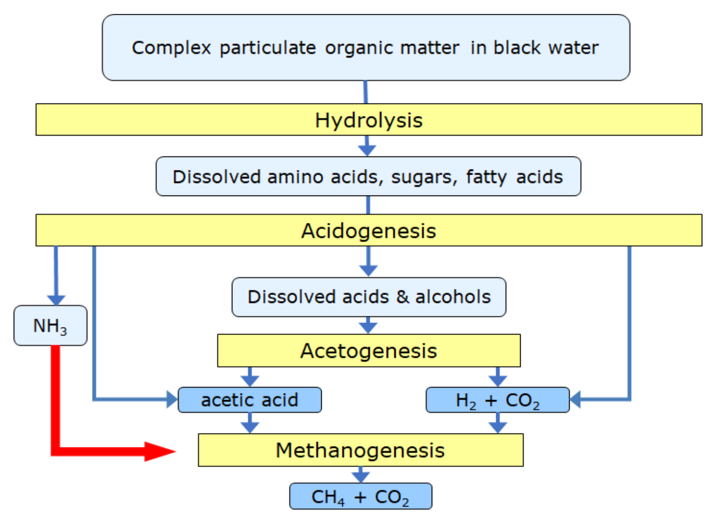
Recovery and utilisation of nutrients for low impact fertiliser

Deliverable 2.2 – Model to determine toxicity of [NH_3] during (H)TAD

What is this deliverable about?

Fertilisers are produced via (hyper)thermophilic anaerobic treatment - (H)TAD - of blackwater collected from the ultra low flush vacuum toilets that were developed in the Run4Life project. Run4Life aims to recover nutrients from wastewaters, producing fertilisers that are safe to use in agriculture. This work describes the development of a model to determine NH_3 concentration during treatment of BW in UASB systems. NH_3 could inhibit methanogenesis



This factsheet

This factsheet is a summery of part of the work carried out for deliverable 2.2, which is made public via peer-reviewed papers. Detailed results of this particular study can be found [here](#).

Black water (BW) and (H)TAD

BW is toilet wastewater. It contains fecal matter and urine, toilet paper and flushing water. The vacuum toilets used in Run4Life have a low flushing volume. The high organic matter and nutrient concentration in the BW (compared to conventional toilet systems) enables treatment in UASB reactors operated at elevated temperatures (55° and 70°C).

Safe fertilisers

Domestic waste streams may contain pathogens, organic micropollutants and other constituents that can potentially be harmful when applied for food production.

What is the goal of Run4Life?

The goal of Run4Life is to demonstrate the feasibility of recovering nutrients from domestic waste streams for its subsequent application in agriculture. Run4Life proposes a new technological concept of circularity models for wastewater treatment and nutrient recovery. Success in these new circularity models requires a change in thinking from involved stakeholders and interested groups, regarding the technical, organisational, social and governance dimensions. In order to achieve this, we need to generate an understanding of how stakeholder groups currently view the context of wastewater reuse, how they interact and engage with one another and how this can be improved.

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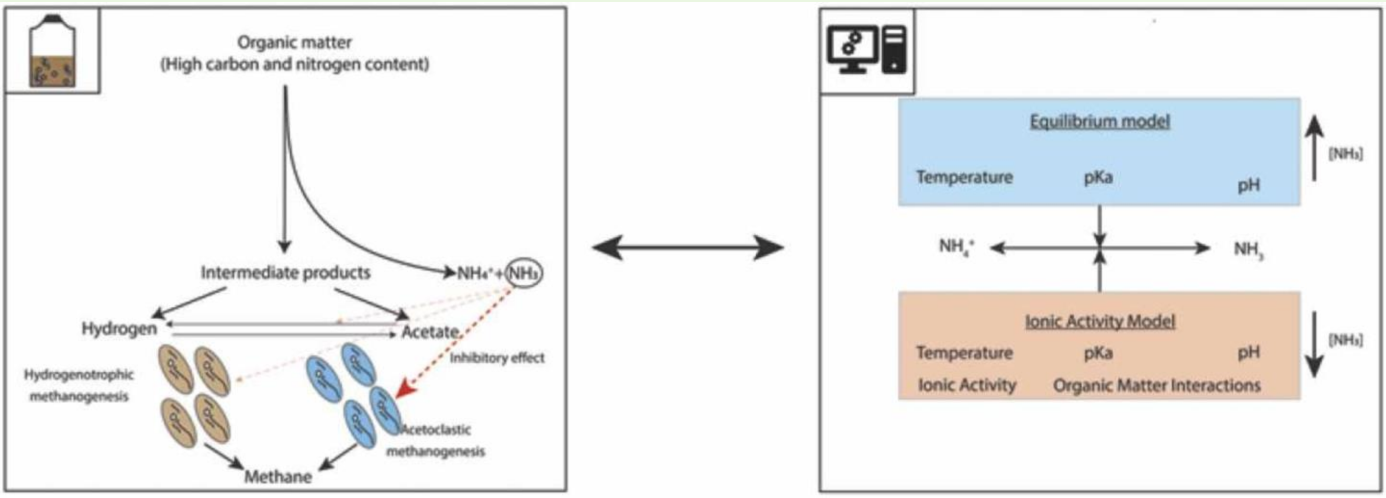
https://run4life-project.eu

Summary and key messages

Summary – the paper in short

Anaerobic digestion is an attractive treatment technology for concentrated waste streams. However, high ammonia concentrations cause inhibition of methanogenesis, especially when operated at elevated temperatures like (hyper-)thermophilic (55 and 70 °C) anaerobic digestion. These emerging (hyper-)thermophilic technologies are beneficial due to high conversion rates and pathogen removal, but are more susceptible for ammonia toxicity as consequence of a temperature-induced pK_a shift. Determination of NH_3-N (free ammonia nitrogen (FAN); toxic form) concentrations is conventionally based on an equilibrium model and the total ammonia nitrogen concentration (TAN). However, the conventional equilibrium model overestimates the FAN concentration and therefore we developed an Ionic Activity Model which takes the ionic strength and organic matter interactions into account. Based on this Ionic Activity Model and batch experiments at hyper-thermophilic conditions, we found that acetoclastic methanogenesis was completely inhibited at FAN concentrations exceeding 588 mg/L, whereas hydrogenotrophic methanogenesis could produce methane up to 925 mg/L. https://doi.org/10.1016/j.jece.2021.106724



Key message 1

Organic matter interactions with NH_4^+ can affect the ammonia equilibrium.

Key message 2

The Ionic Activity Model results in lower predicted [NH_3] than equilibrium models.

Key message 3

Hydrogenotrophic methanogens can tolerate up to 925 mg/L NH_3-N at 70 °C.

Key message 4

Acetoclastic methanogens can tolerate up to 588 mg/L NH_3-N at 70 °C.

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