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Unifying ammonia inhibitory limits in anaerobic digestion: link with operational conditions and microbial communities

16TH IWA World conference on Anaerobic Digestion
23-27th June, Delft, The Netherlands

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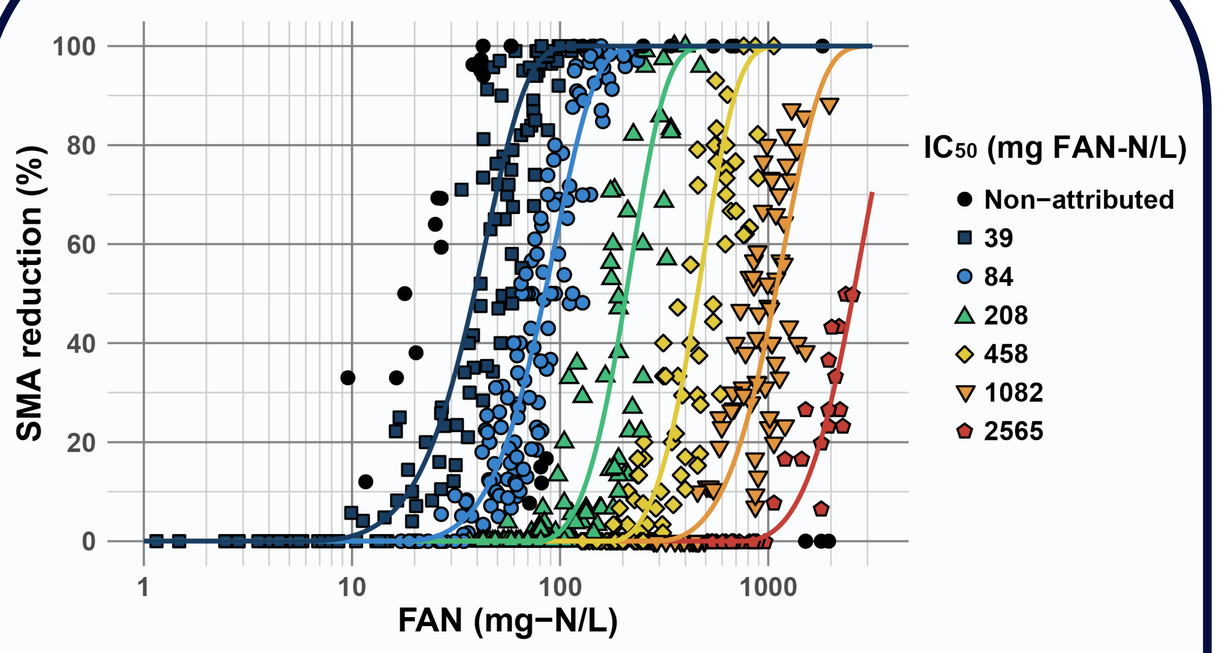
Introduction

- Free ammonia nitrogen (FAN) is a major inhibitor in anaerobic digestion processes
- There is no current agreement in the literature regarding inhibitory limits
- Data from literature was used to unify inhibitory limits and link inhibition resilience to operational parameters and archaeal populations

Materials and methods

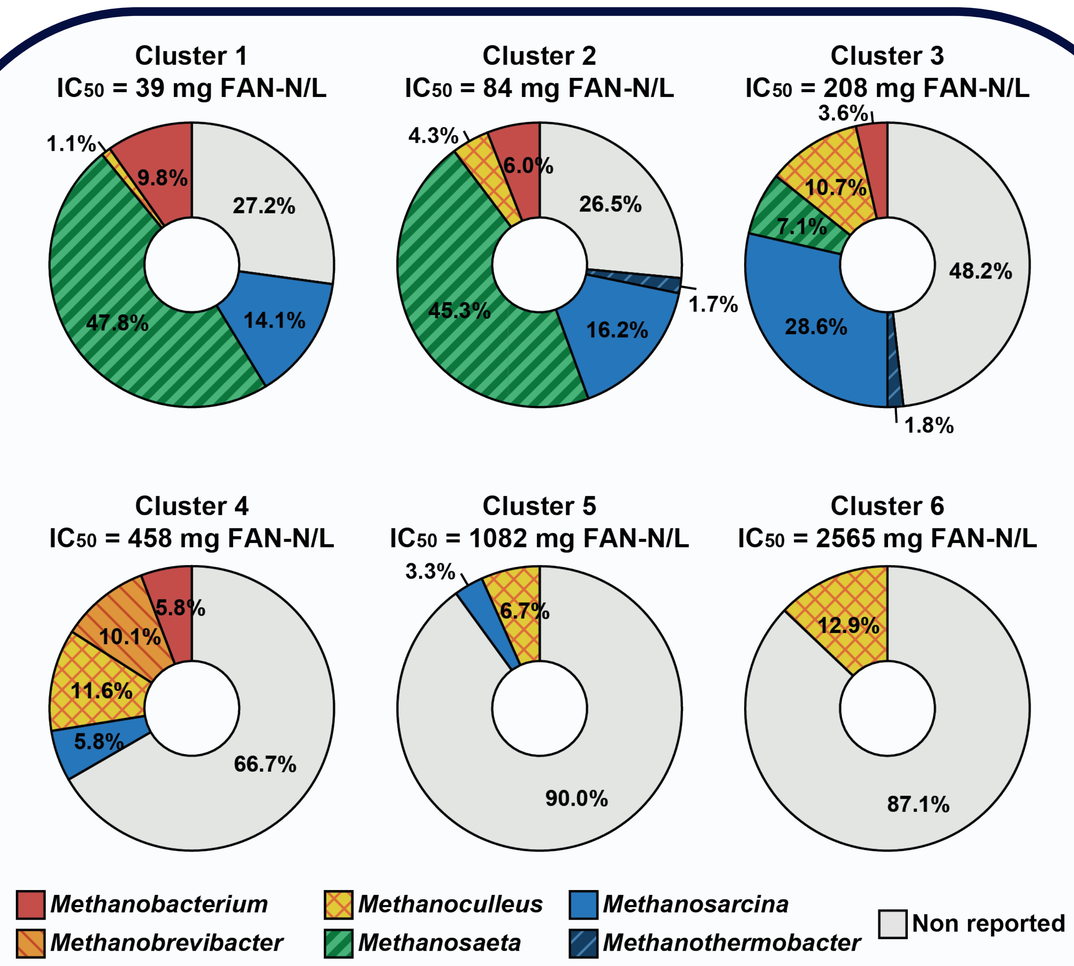
- A database containing 1,590 points was generated (from 50 articles)
- FAN concentrations were recalculated using a modified Davies equation to account for the ionic strength in N-rich media (Capson-Tojo *et al.*)
- The inhibitory constants (IC_{50}) were calculated using a threshold inhibition function (Astals *et al.*, 2018)
- An iterative clustering approach based on regression analysis over the inhibition function was used to obtain different IC_{50} values

Main results



Reduction of the specific methanogenic activities (SMA) at different FAN concentrations. The set of inhibition curves and IC_{50} values resulting from the clustering approach are also shown.

- Six different inhibition curves were obtained, forming **six data clusters with increasing resilience to FAN** (higher IC_{50} values)
- A **sensitivity analysis** verified that the cluster distribution was optimal according to defined criteria
- The median **temperatures and pH** of each cluster **increased with the IC_{50}**
- The total ammonia nitrogen (**TAN**) **and** the **NH_4^+ concentrations** were **not significantly different between clusters**



Repartition of the main archaeal genus after anaerobic digestion for each resulting cluster. Only the predominant genus (that with the highest percentage in relative abundance) was considered for the counting. "Non-reported" corresponds to studies in which the microbial communities were not analysed.

- Clusters with **low IC_{50} values** were dominated by **acetoclastic** methanogens (mainly *Methanosaeta*)
- ***Methanosarcina*** (mixotroph) dominated at **low-intermediate IC_{50} values**
- **Hydrogenotrophic** methanogens showed the **highest IC_{50}**

Take home message

- **Resilience to FAN inhibition is affected by both the operational parameters and the archaeal composition**
- **The working pH and temperature, rather than the TAN content itself, are the main factors affecting FAN resilience**
- ***Methanosaeta*-dominated reactors presented lower inhibition limits when compared to mixotrophic and hydrogenotrophic systems**
- **More research must be carried out to study the microbial communities in nitrogen-rich systems at high FAN levels**

References

Astals et al., (2018), Characterising and modelling free ammonia and ammonium inhibition in anaerobic systems. Water Res, 143:127–35
Capson-Tojo et al., Unraveling the literature chaos around free ammonia inhibition in anaerobic digestion. Submitted to Renewable & Sustainable Energy Reviews

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