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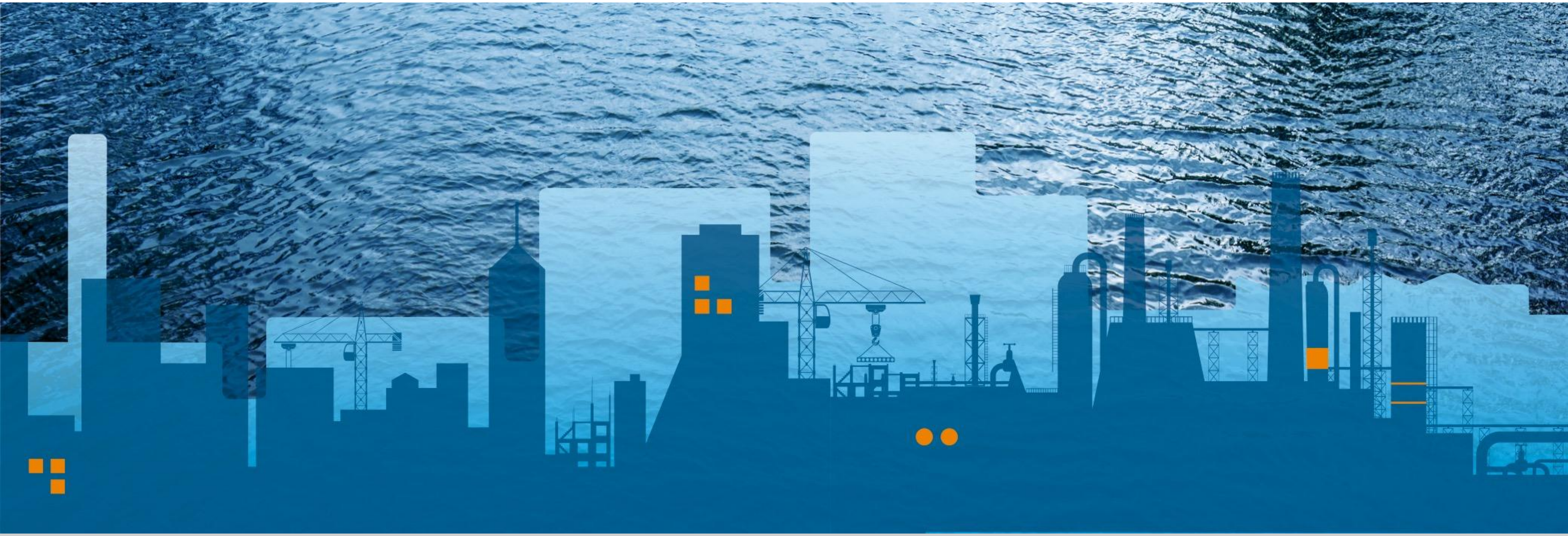
Better Efficiency for Industrial Sewage Treatment

Impact of inhibitors on biological wastewater treatment processes



Project Workshop in Kaliningrad, Russia
November 27, 2019

Riga Technical University
Dr.Sc.ing. Kristina Tihomirova, Mg.Sc.ing. Ksenija Golovko, Dr.sc. Ing. Tālis Juhna

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Industrial Sewage Treatment

What the

Heavy metals

Toxic substaces

Overload with typical components

GoA2.2 Data collection and feasible technologies testing (RTU)

1. Communication with water utilities companies
2. Literature study

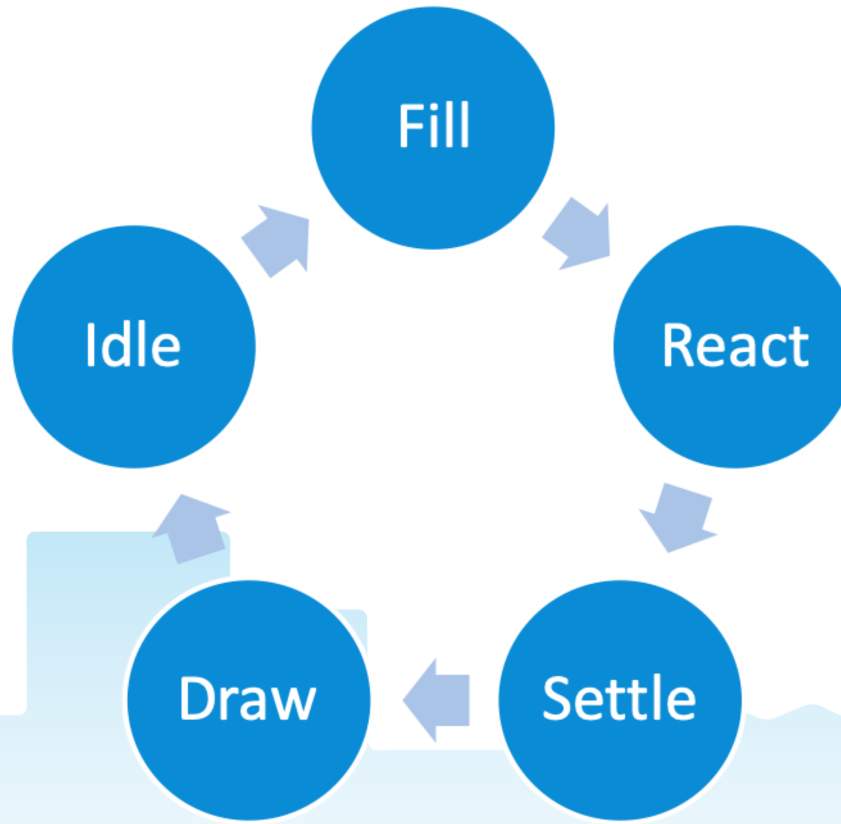
1. Data collection about accidents at WWTP (inhibition of the process)
2. Comparison of collected data and literature

1. List of the most popular inhibitors
2. Planing of experiments

Lab scale experiments: inhibitors of the biological wastewater treatment process

SBR pilot setup

SBR cycle stages



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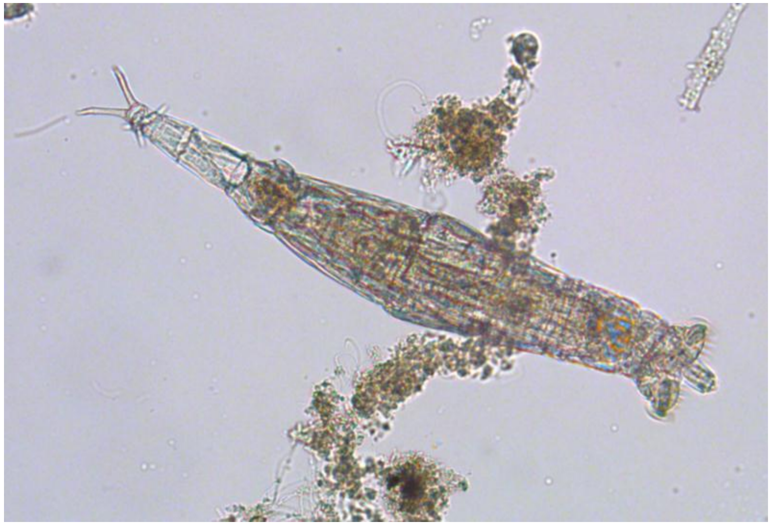
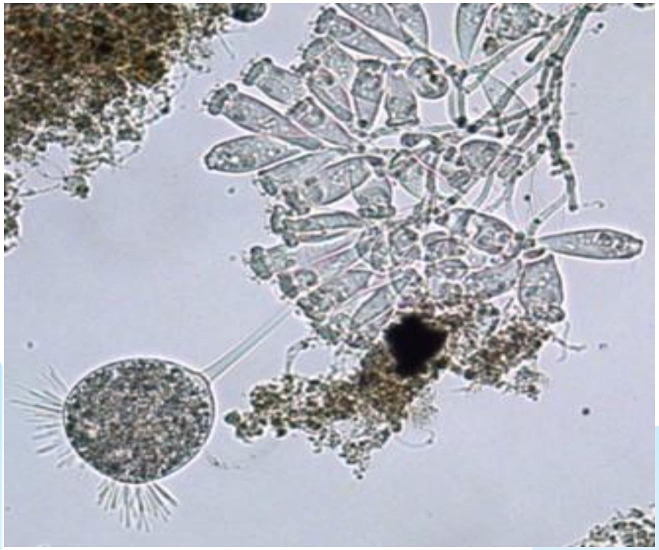
Sludge microfauna 12 indicative organisms

Shannon-Weaver diversity index identification used to evaluate changes.

Only 1h for analysis



Rotifer (*Rotaria* sp.)



Podophrya sp. and stalked ciliates colony

Worms (*Aeolosoma* sp.)

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1st Inhibitor:
Ammonia shock load reasons

What the concentration of ammonia is in the municipal wastewater

Municipal wastewater + Pre-treated industrial wastewater = **Inhibition**

30-100 mg/l

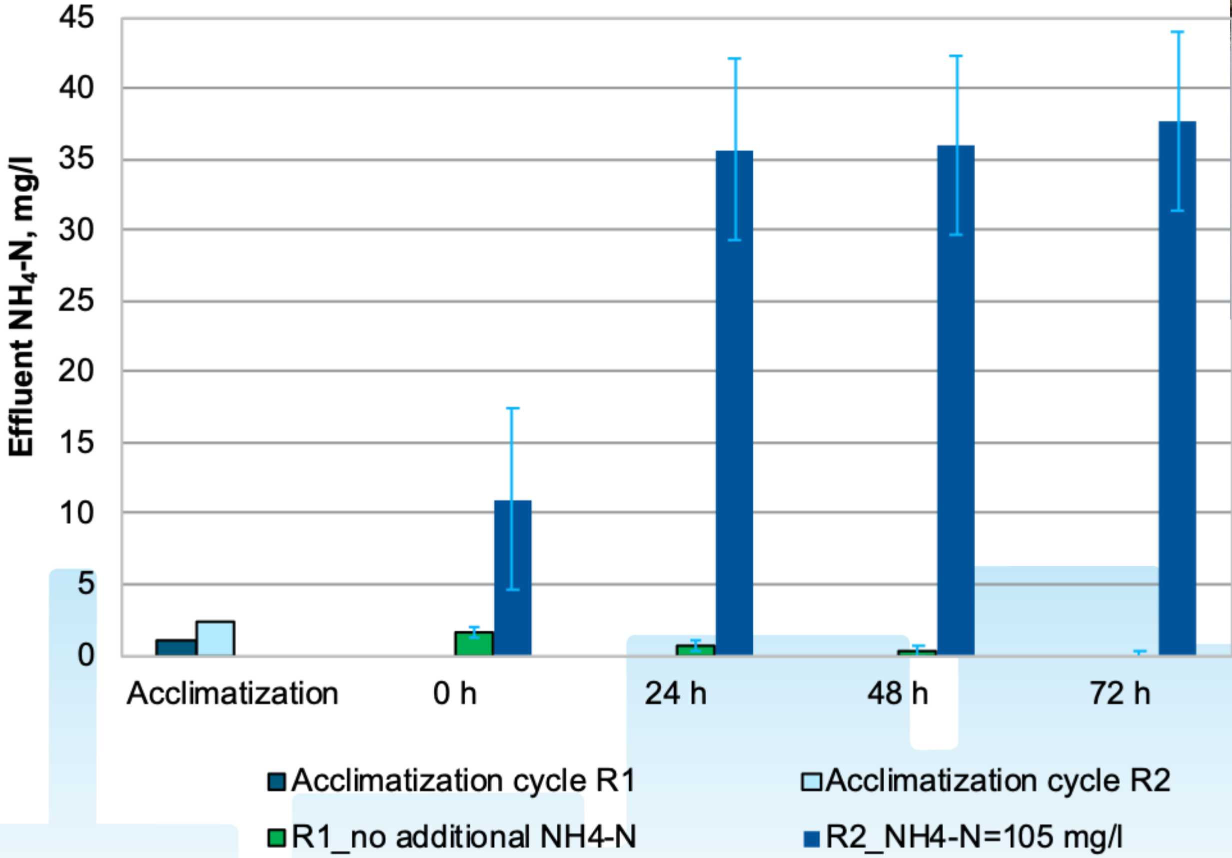
1st Inhibitor:
Ammonia shock load reasons

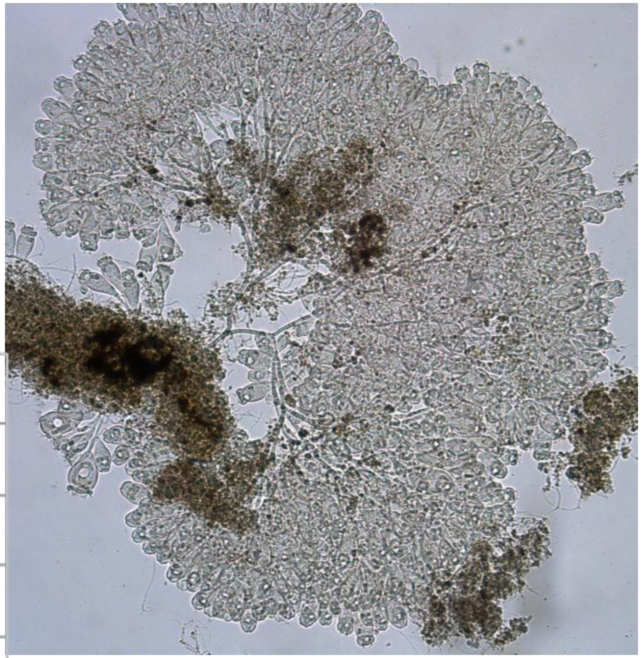
What the concentration of ammonia can be in the pre-treated industrial wastewater

Municipal wastewater + Pre-treated industrial wastewater = Inhibition

30-100 mg/l | **Up to 1000 mg/l**

Ammonia shock load effect





Epistylis sp. colony

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Take home messages:

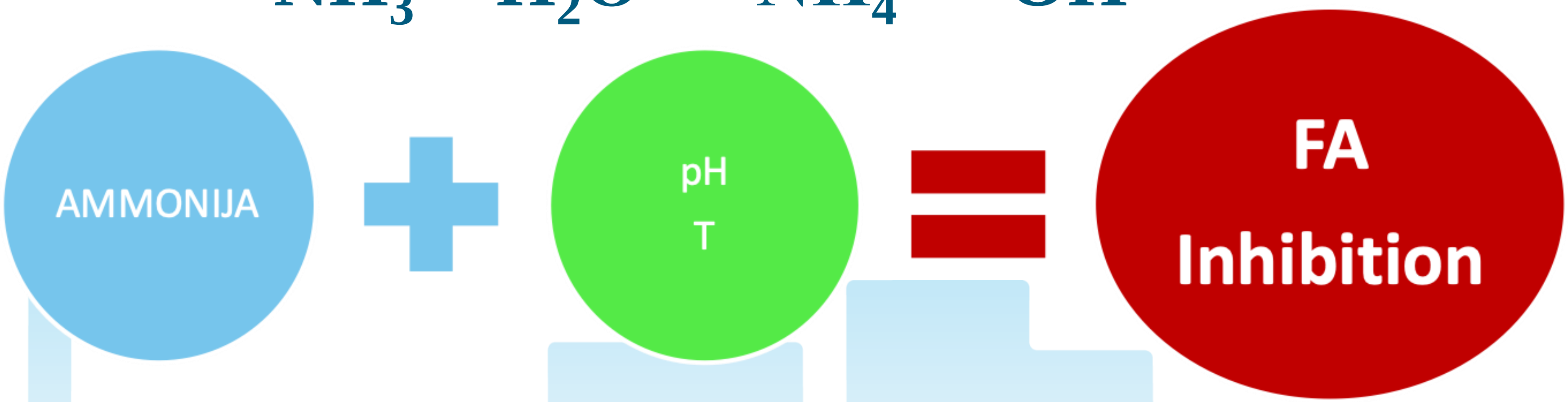
- Regeneration of the nitrification process after the shock organic compound load – after 10-24 hours (Hamoda and Al-Sharekh, 1999).

- At the same time, if ammonia concentration increases gradually, then after 48 hours ASP is capable of resisting up to 3 times higher ammonia concentrations than it was initially recorded (Puigagut et al., 2005).

2nd and 3d Inhibitors: pH and Free Ammonia (FA)

Ionized (NH_4^+) and unionized (or free ammonia NH_3 – FA) ammonia equilibrium:

$$\mathbf{NH_3 + H_2O \leftrightarrow NH_4^+ + OH^-}$$



2nd and 3d Inhibitors:
pH and Free Ammonia (FA)

What the concentration of FA is toxic for sludge biomass

AMMONIJA + pH T = FA Inhibition

>0,1 mgFA/l toxic for NOB
>10 mgFA/l toxic for AOB

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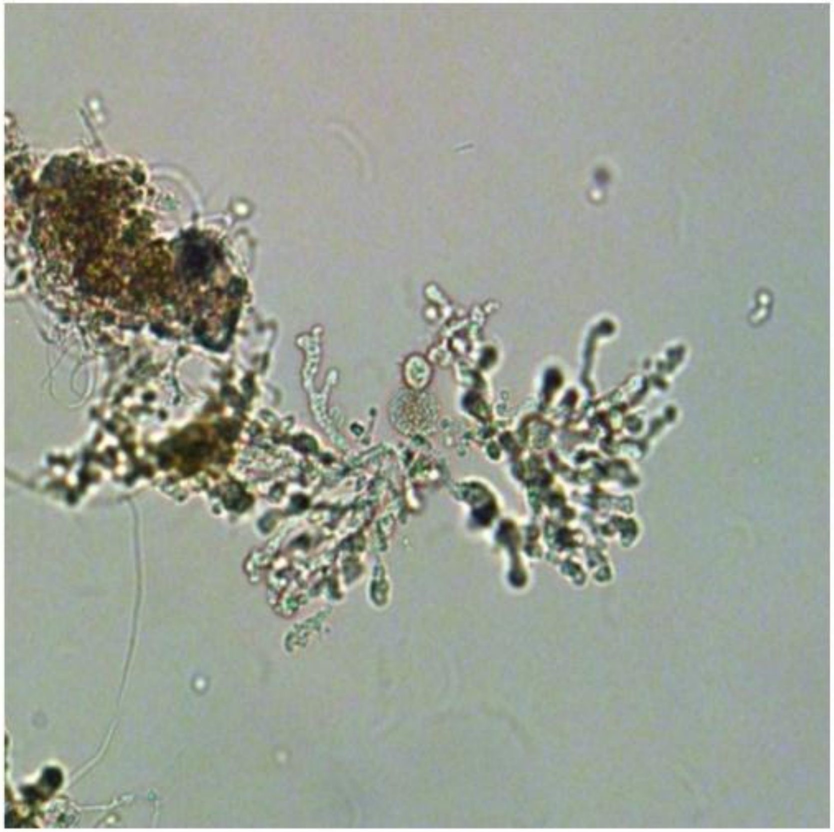
Low FA and low pH factors



Zooglea ramigera

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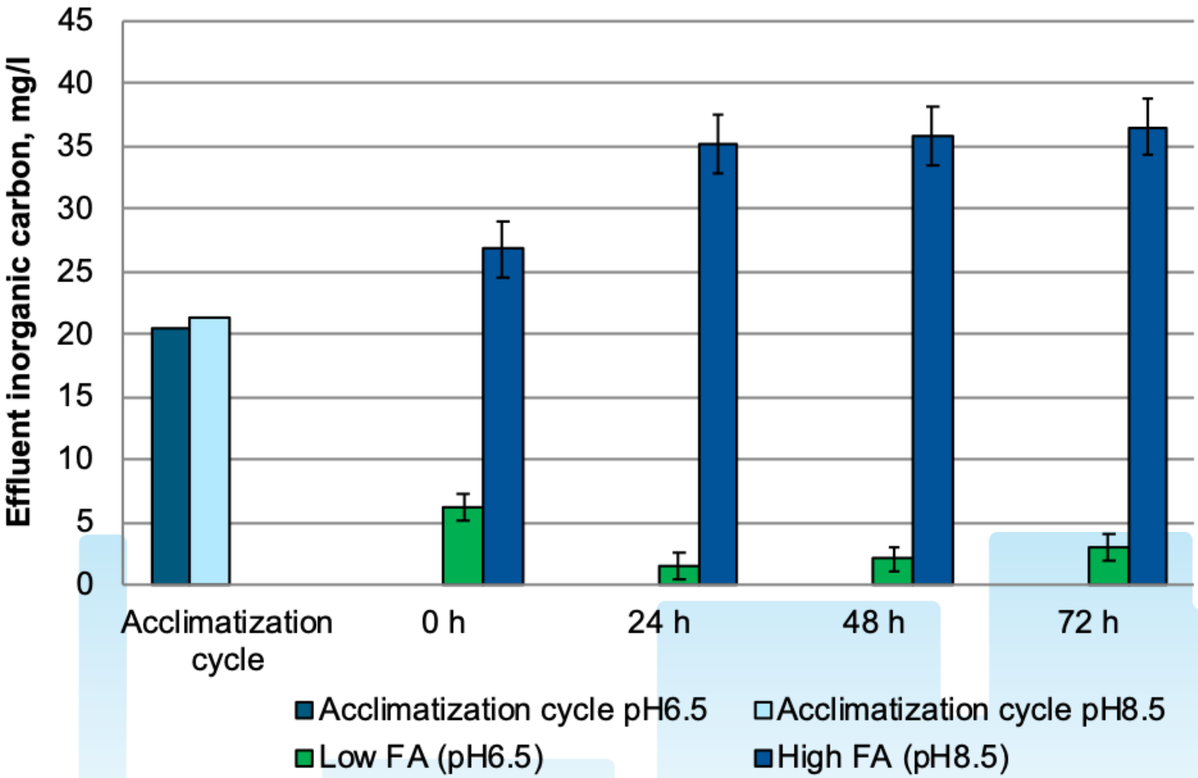
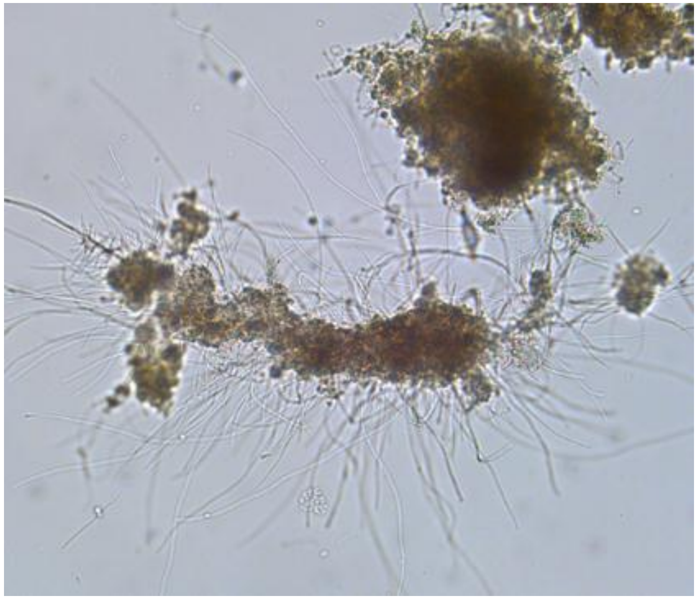
High FA and high pH factors





Filamentous sludge floccule

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Take home messages:

- Low FA (approximately 0.1 mg/l) under pH 6.5 is more destructive for the ASP-process than high FA under pH 8.5 (approximately 10 mg/l).
- Low FA reactor sludge microfauna had no population decrease comparing with high FA reactor. Although, low FA under pH 6.5 lead to zoogloea, gymnamoebae and *Chilodonella* sp. development.
- Zoogloea high abundance influenced sludge settleability, that led to sludge wash out from low FA reactor with following organic load increased and sludge foaming.

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4th Inhibitor:
Sodium chloride (NaCl)

What type of indutry is the main source of sodium chloride in wastewater

Municipal wastewater + Pre-treated industrial wastewater = Inhibition

FOOD industry

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4th Inhibitor:
Sodium chloride (NaCl)

What the EC level is in municipal wastewater usually

Municipal wastewater + Pre-treated industrial wastewater = **Inhibition**

0,7– 3 mS/cm

4th Inhibitor: Sodium chloride (NaCl)

What the EC level can be in pre-treated industrial wastewater

Municipal wastewater + Pre-treated industrial wastewater = Inhibition

0,7– 3 mS/cm

6 – 16 mS/cm

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Effect: Microfauna osmotic shock

Cephalodella (before NaCl addition)

Cephalodella (after NaCl addition)

Take home messages:

- AOB and NOB inhibition can be described by sludge leaching with following COD increase and degradation of microfauna
- Sludge microfauna have osmotic shock and dewatering after NaCl addition
- The most NaCl resistant microfauna genus/species are: testate amoebae *Arcella*, crawling ciliate *Aspidisca*, stalked ciliate *Epistylis*.

Acknowledgement

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#R054 BEST

We thank the Riga Water Ltd for providing test materials and supported microbial testing.

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Water Research laboratory

UITK

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