Influent Monitoring for Proactive Operations

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SPEAKERS

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Agenda

1. Introduction: Influent Fluctuations – Sources and Consequences
2. “Watch Dog” Solutions
3. Influent Organic & Nutrient Monitoring
4. Influent Toxicity Monitoring
5. Bonus: Influent Wastewater Surveillance for Public Health

Introduction

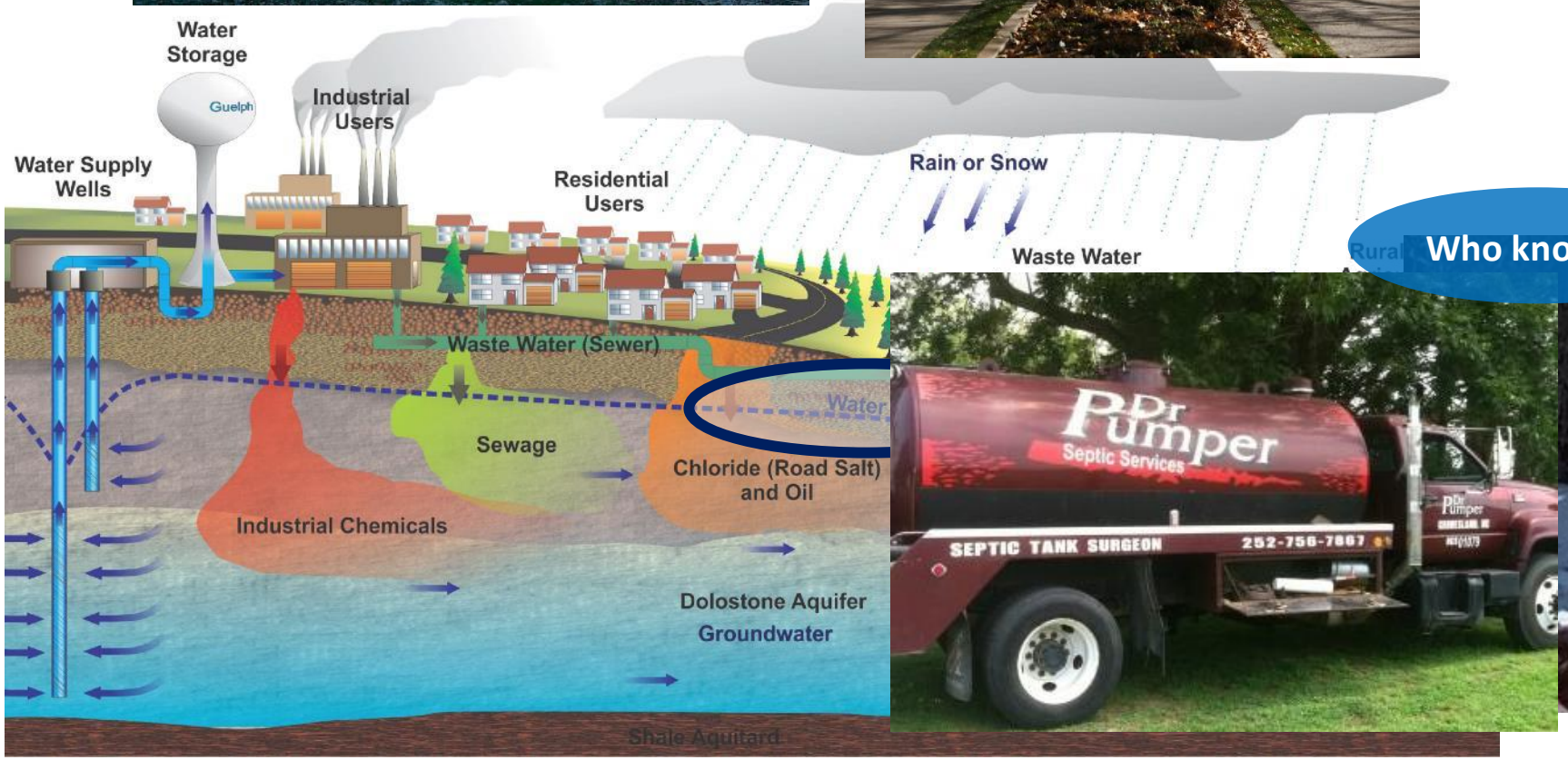
Sources of Unpredictable Influent

Industries

Rapid population changes

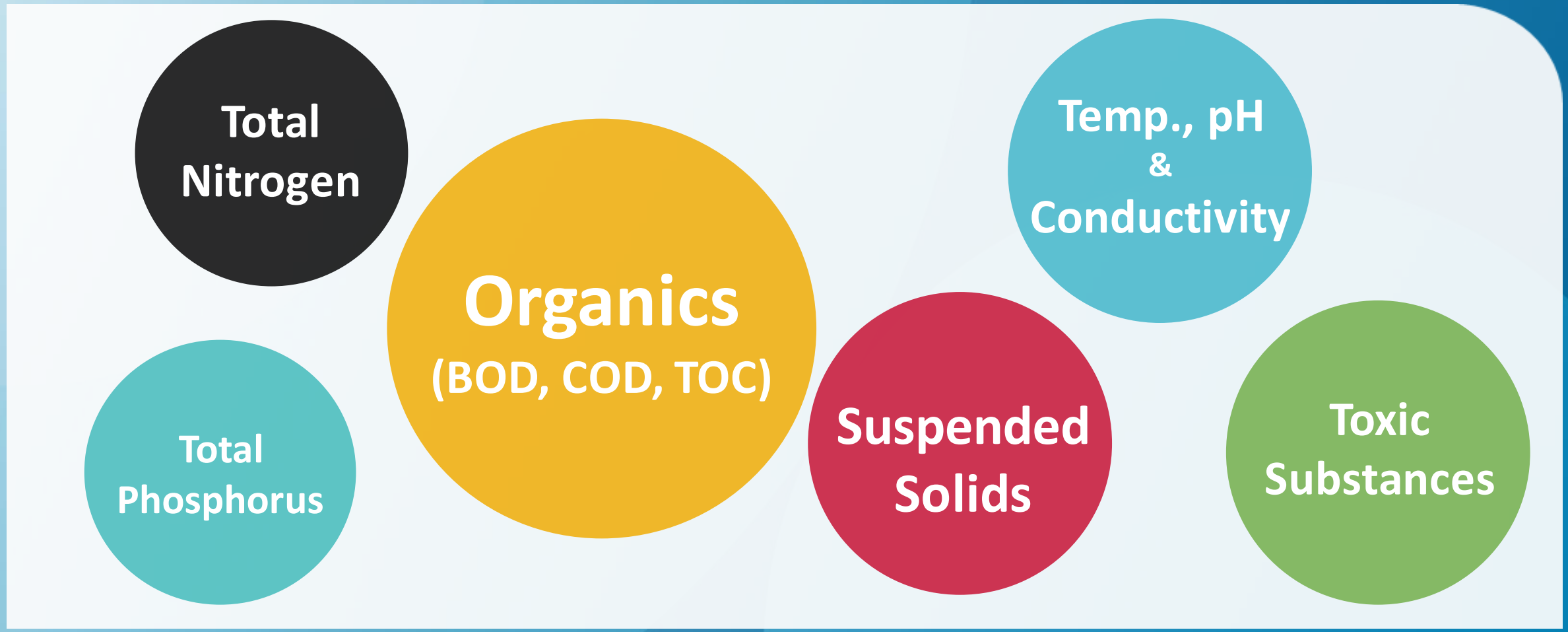
Clean water infiltration

Saltwater intrusion

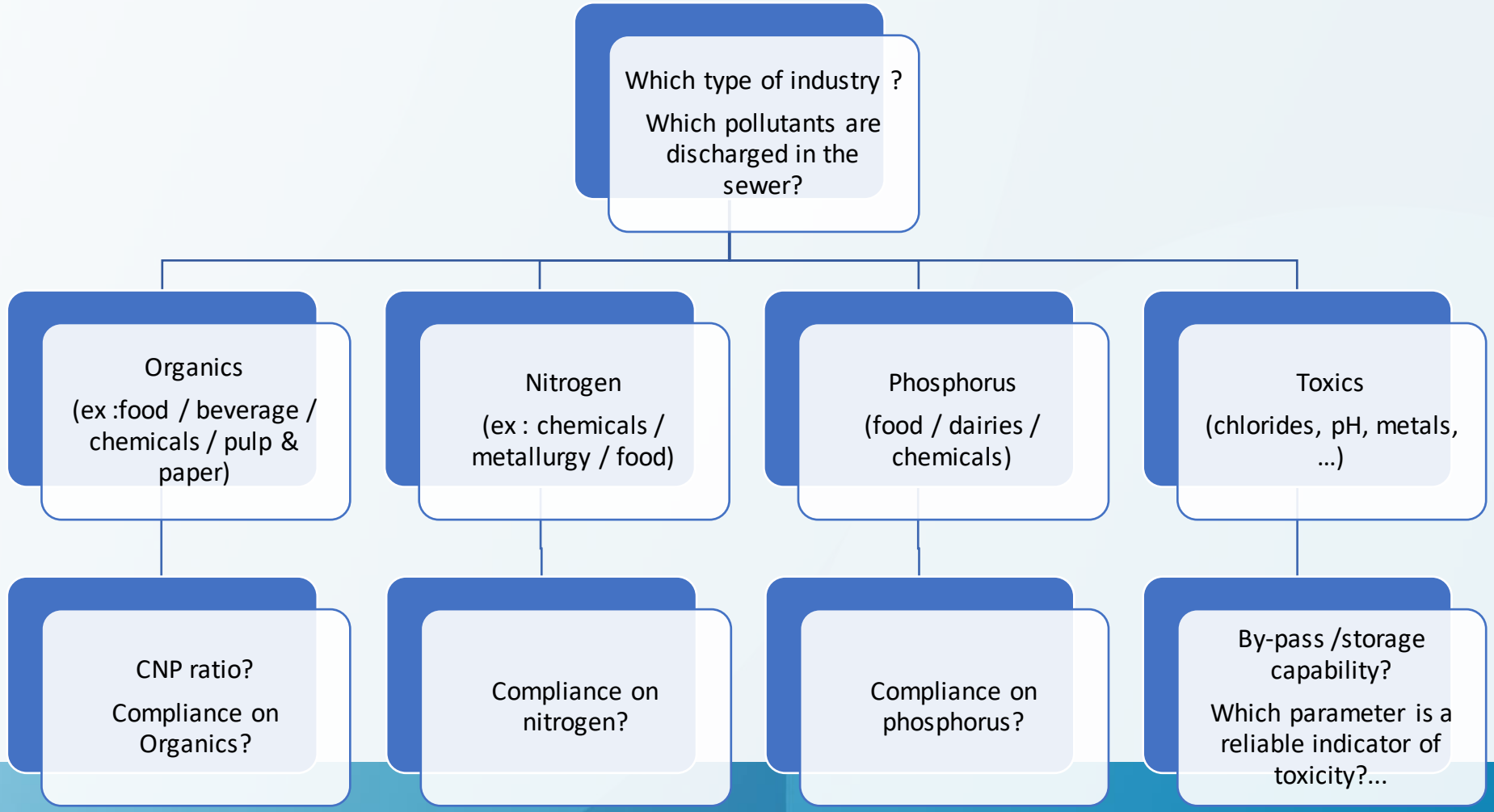


Who knows??

Common Parameters of Concern



Where does the loading come from?



Potential Consequences of Unexpected Influent Loadings

How do you know you have an influent issue?

Ammonia levels increasing

BOD/COD bleed through

Oxygen consumption/ DO levels

Effluent compliance issues?

Microorganism die off

Something Doesn't add up...

Secondary system settling issues

High turbidity in effluent

Effluent phosphorous increasing

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Solutions Overview

"Watch Dog" Monitoring

Samplers

Laboratory

pH, ORP, Temp, Cond.

Solids

Advanced parameters

Influent Toxicity

Organics & Nutrients TOC/TN/TP

Influent Wastewater Surveillance

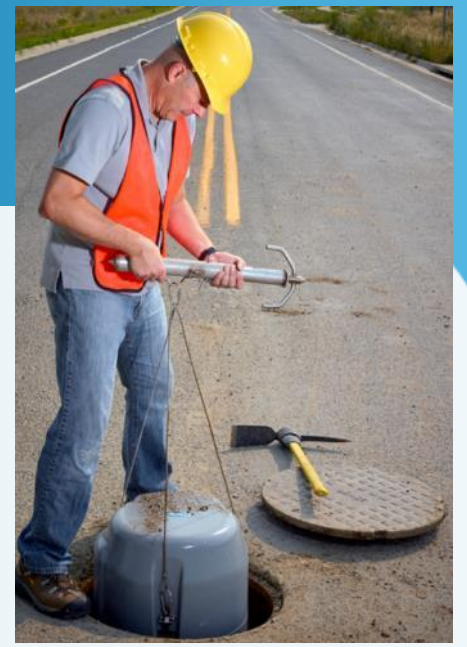
Poll

The Watch Dog Solutions

Sampling and Field Testing

Automatic samplers (H2S resistant)

Portable samplers for occasional campaign



Laboratory Solutions for Influent Monitoring

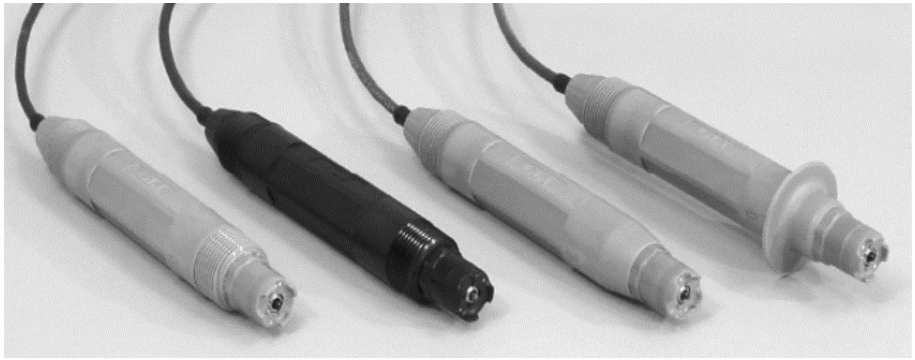
Test ‘n Tube (TNT+) Chemistry

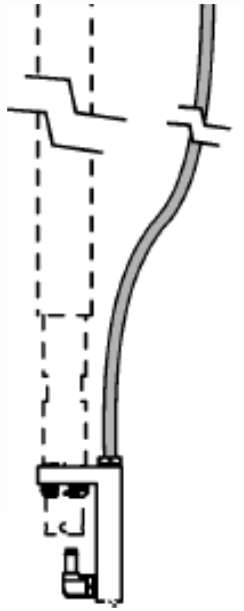
Cuvette tests adapted to influent monitoring
COD / TOC / COD for sample with high chloride load
$TN/NH_4/NO_2/NO_3$
TP/PO_4
Chloride
Trace metals (Cu, Zn, Cd, Hg, Pb…)

Spectro-photometer

Heating blocks

Electrochemical Measurements: pH, T°C and ORP





- Help to identify abnormal situations, progressive drift or sudden change
- Potential indicator of an industrial discharge
- High or Low pH can lead to treatment limitations (ex : coagulation, flocculation, biological treatment..)
- ORP “jumps” can be used for event detection

Electrochemical Measurements: Conductivity

- Allow observation of sudden change or progressive drift of inlet conditions
- Indicator of possible impact of industrial discharges (ex : food, dairy, etc…)
- Indicator of sea water intrusion salty runoff
- A high salinity can negatively impact biological processes

Solids Measurements

- Allow observation of sudden change or progressive drift of inlet conditions
- Indicator of possible impact of industrial discharges

Sensor Management

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Claros™

The Water Intelligence System from Hach®

Mobile Sensor Management

Focus on Your Highest Maintenance Priorities

Prioritize critical issues and proactively plan for upcoming maintenance to avoid downtime

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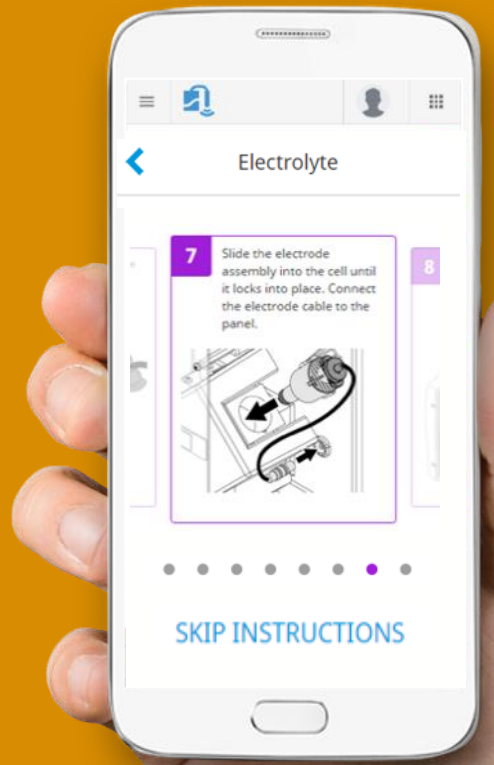
Claros™
The Water Intelligence System from Hach®

Mobile Sensor Management

Step-by-Step Maintenance Instructions in the Palm of your Hand

Perform instrument maintenance quickly and accurately by following step-by-step instructions on your mobile device



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The Water Intelligence System from Hach®

Mobile Sensor Management

Align Process and Laboratory Measurements

Verify process instrument measurements versus lab reference values and calibrate remotely

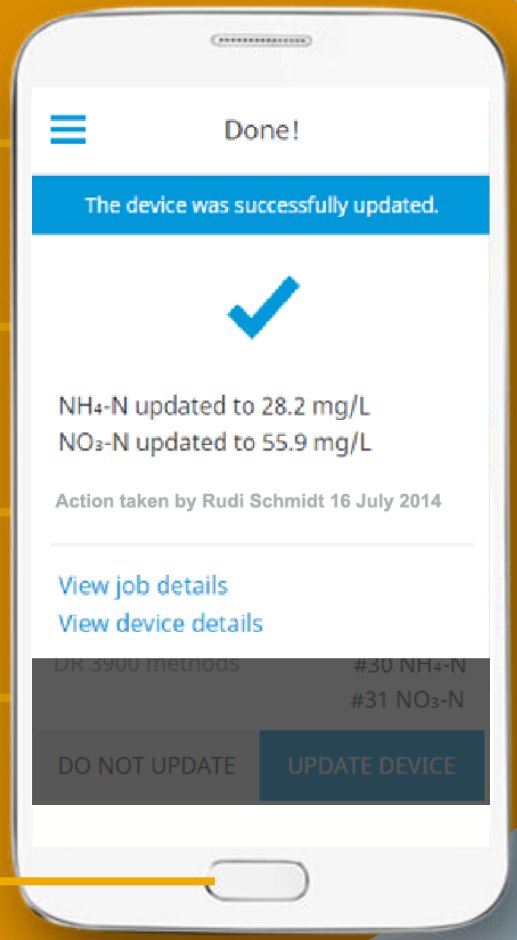
Take Process Measurement along with Grab Sample

Send to Lab

Compare Process & Lab Results

Send calibration instructions to process instrument

Process instrument calibration complete



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Influent Organic & Nutrient Monitoring

TOC/TN/TP Analyzer

- TOC online measurement up to 20.000 mg/L
- B7000i for TOC only and up to 6 channels
- B7000 TOC TN TP for combined measurement of TOC and nutrients and up to 3 channels

Applications: Municipal and industrial wastewater

Biotector B7000 Series

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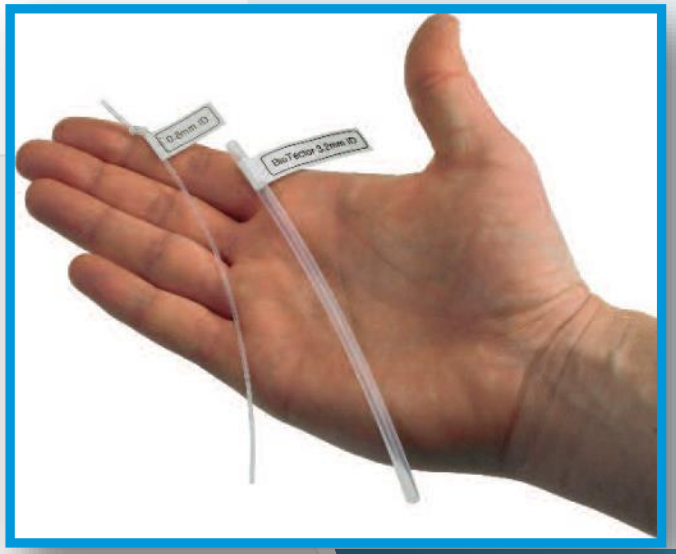
TOC Measurement with BioTector

- Large sample volume - representative
- Optimal accuracy
- Large sample tubes – no filtration needed
- Particles up to 2 mm ok



TSAO Technology

Very strong basic digestion

- Automatic cleaning of sample lines
- 6 months maintenance interval
- Low operation and maintenance costs
- High up-time (MCert. 99.86%)

Method: TSAO (Two stage advanced oxidation)

TIC Sparging

- Addition of acid and sparging of inorganic carbon (TIC)

1st Base Oxidation Phase

- Addition of base and ozone for oxidation via $OH^{\bullet}$ Radicals

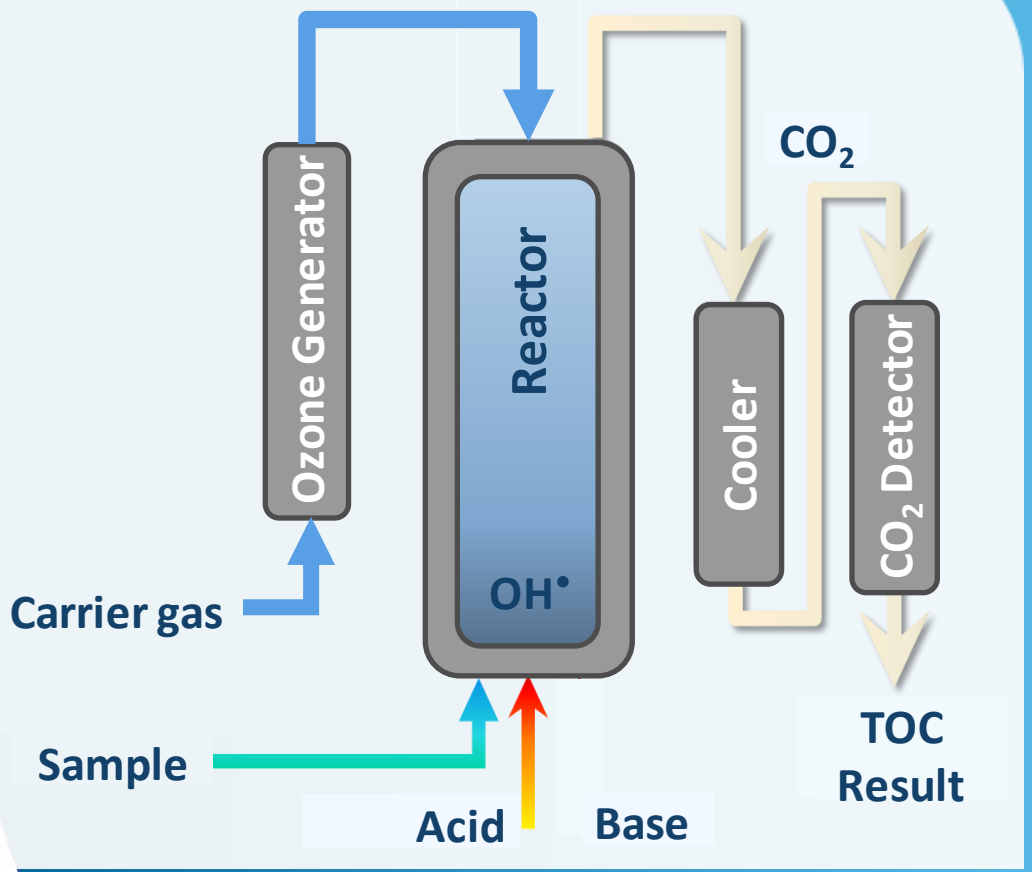
2nd TOC Phase

- Addition of catalyst and acid to complete oxidation and sparge all CO_2

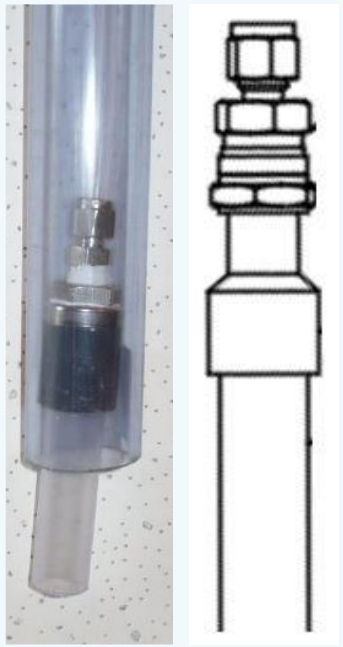
Nutrient Measurement

- **TN:** direct photometric measurement of nitrate in fully oxidized sample.

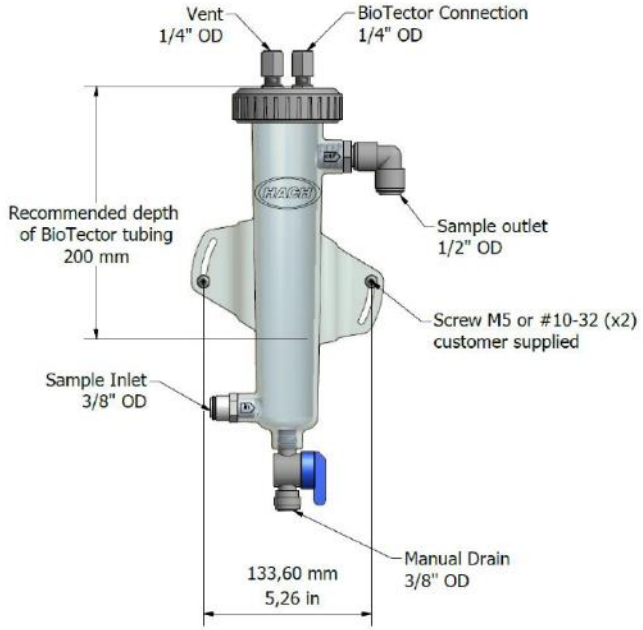
- **TP:** colorimetric analysis of Phosphate with standard Vanado-molybdo-phosphoric-acid method after oxidation



Biotector Sampling Systems



Sand trap
Sampling from tank



Overflow vessel
Water with particulates

Flow through sand trap
Flowing sample

Venturi Sampler
Far away or dirty samples

Case Study 1 – Wastewater Treatment Plant in EU (Oijen, NL)

Starting Point

- WWTP Oijen: sewage from 350.000 inhabitants + industries
- No nutrient analyzers for influent or effluent monitoring.
- Unpredictable spikes from industries

Third-party lab testing for nutrients

Exceedance of phosphate discharge limits

Process upsets
-> costly remediation

Case Study – Wastewater Treatment Plant Oijen, NL

Solution

- 2 Hach BioTector B7000 TOC/TN/TP analyzer at plant inlet and outlet
- Influent monitoring for insights into mix of industrial and municipal WW
- Identify frequent spikes and react.
- Find root cause for not meeting effluent limits. (process or external discharges?)

Case Study – Wastewater Treatment Plant Oijen, NL

Benefit

- Hach BioTector TOC/TN/TP analyzer alerts plant managers to spikes
- Fast tracking of industrial pollutants possible

Reduced costs due to process upsets

Consistent effluent compliance since BioTector installation

Case Study 2: Influent Monitoring Solution at Cold Weather Facility in North America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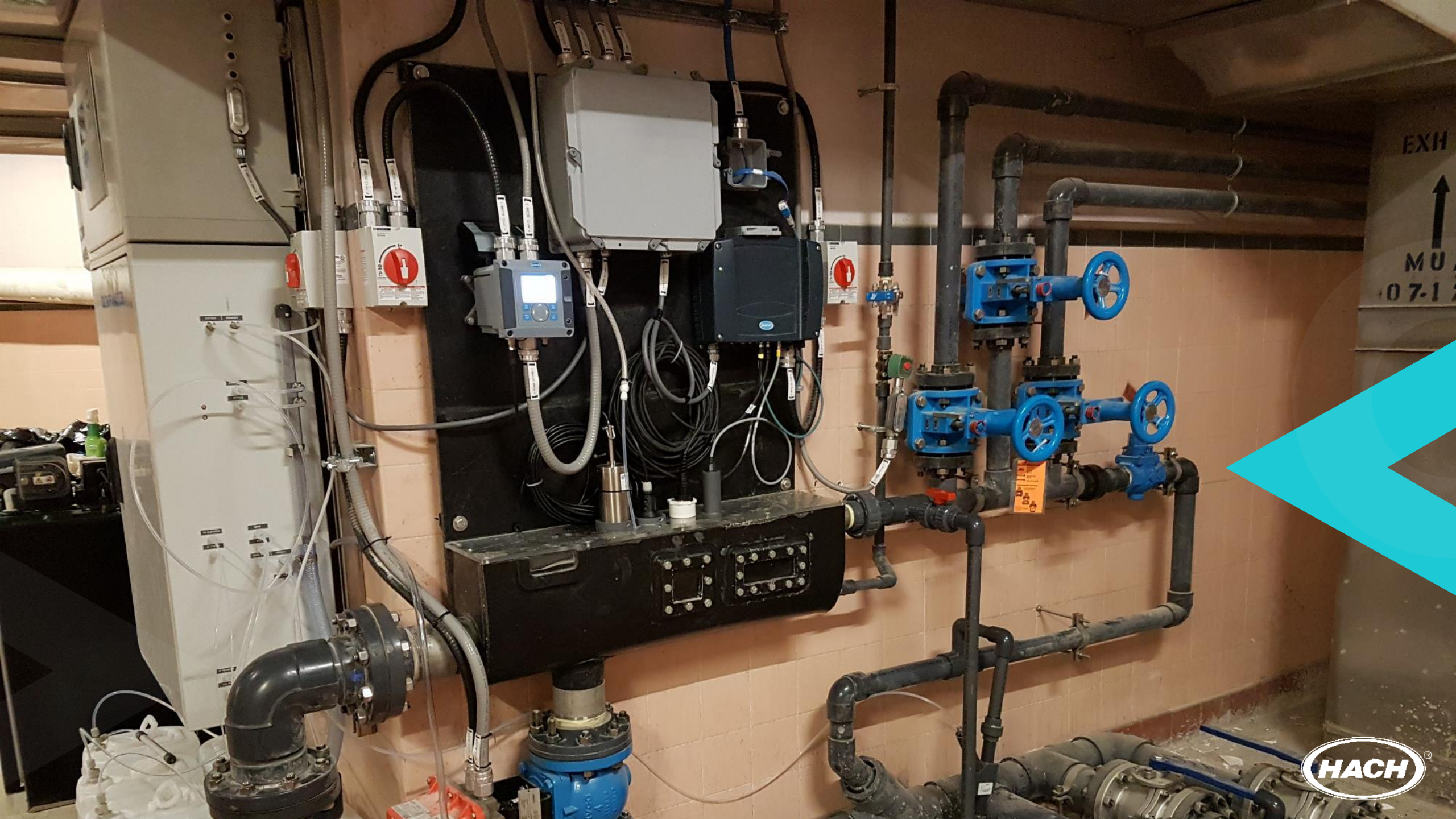
BioTector
B7000
TOC TN TP ANALYZER
BioTector OXYGEN CONCENTRATOR
HACH
CAN-AM
HACH


EXH
HACH

1936232 - SOLITAX sc

14:59 | 1 December 2020

TSS mg/L 134.60

COND SENSOR - 3798-S sc V2

14:59 | 1 December 2020 16.49 °C

Conductivity µS/cm 1,754.17

pHD202435906 - pHD sc V2

14:59 | 1 December 2020 17.64 °C

pH pH 7.46

000000104008 - mA Input

14:59 | 1 December 2020

Channel 1 - FP360
PAH 135.54

Channel 2 - TOC
TOC mg/L 102.42

Channel 3 - TP
Phosphorus, Total mg/L 6.66

Channel 4 - TN
Nitrogen, Total mg/L 36.18

1947875 - sc1500

Sensors 3
Outputs 2
Inputs 1
Relay 1

ADD DEVICE

MSM

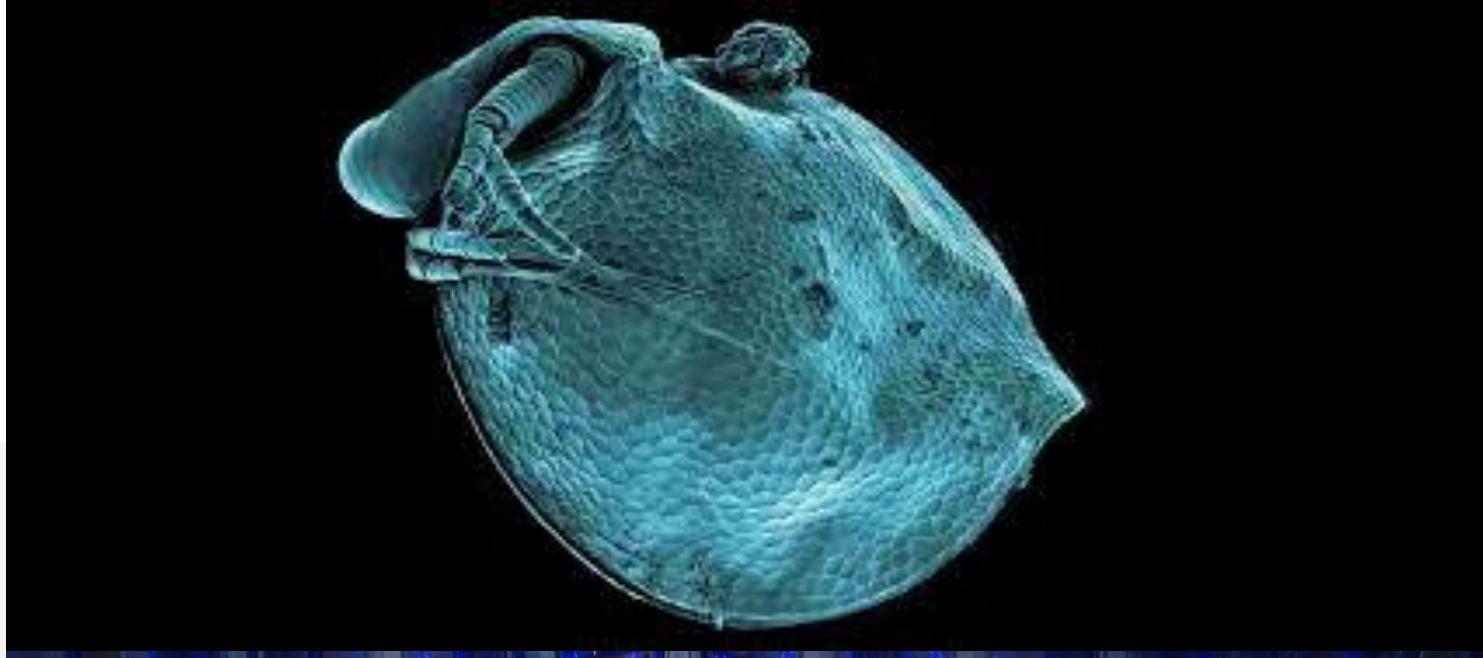
sc1500/sc200 digital sensors

Previous | November 2020 | Next View year View day

	A	B	C	D	E
1		pH pH Separate Analyzers pHD202435906	Conductivity µS/cm Separate Analyzers COND SENSOR	TSS mg/L Separate Analyzers 1936232-TSS/Turb	PAH #/mL Separate Analyzers PAH: FP360
24	11/23/20	7.15	1,617.96	125.26	102.10
25	11/24/20	7.19	1,587.20	103.46	79.25
26	11/25/20	7.26	1,578.06	128.58	63.70
27	11/26/20	7.22	1,614.03	113.56	64.81
28	11/27/20	7.12	1,639.83	72.61	74.51
29	11/28/20	7.06	1,665.30	54.41	89.28
30	11/29/20	7.03	1,681.68	80.41	113.09

Influent Toxicity Monitoring

Influent vs. Effluent Toxicity



Influent Toxicity –
Unique Parameter for Protecting Biomass and Process Troubleshooting

VS.

Effluent Toxicity –
Standard Method for (WET Testing)

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Influent Toxicity Issues in Wastewater Treatment Plants

Definition of toxicity (in water)

Influent toxicity is a non-specific parameter that allows for monitoring and protection of WWTP bacteria by alerting the plant to changes that show toxic substance inhibition in plant influent

1. Respiration inhibition: when toxicity of influents threatens the metabolic ability of the activated sludge.
2. Nitrification inhibition: when nitrifying bacteria no longer can convert ammonia-nitrogen to nitrate or nitrite.
3. Shock loads: when a high strength waste upsets the microbial culture of the plant.

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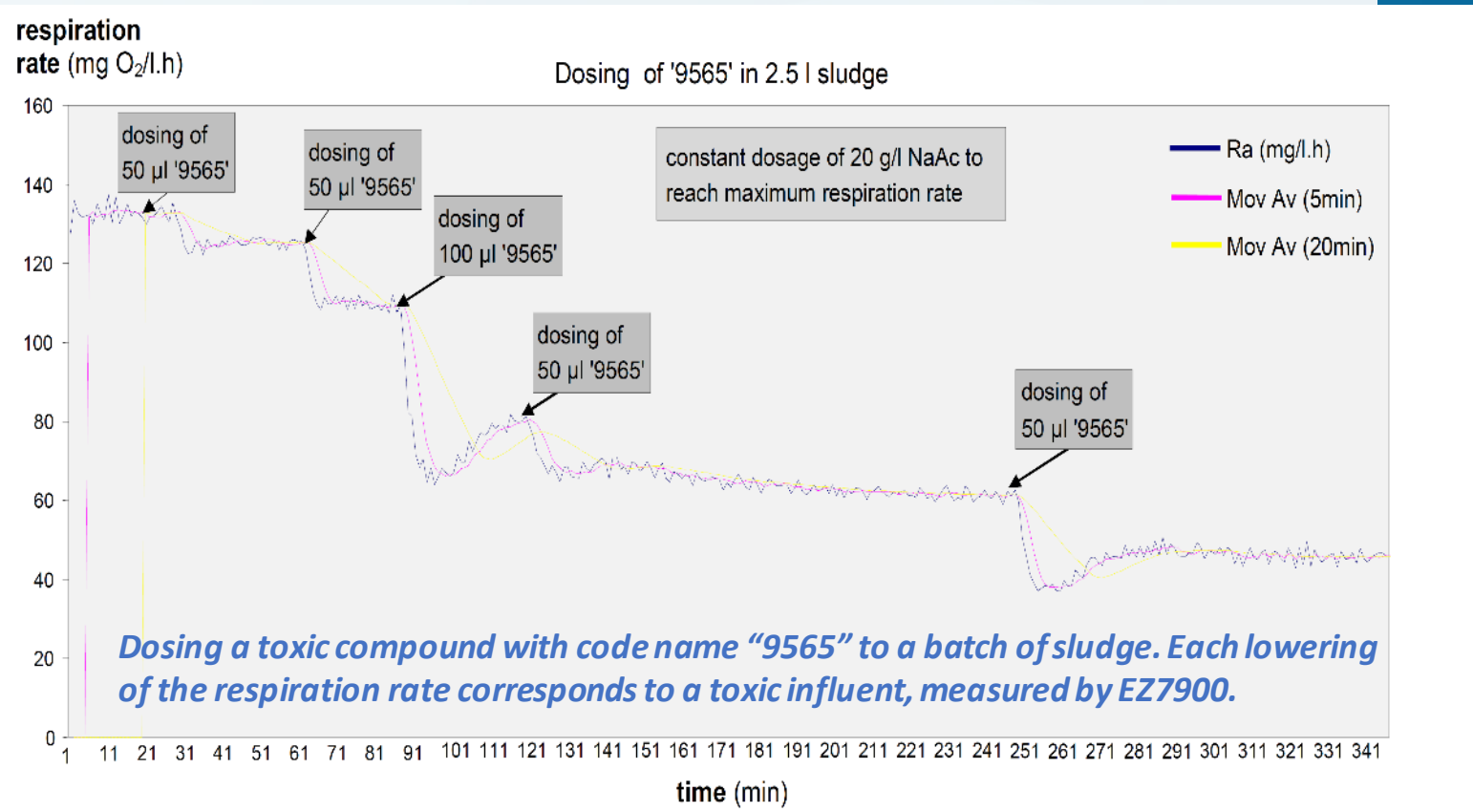
Toxicity & Respirometry for WWTP Protection

Activated sludge used in the treatment plant is a mixture of bacteria and microorganisms that can degrade effluent quality, while doing this they consume oxygen / respire

Toxic influent → respiration ↘ → Metabolic rate ↘ → BOD/COD removal ↘

- Respirometry is a valuable technology for monitoring toxicity, and control of the activated sludge process.
- Respirometry allows a quick assessment of the metabolic condition of microorganisms in the activated sludge.
- The respiration rate reflects the metabolic condition of bacteria



Dosing a toxic compound with code name "9565" to a batch of sludge. Each lowering of the respiration rate corresponds to a toxic influent, measured by EZ7900.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How
do we measure
Influent Toxicity?

Respirometry and Influent Toxicity

Respirometry is a valuable technology for monitoring and control of the activated sludge process.

Respirometry allows us to assess quickly and efficiently the metabolic condition of the microorganisms in the activated sludge.

The respiration rate reflects the metabolic condition of bacteria.

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Respirometry Explained

A respirometer is an instrument designed for measurement of the respiration rate or oxygen consumption rate:

$$\text{Respiration rate} = \frac{Mass\ of\ oxygen\ (mg)}{unit\ of\ volume\ (L)\ x\ time(h)}$$

- The respiration rate is measured directly by the measurement of the DO probe in the sample
- Method based respiration of activated sludge, related to the oxygen uptake rate (OUR) test

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Respirometry – In the Laboratory

The technique is mainly focused solely on the measurement of the Biochemical Oxygen Demand (BOD) of wastewater.

HQd and LBOD101 probe

Automatic monitoring of BOD5:

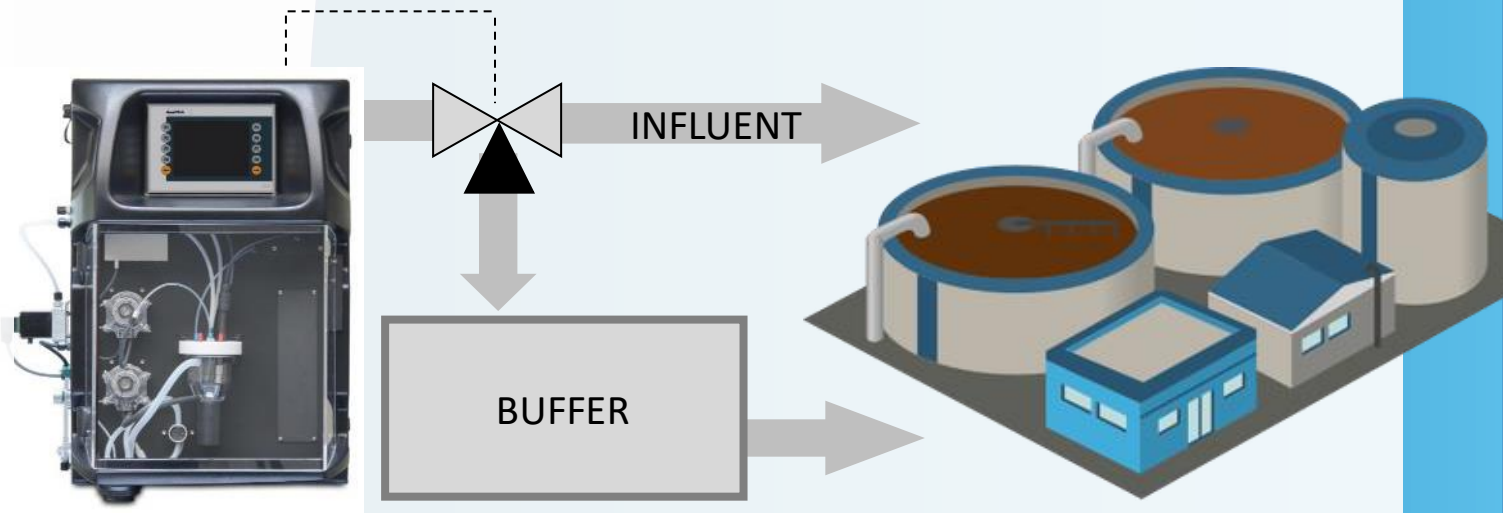
BOD Direct Plus

BOD TRAK II

EZ7900 Series for In-Process Monitoring

Measurements are carried out on **real sludge, freshly sampled** from the WWTP reactors by means of a dedicated filtration unit.

- Dynamic changes in biomass viability are taken into account.
- Measurement at same conditions as the WWTP (pH, Temperature)
- Provide early warning to toxic events or chronic toxicity caused by cleaning agents or shock loads
- Allows operators to take corrective actions to protect the viability of the wastewater treatment plant



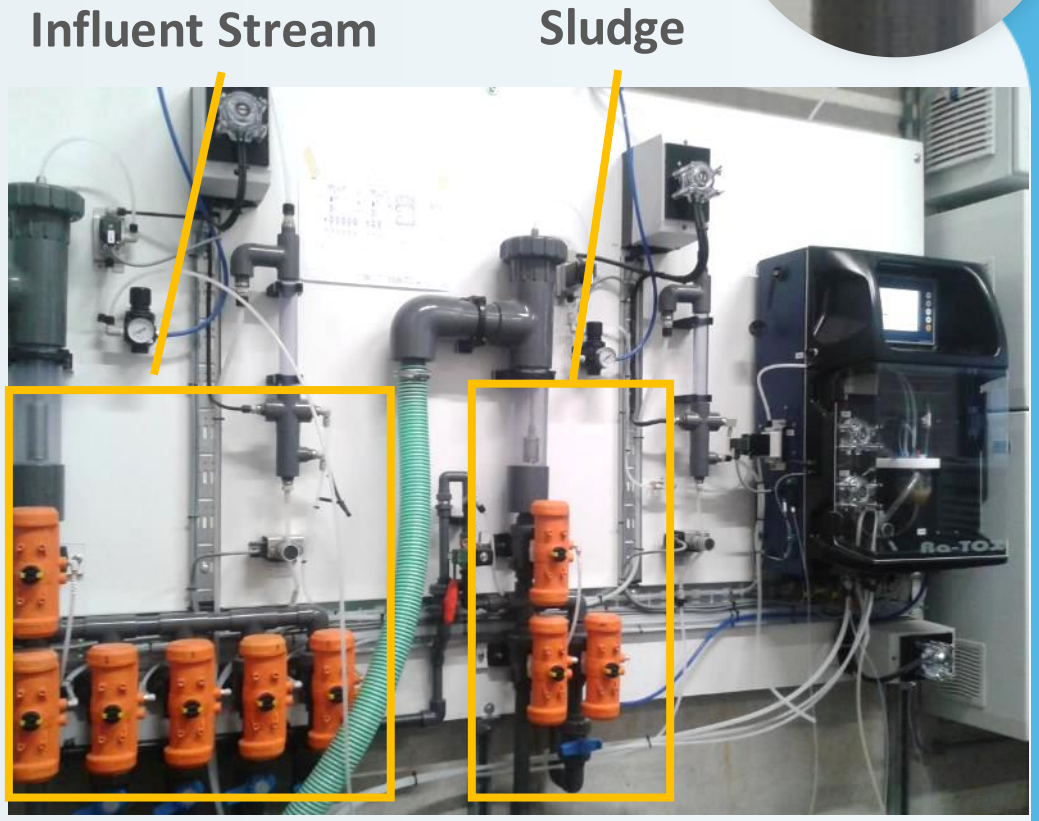
EZ7900 Series for In-Process Monitoring

The EZ7900 is respirometry-based analyzer able to monitor **acute** and **chronic** toxicity on-line

- Measurement of the respiration rate by means of a dissolved oxygen electrode
- With 15 min cycle time, it’s an early warning system
- Multi-stream option w/ standard automatic sampling and cleaning features
- Standard 4 – 20 mA output or Modbus with alarm processing through the panel PC

EZ9100: Filtration & Sample Conditioning

- Sampling with EZ9100 external filtration system
- 2 adequate sample modules:
  - ✓ EZ9110 for water inlet (500µm filtration)
  - ✓ EZ9120 for sludge (1000µm filtration)
- Multi-stream analysis available (typically 2-4 sample streams influent)
- Sample selection controlled by the analyzer
- Results of each stream can be communicated through individual analogue outputs or Modbus
- Automatic cleaning of filter and sample chamber



Sampling with EZ9100 external filtration system

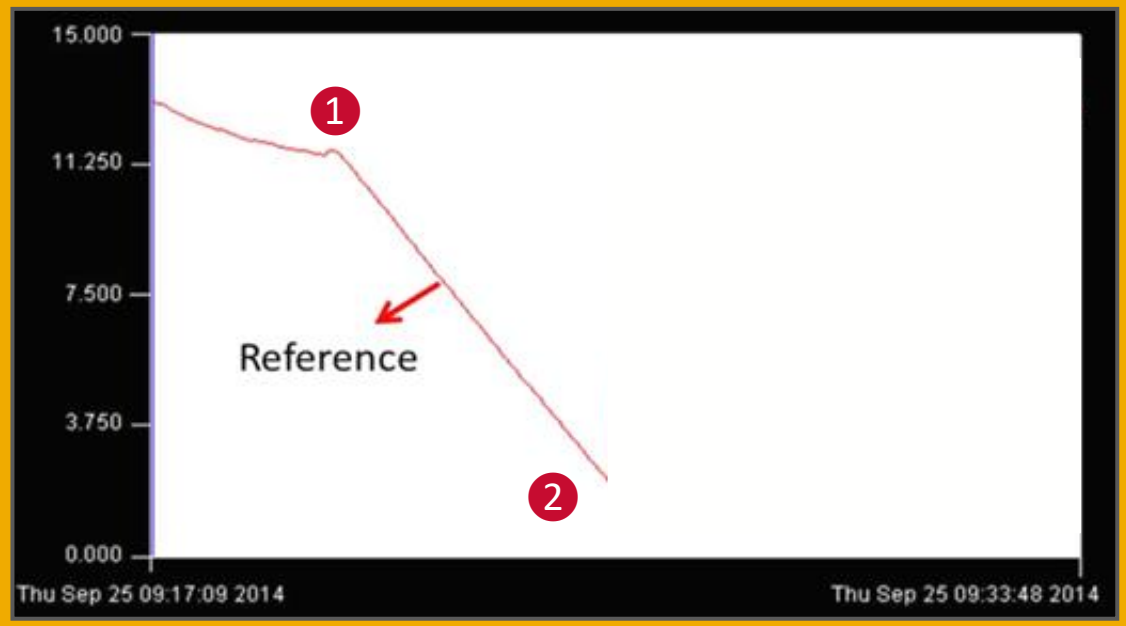
EZ7900 Analyzer: Method Overview

Reference Measurement:

1. Activated sludge and influent WW are auto-filtered
2. Analyzer aerates sludge and adds nutrient buffer
3. Aeration stops and O_2 consumption in sludge measured
4. Respiration rate for “healthy” sludge calculated

Calculation #1 (Reference Value)

$$Respiration\ Rate\ REF = \frac{Oxygen\ 1 - Oxygen\ 2}{Time}$$



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EZ7900 Analyzer: Method Overview

Calculation #2 (Toxic Respiration Rate)

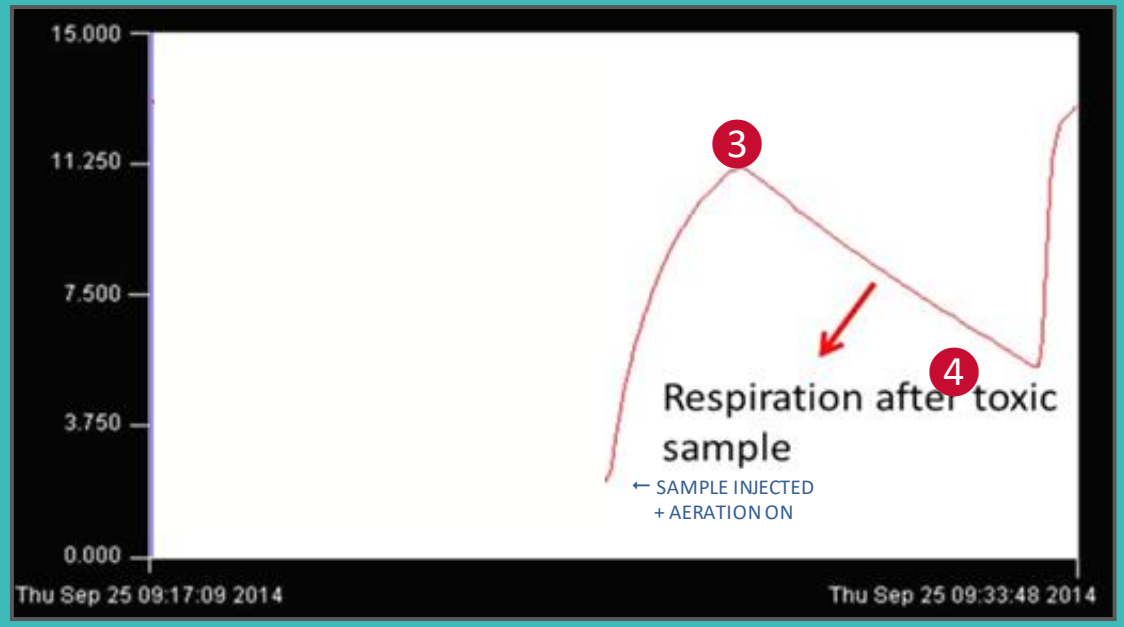
$$Respiration\ Rate\ TOX = \frac{Oxygen\ 3 - Oxygen\ 4}{Time}$$

Calculation #3 (Final Result)

$$Toxicity\ Index\ (\%\ Inhibition) = \frac{R.R.TOX}{R.R.REF}$$

Toxicity Measurement:

5. Wastewater influent added to vessel and aerated
6. Aeration stops and second O2 consumption value measured
7. Respiration rate for wastewater sample calculated
8. Calculation of respiration rate and toxicity index made
9. Filters, analyzer, and O_2 probe are auto flushed & rinsed



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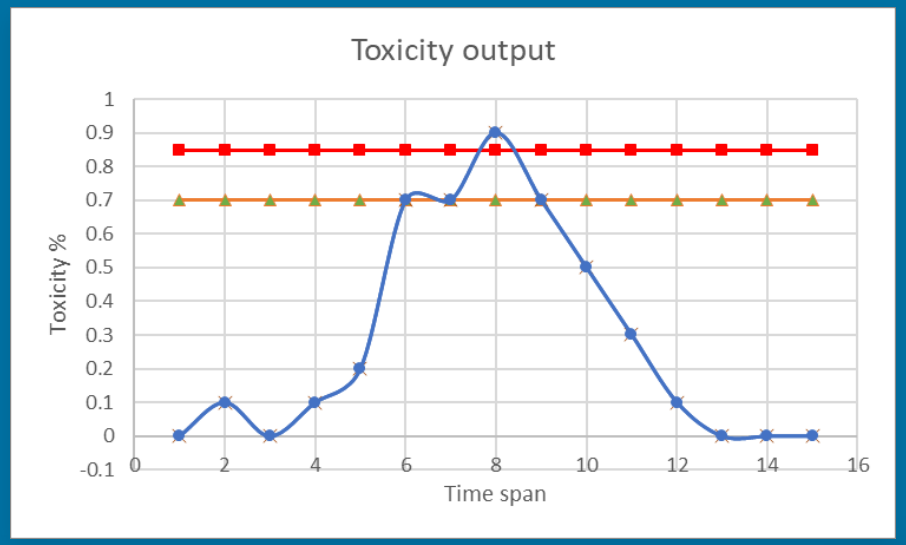
Case Study: Industrial Discharger

1. Inlet and pH correction
2. Analytical cabinet
3. Pre-clarifier
4. Aeration train
5. Post clarifier
6. Effluent

* Emergency/EQ Tanks



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Case Study

Chemical Plant Takes Action Utilizing Influent Toxicity Data

Problem

- Production of surfactants requires constant uptime
- Upsets disrupt the process $ reduces profitability
- Protecting the WWTP from toxicity caused regular, unwanted diversion of flow

Solution

- Installed automated toxicity monitoring
- EZ7900 provides toxicity index values to control
- WWTP inlet flow
- Action level at 85% diverts flow to EQ tank

Benefits

- Increase in plant uptime
- Protection of critical WW treatment process
- Improved WW operations via automation

Flow diversion prevents chronic toxicity and acute upsets

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Influent Monitoring for Public Health

Wastewater Surveillance for COVID-19 and Beyond

Effective for monitoring COVID-19 (Leading indicator vs. Clinical methods)

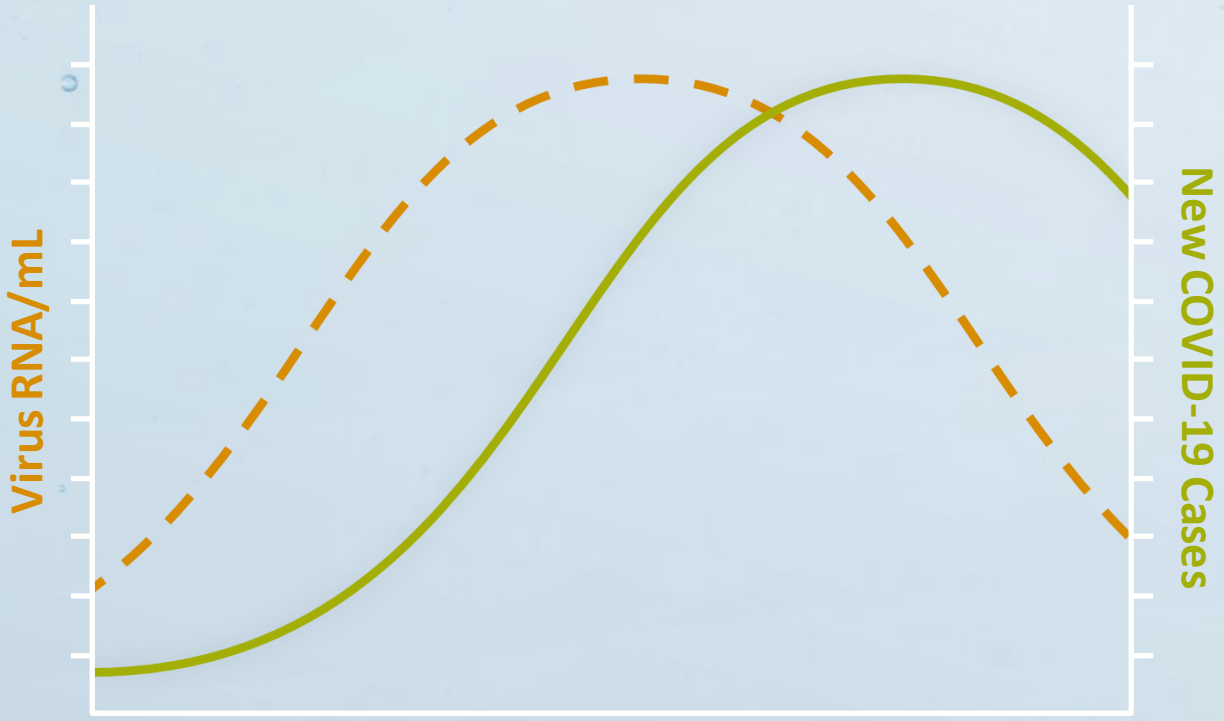
> Detected in sewers 1-2 weeks before clinical detection

Reflects asymptomatic and symptomatic population (complements/confirms clinical data)

Independent of healthcare-seeking behaviors and access to clinical testing

75-80% of US households are served by municipal sewage systems

Useful for variant tracking



SARS-CoV-2 RNA concentrations in primary municipal sewage sludge as a leading indicator of COVID-19 outbreak dynamics

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Wastewater Surveillance “In-a-Nutshell”

Step 1

Wastewater sample collected

Step 2

The sample is prepared for analysis through a qPCR methodology (to amplify the concentration of virus RNA and make it detectable)

Step 3

Sample analyzed to detect the presence of COVID-19 and converted to copies/mL or Genomic Units/L. May be able to estimate rough infection % in population. Typical use will be to monitor trends.

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Solutions

GeneCount Solution

Summary

1) Relatively Simple Sample Prep
2) Medium Sensitivity
3) Laboratory environment is ideal
4) Higher Volume of Tests

GeneXpert Solution

Summary

1) Simple 1-step analysis – fully automated
2) Great Analytical performance Sensitivity
3) Safe: Self-contained cartridges
4) Low Volume of Tests

Questions


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