Inhibitory effects on Nitritation by vapour condensates from sludge drying

- Optimization of sludge liquor treatment -

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BACKROUND AND MOTIVATION

Nitritation has gained high interest as an option to treat ammonium-rich waste waters in full-scale applications due to its economic benefits by reduced aeration costs. Especially the operation as side stream treatment for waste waters from sludge liquor treatment is well explored and adopted. Essential for the efficient and energy saving implementation of a Nitritation are a high biomass concentration and adequate conversion rate of Ammonium-Oxidising-Bacteria (AOB). While the sensitivity of AOB to a variety of inhibitory factors like pH, ammonia and nitrous acid are well studied, other inhibitory influences related to waste water specific substances are less established.

In regard to an overall energy optimized treatment concept the combination of an extensive carbon utilization and the energy minimized nitrogen removal process Deammonification is studied in the scope of the BMBF project E-KLÄR. Therefore, waste waters from different sludge (pre-) treatment steps like anaerobic digestion, thermal pressure hydrolysis (CAMBI) and sewage sludge incineration are investigated and tested for inhibitory effects on autotrophic biogenesis within this project.

This poster is focused on:

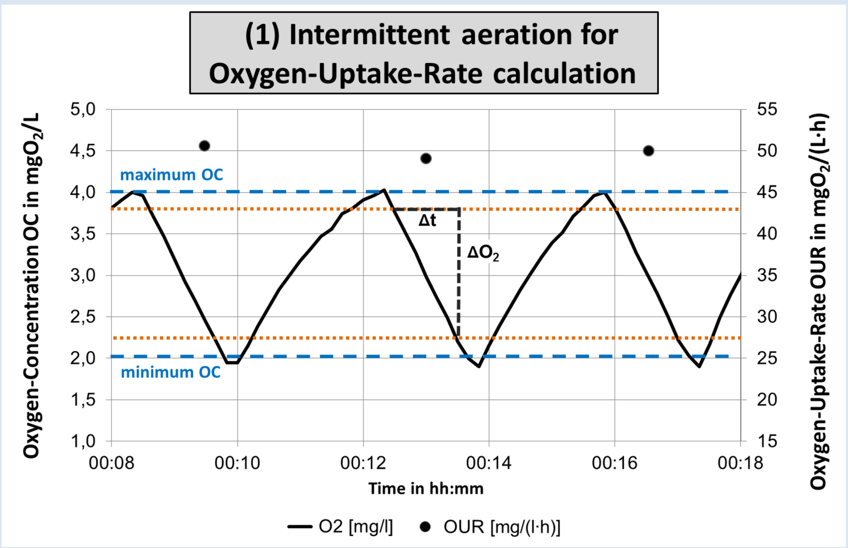
(A) an efficient and optimized method to determine inhibition effects by Oxygen-Uptake-Rate measurement
(B) established inhibition effects by vapor condensate from sludge drying facilities

(A) METHOD TO DETERMINE INHIBITION EFFECTS

Application of intermittent aeration for OUR calculation (picture 1)

- A two-step-aeration control is installed to determine the Oxygen-Uptake-Rate (OUR)
  - $4 < OC < 2$ mgO_2/L → aeration is automatically switch off/on
  - Aerobic conditions are beneficial for biomass and no oxygen limitation occurs

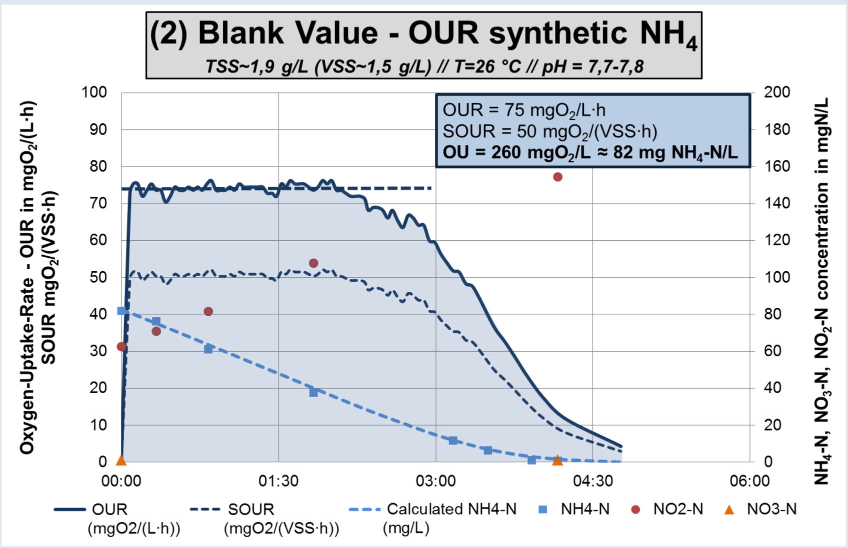
→ OUR is calculation from the linear OC decrease period between 3.8 down to 2.2 mgO_2/l

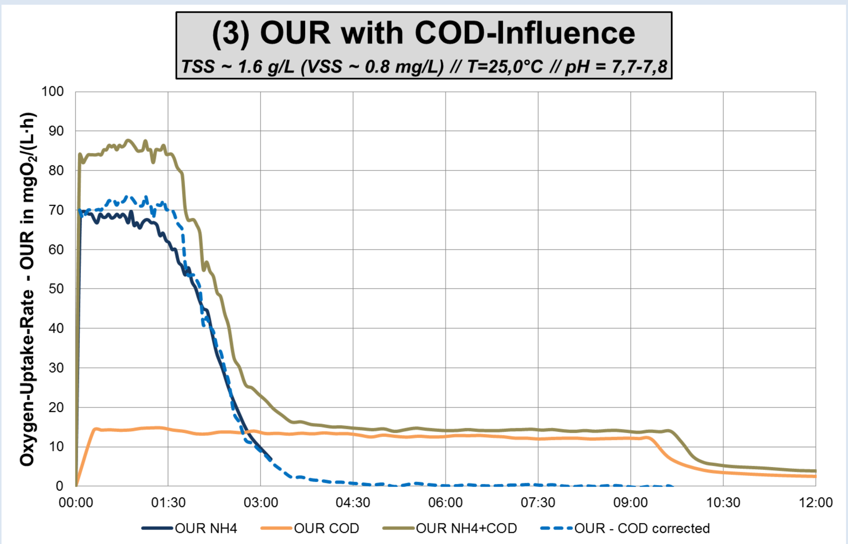


Batch Setup

The respiratory measurement of the Oxygen-Uptake-Rate (OUR) is a reliable and efficient method to determine the fraction and the activity of aerobic sludge communities. By means of the reviewed composition this technique can also be used to determine inhibition effects on activated sludge. For that purpose particular details have to be considered.

- Blank value is required → gain a comparable and non-inhibited OUR for autotrophic respiration
  Reactor A - 100% synthetic NH_4-N dosage (picture 2)
- In activated sludge communities diverse types of microorganism occur and the waste waters contain COD as well as nitrogen compounds. Therefore, the OUR has to be distinguished for different respiration processes → gain heterotrophic OUR from COD degradation (picture 3)
  Reactor B - 100% waste water and Allylthiourea (ATU; 86 µM)
- To identify the waste water related inhibition factor the OUR for each waste water is determined in 2 dilution ratios (picture 4)
  A massive difference in these 2 curves allows to derive inhibition effects by the waste water.
  Reactor C1 - 100 % waste water
  Reactor C2 - 50% waste water + 50% synthetic NH_4-N dosage
- For comparable and reliable results the TSS content and NH_4-N concentration/load should be similar in every reactor. Furthermore temperature and pH control is required.





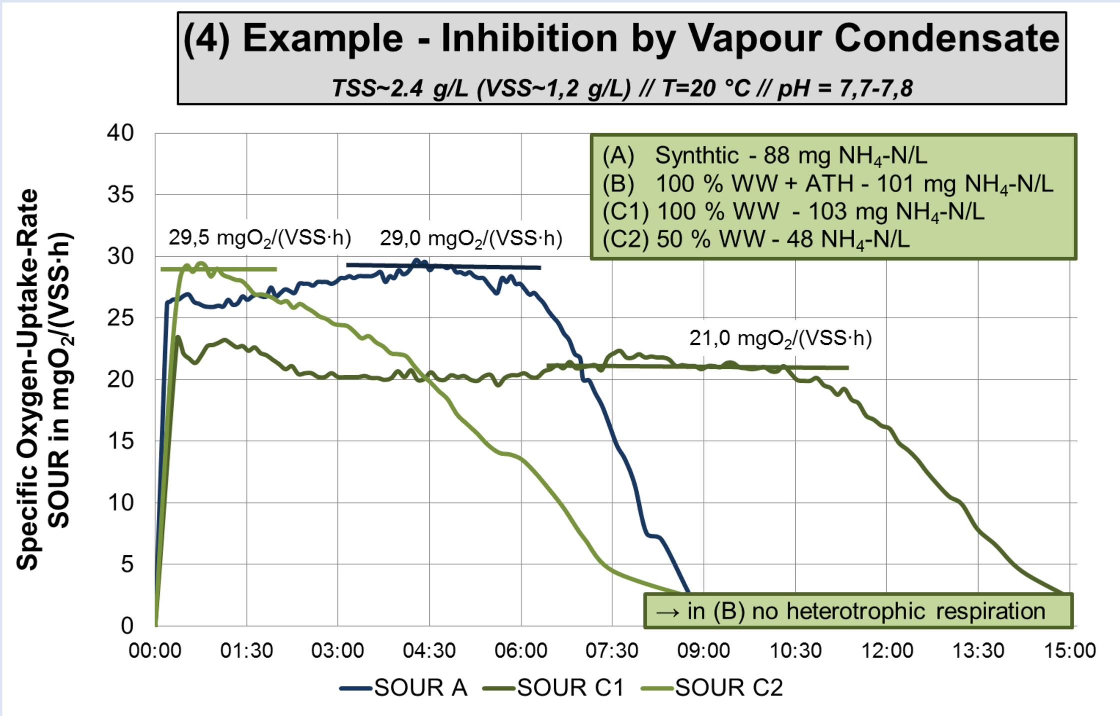
Evaluation

→ Immediate increase of OUR up to maximum value followed by stable trend (no inhibition)
→ Integration of shaded area → Total oxygen uptake (OU) in mgO_2/L → OU can be correlated with present NH_4 load (picture 2)
→ Specific-Oxygen-Uptake-Rate (SOUR) in $mgO_2/(VSS \cdot h)$ for reactor specific respiration rates
→ COD influences can be corrected → exclusively AOB activity can be evaluated (picture 3)

Résumé

→ Fast evaluation possibility to determine first inhibition effects within 1 h.
→ Ideally OUR measurement requires no detailed application of chemical analysis for standard parameters.

(B) INHIBITION EFFECTS BY VAPOUR CONDENSATE



Inoculum - Nitritation Sludge originates from an intermittent aerated high loaded full-scale Nitritation reactor for sludge liquor treatment of a municipal WWTP.
Vapour condensate originated from an incineration plant (GER), where sludge is dewatered in centrifuges and dried in thin layer dryers at T=110-140°C.

Evaluation of inhibition effects:

→ Increase of the OUR up to different maximum values
→ OU in mgO_2/L is still correlated to specific NH_4 load
→ Heterotrophic respiration - $SOUR_B = 0$ $mgO_2/(VSS \cdot h)$ → no COD respiration
→ Uninhibited $SOUR_{max}$ in B+C ~29 $mgO_2/(VSS \cdot h)$
→ Reduced $SOUR_A$ of 21 $mgO_2/(VSS \cdot h)$ + longer respiration time → 30% inhibition

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