Optimization of Two-Stage Treatment of the Liquid Phase of Digestate

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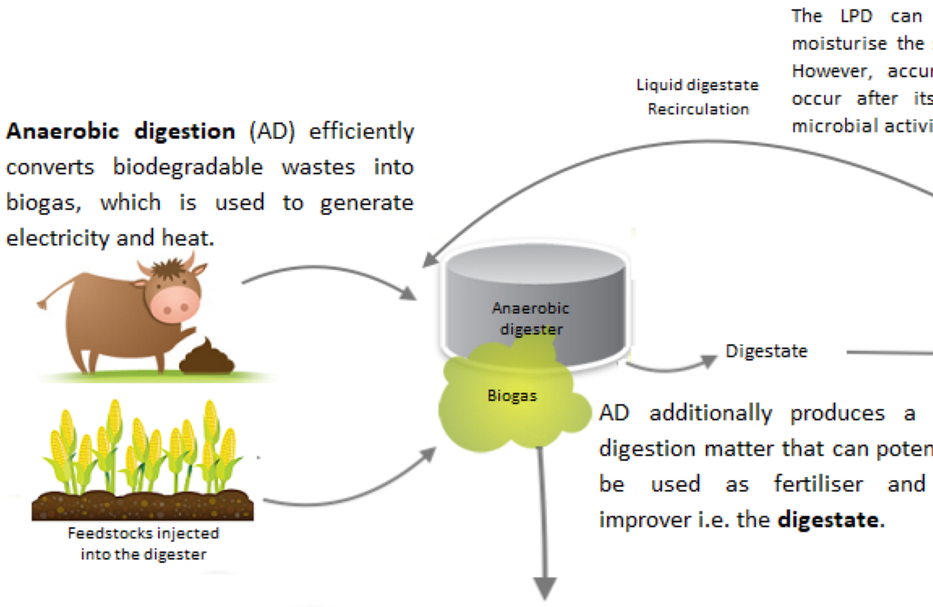
Introduction

Anaerobic digestion (AD) efficiently converts biodegradable wastes into biogas, which is used to generate electricity and heat.



AD additionally produces a post-digestion matter that can potentially be used as fertiliser and soil improver i.e. the **digestate**.

The LPD can also be recirculated in order to moisturise the substrates going into the AD process. However, accumulation of ammonia nitrogen may occur after its repeated recirculation, leading to microbial activity inhibition.

The digestate can be subjected to separation in different fractions that are easier to store and transport, i.e. a solid faction (SPD) and a liquid fraction (LPD), with nitrogen remaining in the LPD in the form of TAN (NH_4^++ NH_3). Moreover, the LPD generally has a pH of around 7.5 to 8.5 and therefore has high NH_3 volatilisation potential.

Biogas plants generally use only 20-40 % of the heat that is produced in the cogeneration units and the remaining heat becomes waste heat.

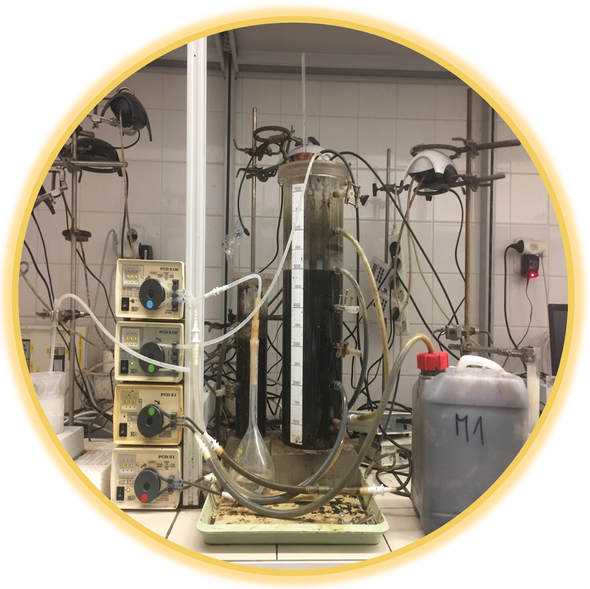
The direct land application in agricultural fields is the most common usage of the liquid phase of digestate (LPD). However, due to different regulations the LPD cannot be applied onto farmlands immediately, but instead, it must be transported and stored nearby the utilisation area until the proper application time.

For these reasons, increasing focus is being placed on various LPD treatment options for reducing its volume and concentrating the nutrients, namely the thermal thickening of LPD by vacuum evaporation. The adjustment of the pH values of the LPD to slightly acidic is a necessary step in order to limit eventual stripping of NH_3 during evaporation.

The nitrification as an LPD pre-treatment seems to be an interesting approach in order to decrease the pH values and make the LPD suitable for vacuum evaporation.

This work thesis seeks to verify the applicability of nitrification combined with thermal thickening by vacuum evaporation of the nitrified LPD in order to concentrate the nitrogen and other chemical compounds in the thickened LPD while simultaneously obtaining clean water and reducing the volume of the LPD.

Methods

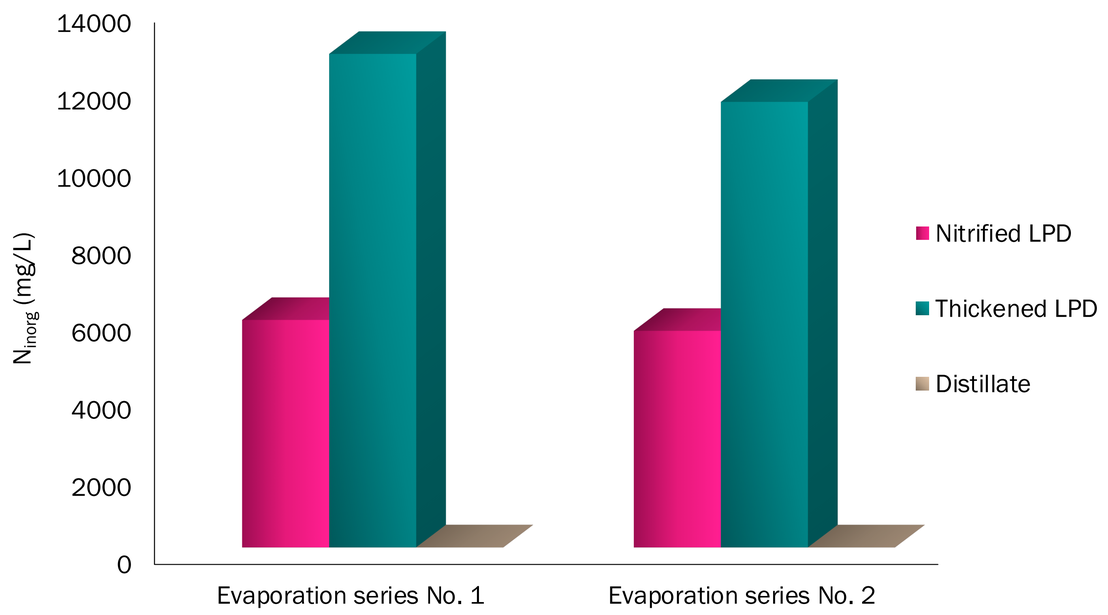


The nitrification of the LPD in a continuously stirred tank reactor (CSTR) was performed as a first step

Next, the nitrified LPD was subjected to two different evaporation series on a ratio of 1:1.5 and 1:1

A thickened LPD (right) and distillate (left) were produced

Results



The total inorganic nitrogen preserved in the thickened LPD of all the samples increased in concentration more than double after the vacuum evaporation with N-NO_3^- being the dominant nitrogen form, whereas in the distillate did not exceed 2 mg/L

Evaporation series No.	Thickened LPD % N_{inorg}	Distillate % N_{inorg}
1	93.3%	0.05%
2	99.9%	0.04%

Mass balance calculations indicate that 99.9% of the total inorganic nitrogen was maintained in the thickened LPD and the percentage of total inorganic nitrogen in the distillates of all the samples did not exceed 0.06%.

Conclusions

- A nutrient-rich thickened LPD, which can be used as a fertiliser, was produced
- A distillate with low concentrations of nutrients, which can be used as a process liquid in the biogas plants for the dilution of feedstocks, was recovered
- The considerable reduction in the volume of the LPD allows the reduction of costs and fossil fuel consumption needed for its transportation
- The evaporation of the LPD is an interesting approach to re-using waste heat to give the BGPs a productivity boost

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