ATBEST

Sustainability and Life Cycle Assessment of feedstock digestion systems

Markus Voelklein

Prof Jerry D Murphy

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QUESTOR CENTRE

ucc
Coláiste na hOllscoile Corcaigh, Éire
University College Cork, Ireland

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Content

1. 2-phase digestion
2. Biological methanation
3. Outlook

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CONTENT

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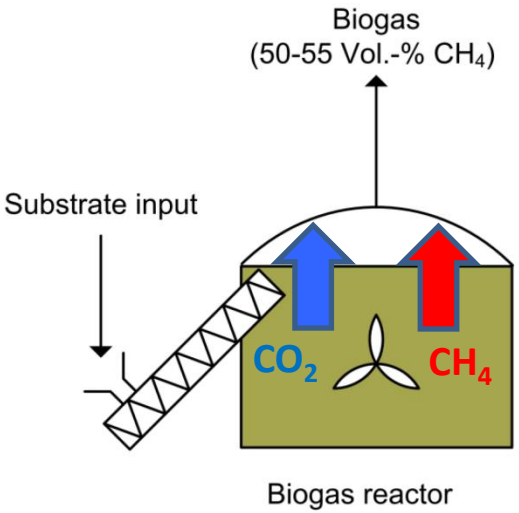
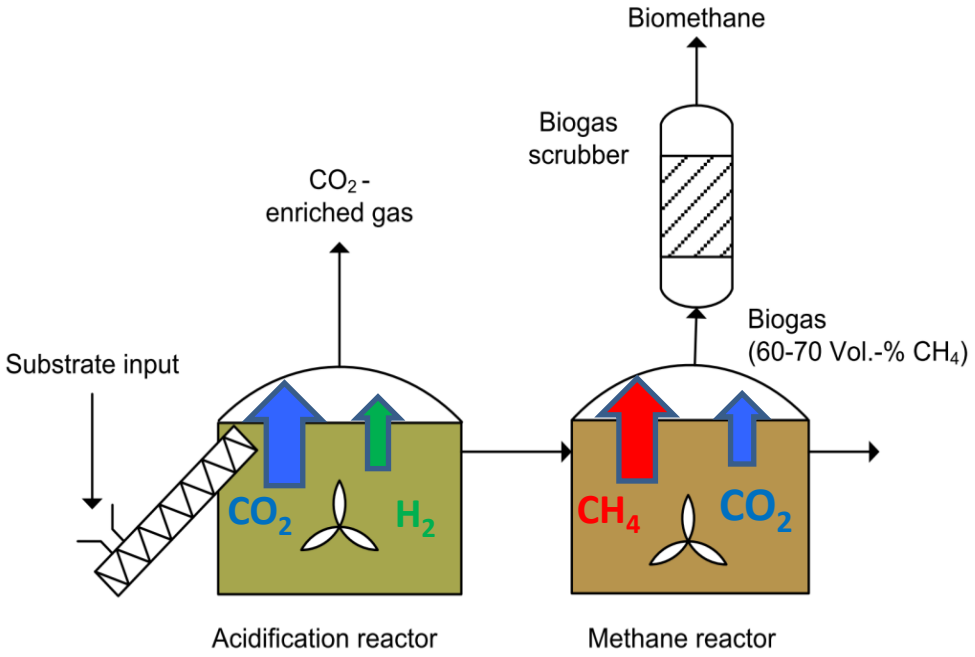
2-PHASE DIGESTION

Key difference of gas production





One phase system:

- **Mix of CH_4 and CO_2**

Two phase system:

- Acidifying hydrolytic phase **H_2 and CO_2**

  (Upstream CO_2-Segreagation)

- Methanogenic phase **CO_2 and CH_4**

  (Increased methane concentration)

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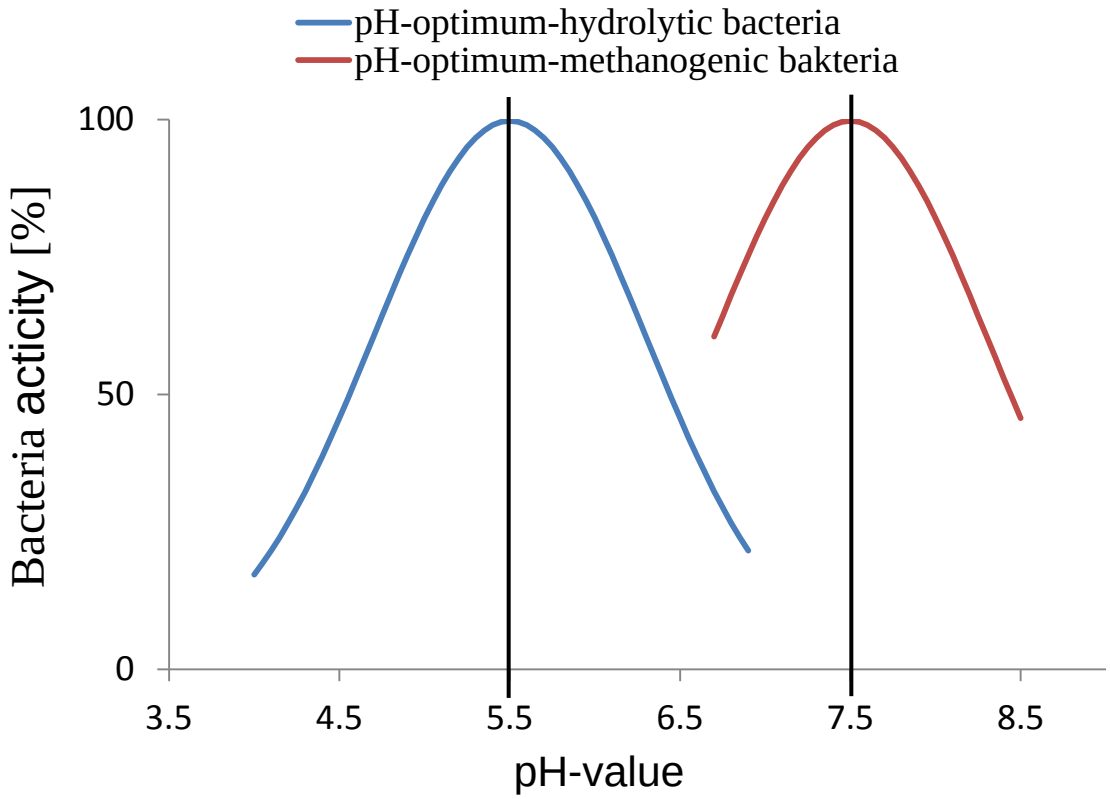
Impact of pH-Value

- Why split the process? ➡ pH-optimum, higher yields



- Significant increase of hydrolytic bacteria activity in 2-phase system

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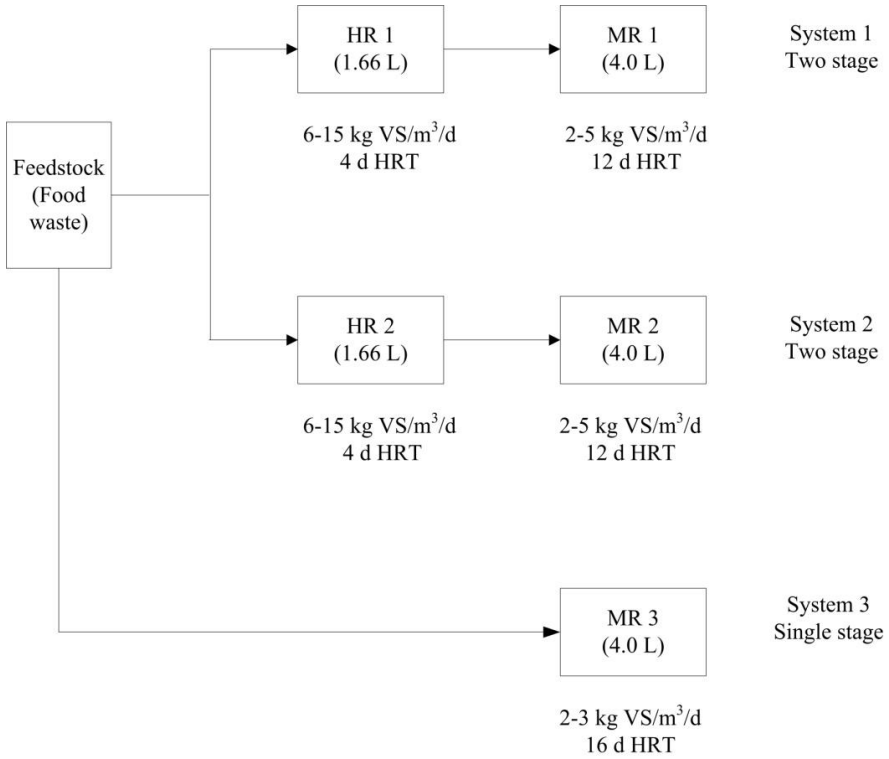
Design and operation conditions of the experiment



- Two individual systems comprising a hydrolysis and methane reactor
- One single stage system
- Test at low, moderate and high loading rates

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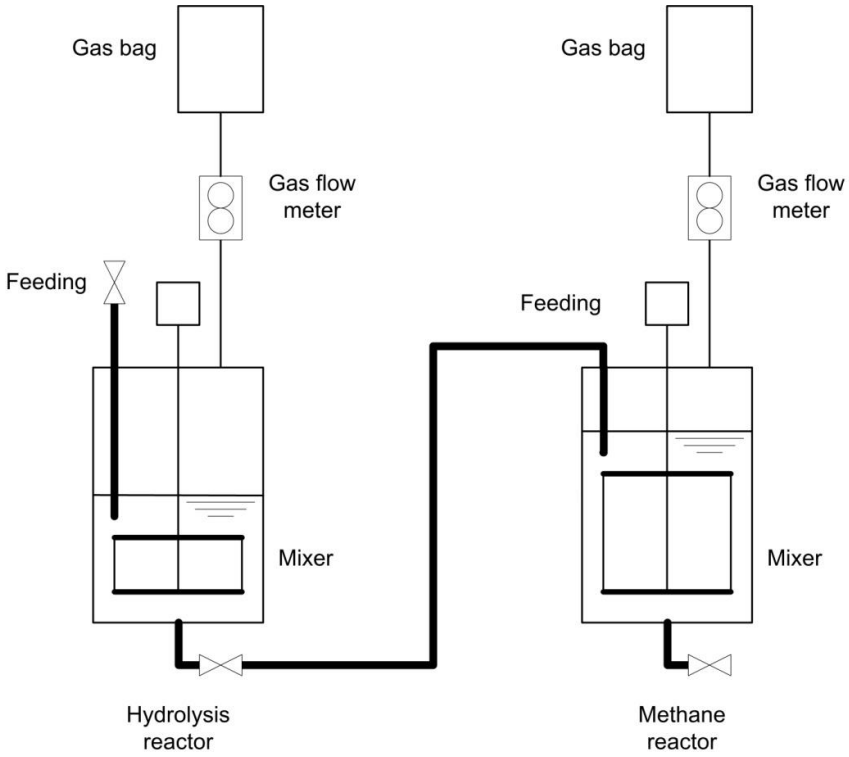
2-PHASE DIGESTION

Experiment lay out

External view of Reactor



Internal view of Reactor

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2-PHASE DIGESTION

Highlights

- Impact of trace element supplementation
- Compare efficiency (carbon- and energy balance) of 2-phase system, 1-phase System, BMP, Buswell
- Evaluation of high OLR on SMY
- Hydrolysis performance and impact of different OLR on the hydrolysis reactor

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CONTENT

1. 2-PHASE DIGESTION
2. **BIOLOGICAL METHANATION**
3. OUTLOOK

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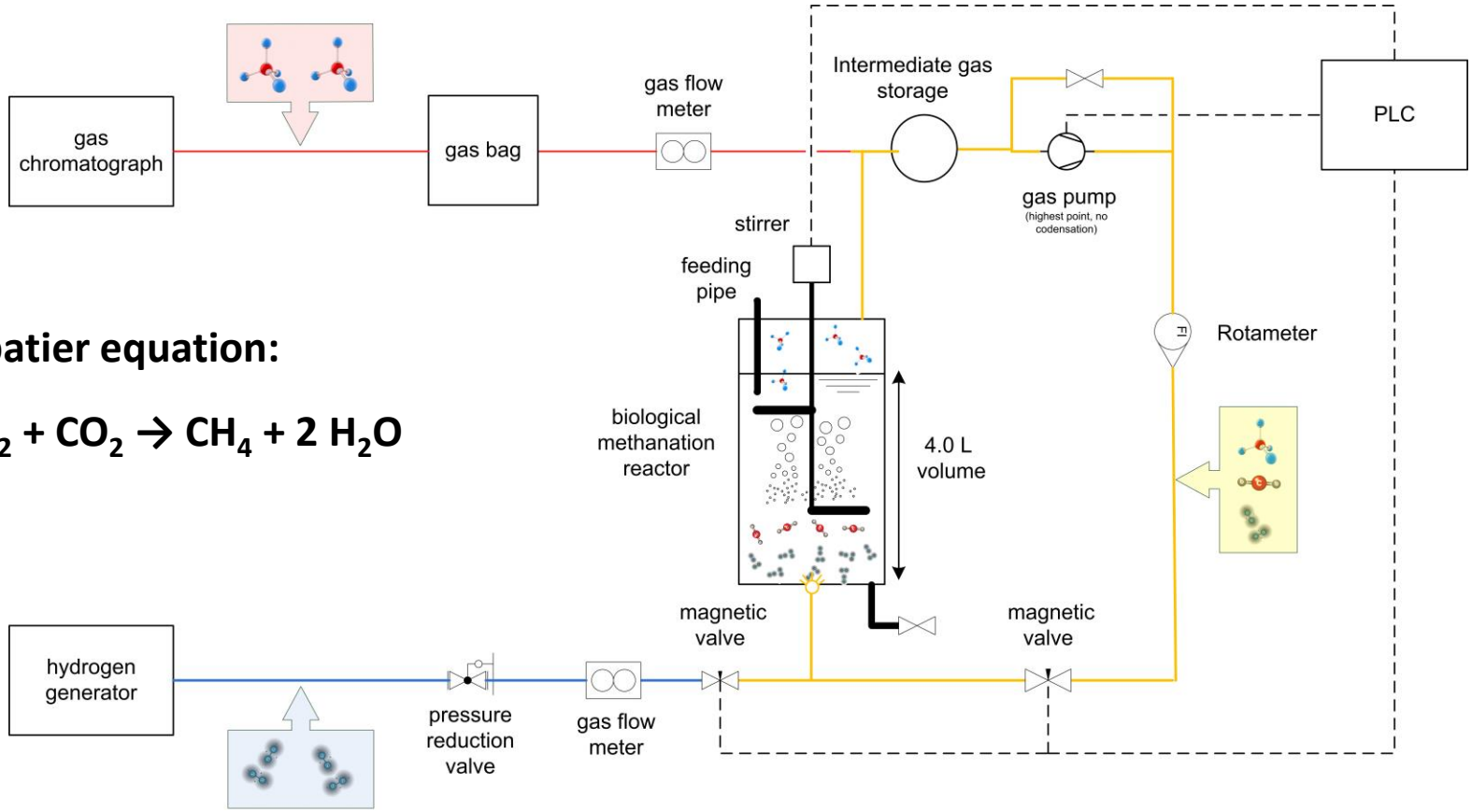
BIOLOGICAL METHANATION

Lab scale experiment



Sabatier equation:

$$4\ H_2 + CO_2 \rightarrow CH_4 + 2\ H_2O$$

BIOLOGICAL METHANATION

Lab scale experiment

Compare results to a duplicate reactor without hydrogen injection

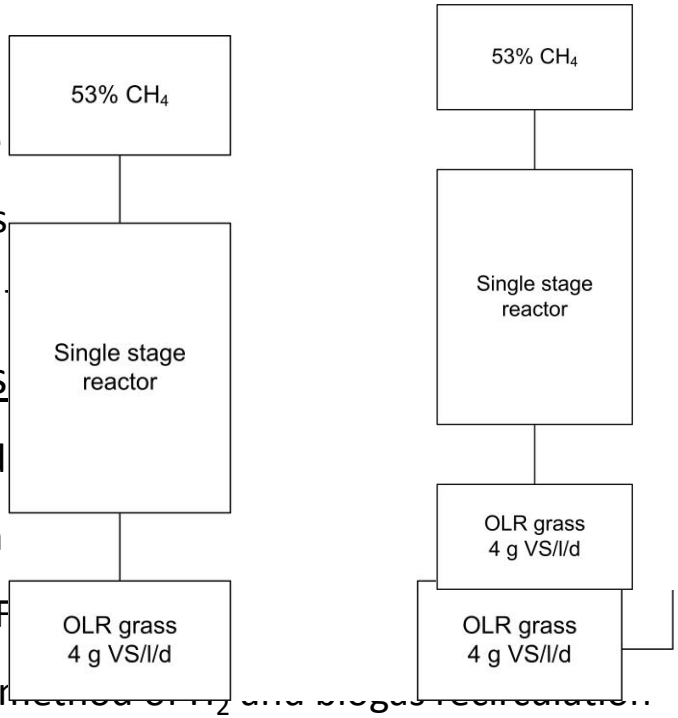
<u>Objectives</u>

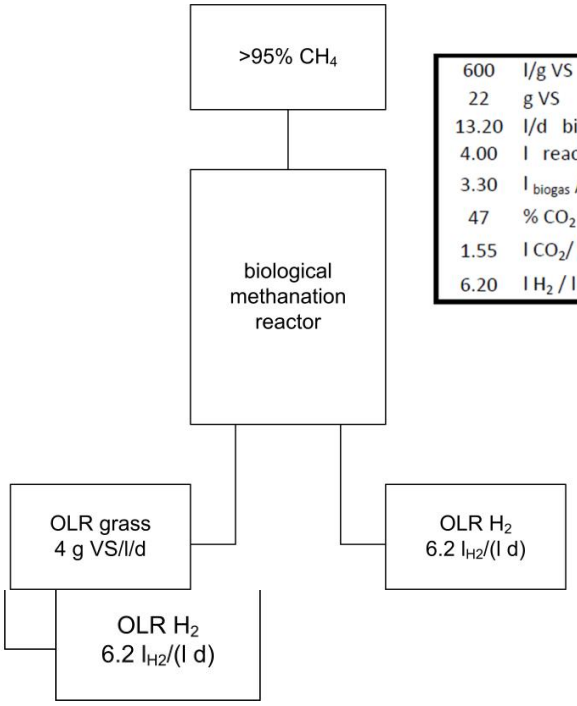
- Maximize
- Increase s

  of H_2 due

<u>Bottlenecks</u>

- Gas liquid
- Hydrogen
- pH and VF
- Injection





600	l/g VS biogas
22	g VS
13.20	l/d biogas
4.00	l reactor volume
3.30	l_{biogas} /$l_{reactor\ volume}$ day
47	% CO_2
1.55	l CO_2/ l day
6.20	l H_2 / l / d

✓ Life cycle assessment including detailed carbon and energy balances

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OUTLOOK

- ✓ Combine 2-phase food waste digestion and biological methanation at lab scale
- ✓ Injecting the hydrolysis gas and external hydrogen into the methane reactor of the 2-phase system
- ✓ Include findings in a full scale biogas plant model. In this scenario, the storage capability of biogas with the associated external hydrogen functions as a "battery" of the electricity grid.

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Thanks for listening

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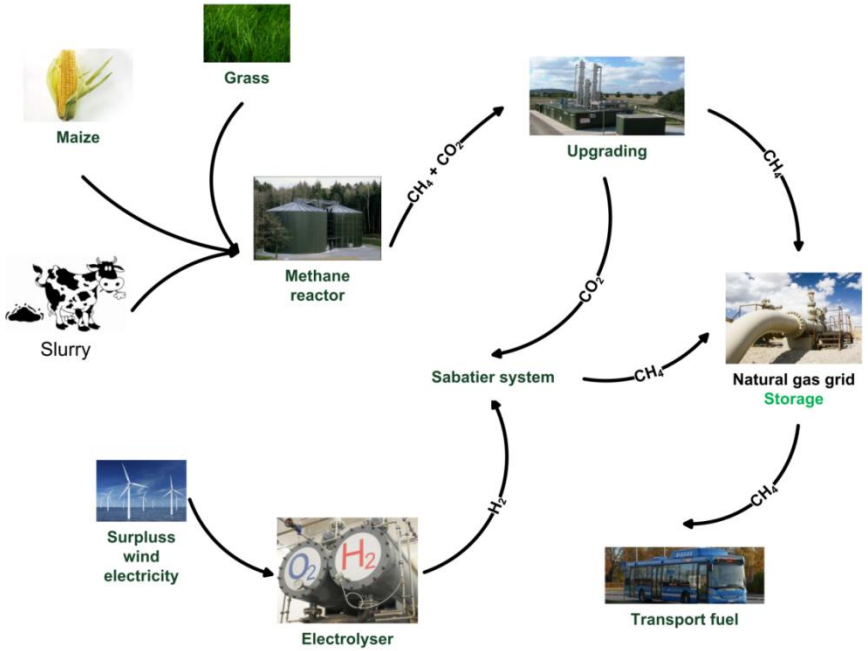
Project coordinated by the QUESTOR Centre
at Queen's University Belfast
www.qub.ac.uk/questor

CURRENT STUDY

Life cycle assessment

Energy, cost-benefit and greenhouse gas analysis address the sustainability and economical viability of a full scale biomethane system.



Highlights:

- Hydrogen to upgrade biogas (Sabatier process)
- Assess demand driven electricity generation

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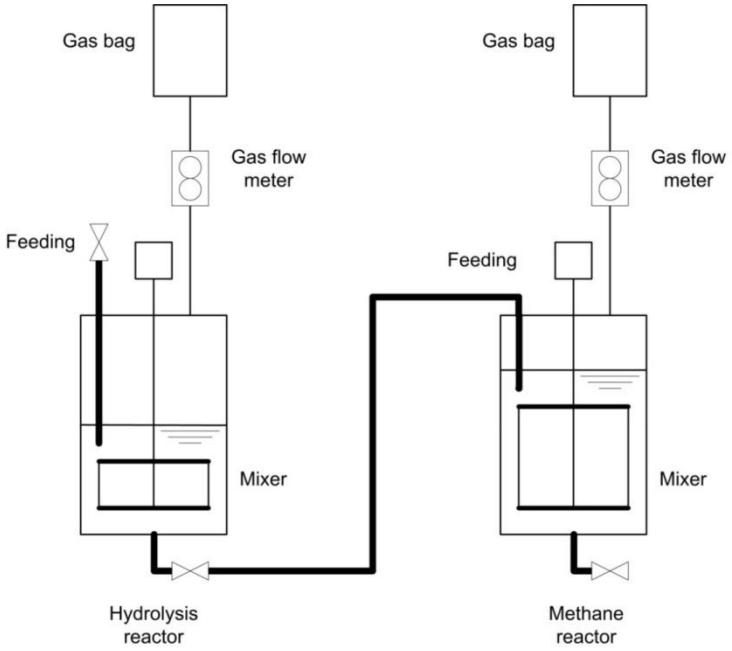
LATEST RESEARCH

2-phase digestion

Investigate the methane potential in a two-phase fermentation process based on food waste at high loading rates.



- Acidifying hydrolytic phase (H_2 and CO_2)
- Methanogenic phase (CH_4 and CO_2)

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