Oslo

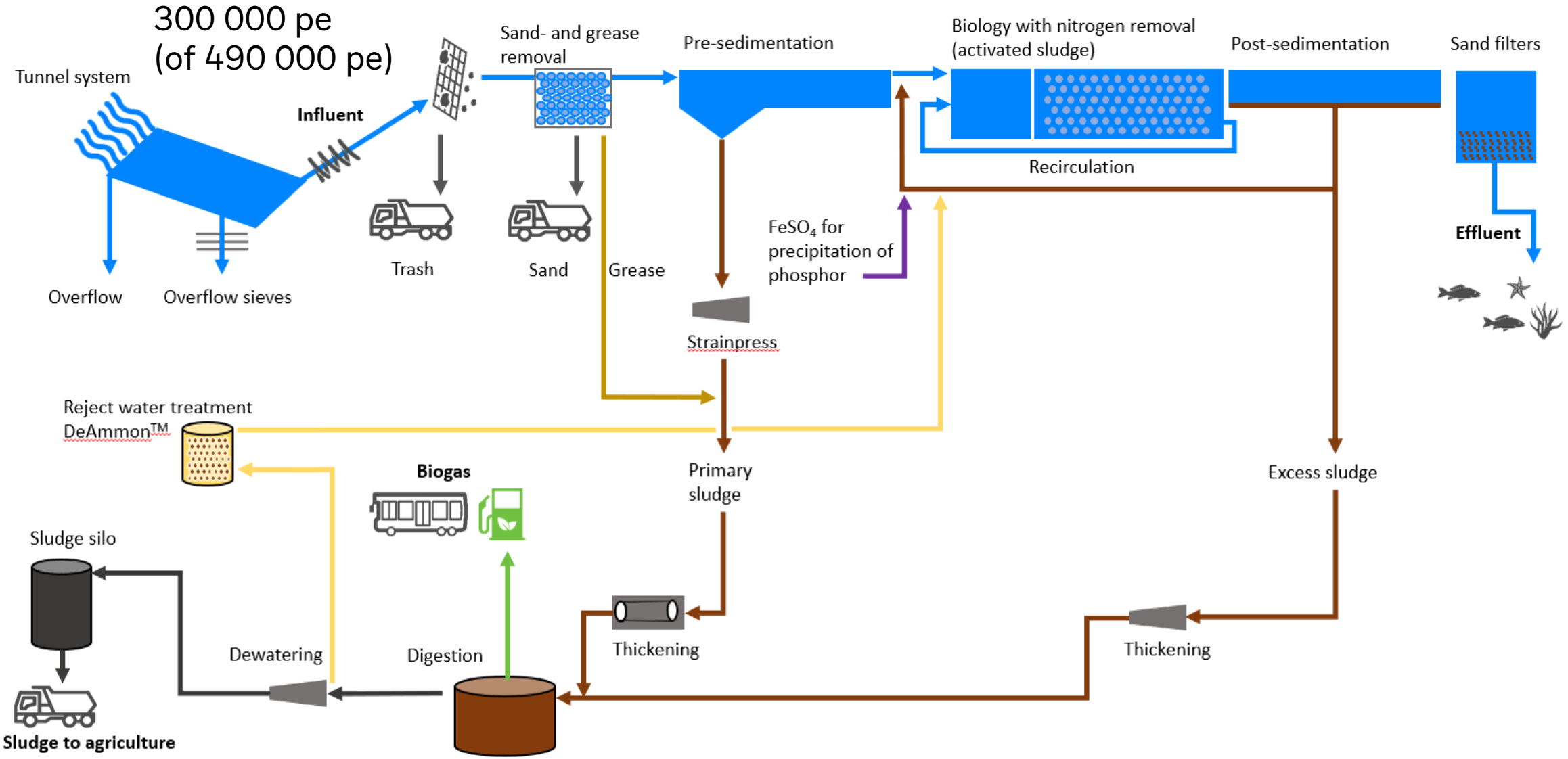
The collapse of the reject water treatment and its revival at Bekkelaget WWTP

Tommy Angeltvedt
Process engineer
8 years on Bekkelaget WWTP
Laboratory work and sample collection
Process monitoring – sludge

Hilde Tsui
Process engineer
2 years on Bekkelaget WWTP
Laboratory work and sample collection
Process monitoring - water

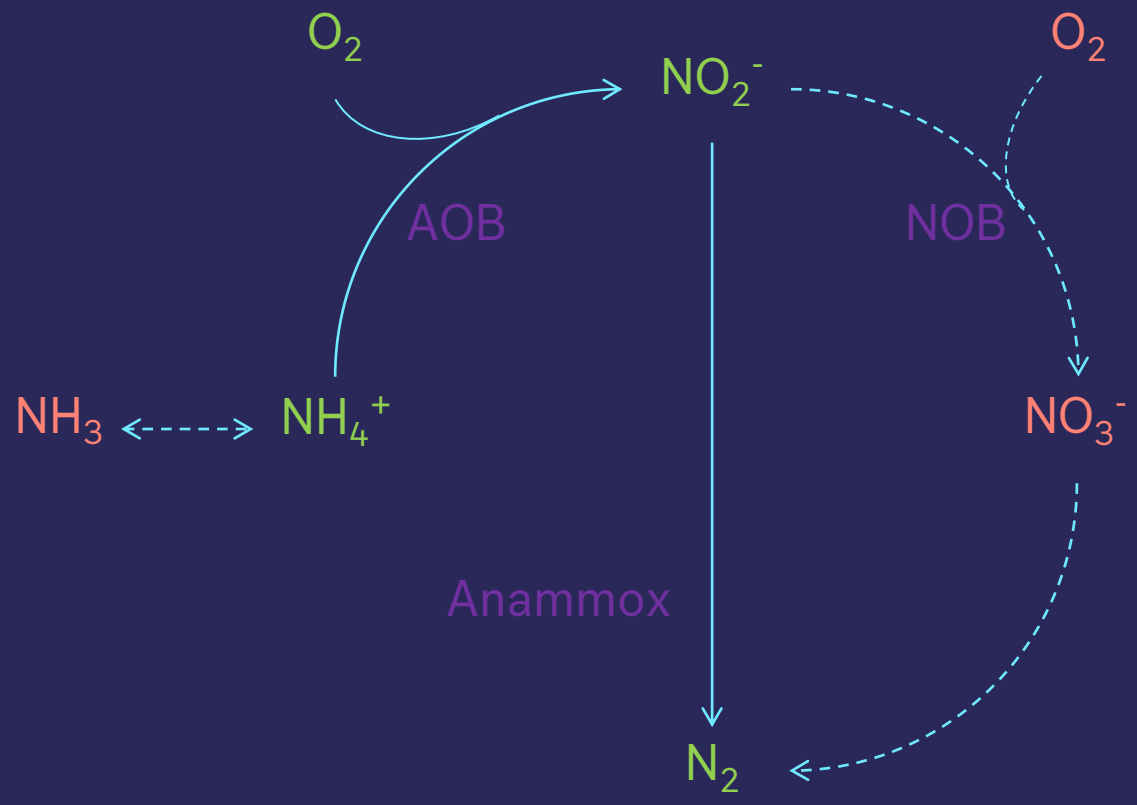
March 31st 2022

Flowchart Bekkelaget WWTP



The DeAmmon process

- AOB
  ammonia-oxidizing bacteria
- Anammox
  anaerobic ammonium oxidation
- NOB (unwanted)
  nitrite oxidizing bacteria



Facts about our reactor

- Moving bed biofilm reactor (MBBR)
- Put into operation in 2015
- Purification efficiency: >80%
- Current inlet: 21 m^3/h, 420 kg NH_4-N/d
- Capacity: 30 m^3/h or 640 kg NH_4-N/d
- Volume: 550 m^3
- Fluid depth: 6,4 m
- Intermittent aeration:
  70% (2,7 mg/L) of 120 minutes
- No additional mixing

Photo by Morten Rostad Haugen

DeAmmon started behaving strangely in 2020

Start-up of new thermophilic anaerobic digester tank as part of the expansion

Unexpected foaming in the reactor

Rise of pH and free NH_3 in reactor, then decrease of pH

pH then rising to new unwanted records 8,4
Accumulation of NO_2^- and sign of low Anammox activity

NO_2^- is stable on unwanted levels >350-450 mg/l, levels over 200 mg/l is poisonous for Anammox

Realization phase

July

NO_2^- still high, temperature in the reactor is dropping, by the end of June we were analyzing samples daily

August

Still daily analyzes, even some weekends. Collecting sample for Anammox analyze externally, made a 120 days plan for the revival

September

Test results regarding Anammox arrived, devastating results as the process is as good as dead with 1% Anammox left

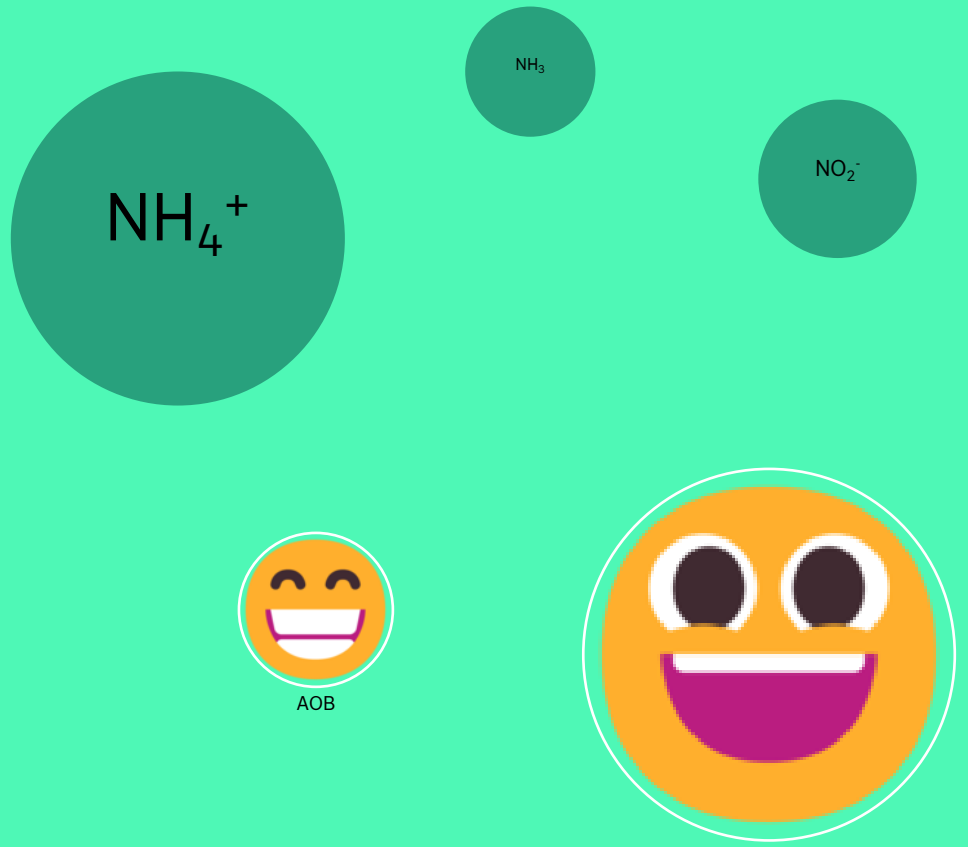
October

Waiting for the heating system to be completed so we can draw energy from the sludge treatment and O_2 blowers

November

The heating system is now delivering enough heat for the dilution of the reject water, start-up late that month

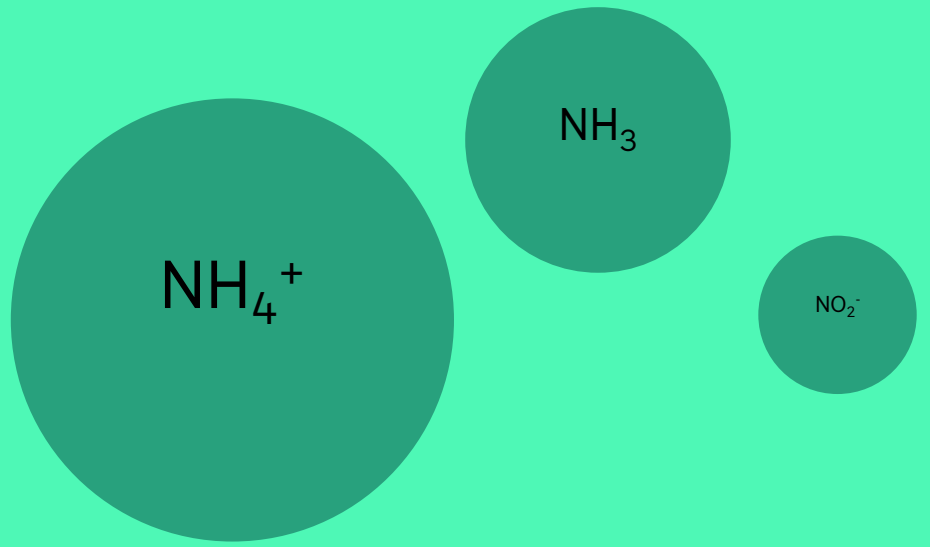
Hypothesis for collapse



1) A happy, healthy bacteria culture

Figures from emojipedia.org

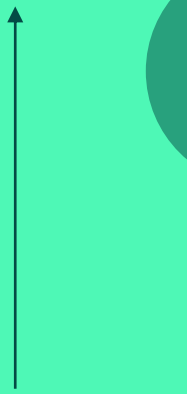
Hypothesis for collapse

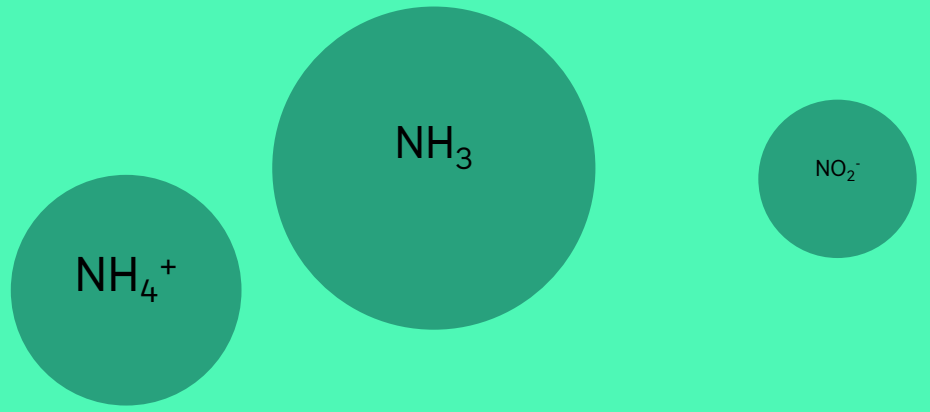


2) Introduced a new digester with the expansion of the plant

Figures from emojipedia.org

Hypothesis for collapse



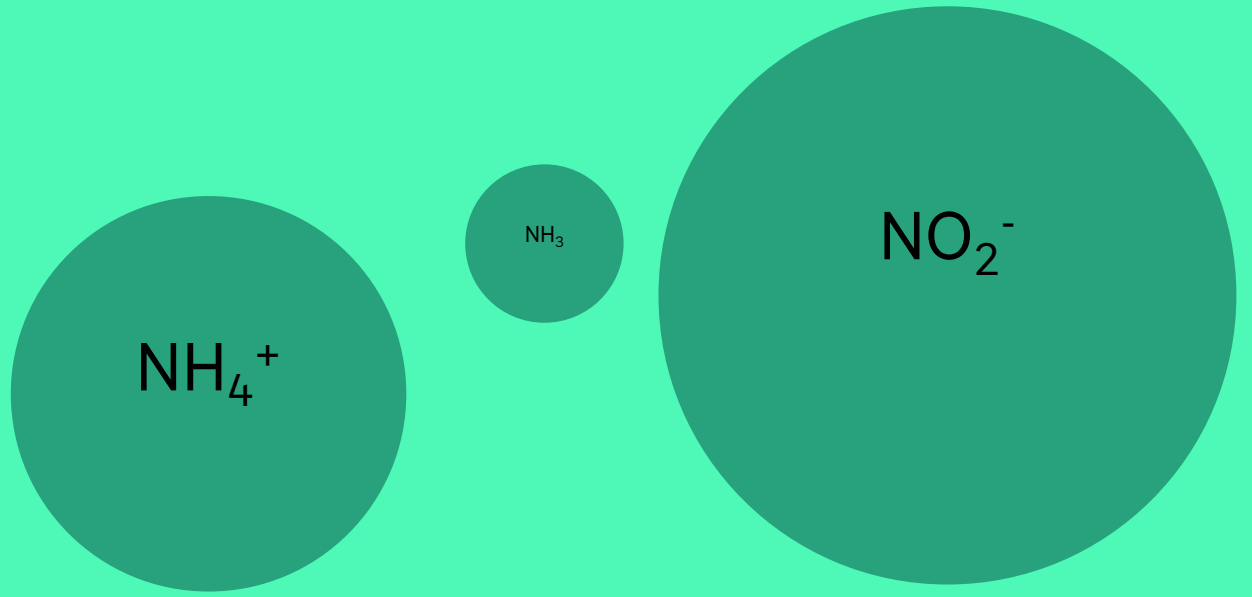


3) Inhibited AOBs led to a rise in pH

Figures from emojipedia.org

Hypothesis for collapse

pH (and temperature)



AOB

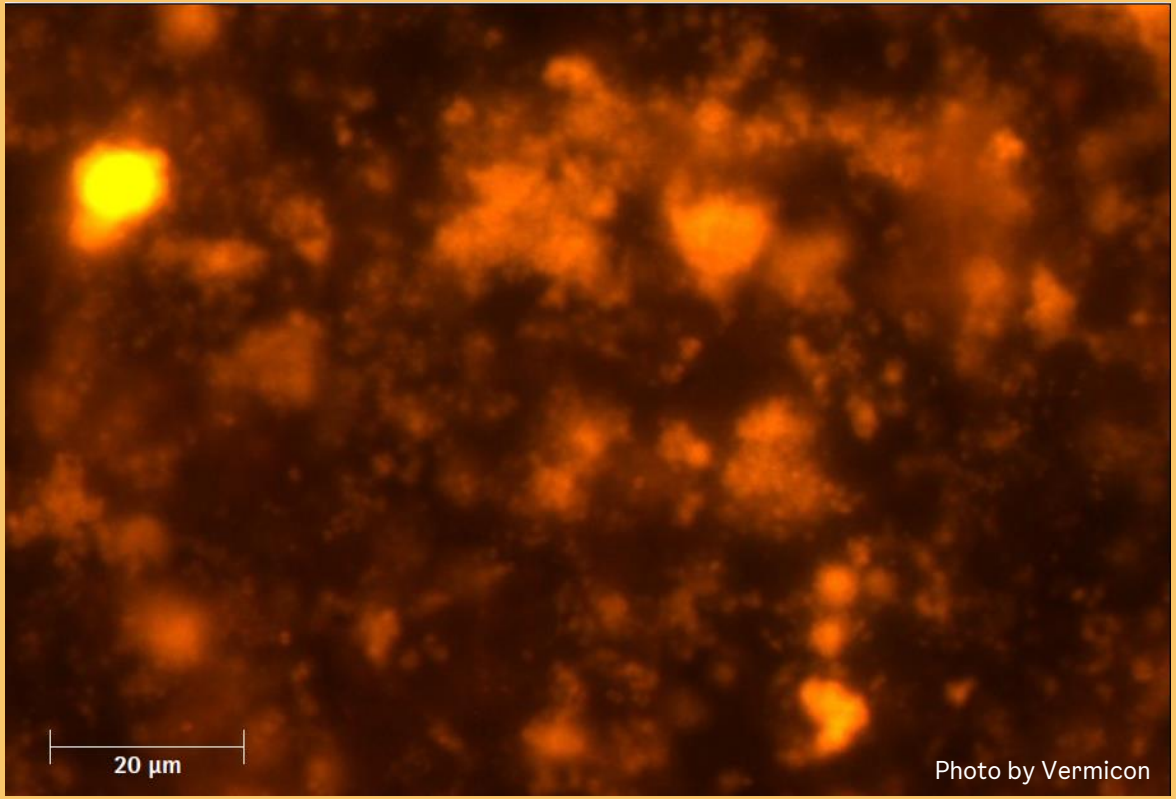
Anammox

4) AOBs recovered more quickly when the pH decreased, producing poisonous levels of NO_2^- for the Anammox bacteria

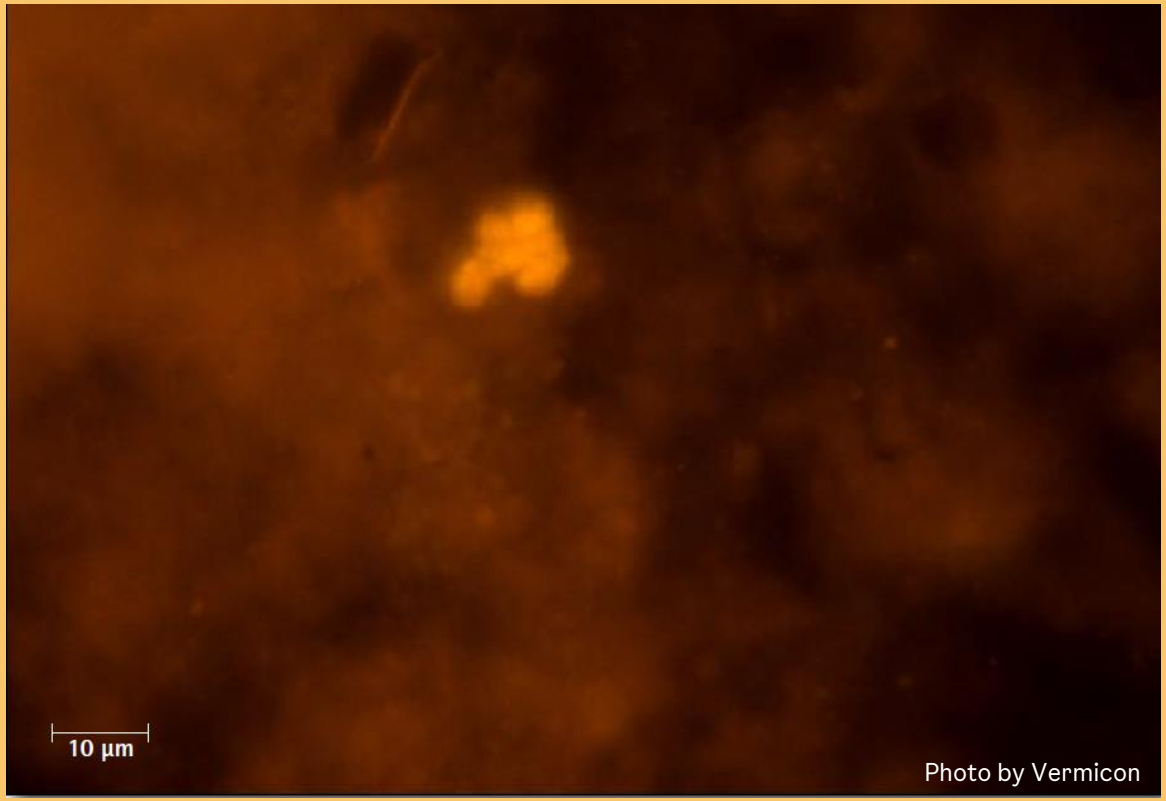
Figures from emojipedia.org

Specific detection of Anammox bacteria
- through a fluorescence microscope

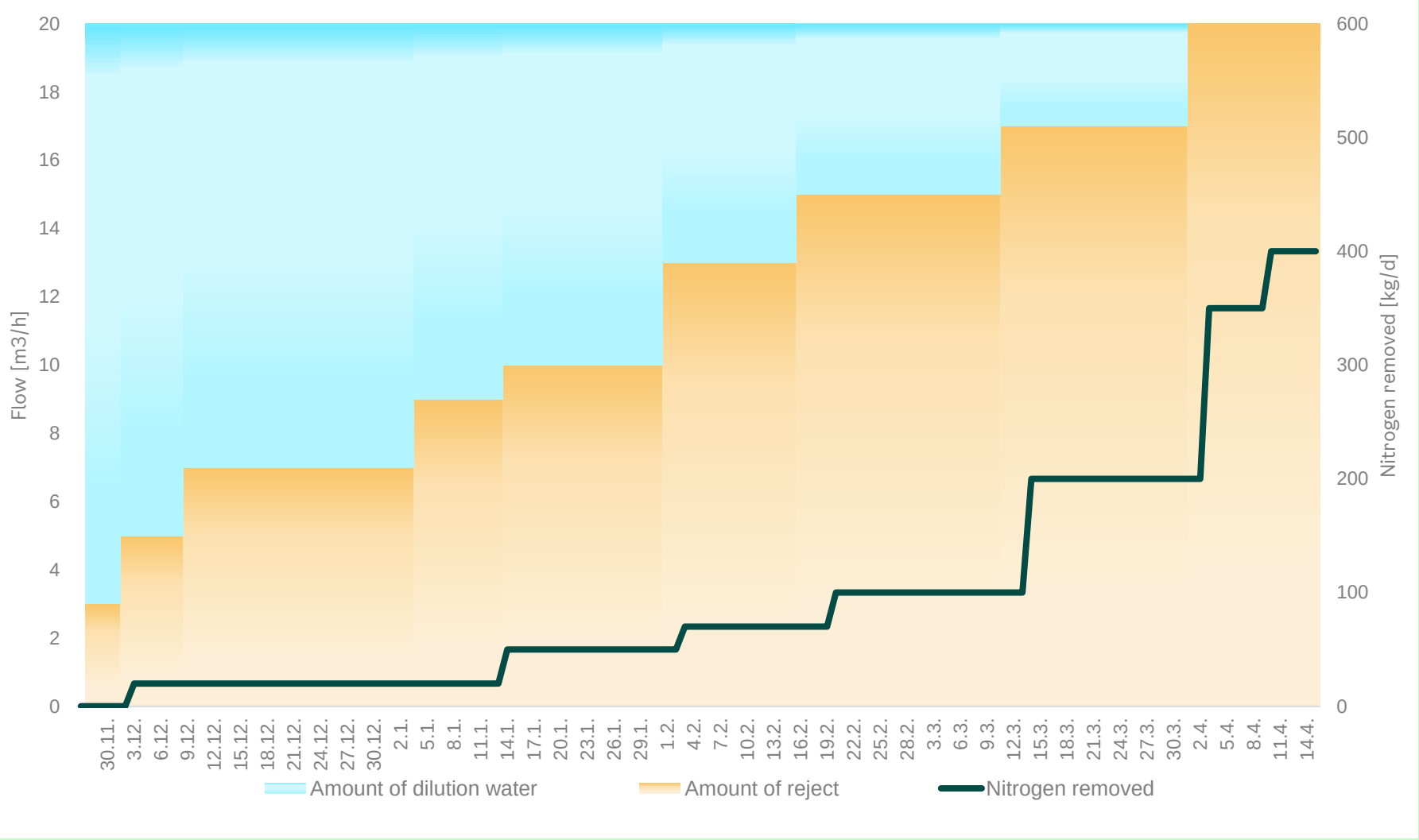
June 2016 (62%)



August 2020 (1%)



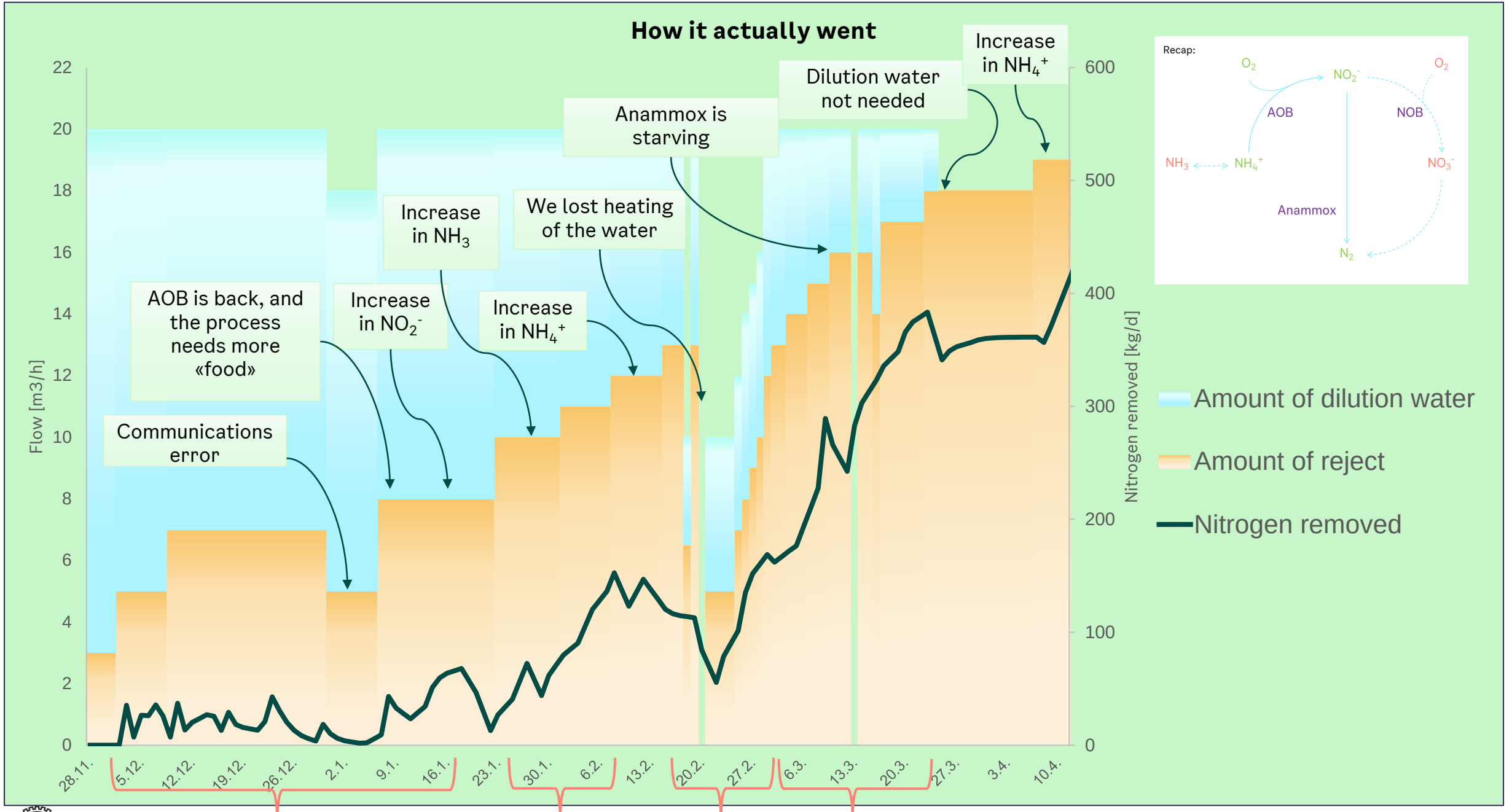
The plan for revival



Plan based on:

- Previous start-up in 2015
  - 120 days
  - Goal 2015: detect Anammox
  - Goal 2021: remove 400 kg N/d
- Best practice
  - Dilute NO_2^- to 50-100 mg/L (from 450 mg/L) before start-up
  - Keep a short HRT for optimal growth of Anammox

How it actually went



First signs of Anammox on day 60

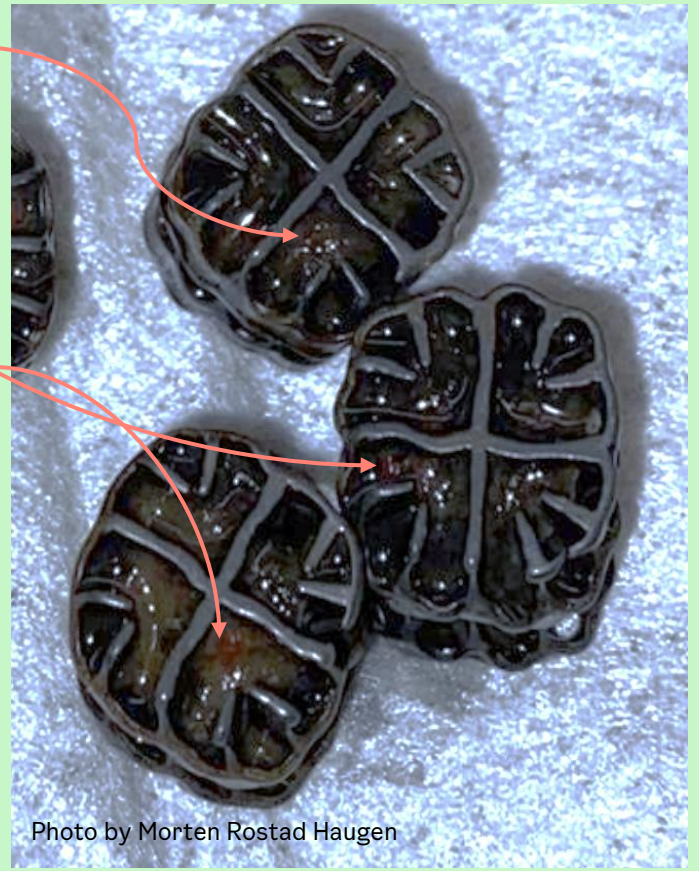


Photo by Morten Rostad Haugen

Anammox goal reached after 135 days
400 kg/d purified

GIF from Tenor.com

Resources

- Follow-up meetings:
  3-5 times/week
- Laboratory analysis:
  3 times/week

Parameter	Inlet	Reactor (outlet)
NH_4^+ [mg/L]	X	X
NO_2^- [mg/L]		X
NO_3^- [mg/L]		X
pH	X	X
Alkalinity [mEq/L]	X	X

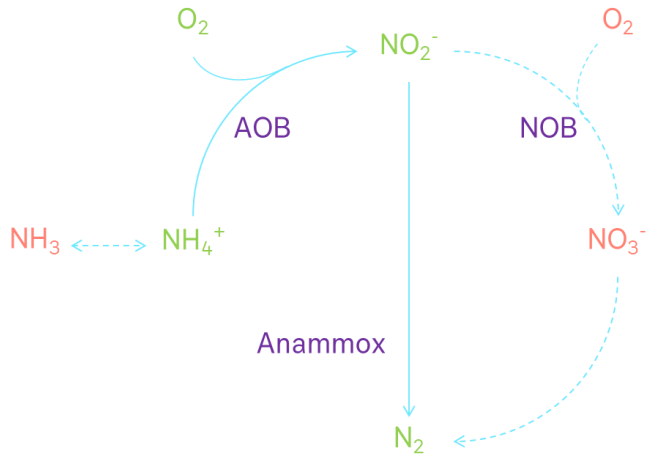


Photo by Hilde Tsui

Reflections

What did we learn?

- Perform lab. analysis regularly when the reactor is healthy
- Increase the frequency of analysis when there are significant changes in the plant
- Monitoring of NO_2^- is important
- When there is a struggle between high amounts of NO_2^- or free NH_3: choose high free NH_3 as it is reversable, thus more forgiving

What should we look for if it happens again?

- Increase in pH and/or free NH_3 followed by an increase of NO_2^-

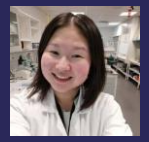
What do we know if it should happen again?

- Familiar with characteristics of a collapse, so it is not necessary to perform daily lab. analysis
- If possible, measures should be taken at once when the increase in NO_2^- occurs (stop inlet or dilute)

Thank you for your attention ☺

Tommy Angeltvedt

- tommy.angeltvedt@vav.oslo.kommune.no
- https://www.linkedin.com/in/tommy-angeltvedt



Hilde Tsui

- hilde.tsui@vav.oslo.kommune.no
- https://www.linkedin.com/in/hilde-tsui

Sources for graphics:
- https://emojipedia.org/ (22.03.22)
- https://tenor.com/view/celebration-confetti-happy-success-cat-gif-18947879 (24.03.22)

Photo by Hilde Tsui