Ozone for Industrial Water and Wastewater Treatment

Alex Bettinardi Global Product Technology Manager, Ozone De Nora Water Technologies





Ozone for Industrial Water Treatment Agenda





Where a is ozone	nd why used?	 Color and Surfactants Fee Iron and Manganese Removal Toxicity Reduction Phenols/Hydrocarbon s 	I, 4 DioxaneII			
	Intake/Process	Wastewater	Sludge Reduction			
Mining	N/A		N/A			
Oil and Gas	N/A					
Textiles	Fe 😴					
Organic Chemicals	Fe 🕄					
Pulp and Paper	Fe 🕄					
Food and Beverage	CEC Fe					
Pharmaceuticals	CEC Fe 🗊					

Ozone Process Scheme & Process Control





Organics oxidation (COD/TOC)

CASE STUDY: DP Lubrificanta, Rome Chemical Company Wastewater Polishing Ozone reactions can be direct or indirect

Indirect reaction pH 8.5 - 12 to form hydroxyl radicals Hydroxyl reactions are fast and non-selective

Direct reaction

O₃ is a selective reaction with slow reaction rate Ozone reacts with unsaturated bond due to its dipole structure





CASE STUDY: Kuwait Refinery Wastewater Polishing

Resistant to traditional biological treatment

Thresholds for effluent are increasingly lower

Ozone and AOP are effective

Atex design capability

Dosage 2 ppm ozone per 1 ppm of phenol 3 ppm ozone per 1 ppm of hydrocarbon





WE ARE DE NORA



CASE STUDY: Lariana, Italy Italian fabric district with blue/purple-colored effluent

Color Ozone reacts with chromofore group.

Surfactants 3ppm ozone per ppm of surfactants



WE ARE DE NORA



Toxicity Reduction

CASE STUDY: West Virginia **Chemical Company**

Table with results of Pilot

Sample s	TUc for Pimephale s promelas Survival	TUc for Pimephale s promelas Growth	TUc for Ceriodaphnia dubia Survival	TUc for Ceriodaphnia dubia Survival			
Non- Ozonated	4	8	4	8			
Ozonated	2	0	0	4			
Hc = 0 means NON-TOXIC							



TUc = 2 means SLIGHTLY TOXIC

TUc = 4 means MODERATELY TOXIC

TUc = 8 means NOTICEABLY TOXIC



1,4-Dioxane

Manufacturing byproduct

Potential human carcinogen

Contaminates groundwater and surface water

Identified in wastewater

Hard to remove





Contaminants of Emerging Concern

Pharmaceutical Micropollutants



Comparison Contact Time 5/10min

Reduction Ozone (%) (Dosing : 3mg/l)

Atenolol											-
Atenololsaure											
Benzotriazol											
Carbamazepin											
Clarithomycin											
Diclophenac											
Gebapentin								-			
Hydrochlorothiazid											
Levetriazepam											-
Mefenamisnaure											
Methyl-Benzotriazo											-
Sulfamethoxazol											
Trimetoprim											
Valsartan											
Venlafaxin											
	0	10	20	30	40	50	60	70	80	90	100

WE ARE DE NORA



Chemical Plant

CASE STUDY: Saudi Arabia Wastewater Treatment Package

- AOP ozone + peroxide for COD oxidation
- 1 x 100% on-skid solution, including

Air preparation system, PSA, ozone generator, cooling system (chiller) side-stream injection system, catalytic ozone destruct unit, Main PLC and instrumentation.

> **Capital Controls Ozone Generator** 2 x TPF91 – XTL - O 2 x 6 kg/hr Installed 2014



Case Study – Dow, Saudi Arabia



- In-batch wastewater treatment
- Advanced Oxidation Process
- Dow, Saudi Arabia
- Ozone Generator Model: TPF91-XTL-O, 6.5 Kg/h @ 10% (350 PPD)
- Inside building installation
- Treatment: In-batch waste water treatment for polymers and hard COD. Wastewater from membrane production processes
- Advanced Oxidation Process $O_3 + H_2O_2$
- Feed gas: PSA
- Contact system: Side stream injection



12

Lab and Pilot Testing

Highly variable contaminant and water matrix

Lab and/or pilot testing is required

Ideal industrial application approach: Lab Bench Top Testing Pilot Testing



Bench Top Lab Testing Options

Stock Solution Test

Solution made at ~33 degrees Concentrations of 20-80 ppm Solution is injected into the sample



Image Source: https://waterqualitysnwa.com/facilities/treatment-equipment/

Simple Diffuser Testing in a Mixed Reactor Sample placed into a stirred vessel and injected with ozone through a diffuser

Instruments measure ozone concentration into and out of the vessel

Treated samples measure key parameters:

- Dissolved ozone
- COD
- Other specific compounds of interest

Small Scale Pilot Testing Systems

Scaled Ozone Water Treatment System Replicates Full-Scale Commercial Systems

Conducted on site

Provides larger quantities of water to be studied

Both batch and continuous testing is possible

Conducted at a De Nora facility

Batch-style testing

Sample size: one tote continuously cycled through the ozone water treatment system

Taking samples over time allows measurements of interest (i.e., COD) to be related to ozone dose Pilot systems use the same precision process as a commercial system Gas concentration monitors Dissolved ozone and ORP monitors

Gas and liquid flow instrumentation

Temperature

pH Safety Monitors for ozone and oxygen



On-site mobile unit

Simulate ozone and ozone AOP processes Multiple methods for ozone contact Ozone-demand or transfer efficiency testing

Ozone BAF

Evaluate advanced wastewater treatment for reuse applications

Optimize mitigation of DBP formation at drinking water plants

Compare O₃-BAF to other treatment technologies for micropollutant removal



CAPITAL CONTROLS® Installations in Asia

China Daqing Dongfeng – 3x3.3 kg/h, 10wt%





China Nanhui – 2x10kg/h, 10w%



China Changsha 7th – 2x15 kg/h, 10wt%



China Anhui Lixin – 2x6.5 kg/h, 10wt%



China Baoding Lugang – 3x40 kg/h, 10wt%

our research - your future

Questions?

discover more

