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INTEGRATED PROCESS FOR ANAEROBIC DIGESTION OF DAIRY MANURE COMBINED WITH AMMONIA RECOVERY AND BIOGAS PURIFICATION

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Introduction

- Anaerobic digestion of dairy manure often results in low biogas yield, which affects the economic feasibility of the anaerobic digestion facility (e.g. conventional CSTR digester).
- Co – digestion of manure with lipid-rich wastes can increase the biogas yield, however special care should be given t and LCF inhibitio

Introduction

- Plug flow reactors (PFR) provide optimum residence time distribution, minimize flow short – circuit and has been successfully applied for organic waste processing under different operating conditions.
- The objectives of this study were to examine the efficiency of PFR reactor for the anaerobic digestion of a complex substrate, consisting of a mixture of screened dairy manure, pressure sterilized animal – by – products and cheese whey.

Feed mixture

- Mixture was a combination of the following substrates from agro-industrial facilities.

Screen dairy manure 51%

Pressure sterilized animal by-products 11

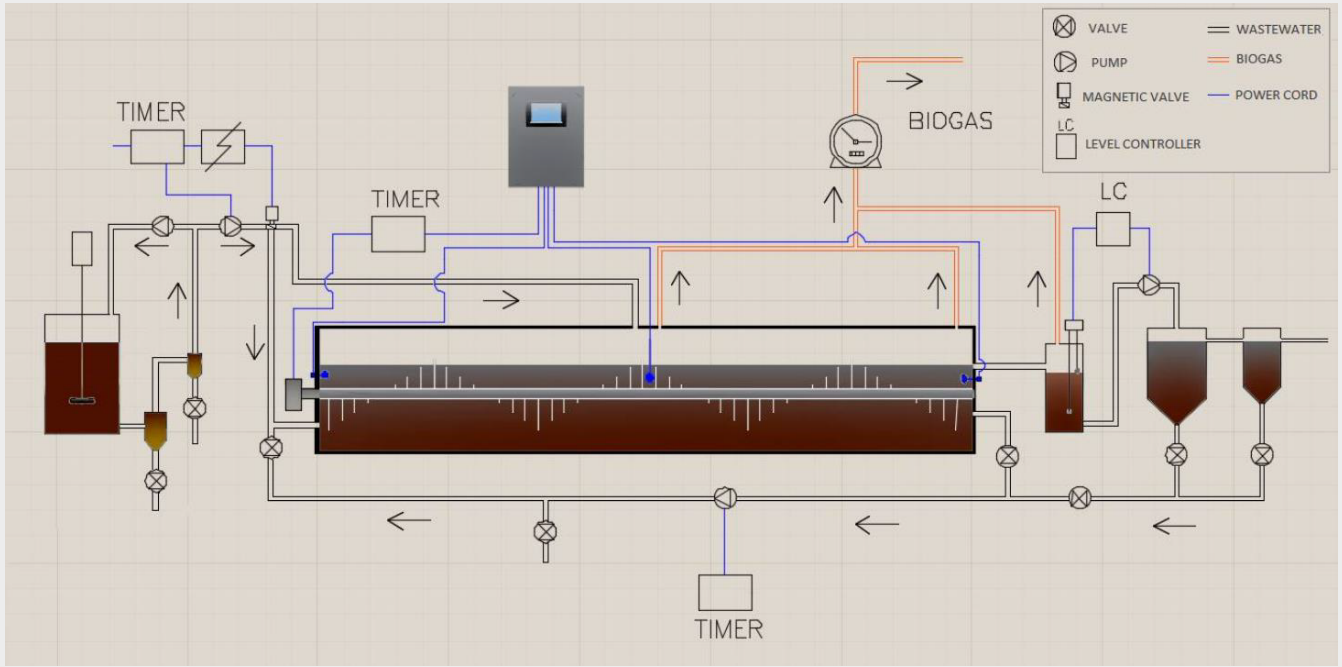
Cheese way 21%

Water 16.6%

Parameter	Units	Value
pH	-	5.9 ± 0.5
EC	mS/cm	11.6 ± 0.8
COD total	g/L	70 ± 8
COD soluble	g/L	26 ± 6
TSS	g/L	20 ± 5
VSS	g/L	18 ± 6
TS	g/L	33 ± 5
VS	g/L	26 ± 2
NH4-N	g/L	1.5 ± 0.3

Anaerobic Digesters Design & Operation

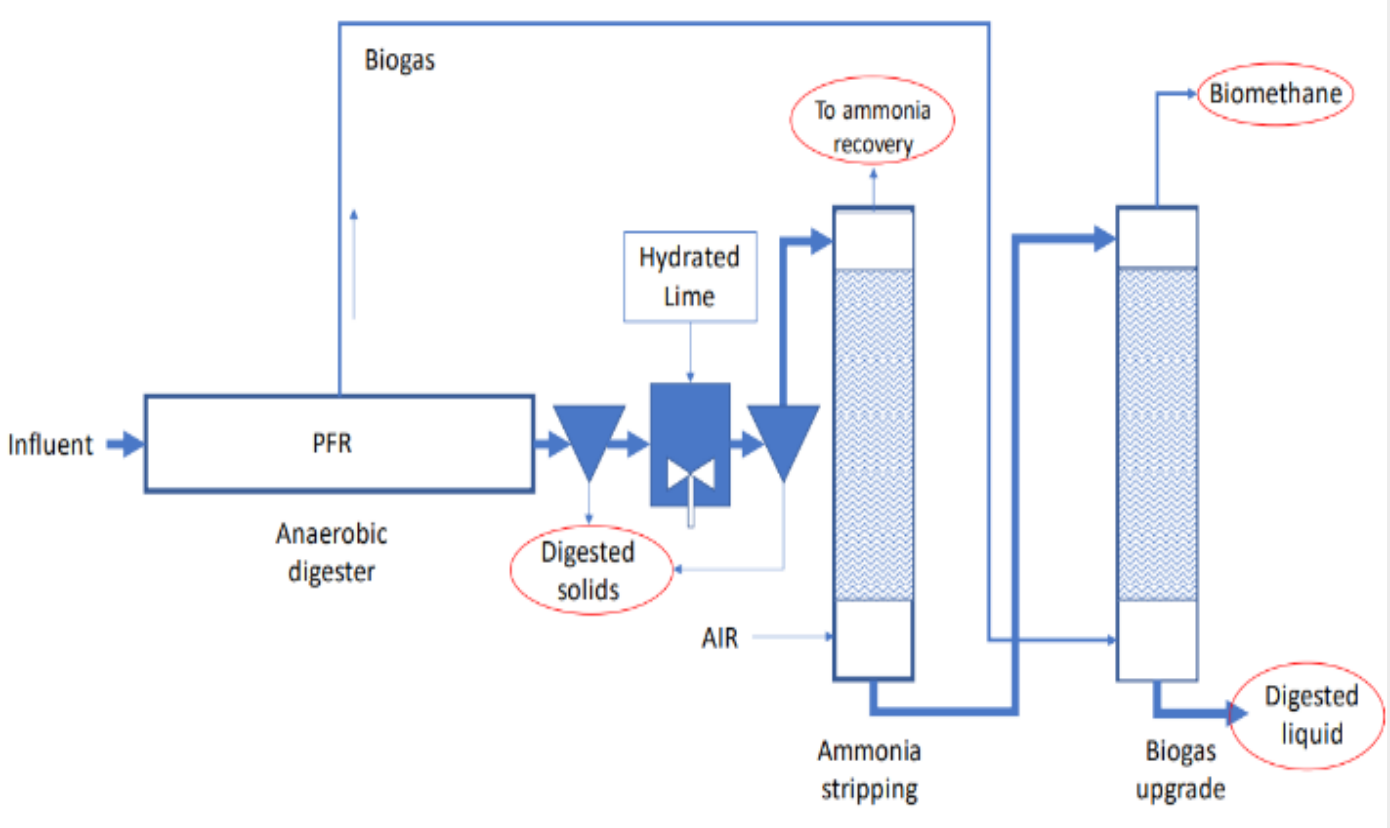
- Plug Flow Reactor



Parameters	
Digester type	PFR
Digester volume	20L
Temperature	Mesophilic ~ 38^{o}C
Mixing velocity	8 rpm/hr
Feeding type	Continuous

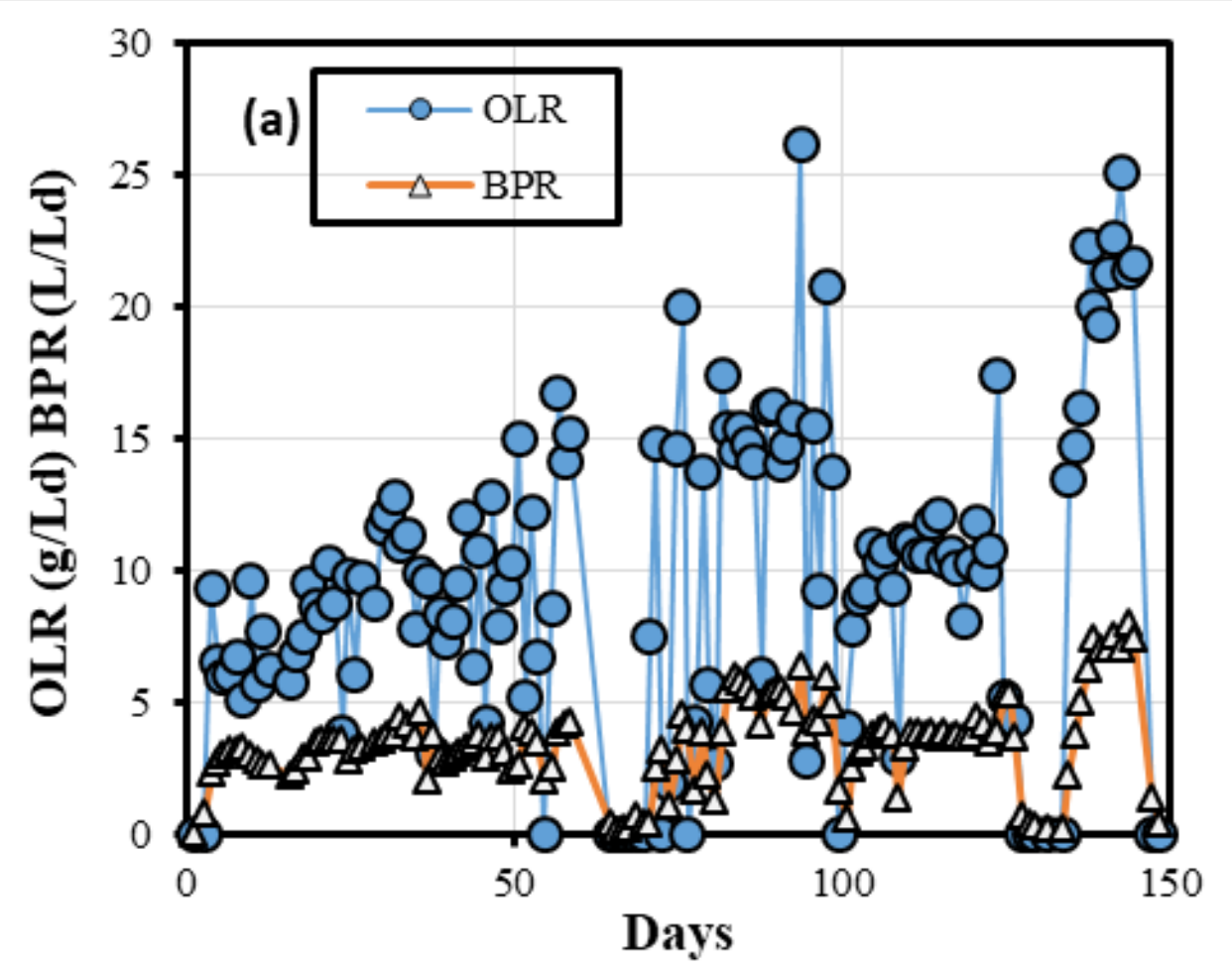
Anaerobic Digesters Design & Operation

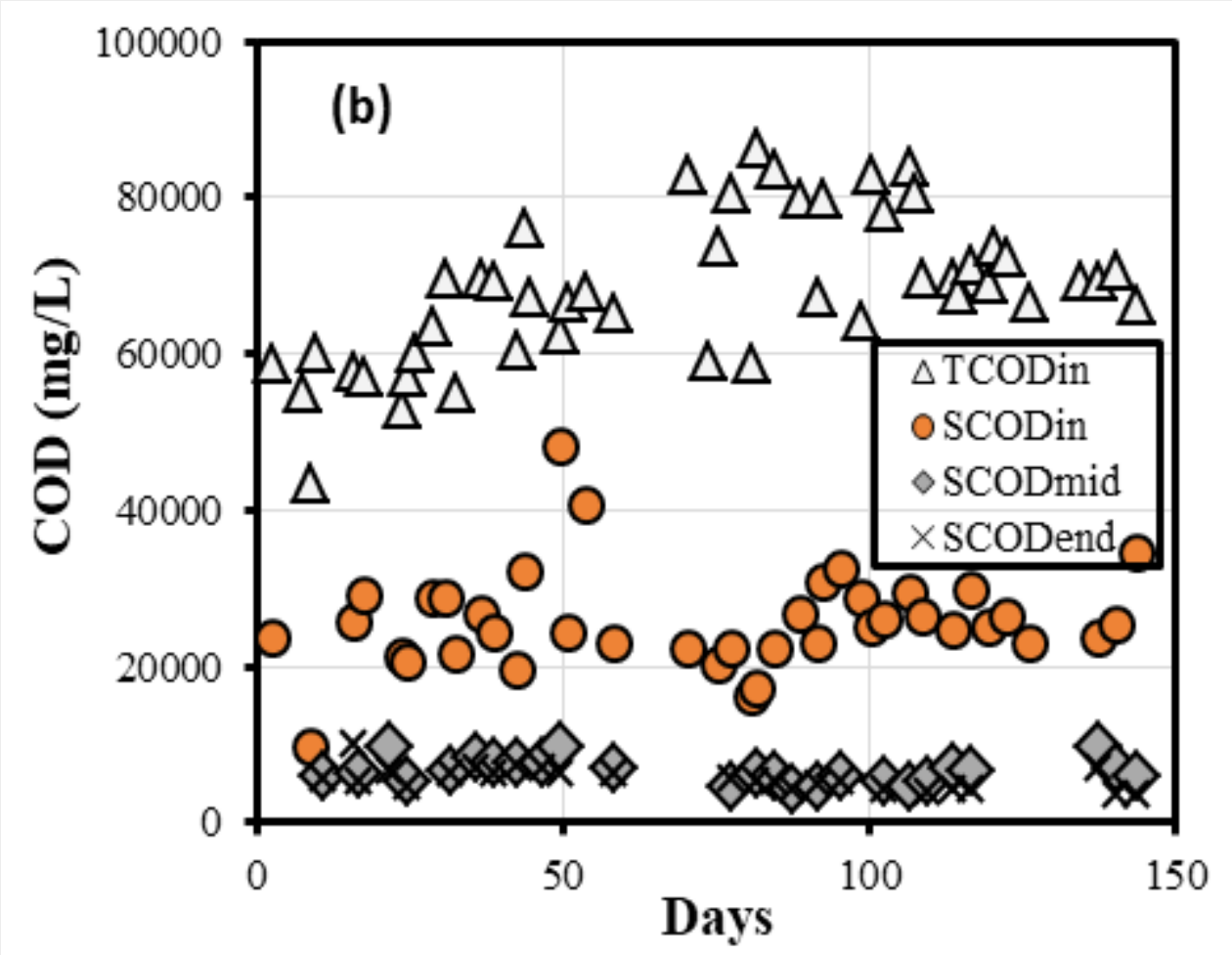
- Ammonia recovery and biogas purification



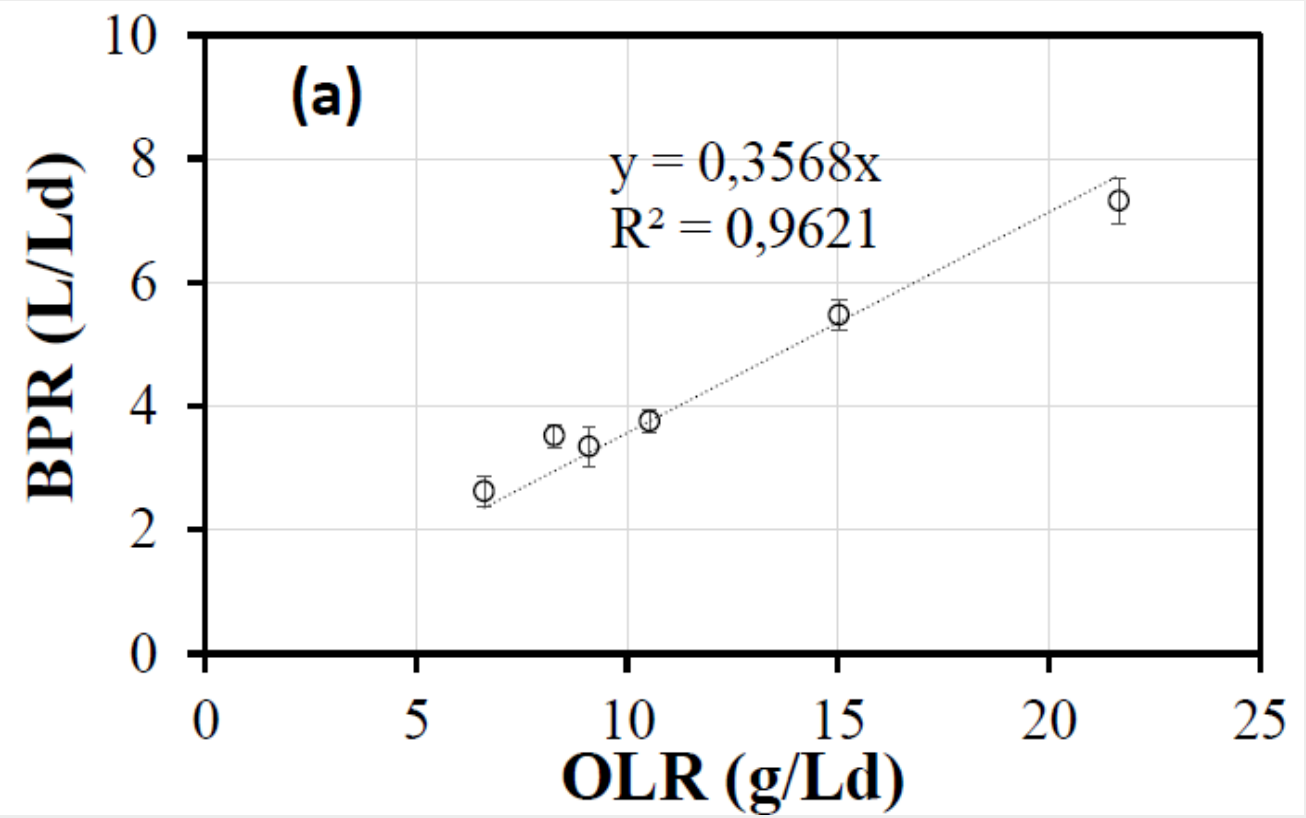
Parameters	
Height	1.5m
Diameter	8cm
Experimental setup	Georgiou et al. 2019

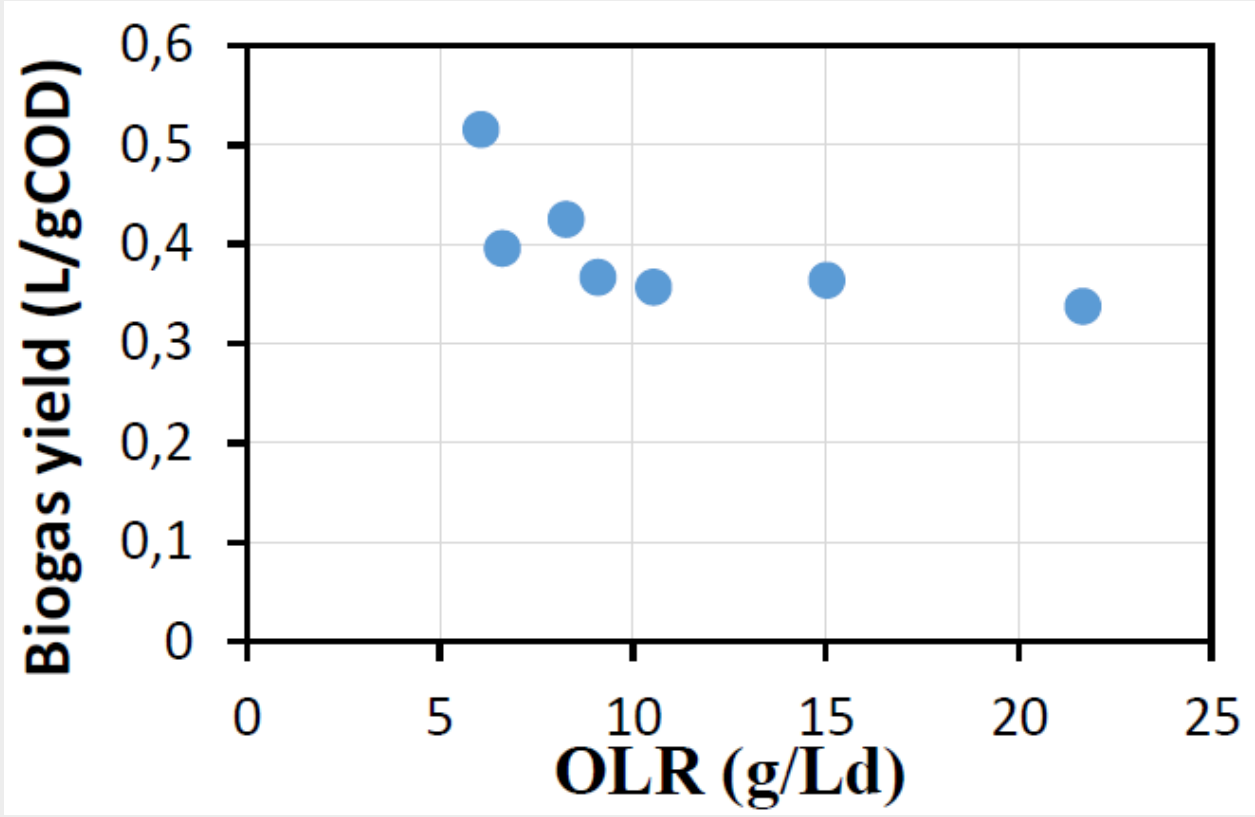
Results – Plug Flow Reactor





Results – Plug Flow Reactor





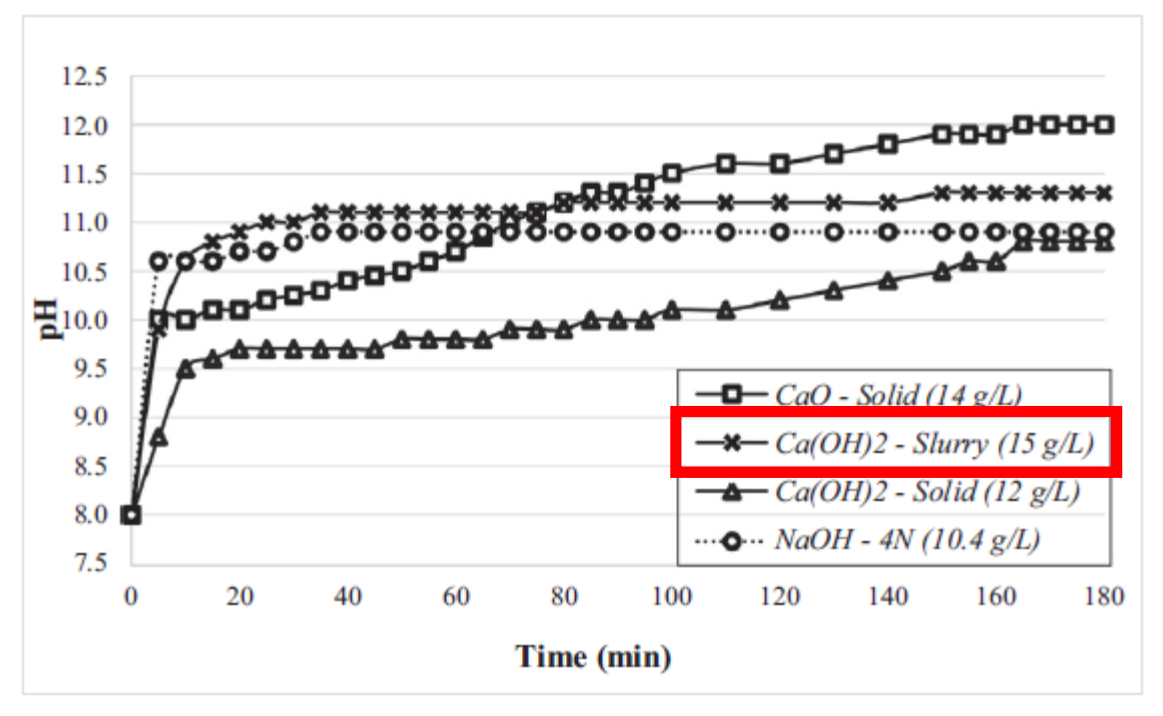
Results – Plug Flow Reactor

- The PFR was operated with an OLR from 7 up to 22 g/Ld.
- BPR was from 2.6 up to 7.3 L/Ld.
- The biogas methane content was 73±3%.
- The anaerobic effluent was characterized by a SCOD concentration of 5.6±1.4 g/L and an ammonia nitrogen 1.7±0.5 g/L.
- SCOD removal efficiency remained constant during the study at 80±4 %.
- The biogas yield was 0.36 L/gCOD fed, for OLR > 9 g/Ld.
- The PFR displayed high process stability during the study with negligible VFA accumulation (< 0.5 g/L as COD), both at the middle and the end of the reactor.

Results – Ammonia recovery

1. Selection of optimum substrate for effective clarification of the anaerobic digestate and elevate pH.

Hydrated lime as a slurry was selected

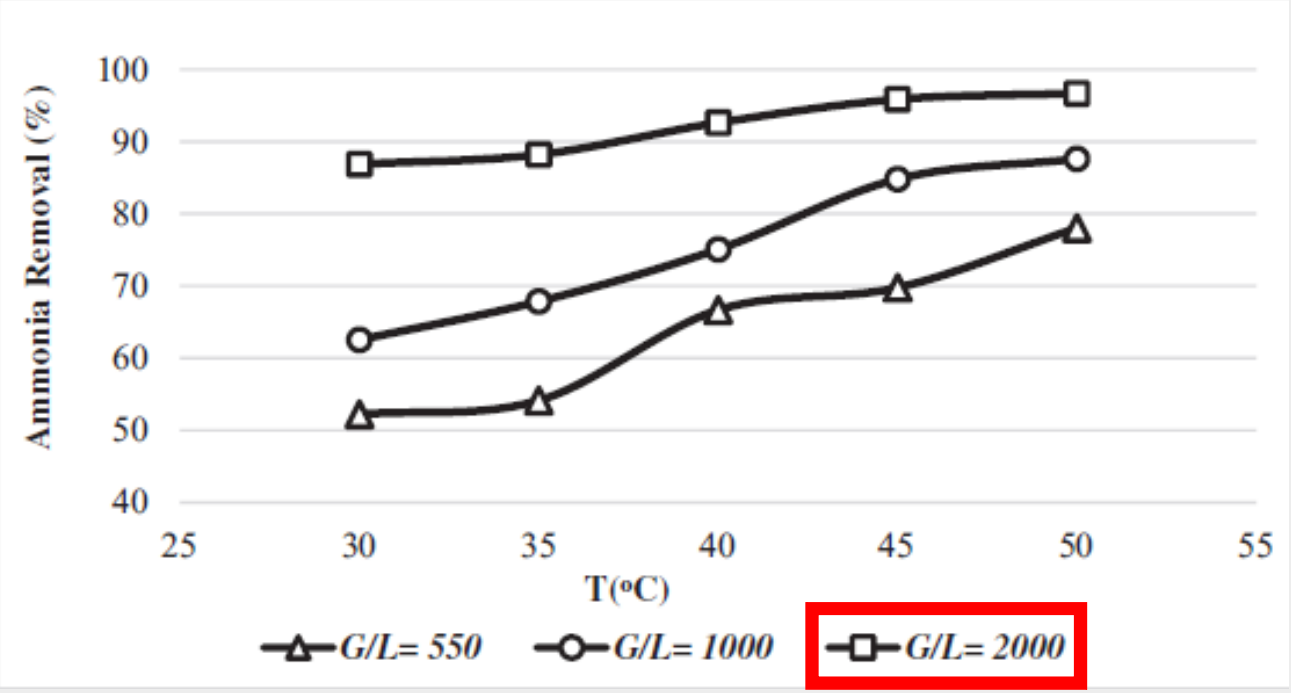


Georgiou D. et al. (2019). Investigation of an integrated treatment technique for anaerobically digested animal manure: lime reaction and settling, ammonia stripping and neutralization by biogas scrubbing, Bioresource Technology Reports, 5, 127-133.

Results – Ammonia recovery

2. Selection of G/L ratio at initial pH 12

Ammonia was almost completely removed (~98%) at 50 °C and **G/L = 2000**.



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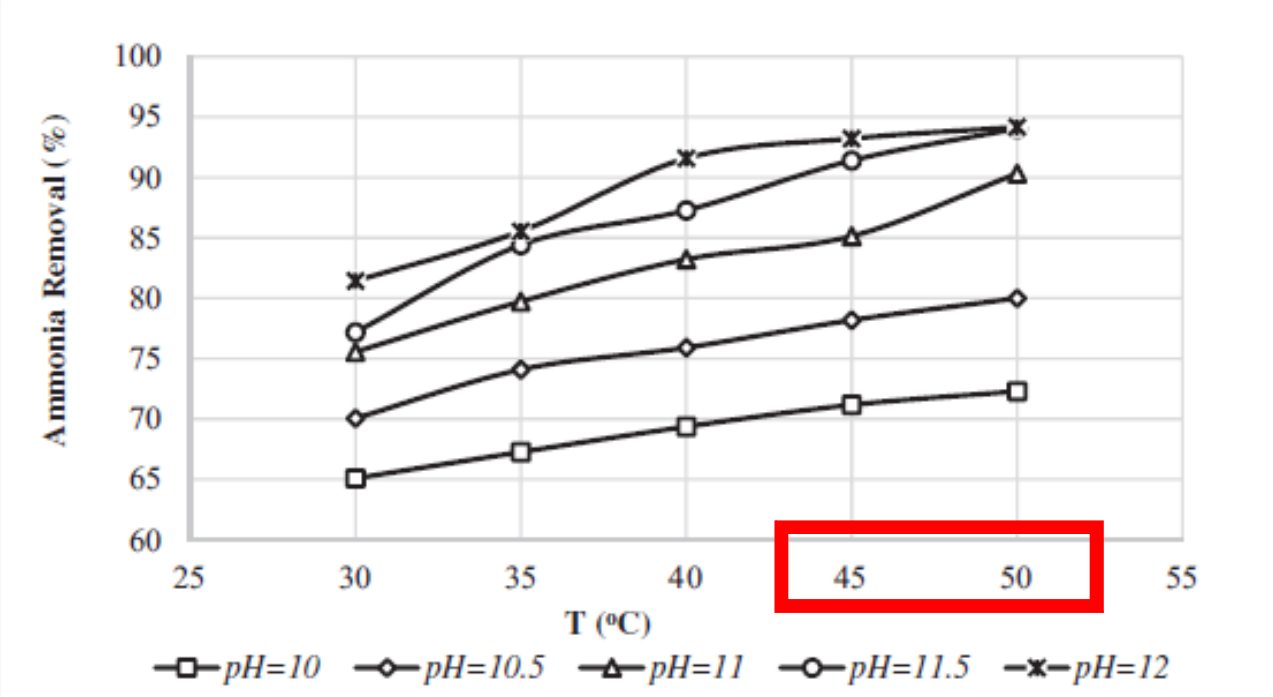
Results – Ammonia recovery

election of optimum temperature at **G/L** ratio of 2000.
mperature of **≥45°C** is suggested for efficient ammonia removal.



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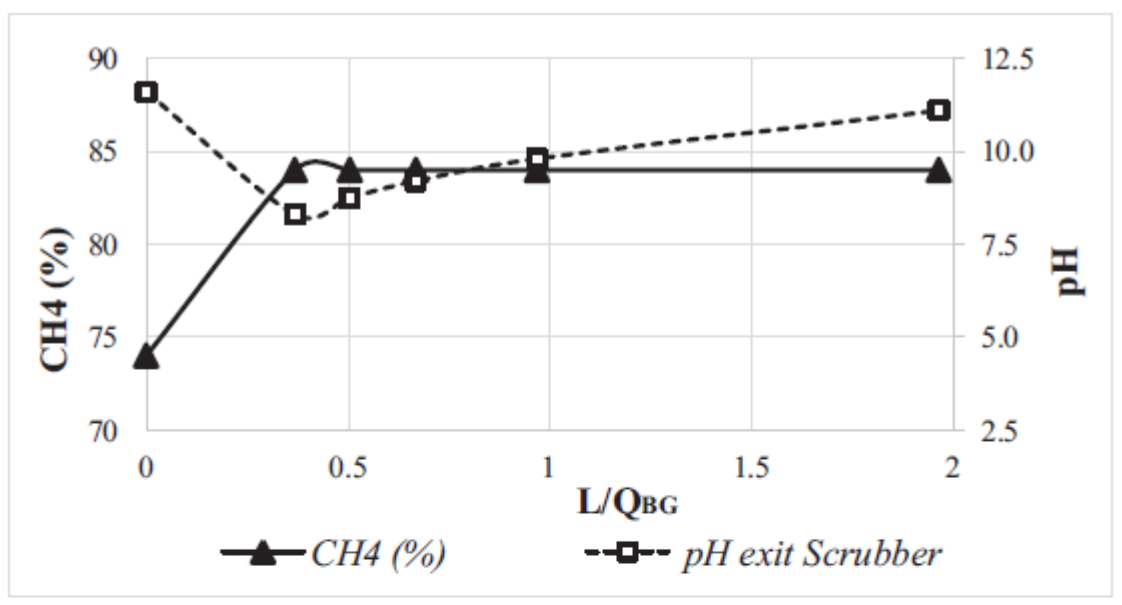
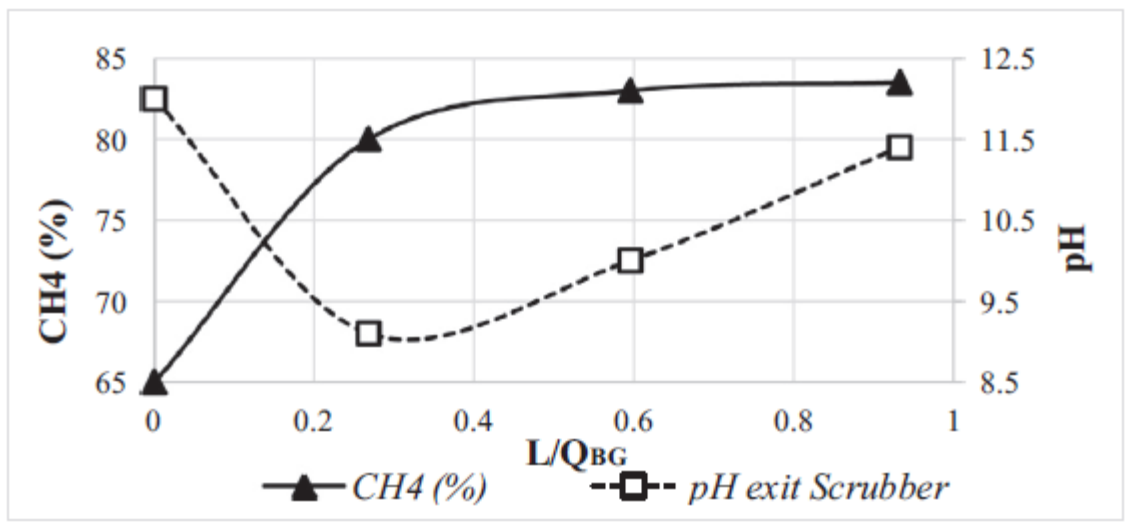
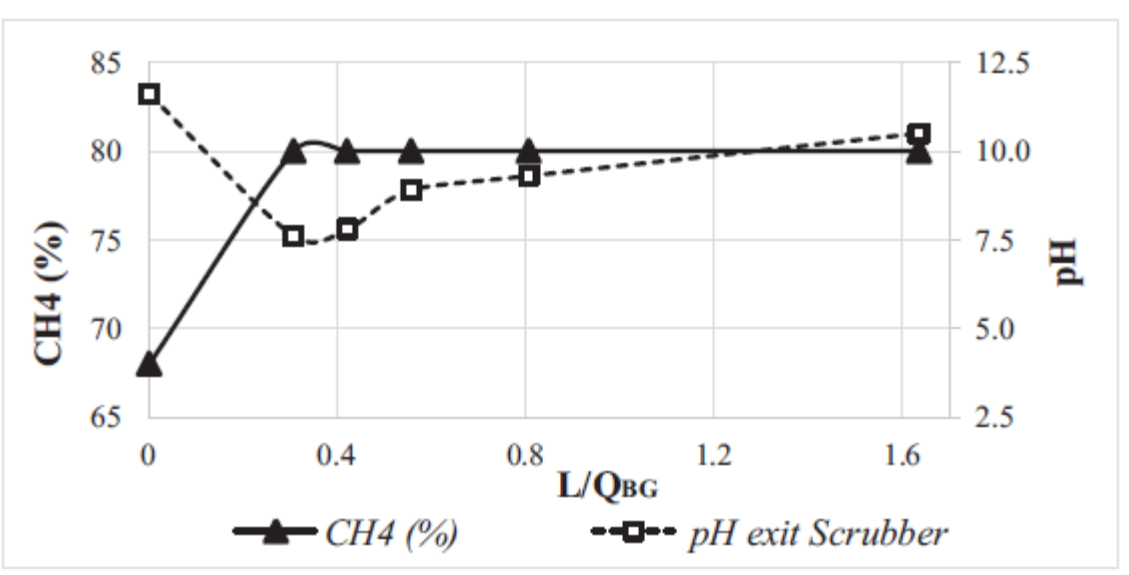
Results – Biogas purification







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Results – Ammonia recovery and biogas purification

- Hydrated lime as a slurry preferred for effective clarification of the anaerobic digestate and elevate pH>11.5.
- A temperature of ≥45° C is suggested for efficient ammonia removal.
- Ammonia was removed by ~98% at 50 °C and G/L = 2000.

- The ammonia stripper effluent was further treated in a chemical absorption tower at different L/Q_{biogas}.
- Biogas was indeed upgraded since methane percentage at the exit of the scrubber reached 84%, at all L/Q_{biogas} ratios.

Acknowledgements

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Thank you