SLUDGE COMPOSITION DURING OZONE ACTIVATION: PRELIMINARY RESULTS OF ITS REUSE CAPABILITIES AS CARBON SOURCE FOR DENITRIFICATION.

Desislava Bögner*, Frederike Schmachtl, Björn Mayr, Lotte Pohl, Christopher P. Franz, Gregor Jaehne, Kai Lorkowski, Matt Slater

AcOMaCS: Activated Particulate Organic Matter as Carbon Source for Denitrification

Aims: **improve** ecological and economic efficiency of RAS **by recycling** particulate wastes. Final product: Processing device for sludge.

Studies on nutrient budgets of RAS with special interest on sludge and foam nutrient contents and system performance at commercial scales

Suitability of Ozone treatment for disintegration of particulate organic matter into biodegradable and readily available carbon sources

Effectiveness of ozone-treated sludge as Carbon source for denitrification tested in mini-denitrification reactors (Lab-scale) and RAS (commercial scale)

Pictures: M. and D. Bögner

AcOMaCS: Activated Particulate Organic Matter as Carbon Source for Denitrification

Aims: **improve** ecological and economic efficiency of RAS **by recycling** particulate wastes. Final product: Processing device for sludge.

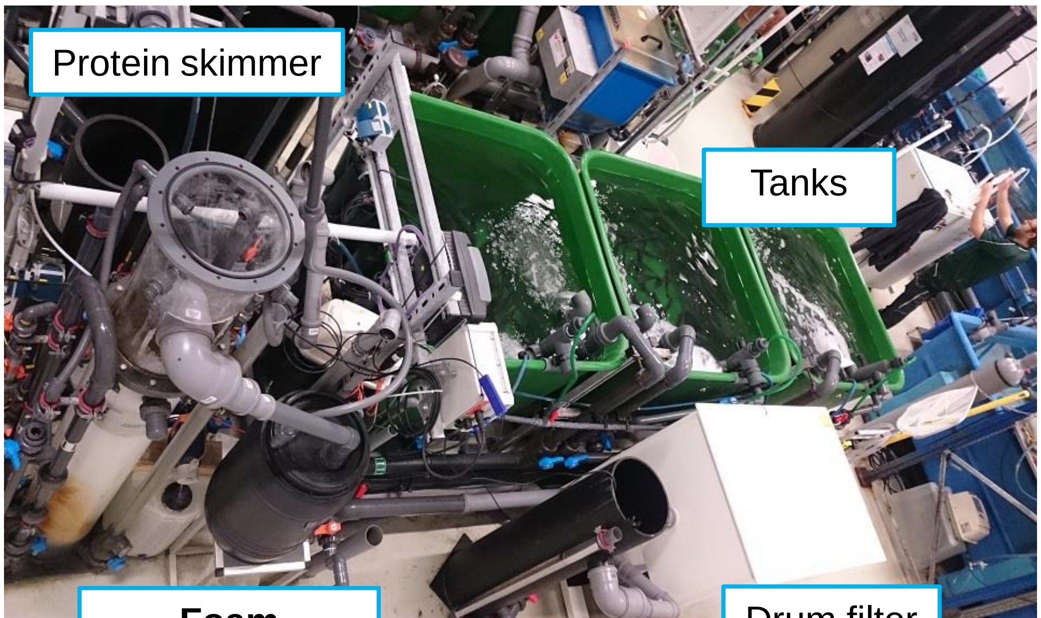
Studies on nutrient budgets of RAS with special interest on sludge and foam nutrient contents and system performance at commercial scales

Suitability of Ozone treatment for disintegration of particulate organic matter into biodegradable and readily available carbon sources

Effectiveness of ozone-treated sludge as Carbon source for denitrification tested in mini-denitrification reactors (Lab-scale) and RAS (commercial scale)

Pictures: M. and D. Bögner

AcOMaCS: Activated Particulate Organic Matter as Carbon Source for Denitrification



Pictures: D. Bögner

AcOMaCS: Activated Particulate Organic Matter as Carbon Source for Denitrification

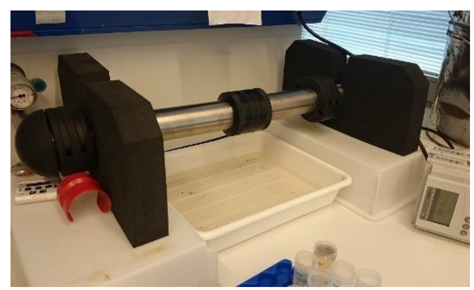
Water chemistry, C/N content and fatty acid profile

Centrifugation and separation of solid and liquid phases

Sampling

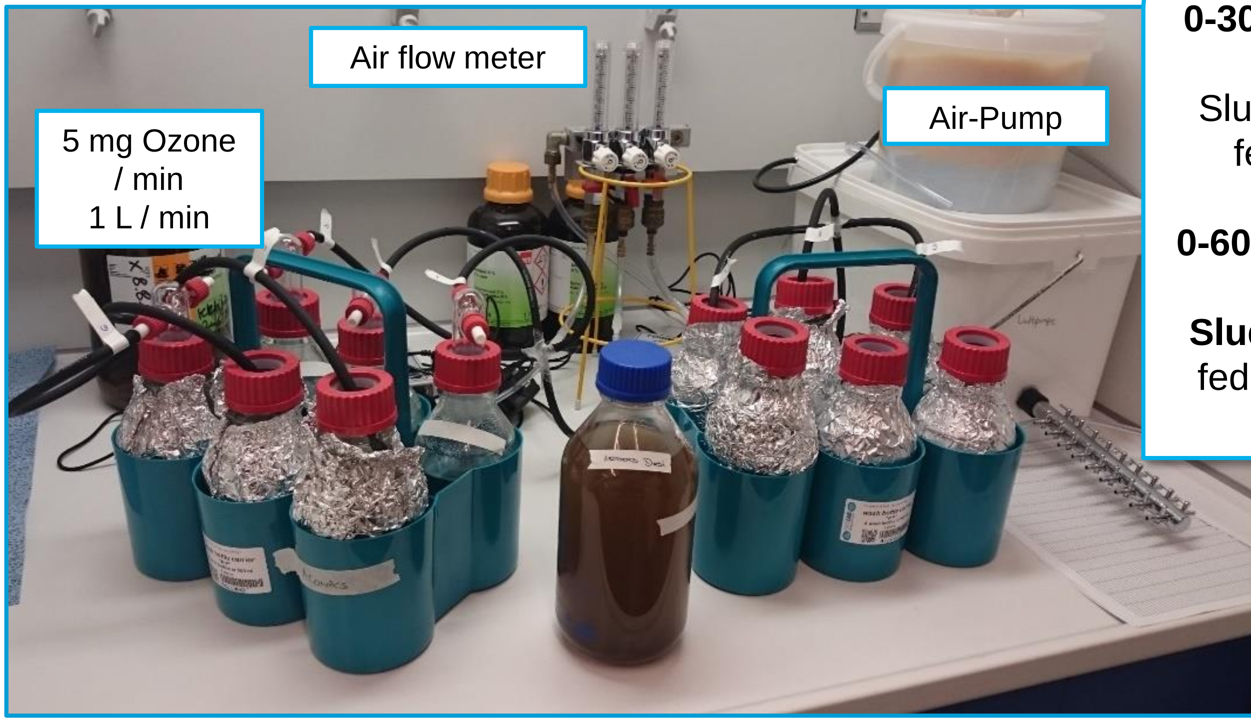
Measurements:
pH / ORP / Sal / T / O_2
DOC-TDN / C:N
NO_3^- / NO_2^- / NH_4^+ / PO_4^{3-}






Pictures: D. Bögner

Ozonization experiments



Ozone treatment
0-30 min: 3 replicates each 4 min
Sludge source: RAS fed Supreme 22

0-60 min: 6 replicates each 10 min
Sludge source: RAS fed Supreme 15 and Supreme 22

Supreme 15 (46% protein, 15% fat)
Supreme 22 (44% protein, 22% fat)

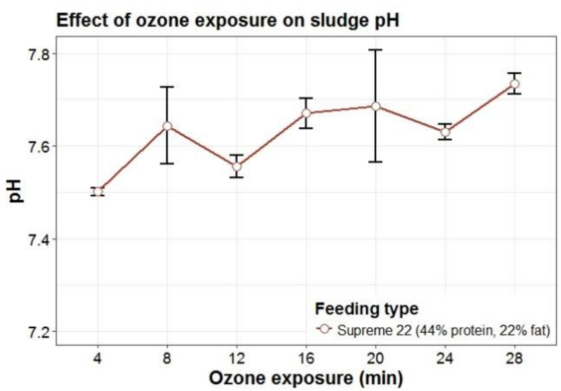
Pictures: D. Bögner

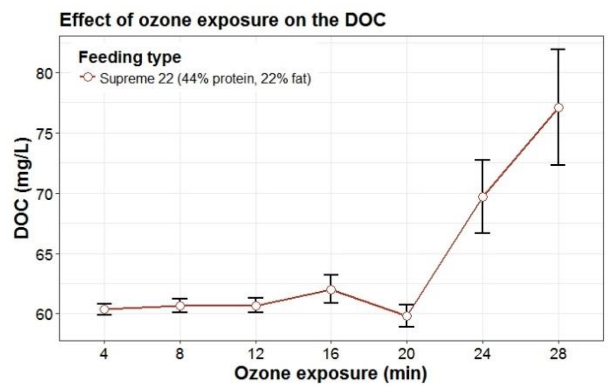
AcOMaCS: Activated Particulate Organic Matter as Carbon Source for Denitrification

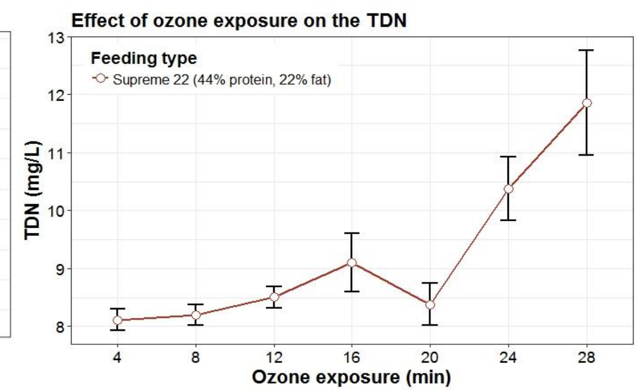
pH

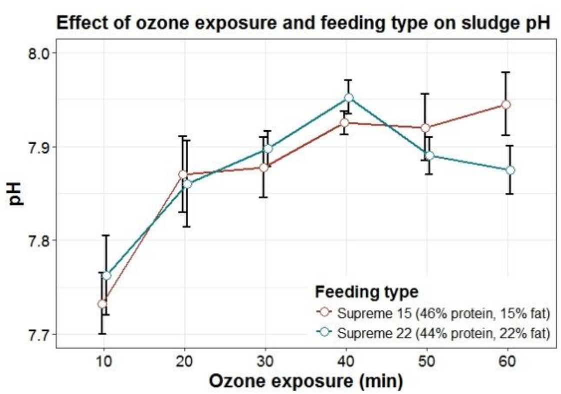
DOC

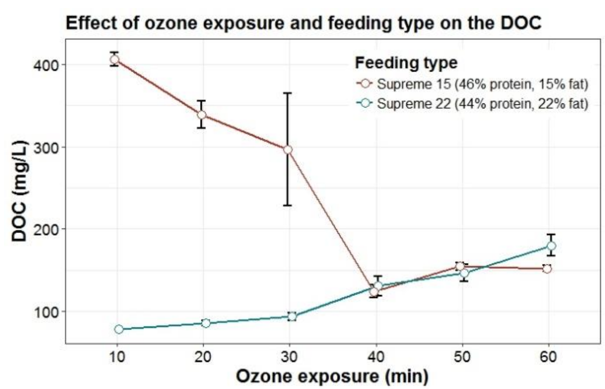
TDN

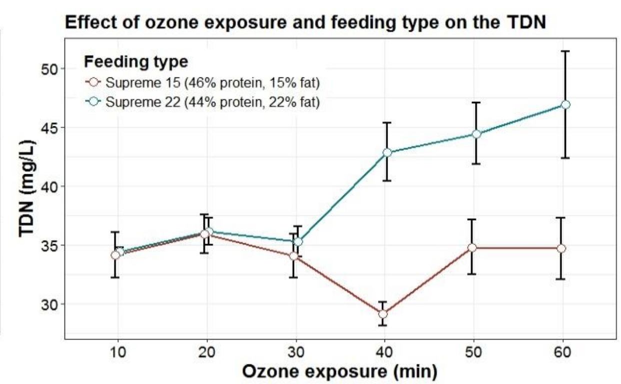




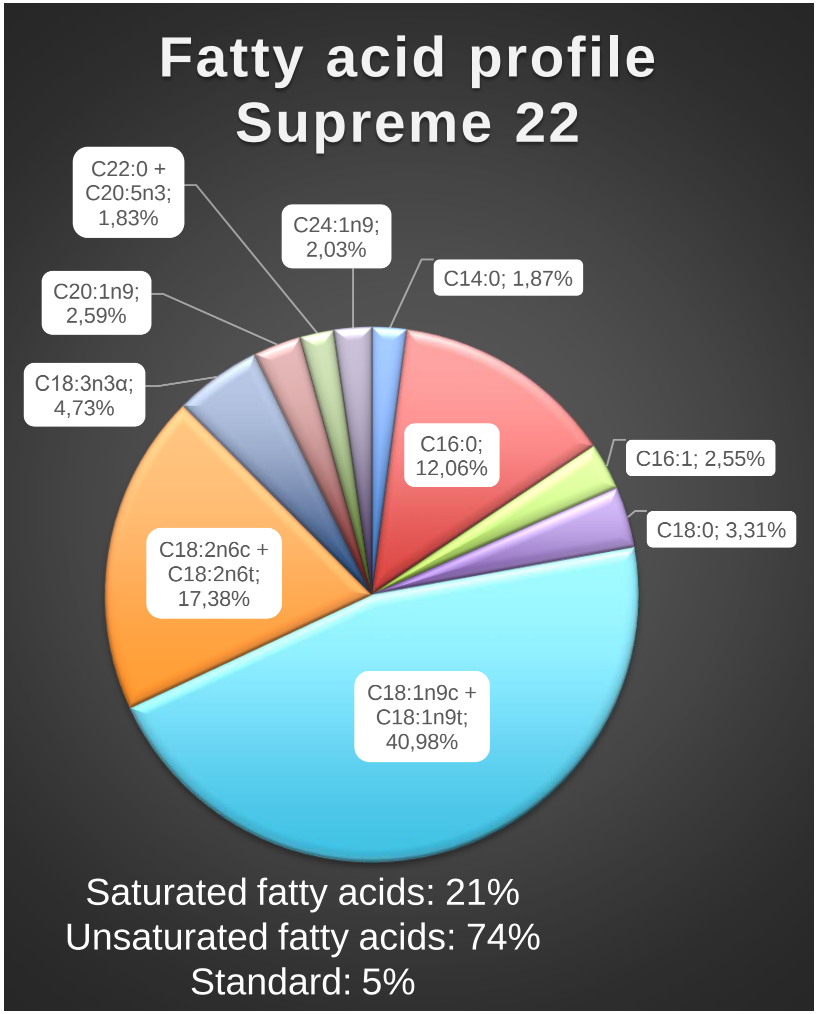


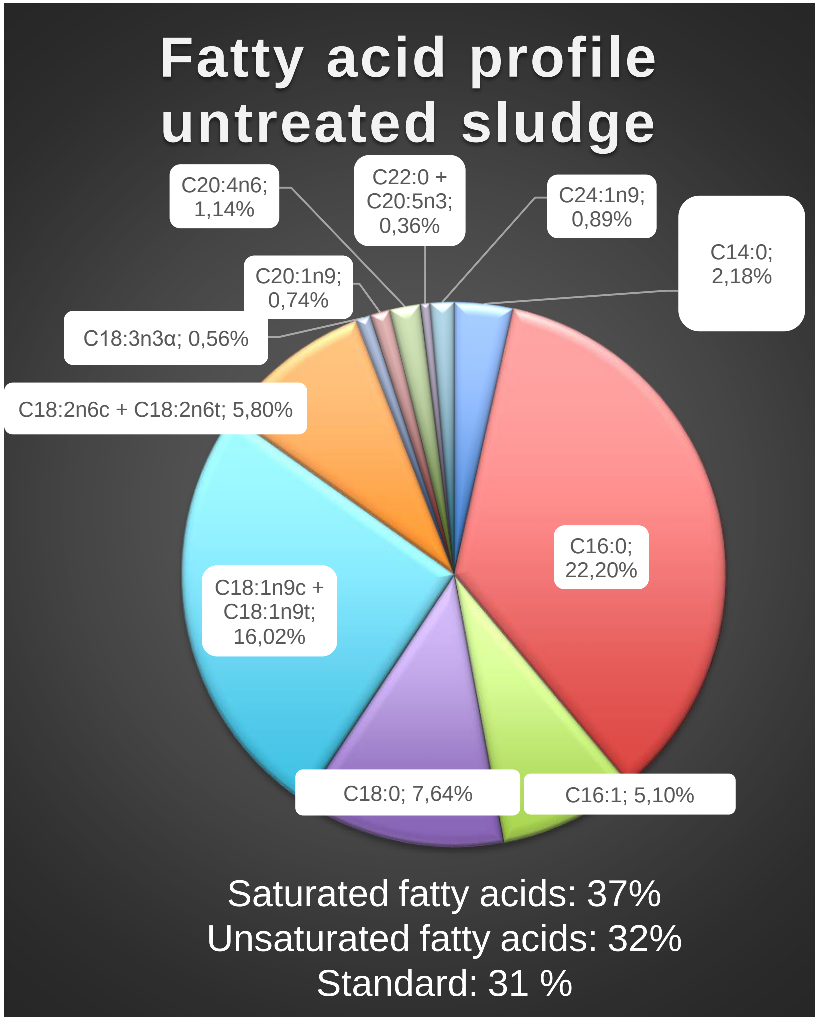






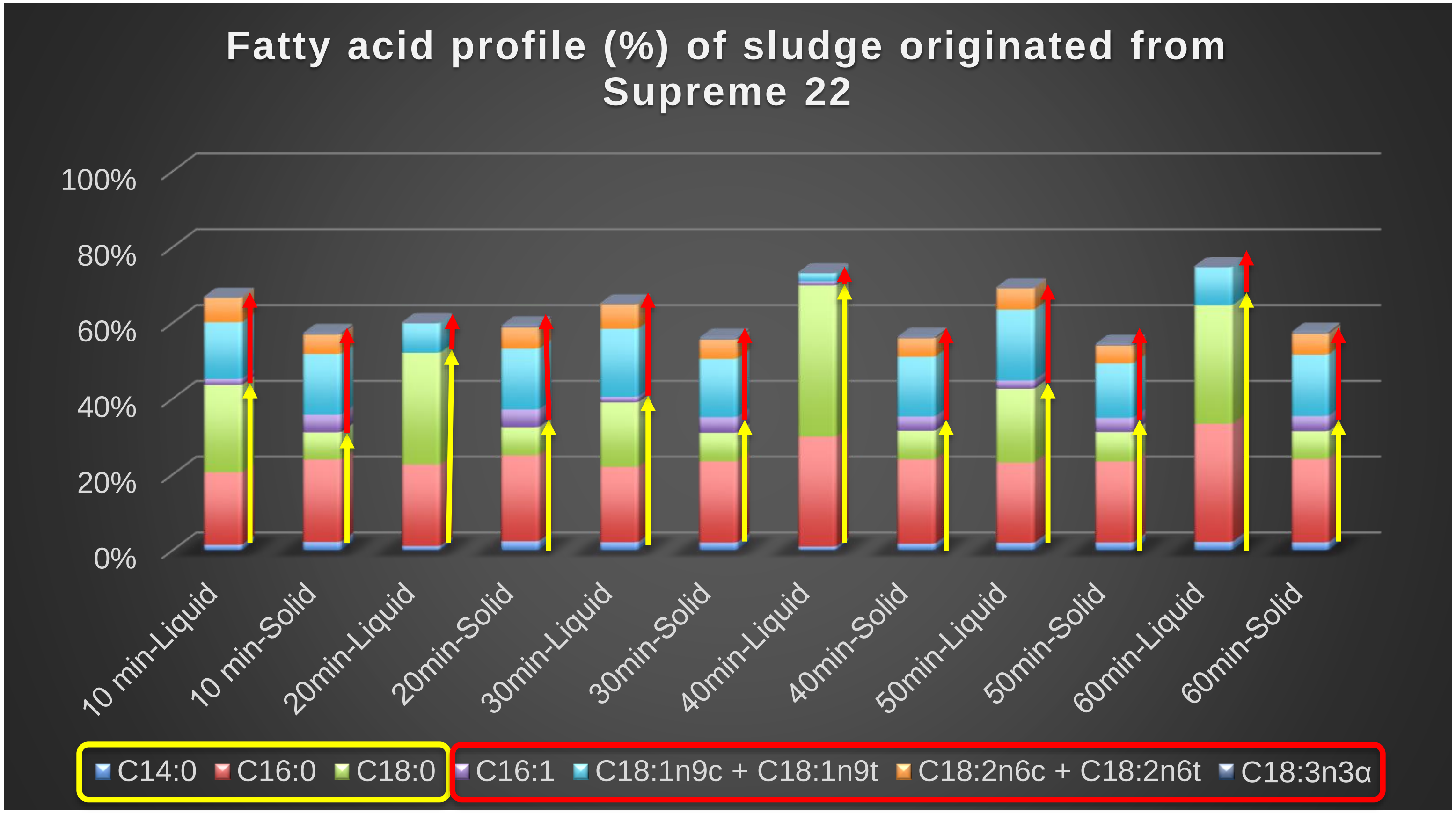
AcOMaCS: Activated Particulate Organic Matter as Carbon Source for Denitrification





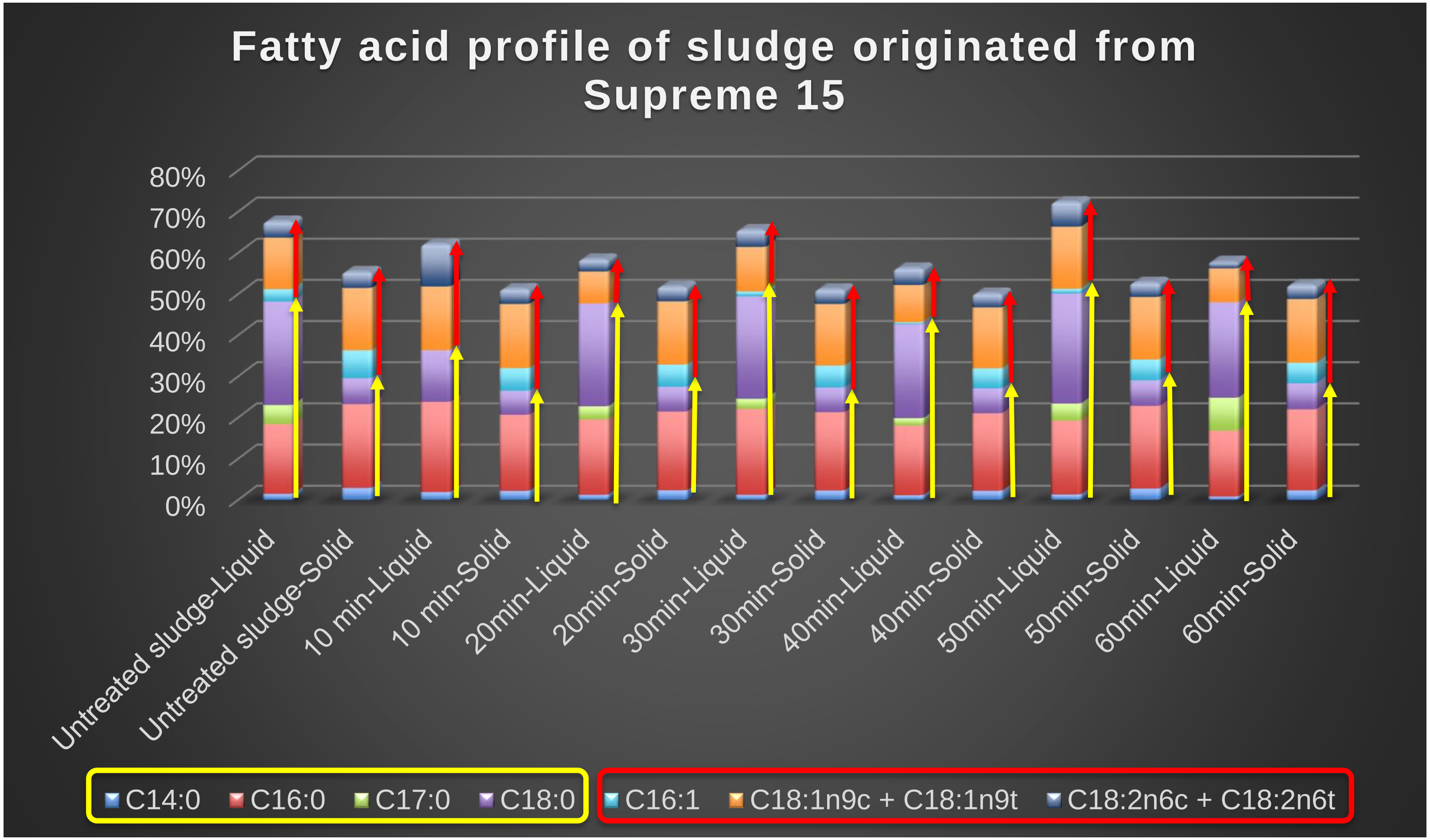
Unsaturated fatty acids are susceptible to degradation by ozone

AcOMaCS: Activated Particulate Organic Matter as Carbon Source for Denitrification



Supreme 22 (44% protein, 22% fat)

AcOMaCS: Activated Particulate Organic Matter as Carbon Source for Denitrification



Supreme 15 (46% protein, 15% fat)

Pictures: D. Bögner

AcOMaCS: Activated Particulate Organic Matter as Carbon Source for Denitrification

Denitrification experiments

$NO_3^- \rightarrow NO_2^- \rightarrow NO / N_2O \rightarrow N_2$

Theoretical optimal C:N ratio depends on the carbon source

Carbon source as electron donor e.g. acetic acid, methanol, acetol, sludge.

Measurements:
pH / ORP / Sal / T / O_2
DOC-TDN / NO_3^- / NO_2^- / NH_4^+ / PO_4^{3-}
State of filter bodies

Experiments:

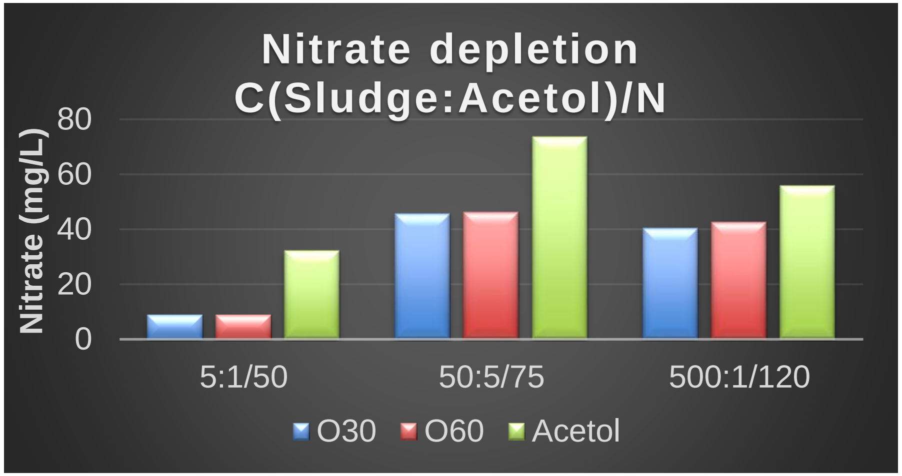
I) 5 Replicates x 3 Treatments (30 min or 60 min Ozone treated sludge / Acetol) increasing amounts of sludge were added to the reactors.

II) 4 Replicates x 4 Treatments (30min ozone-treated sludge with 10%, 25% and 50% volume exchange vs Acetol).

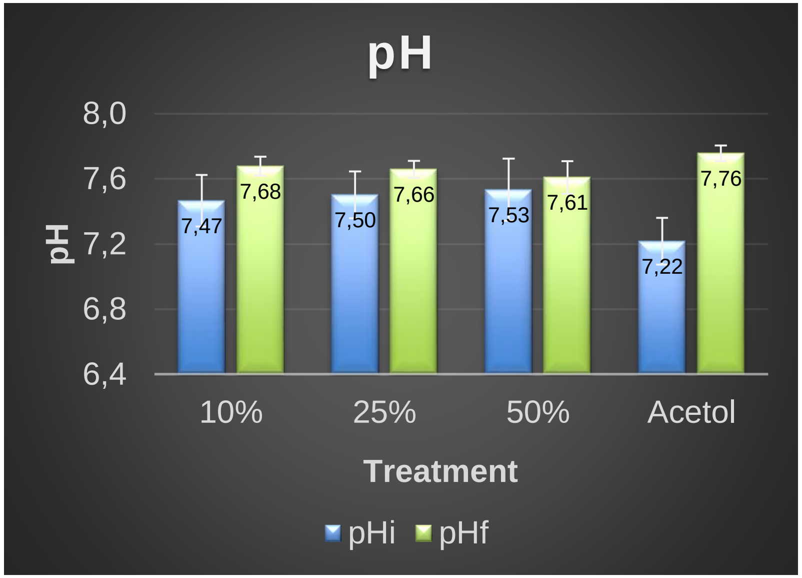
Pictures: D. Bögner

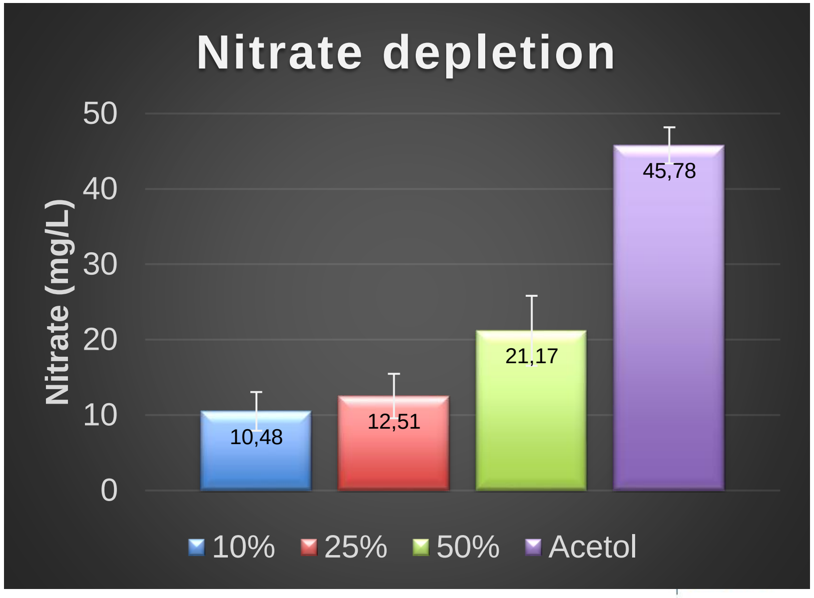
AcOMaCS: Activated Particulate Organic Matter as Carbon Source for Denitrification

Sludge:Acetol(ml)	NO3_N(mg/L)
5:1	50
50:5	75
500:1	120

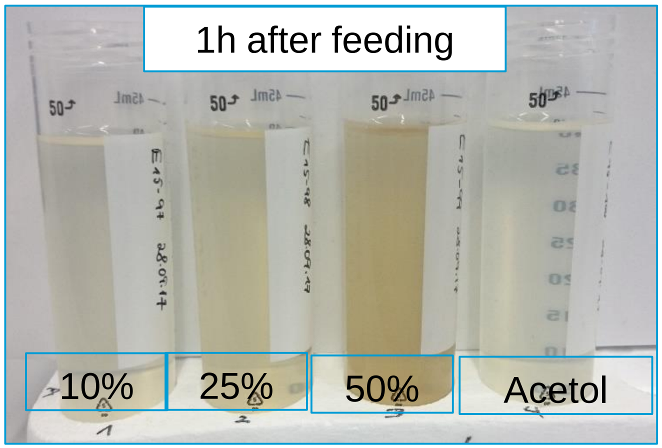


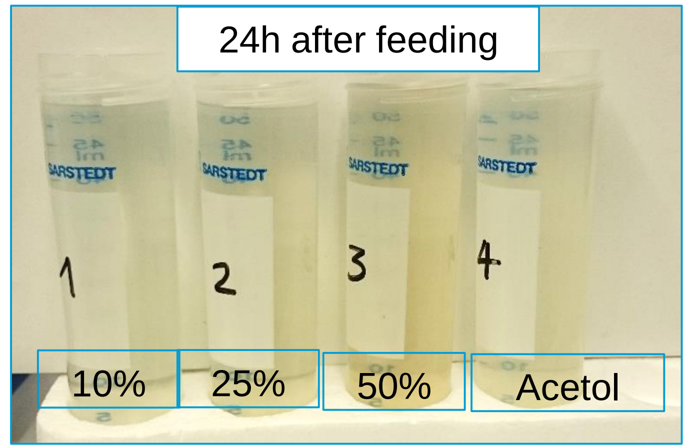
Volume Exchange: 500ml/1250 ml/ 2500ml vs. Acetol; 50mg/L NO3-N





AcOMaCS: Activated Particulate Organic Matter as Carbon Source for Denitrification





10%

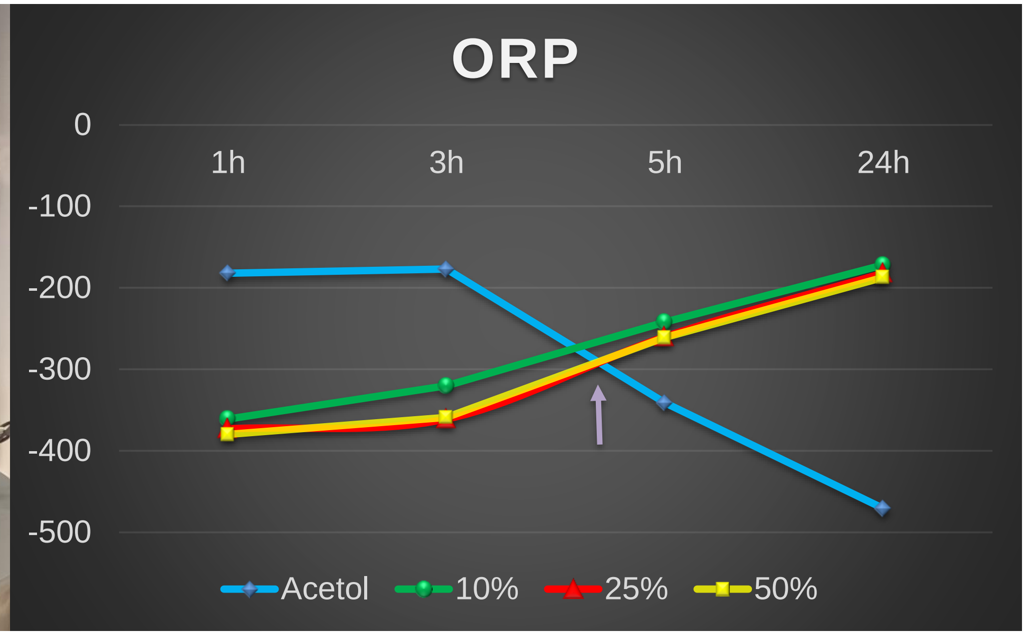
25%

50%

Acetol

Pictures: D. Bögner

AcOMaCS: Activated Particulate Organic Matter as Carbon Source for Denitrification



Water parameters of the samples:
pH : 7.4-7.6 (Sludge); 7.2-7.8 (Acetol)
Sal : 30.2 all treatments
T : 20°C all treatments
O_2 : 0 mg/L (Sludge); 0.02-0.05 mg/L (Acetol)

Pictures: D. Bögner

Next steps…

- Aminoacids profiles of ozone- treated sludge and foam
- Adjustment (fine-tuning) of the ozone concentration and exposure time
- Statistical modelling of the water chemical parameter which better describe the process and are prone to be used as control parameters
- Analysis of changes in bacterial community composition of the filters
- Test at commercial scale of a sludge processing device based on ozonisation

Take home messages…

- The application of Ozone **is effective in reducing solid discharge/ concentrations of humic compounds, and increasing the concentration of long-chain fatty acids in the liquid phase**, but **short-chain fatty acids are all mineralized**.
- **Ozone treatment may lead to accumulation of Ammonium**. This might force the denitrification reactor toward conditions favouring bacterial communities of the anammox genera.
- **At least 24 min ozone treatment is necessary to obtain increased amounts of carbon compounds in solution.**
- **Ozone treated sludge alone is not efficient in accomplishing a complete Nitrate reduction.** A combined use with an external carbon sources might reduce the costs of RAS production

Thank you for your attention!

Pictures: Webpage AWI and D. Bögner

Technical assistants (Timo Hirse, Sabine Strieben, Anja Sawicki and Mona Dannemeyer), **other research sections of AWI** and Staff of the Hochschule Bremerhaven, which kindly offer their infrastructure facilities and advices (Prof. Boris Koch, Claudia Burau, Jana Geuer, Ute Marx, Prof. Stefan Wittke, Lukas Wildförster, Kerstin Klockgeter), **volunteers** (Sarah Zwicker), **staff of the AQF Group and ZAF** (Mirko Bögner, Jörn Halfer, Rajko Thiele, Jan Köbel).