste refineries
- ✓ Cement production
- ✓ Iron / steel manufacturing
- ✓ Aluminum smelting
- ✓ Petrochemical
- ✓ Trucks and heavy prime movers

## Ecospec's R&D Commitments

Ecospec has always been in the innovation forefront. During the years spent in research activities, spanning over a decade, Ecospec has developed a myriad of cutting edge systems that promotes environmental sustainability. Despite the accolades, Ecospec has not rested on its laurels but push forth to continually develop and introduce new technologies to the market, reinforcing its status as a R&D and technological company that consistently presents groundbreaking green solutions for the environment.



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