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Ozone to Control Bulking and Foaming in Municipal Waste Water Treatment Plants

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DSD International Conference 2014, 12-14 November 2014, Hong Kong

Presentation Outline

1. Properties and history of Ozone
2. Ozone applications
3. Process principles
4. Full scale References
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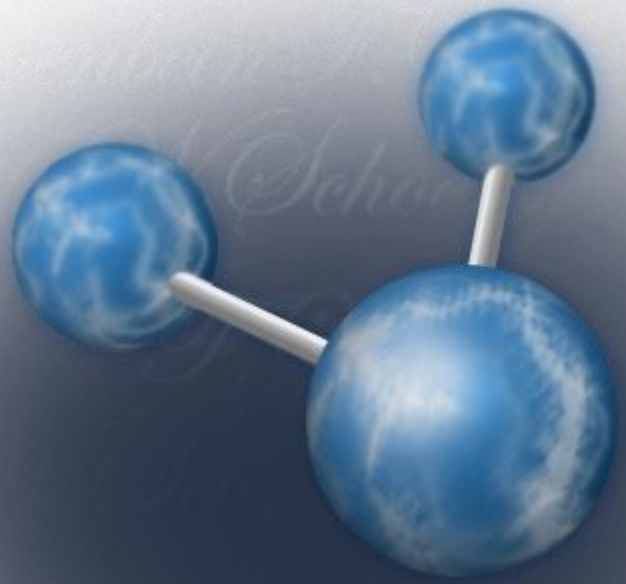
   b) Idrica Ardea, Italy
   c) Lariana, Italy
5. Summary

The long History of Ozone

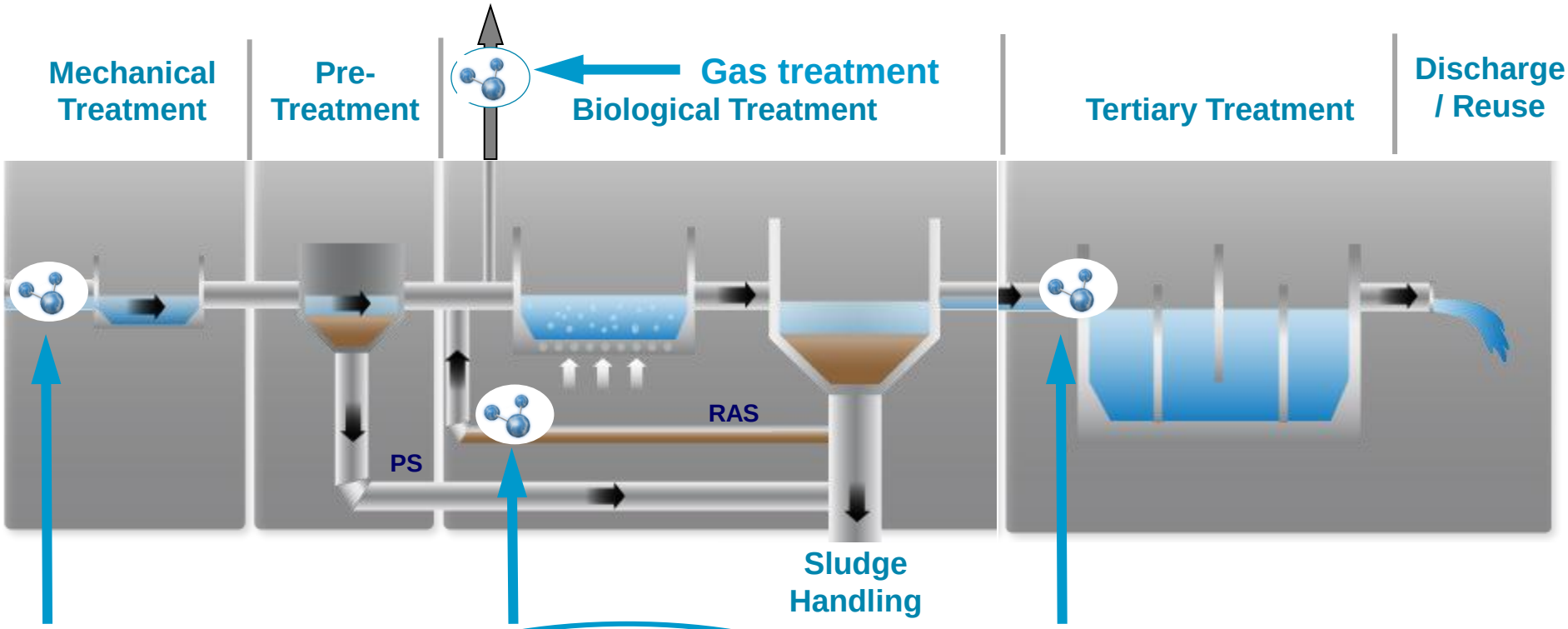
- Discovered in 1840s by Schoenbein
- First known ozone generator invented in 1850s
- First full scale installations for drinking water disinfection (1890s – 1900s); in Europe
- By 1914, over 50 ozone installations for drinking water
- Today: widely known and accepted as a proven technology for multiple uses in water, wastewater and industrial processes (oxidation and disinfection, etc.)
- Outlook:
  - Increase of ozone concentration in gas
  - Decrease of energy demand
  - Optimization of overall system



Ozone has been used in water treatment for over 100 years!!

Sludge treatment with Ozone
- Ozone applications -

Multiple use of Ozone



Treatment of toxic or highly polluted, Industrial Waters

Ozone in Sludge treatment

- Foaming and Bulking Control
- Waste Sludge Reduction

- Reduction of Micropollutants
- Disinfection
- Colour Removal
- COD-Reduction

Sludge is becoming the #1 issue

Sludge disposal is today one of the top issues for wastewater treatment operators

Issues:

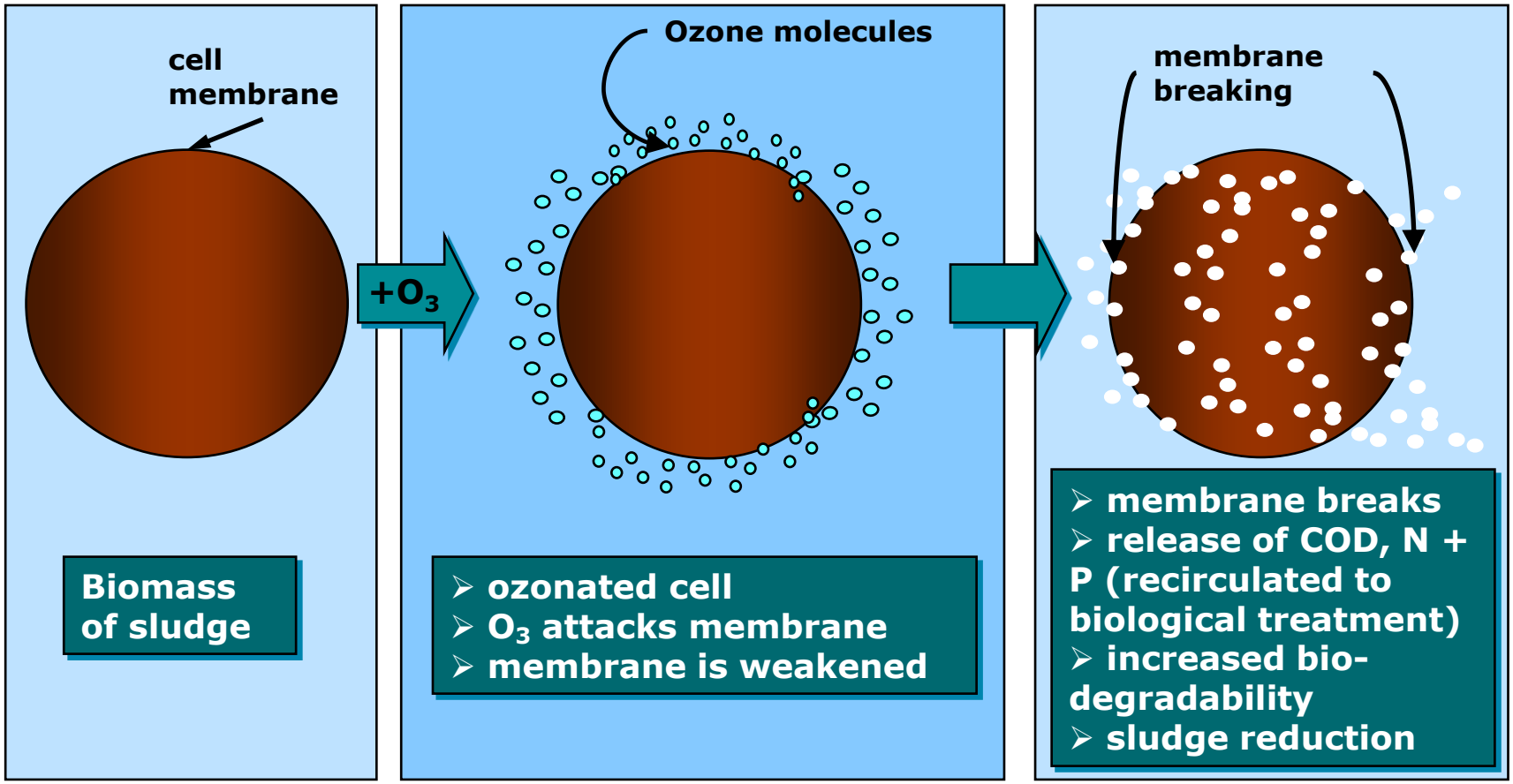
- **Volumes** – more to handle
- **Contaminants** – restrictions on heavy metal / micropolutants
- **Disposal routes** – less landfill sites available, agricultural use banned
- **Costs** – rising rapidly

45% of the costs of wastewater treatment is due to excess sludge*

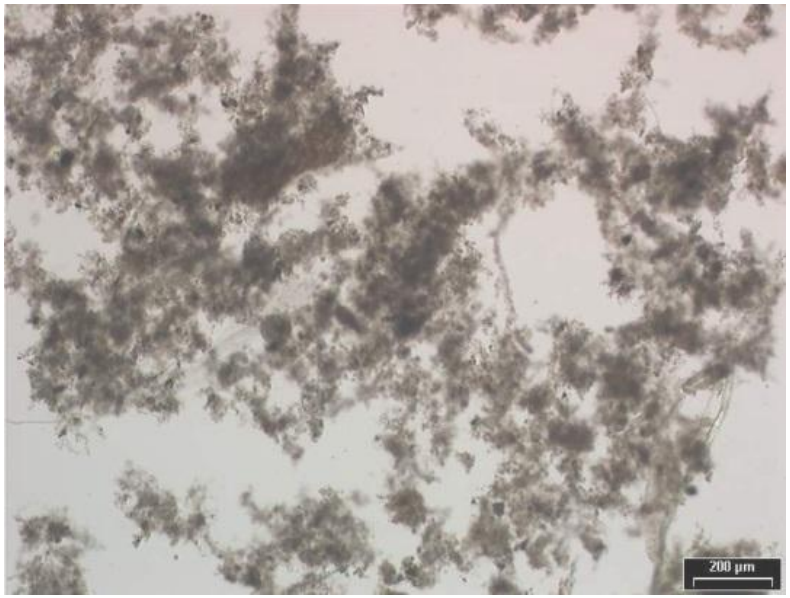
* **Kroiss, Helmut (2014)**: Perspektiven von Schlammmanagement und Schlammverwertung in Europa, Enduser Konferenz FP7 „ROUTES“; BS 2.4.14

Sludge treatment with Ozone – Process principles –

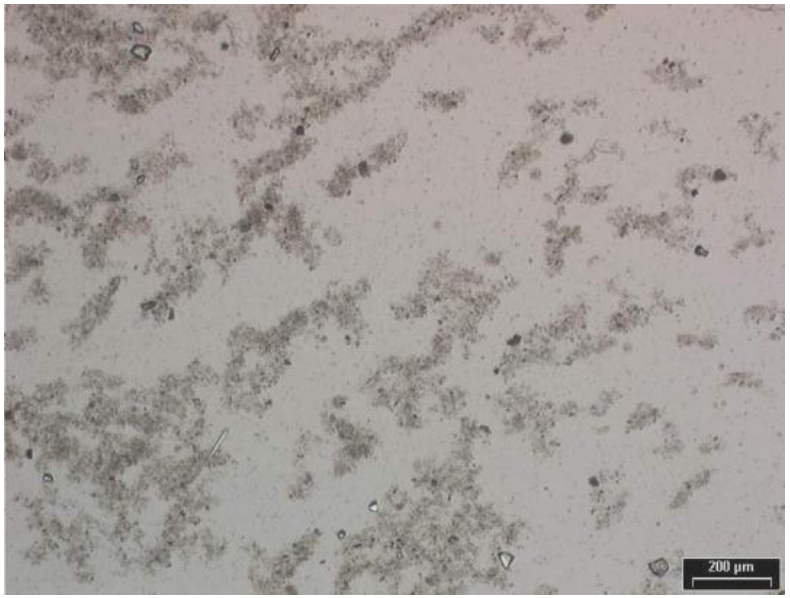
Cell lysis with ozone



Effect of cell lysis



$+O_3$



Activated sludge before ozonation

Activated sludge after ozonation

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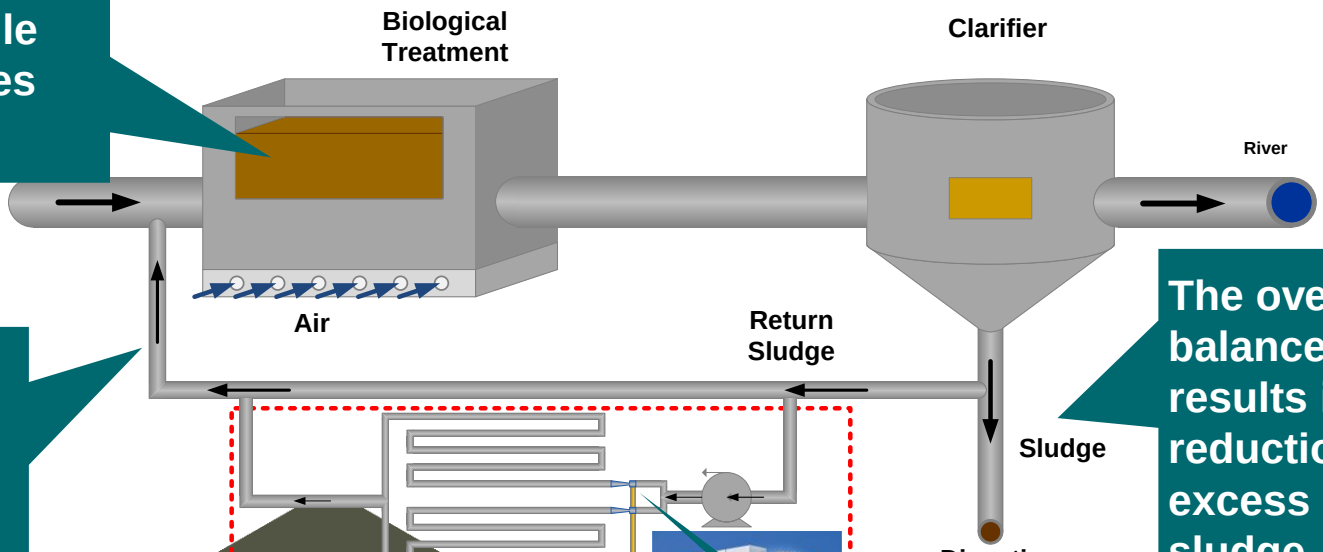
Aerobic sludge reduction in RAS line

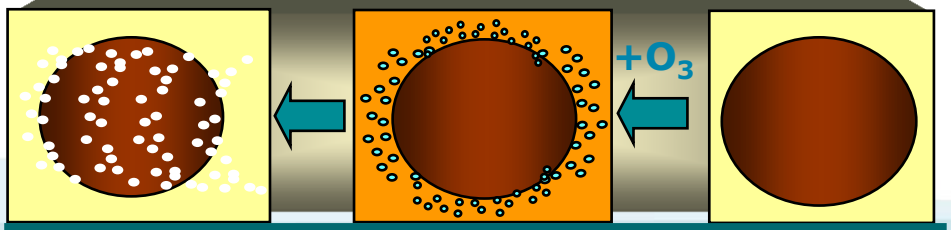
A part of the new food is used for cell metabolism, while the rest generates new cells



Highly biodegradable, new food for biomass (COD, N & P) is recycled to biological treatment.

The overall balance results in a reduction of excess sludge produced

O_3 is applied to RAS



O_3 attacks membrane and releases COD/N/P

Operational Improvement

The ideal solution for:

- Reduction of foaming + bulking
- Enhancement of settling / SVI / MLSS
  → Improve capacity
  → improve operational reliability

- **Same system layout as for Sludge Reduction**
- **Smaller Ozone dose**

Advantages

- Faster reactivity than chemical dosing – impact after 1-2 days
- No chemicals residuals (Al, Fe, Cl) in the water
- Opex for ozone is 50% of chemical dosing opex

Sludge treatment with Ozone
– 3 References –

- Bottrop, Germany
- Lariana, Italy
- Ardea, Italy

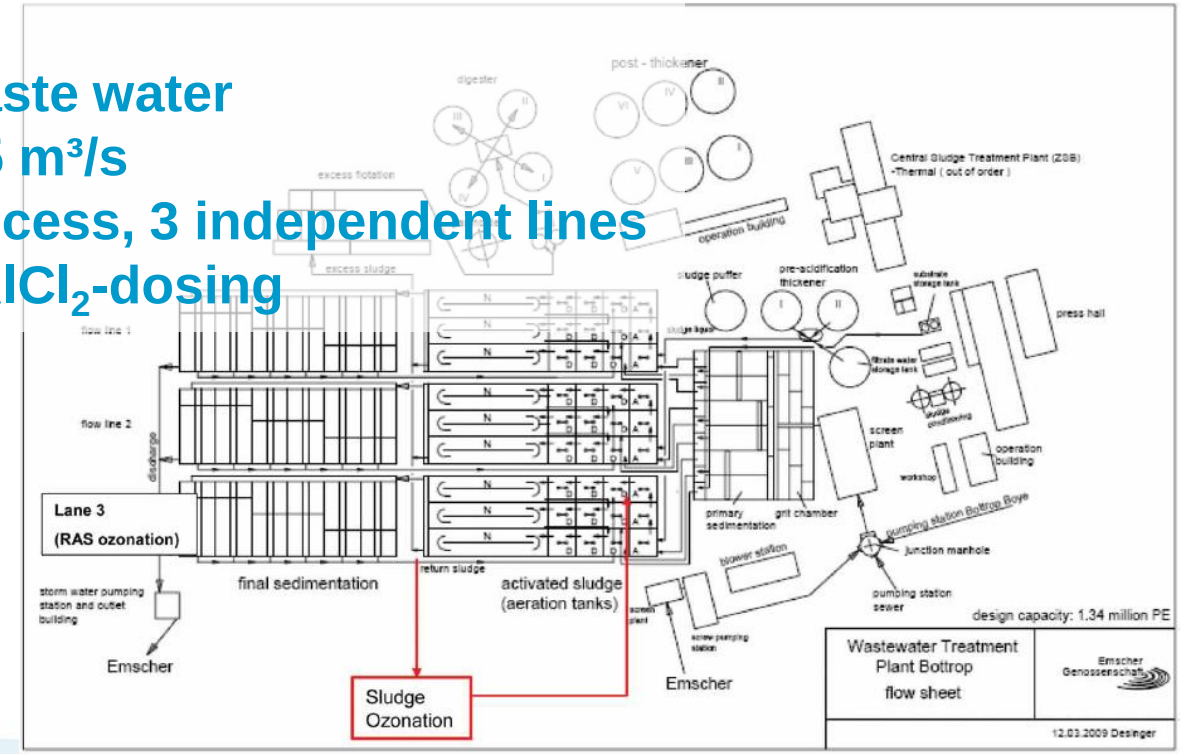
Reference 1: Bottrop, Germany

Client: Emschergenossenschaft

Application: Control of bulking / Filamentous reduction

Facts:

- 1.3 Mio. PE
- mainly municipal waste water
- Plant flow (dry): 4.25 m^3/s
- activated sludge process, 3 independent lines
- Bulking control by $AlCl_2$-dosing



Scheme of WWTP Bottrop [Lyko et al. 2012]

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Reference 1: Bottrop, Germany

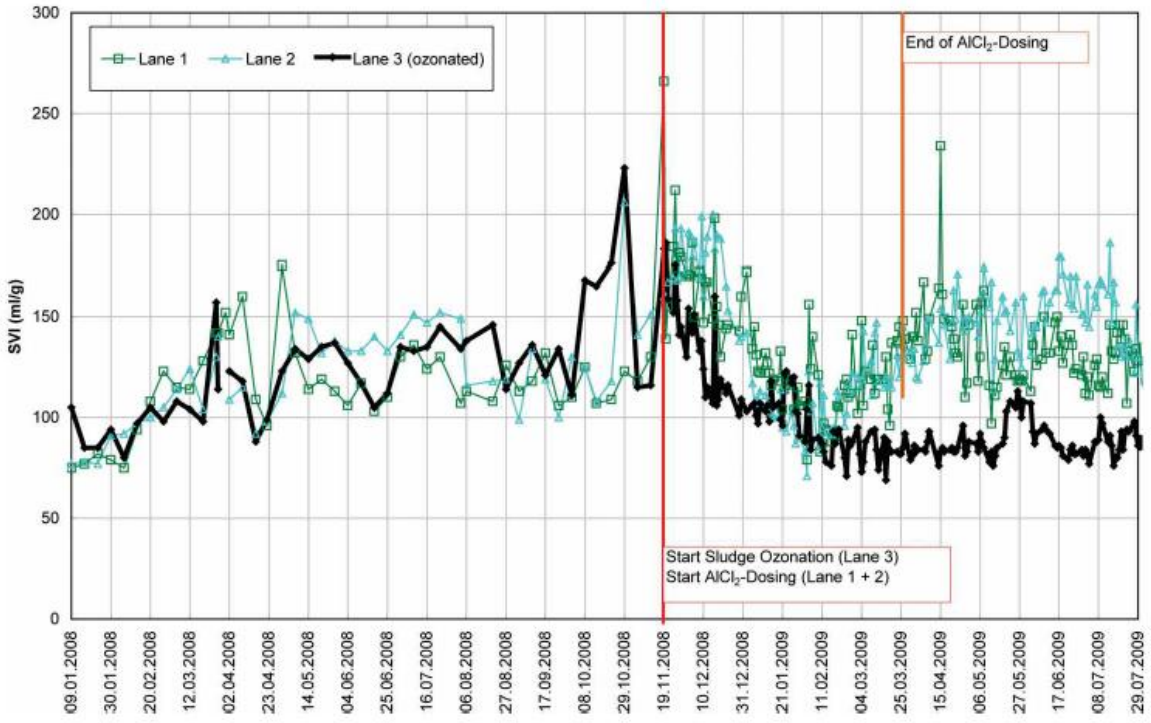
Equipment:
WEDECO SMO 600 (containerized), injection system, chilled water supply, O_3 contactor, ASPAL™ sludge process by AIR Liquide

Date of installation: 2008
upgrade to 1.3 Mio PE: 2013

Trials for Reduction of filamentous:

- 1 line of aeration tank treated with ozone, 2 reference lines
- ozone injection to sidestream of RAS: ~ 300 m³/h RAS (6% of total RAS)
- injection system: venturi + pipe reactor
- dosage: ~ 0.6 g ozone/m³ RAS
  ~ 0.0016 g ozone/$gTSS_{treated}$
- Alternating operation (1 week on / off)

Reference 1: Bottrop, Germany



Comparison of the evolution of SVI at WWTP Bottrop [Lyko et al. 2012]

Results:

- **Reduced SVI / Improved settleability**
- **Reduced consumption of flocking agent**

→ Upgrade to all 3 lines in 2013!

Results of trials:	O_3 treated line	Reference line ($AlCl_3$)
• Positive effect on settleability	SVI < 100 mL/g	SVI > 130 mL/g
• Increase of MLSS	3.5 g/L	2.5 g/L
• Detection of effect	after 2 days	up to 10 days

Reference 2: Lariana, Italy

Foam and bulking in the activated sludge process at WWTP Lariana, Italy [Fabiyi et al. 2007]

Client: WWTP Lariana, Bulgograsso, Italy

Application: Sludge reduction

Facts:

- 25,400 m^3/day
- mainly industrial wastewater (textile)
- activated sludge process, 2 lines
- sand filtration
- existing ozone system for decolourisation

Trials for Sludge Reduction:

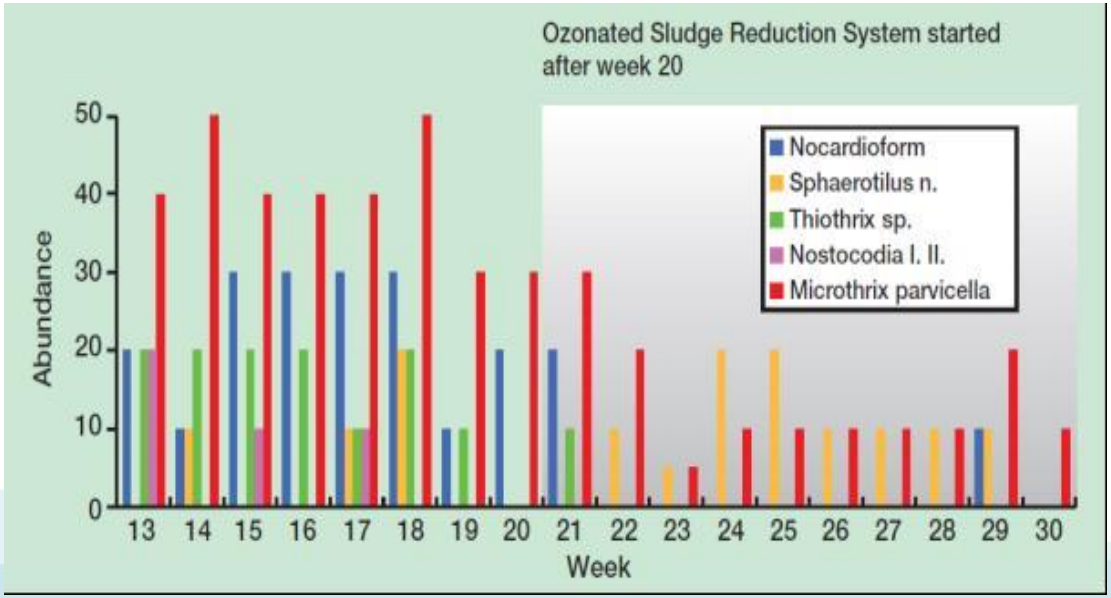
- 1 line treated with Ozone, 1 line reference
- ozone injection to sidestream of RAS: ~ 300 m^3/h RAS treated
- Dosage: ~ 10 g/m^3 $RAS_{treated}$
  0.05-0.10 kg O_3/kg $TSS_{removed}$
- Injection system: venturi + pipe reactor

Reference 2: Lariana, Italy

Foam and bulking in the activated sludge process with ozonation in operation [Fabiyi et al. 2007]

Results of trials:

- ~ 40% reduction of excess sludge
- Reduction of foam + filamentous bacteria
- Improvement of dewaterability
- Increase of dry solids content from 19 to 22%
- No increase of COD, Total nitrogen removal not affected



Investigation on filamentous and their reduction by ozonation [Fabiyi et al. 2007]

Reference 3: Idrica Ardea, Rome, Italy

Client: Idrica SPA

Application: Sludge reduction (2012)
+ elimination of micropollutants (2013)

Facts:

- 72.000 PE (W) up to 90,000 PE (S)
- Increase of population by 25%
- mainly municipal waste water
- Discharge into the sea (touristic area)
- activated sludge process

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Reference 3: Idrica Ardea, Rome, Italy

Equipment:

- Ozone generator WEDECO SMO600S (containerized assembled)
- venturi injection + contact tank (12 m³)
- chiller for closed loop cooling system

Date of installation:

pilot trials 2011 (6 months)
Startup full scale 2013

Details:

- ozone injection to sidestream of RAS:
  ~ 50 m³/h RAS (8% of total RAS)
- injection system: venturi + tank reactor
- dosage: ~ 4 g ozone/m³ RAS
  ~ 0,005 ozone/gTSS$_{treated}$

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Reference 3: Idrica Ardea, Rome, Italy

Results:
- SVI reduction
- Increase sludge dewatering + centrifuge performance
- Avg. excess sludge reduction ~ 40%

Multiple use concept (July 2014):
Implementation of ozone to effluent of WWTP for
- Disinfection (vs. chlorine)
- Micropolutant removal
- Decolorization

Add on:
- Disinfection + Micropollutant removal

Sludge treatment with Ozone
– Summary –

Summary - O_3 for Bulking & Foaming control

What full scale applications show…

- Required Ozone dosages for bulking control < 1 g/m³ $RAS_{treated}$
- Positive effects on settleability
  - → Decrease of SVI
  - → Increase of MLSS
  - → Improve plant capacity
  - → Improve operational reliability
  - → Reduction of flocculants + polymers
- Effect on filamentous detectable within 2 days
  - → Alternating operation possible (1 week on/ 1 week off)
- No negative effects on
  - → COD removal
  - → Nitrification rates
- Easy retrofit possible
- Multiple use of one ozone system for different treatment goals
  - → reduce overall invest and OPEX

Questions welcome!

Thank you for your attention!

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