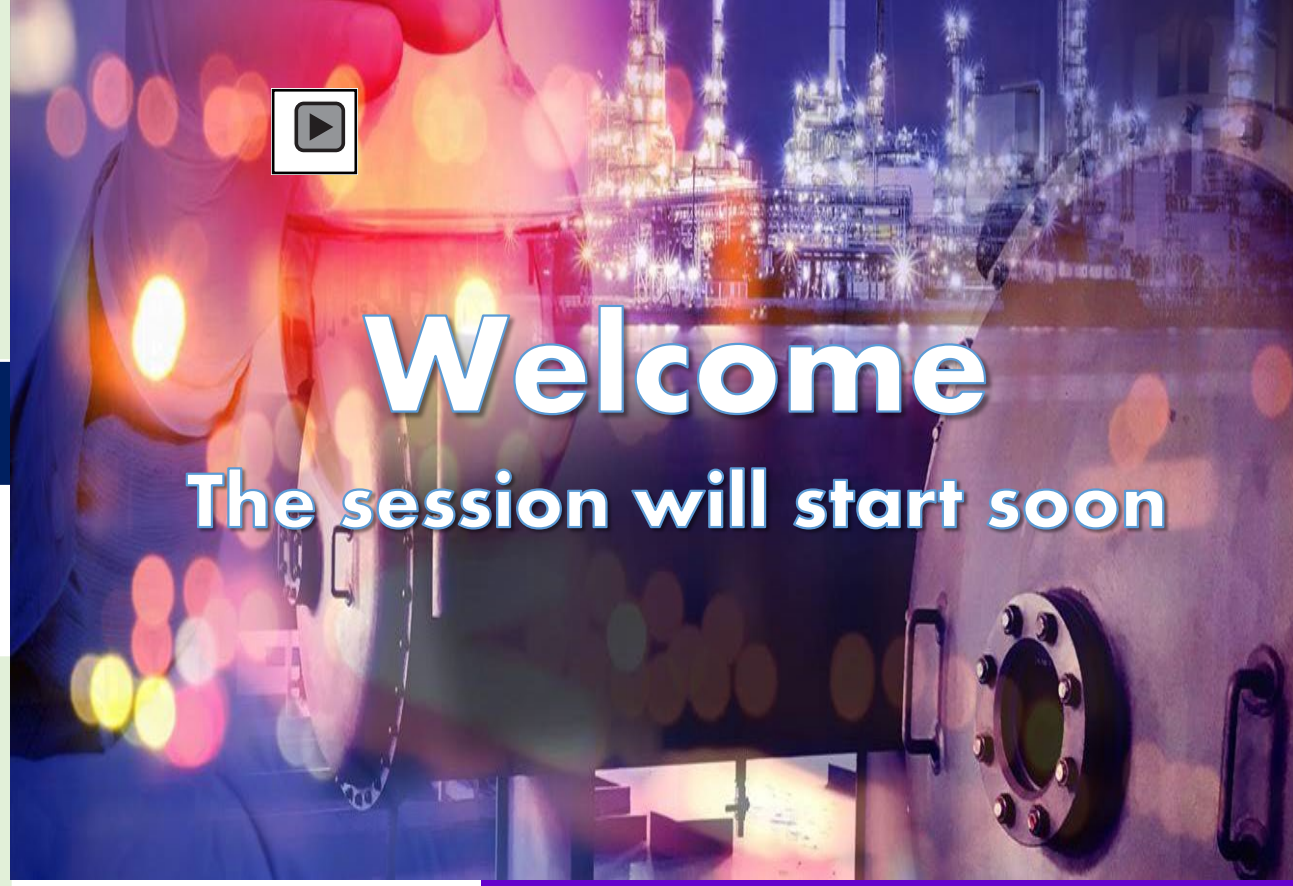
WEBINAR

Ozone and AOP:

going beyond traditional wastewater treatment

Programme

3.00 pm	**Opening and House Keeping Rules** *by SWA*
3:05 pm	Speaker ***by Mr. Alex Bettinardi*** *Product Technology Manager* *De Nora Water Technologies*
3.35 pm	**Q&A Session**
3:50 pm	**Closing by SWA**



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Welcome

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- ✓ Please share your questions in Q & A icon (right bottom) where we will try to provide answers where possible. Do identify yourself so we can respond to any unanswered questions
- ✓ If you need real time speech-to-text translation, please select your preferred language in the bottom left CC icon
- ✓ Please complete a 1min poll survey at end of the session.

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Speaker

Mr. Alex Bettinardi
Product Technology Manager
De Nora Water Technologies

Mr Alex Bettinardi has 12 years of experience dedicated to Ozone and Advanced Oxidation Processes for water treatment. Mr Alex uses this experience to translate a customer's need for contaminant removal into effective, and practical solutions. And he has the backing of De Nora's decades of experience in providing world class ozone system designs.

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Ozone and AOP:
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Presenter
Alex Bettinardi

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Agenda

What are AOP Processes?

Case Studies

Piloting

Q&A

Advanced Oxidation Processes (AOP)

Generates hydroxyl radicals, very powerful oxidants

Destroys organic contaminants, rendering them harmless

Most technically and economically feasible solution for removing 1,4-Dioxane

Air stripping and GAC not suitable for 1,4-D due to its solubility in water

Treating 1,4-Dioxane: AOP Solutions

UV + Hydrogen Peroxide

UV + Chlorine

Ozone + Hydrogen Peroxide

Used generally when UV Transmittance Higher

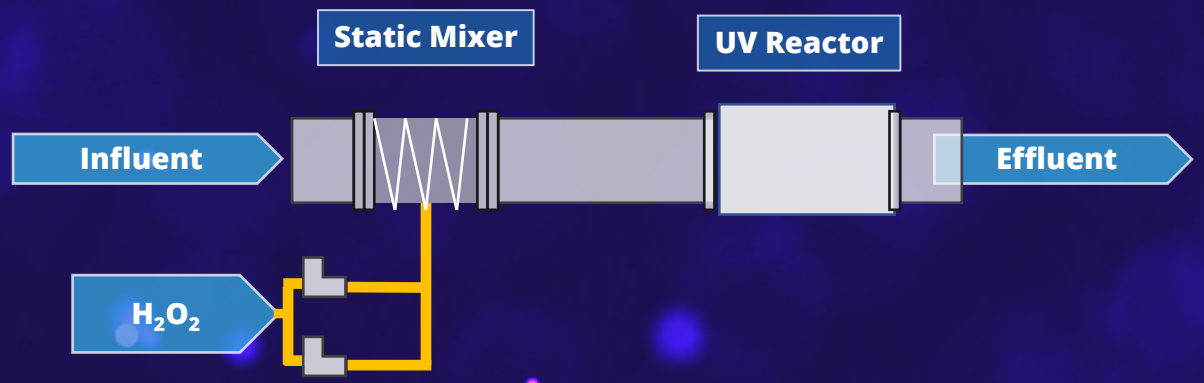
Used when UV Transmittance Lower

Other factors

- TOC
- Power Costs
- Footprint
- Availability of oxygen
- Current technologies in use
- Peroxide cost
- Peroxide destruction cost

Treating 1,4-Dioxane: UV + Hydrogen Peroxide

- Hydroxyl radicals (·OH) are generated by the photolysis of hydrogen peroxide
- H_2O_2 is dosed and mixed in ahead of the UV reactor



$$H_2O_2 + h\nu \rightarrow 2 \cdot OH$$

UV Photon

Treating 1,4-Dioxane:
Ozone + Peroxide

$OH^{\cdot}$ compounds

- Radicals with high electronic potential
- Very strong oxidizer
- Activation is a complex process with different reaction mechanisms

- Hydrogen peroxide in water $H_2O_2 \rightarrow HO_2^- + H^+$
- HO_2^- ion + ozone produces radicals $2\ O_3 + H_2O_2 \rightarrow 2\ OH^{\cdot} + 3\ O_2$

When is Ozone Best?

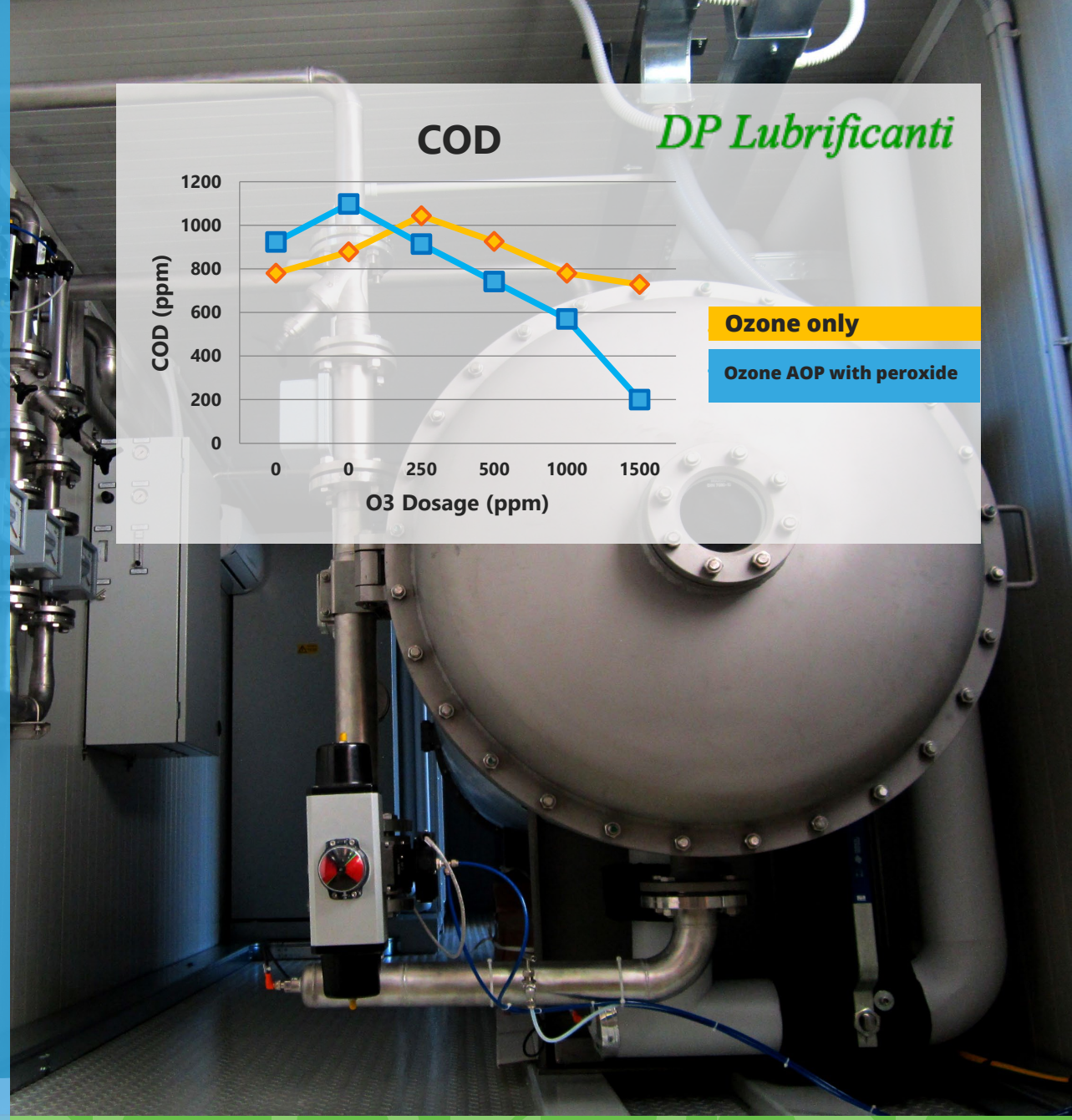
- Low water UV-T value
- High TOC value in the water
- When H_2O_2 quenching is a concern
- When ozone is applied to solve other issues at the same time (pharma micropollutants, mycotoxins, etc.)

Recalcitrant Organics

CASE STUDY: DP Lubrificanti, Rome

Chemical Company Wastewater Polishing

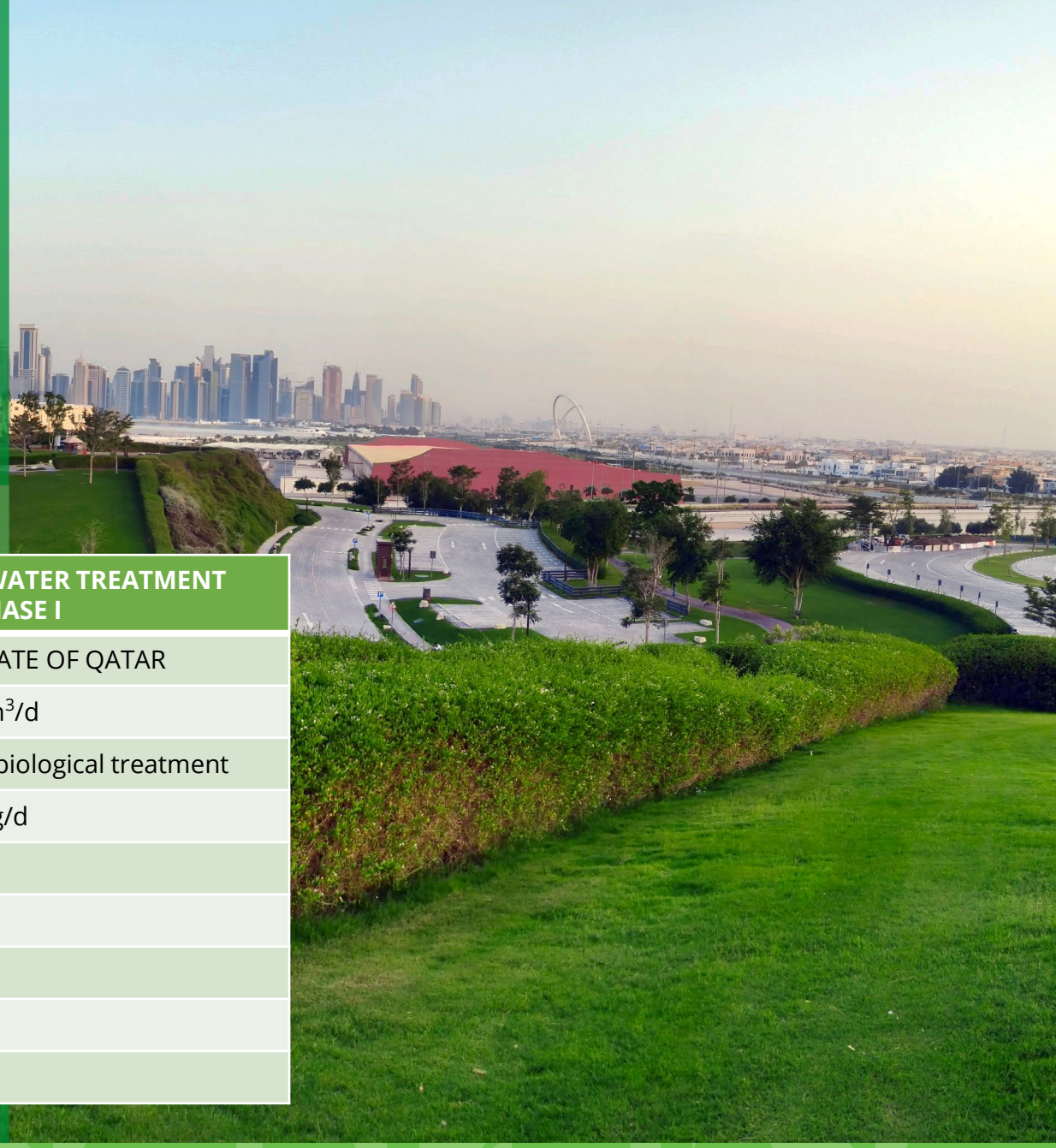
- Biodiesel production
- Using GAC downstream to reduce COD
- Spending hundreds of thousands of €/year in GAC replacement.
- Ozone applied for two applications:
  - **Sludge reduction**
  - **Non-biodegradable COD oxidation – tertiary treatment.**



Recalcitrant Organics

CASE STUDY: Ashghal, Qatar

Agricultural Wastewater Reuse



Project Name	INTEGRATED INDUSTRIAL WASTEWATER TREATMENT WORKS (IIWWTW) PHASE I
End-User	PUBLIC WORKS AUTHORITY STATE OF QATAR
Design Flow	462 m^3/h – 11,096 m^3/d
Process Objective	RCOD to BCOD conversion, prior to biological treatment
RCOD (inlet)	323 ppm – 3,587 Kg/d
Target Conversion Rate (RCOD to BCOD)	85%
Ozone to RCOD Ratio	0.5 gO3/gRCOD
Total Ozone Capacity	75 + 25 Kg/h
Ozone Concentration	10% wt
# of Ozone Generators (duty, stand-by)	3 +1

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Phenols and Hydrocarbons

CASE STUDY: Kuwait

Refinery Wastewater Polishing

Resistant to traditional biological treatment

Thresholds for effluent are increasingly lower

Ozone and AOP are effective

Dosage

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

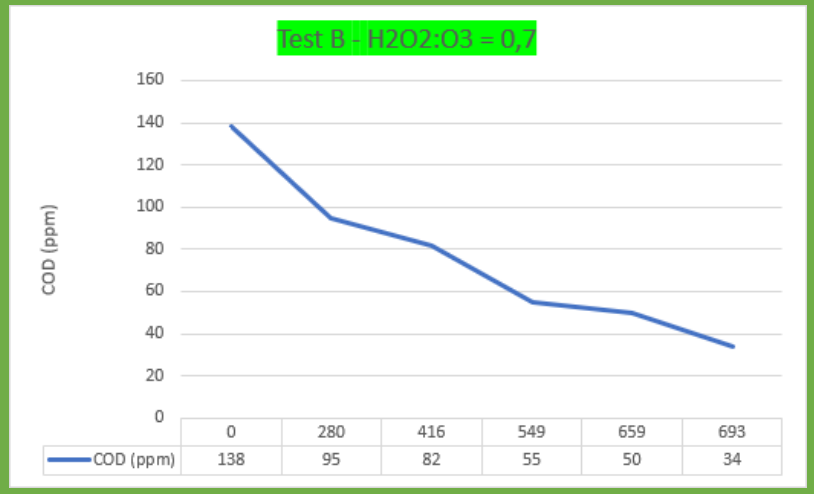
Cyanide

CASE STUDY: Brazil

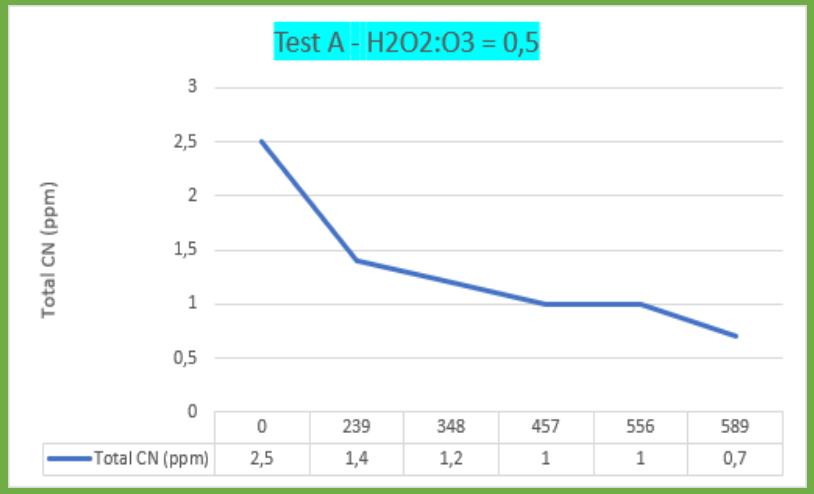
Chemical Plant
Wastewater Polishing

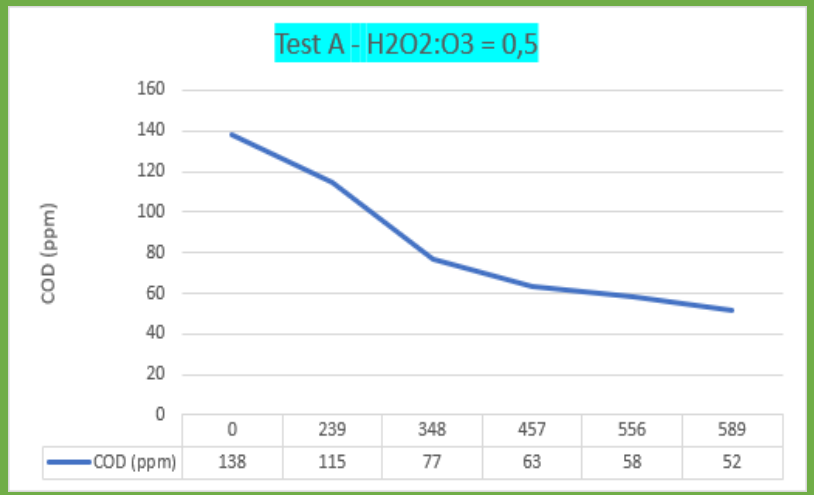
- 85 m^3/h full scale
- Target cyanide <1 ppm
- Tests conducted in batch

Note: 6.66 O3:COD ratio



Note: 6.85 O3:COD ratio





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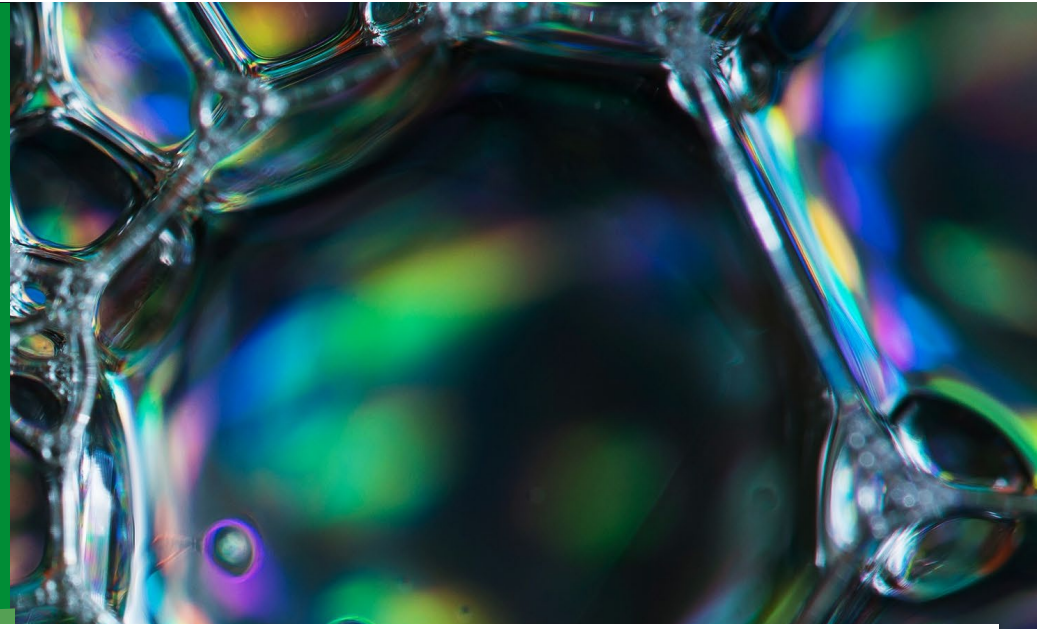
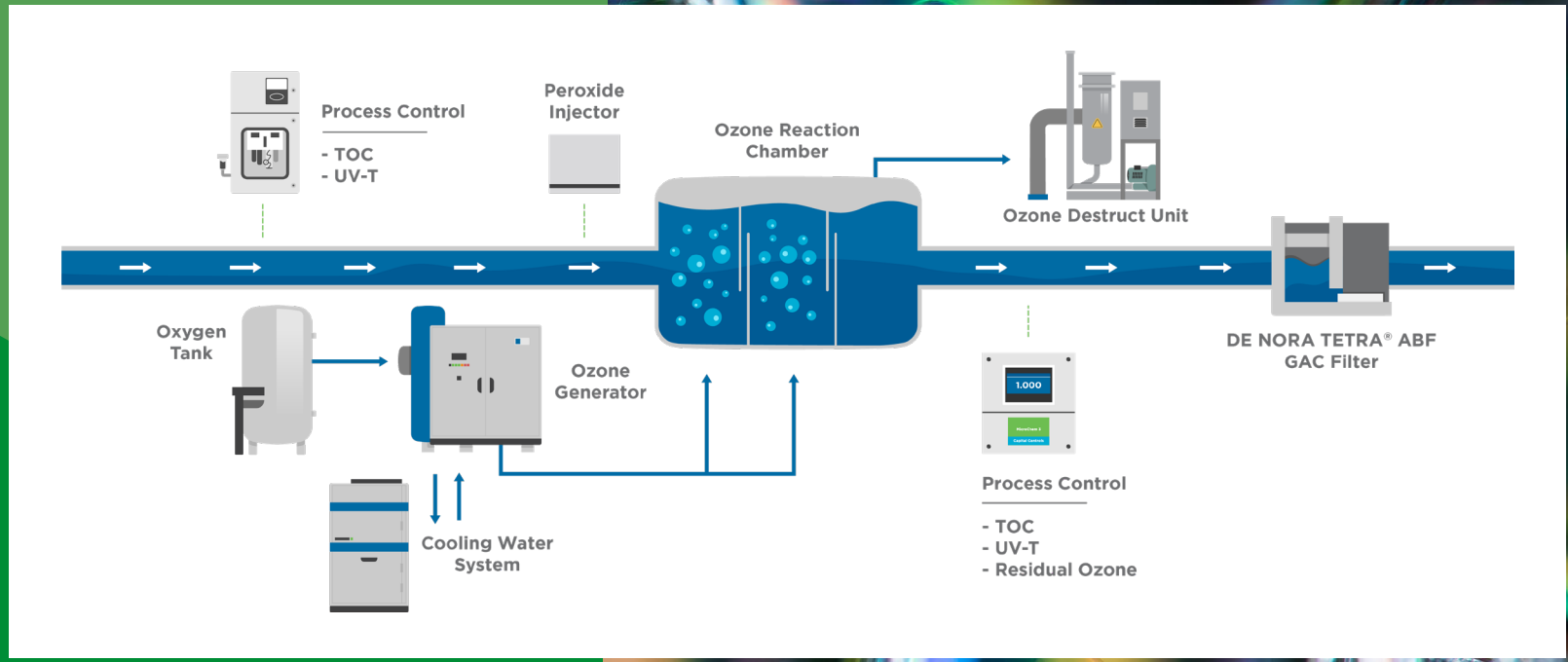
1,4-Dioxane



- Manufacturing by-product
- Potential human carcinogen
- Contaminates groundwater and surface water
- Identified in wastewater
- Hard to remove



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CASE STUDY:
Water Authority in the Northeast US

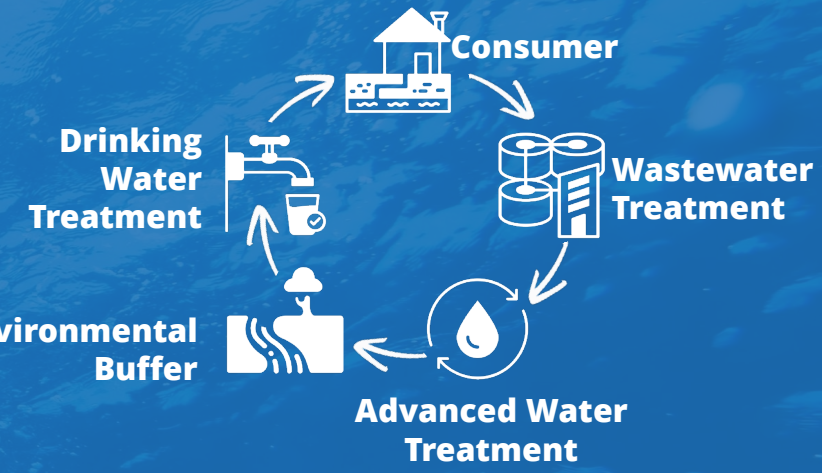
Initial process scheme
Flocculation-sedimentation -> Ozone -> GAC -> UV-AOP

Revised process
Flocculation-sedimentation -> Ozone-Peroxide (AOP) -> GAC -> UV

Design data:

Peak Design Flow	16.0 MGD(US)
UV Transmittance	89% (minimum)
Targeted Treatment #1	0.3-Log Removal of 1,4-Dioxane
Targeted Treatment #2	1-Log Removal of *N*-nitrosodimethylamine (NDMA)
Disinfection Requirement	4-Log inactivation of virus (>186mJ/cm^2 per USEPA UVDGM)

Indirect Potable Reuse



Results

$2 Million USD savings in capex

80% less peroxide consumption

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Color and Surfactants Removal

CASE STUDY: Lariana, Italy

Italian fabric district with blue/purple-colored effluent

Color

Ozone reacts with chromophore group

Surfactants

3ppm ozone per ppm of surfactants

Lab and Pilot Testing

Highly variable contaminant and water matrix

Lab and/or pilot testing is required

Ideal industrial application approach:

- **Lab Benchtop Testing**
- **Pilot Testing**

Lab Benchtop 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

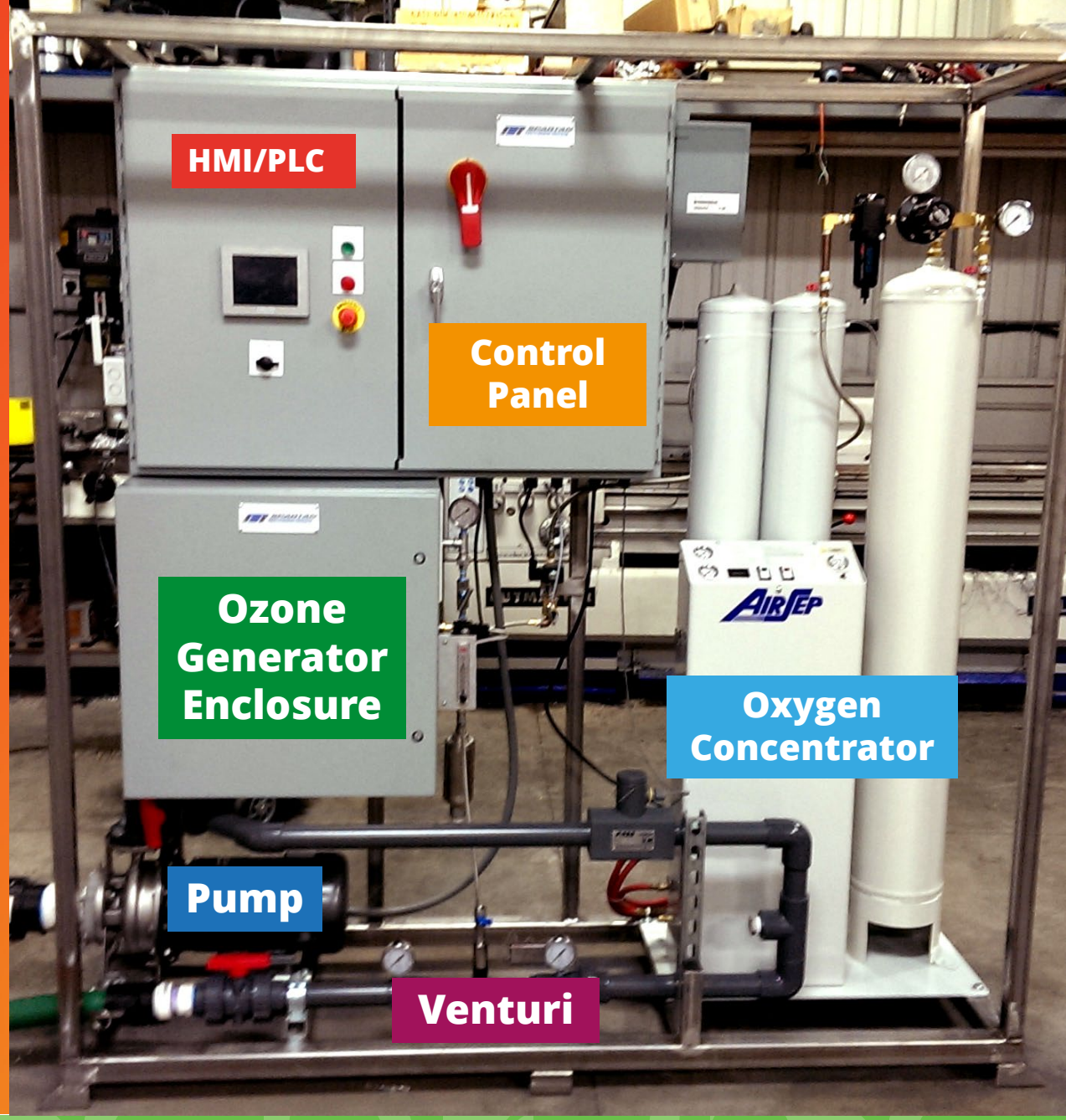
- Provides larger quantities of water to be studied
- Both batch and continuous testing is possible

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 O_3-BAF to other treatment technologies for micropollutant removal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Q & A

Moderate by:
Ms Fran House, Marketing Manager
(EMEA, Americas and Marine)
De Nora Water Technologies

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Upcoming Events

Technical Site Visit: 11 Jan 2023
Keppel Marina East Desalination Plant

Networking Session: 02 Feb 2023
Singapore Water Industry Nite (SWIN)

Webinar: 15 Mar 2023
Sharing with Austria Embassy and Companies

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Thank You

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