9th International Conference on Sustainable Solid Waste Management

Combined production of biogas and volatile fatty acids from a pure primary sludge: preliminary results of a pilot test

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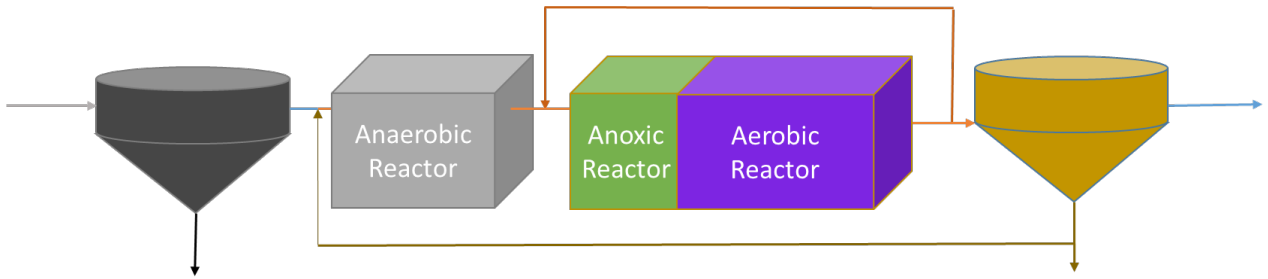
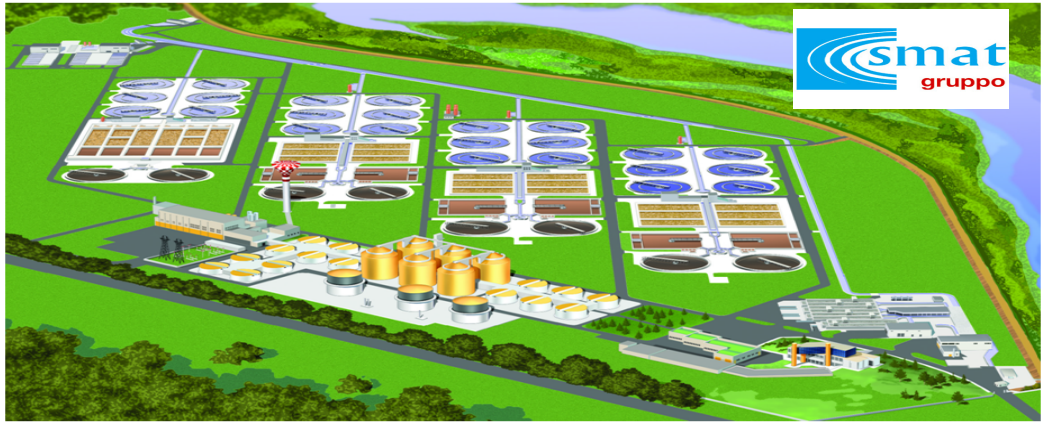
**Smat - Società Metropolitana Acque Torino

Castiglione Torinese WWTP

- ***Municipal and industrial wastewater***
- ***Capacity: 2,000,000 E.I. (1.5M civil inhabitants, 800 industrial plants)***
- ***Average flow rate: 7 m3/s***

Biodegradability





-49 %

-10 %

q	140	m3/h
q (Primary Sludge)	61.5	%
q (Secondary Sludge)	38.5	%
Primary Sludge TSfed	2,755	kg/h
Primary Sludge VSfed	1,975	kg/h
Secondary Sludge TSfed	1,562	kg/h
Secondary Sludge VSfed	1,076	kg/h
Methane production	650	Nm3/h
CH4(WAS)/ CH4(Tot)	15	%
Primary Sludge TSdischarged	1,860	kg/h
Primary Sludge VSdischarged	1,005	kg/h
Secondary Sludge TSdischarged	1,399	kg/h
Secondary Sludge VSdischarged	907	kg/h

Theoretical Potential Energy- COD (ThPE-COD)

The production of CH4 from COD in anaerobic processes is mainly determined by methanogenesis, with a maximum conversion efficiency of 0.25 kg CH4/kg COD, or **0.35 Nm3 CH4/kgCOD**

$$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O(l) \qquad \Delta H° = -890\ kJ/mol\ CH_4$$

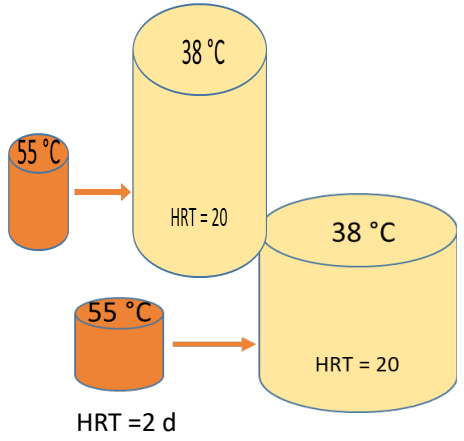
suggesting that 13.91 kJ of energy could be obtained from each gram COD removed from wastewater. **(13.91 kJ/gCOD)**

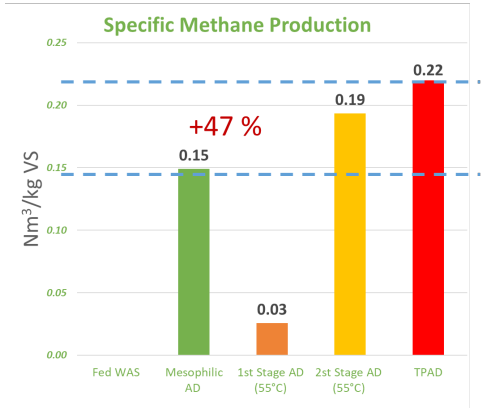
" ….**the A-stage** is primarily designed for direct capturing or **conversion of COD to methane gas via anaerobic treatment** without producing excess sludge and the **B-stage** is designated for **nitrogen and** phosphorous removal **– may offer a feasible engineering option for turning the operation of current municipal WWTPs from being energy-negative to energy self-sufficient**"

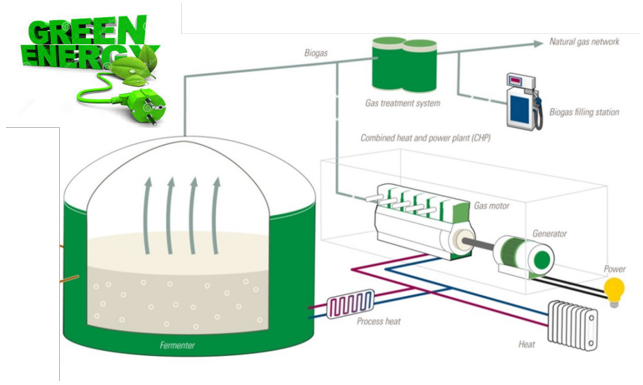
Temperature Phased Anaerobic Digestion (TPAD)

Research

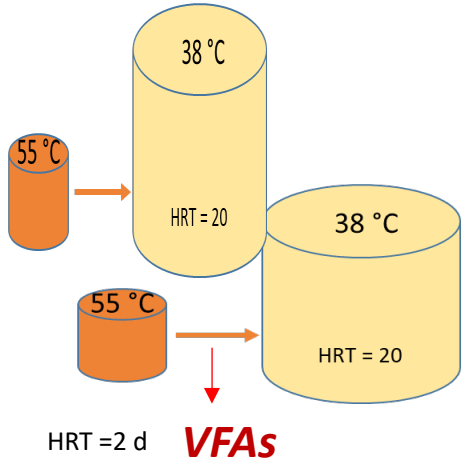
WAS



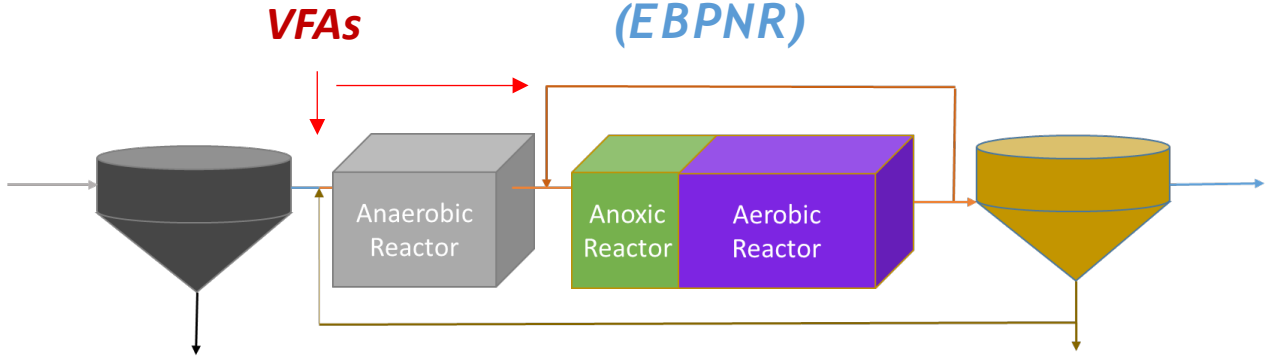




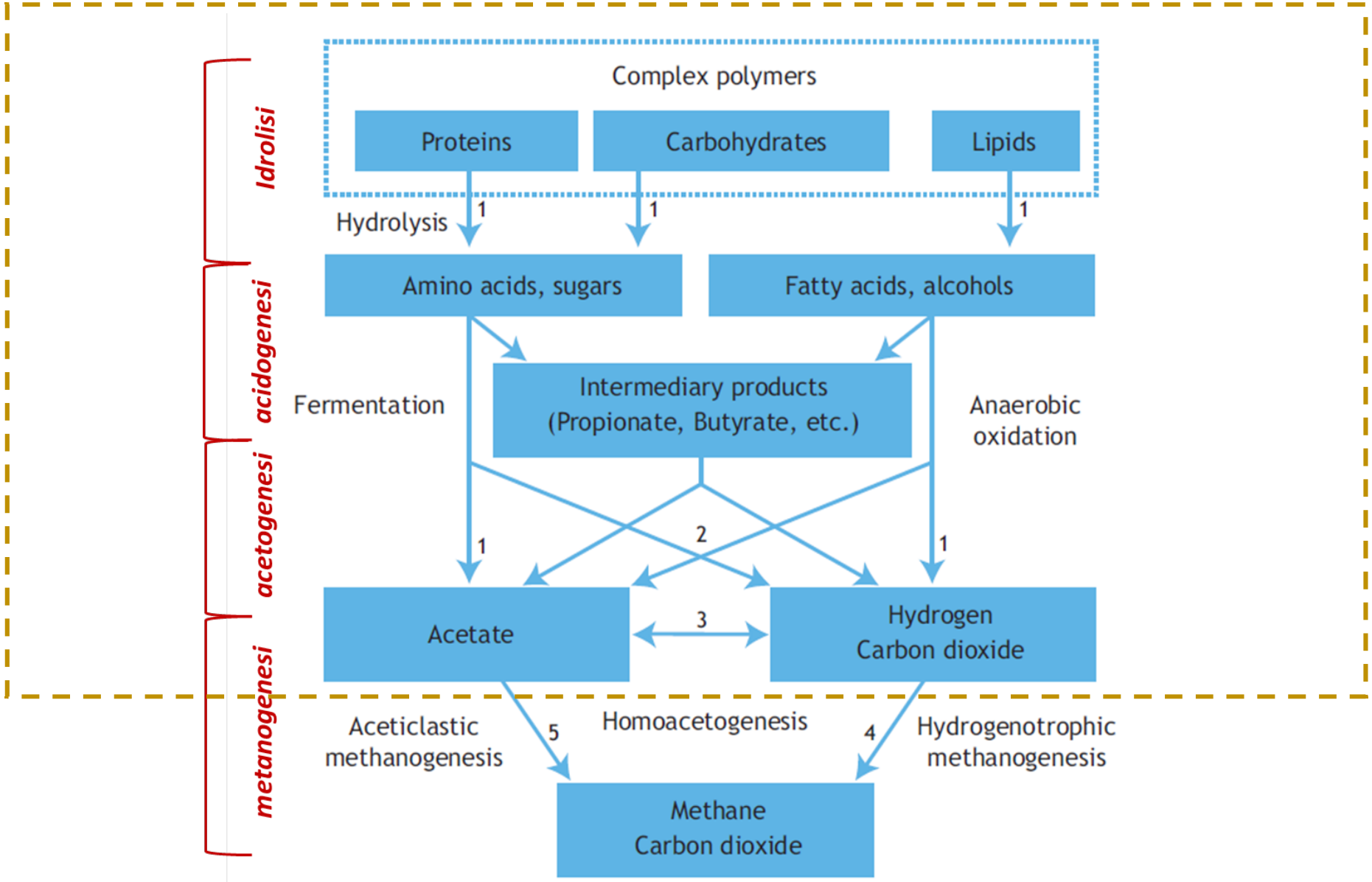
Primary sludge



Enhanced biological phosphorus and nitrogen removal (EBPNR)

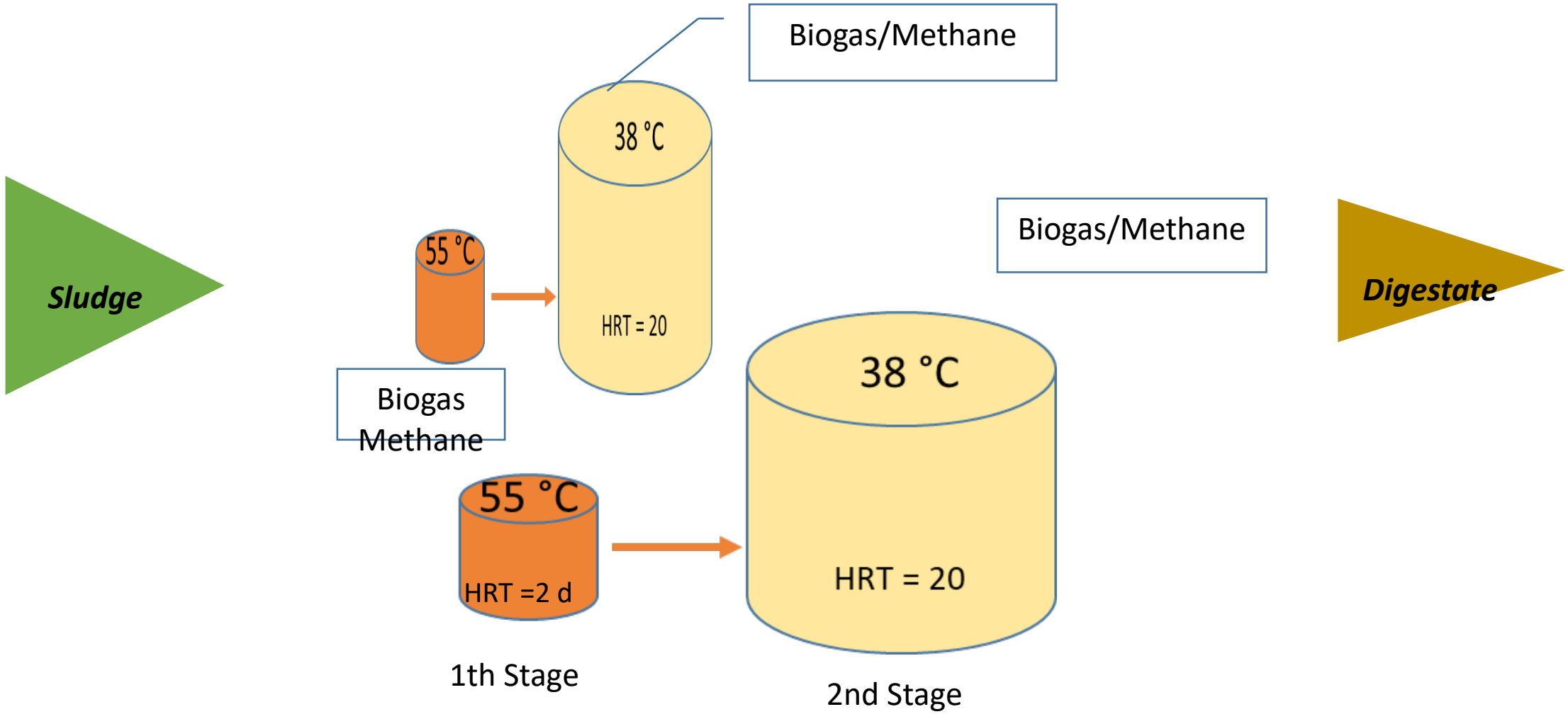


Anaerobic Digestion



Materials and methods

Temperature Phase Anaerobic Digestion



Materials and methods

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Pre-thickened primary sludge

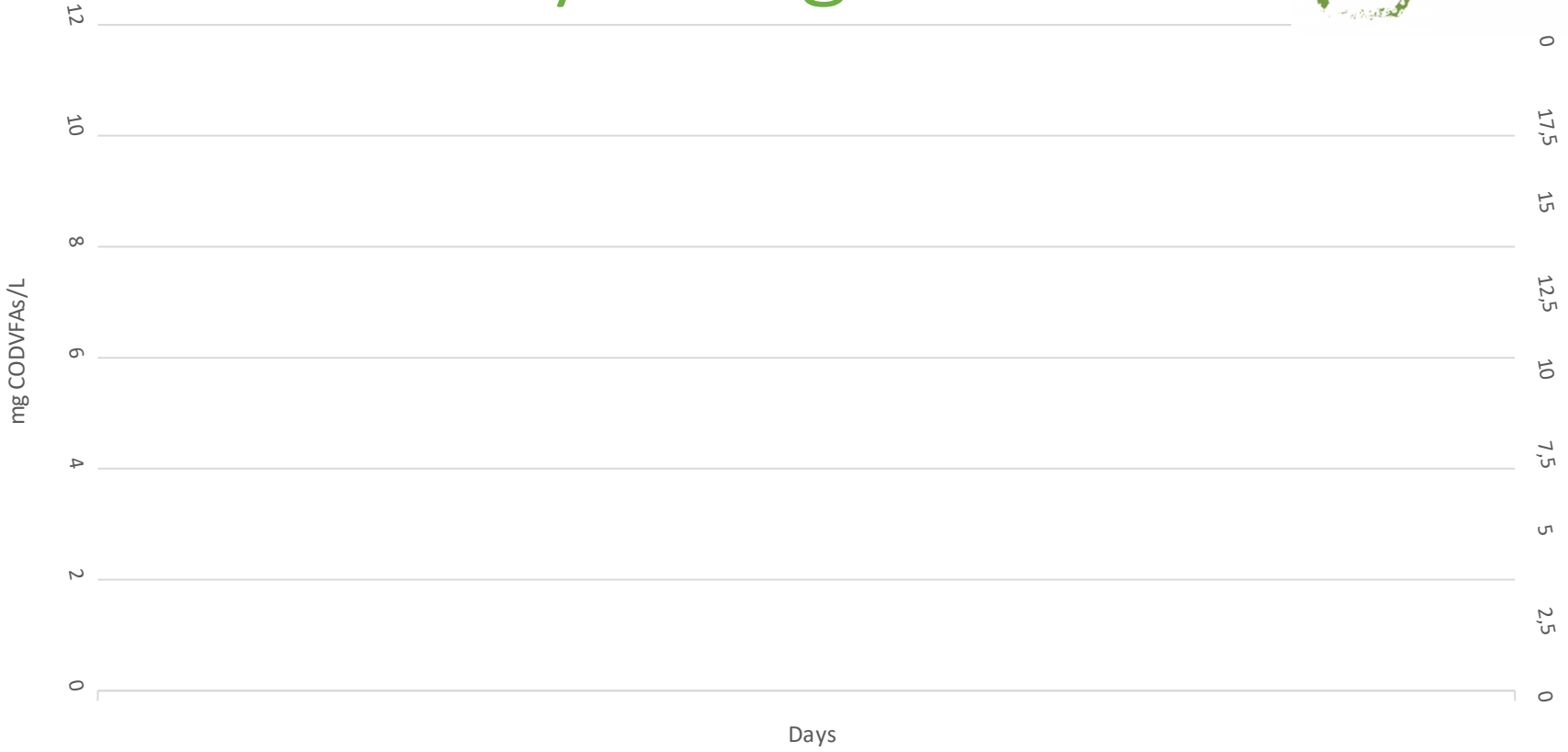
Total Solids %
Volatile Solids %
pH
Acidity and Alkalinity
sCOD mg/L
sP mg/L
NH4+ mg/L
VFAs

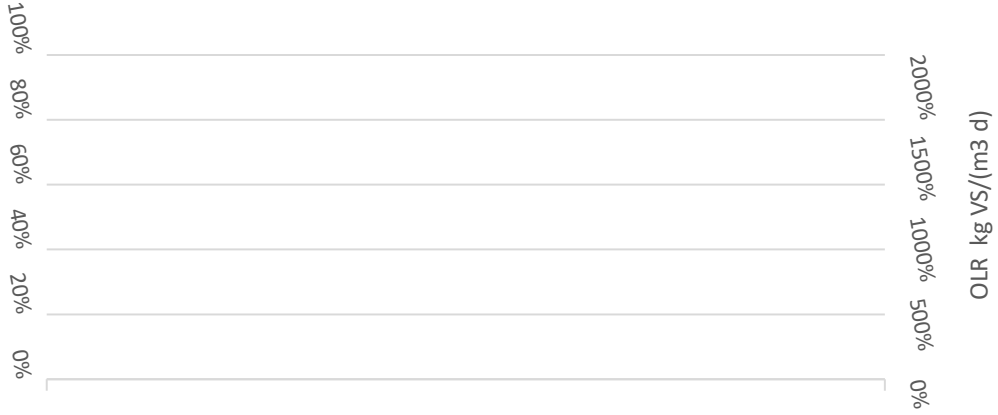
Digested sludge

Total Solids %
Volatile Solids %
pH
Acidity and Alkalinity
sCOD mg/L
sP mg/L
NH4+ mg/L
VFAs

VFAs – Primary Sludge

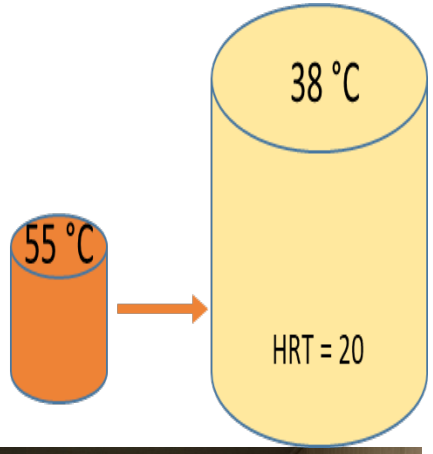
Results:

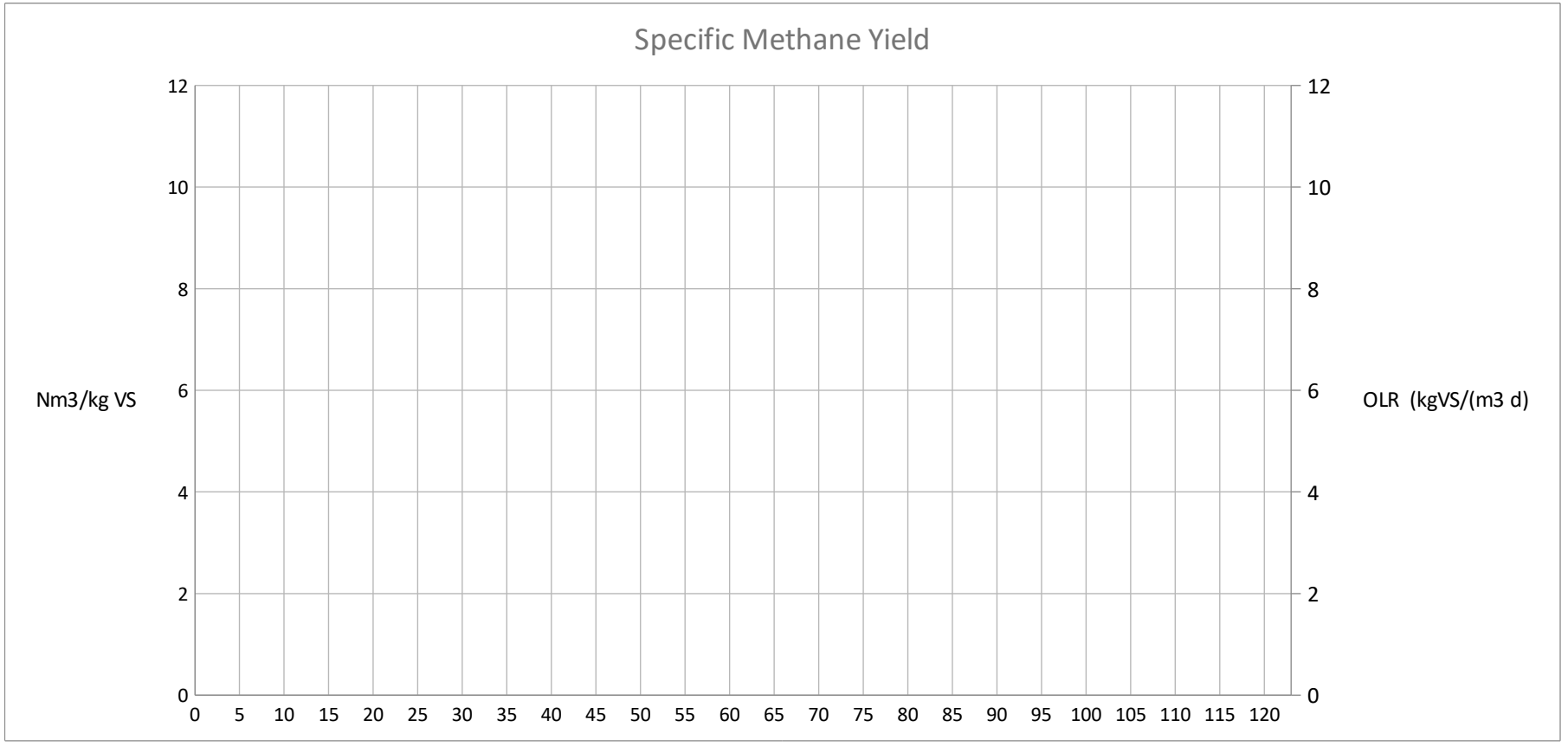




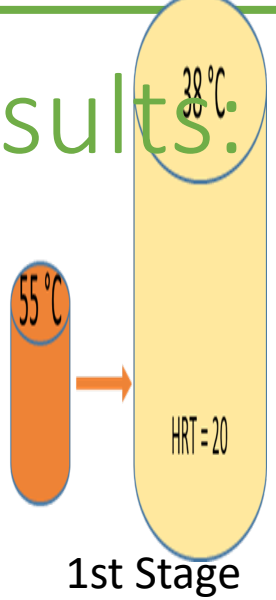
Results:

Mesophilic PS-AD

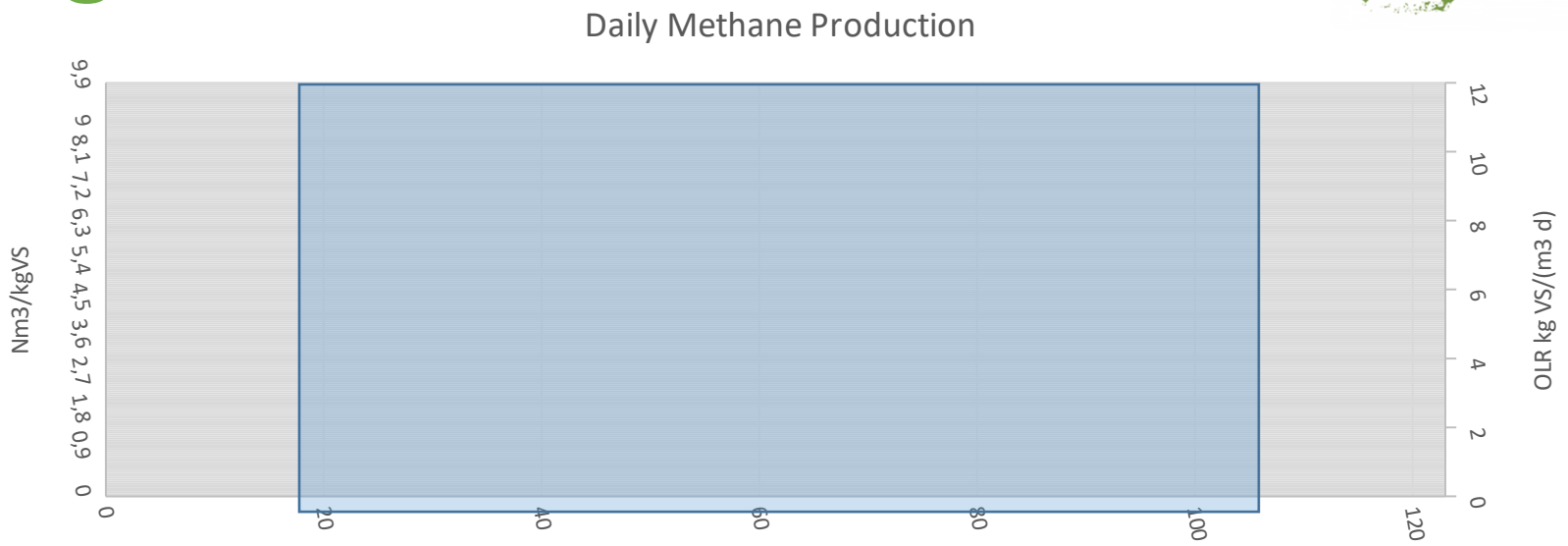


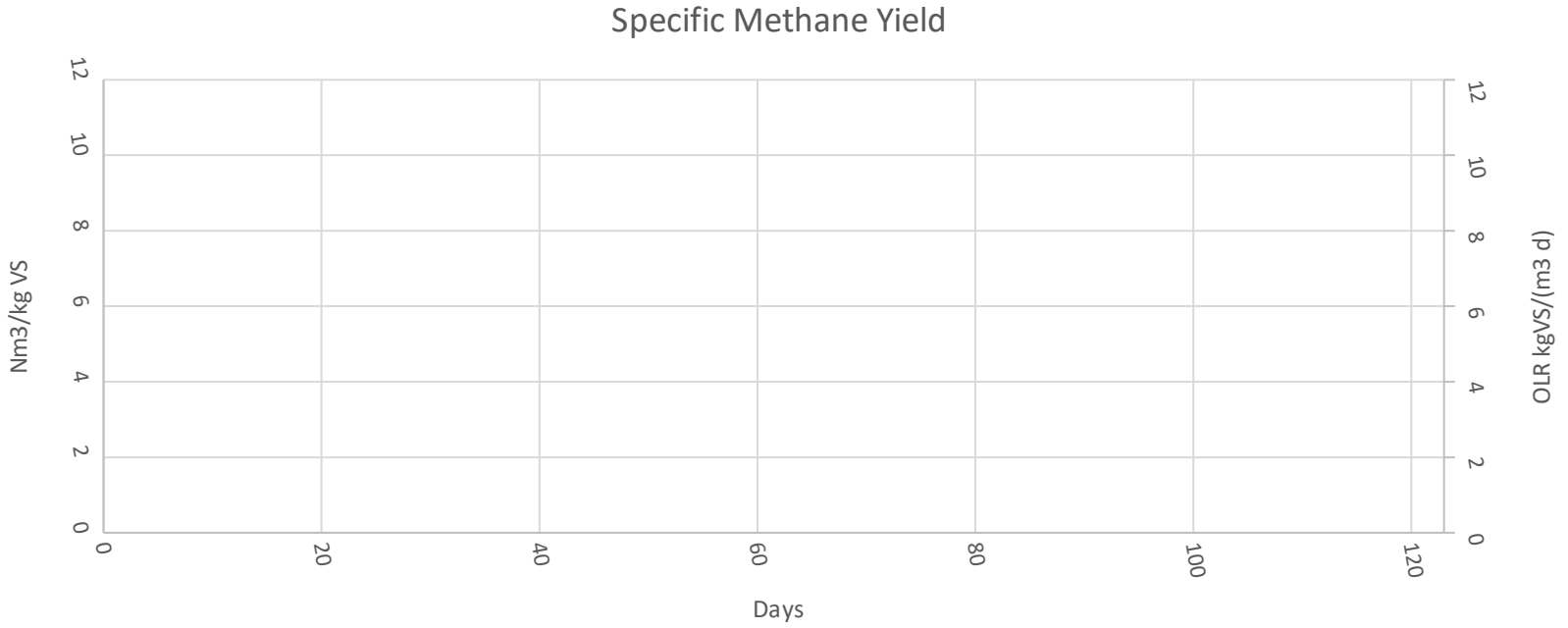


Results: 1st Stage PS-AD

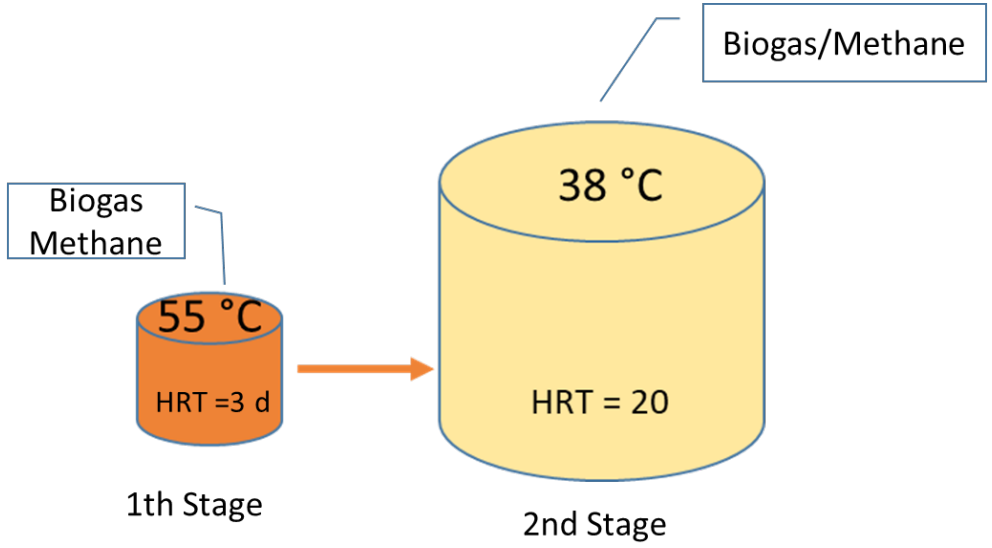


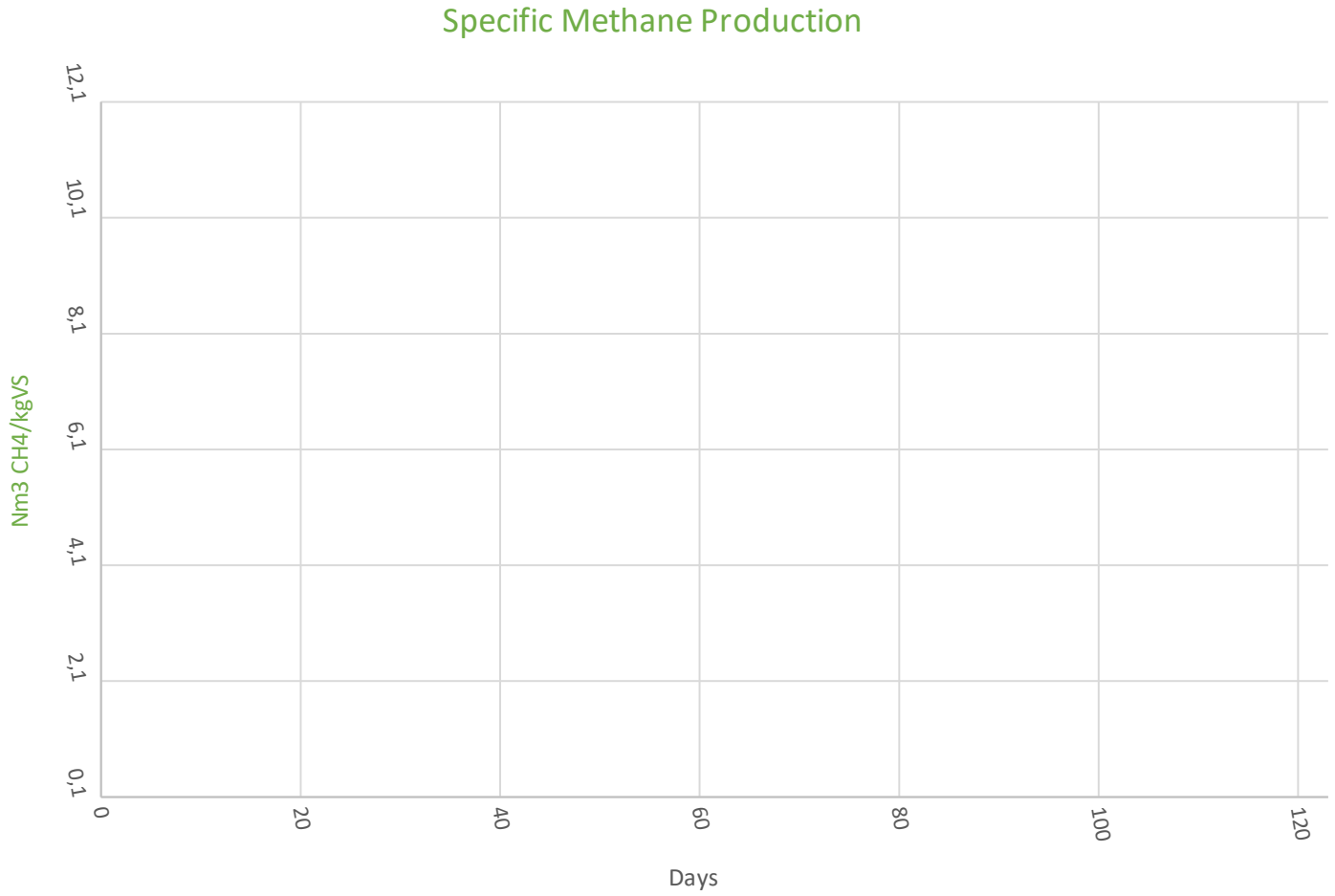
1st Stage



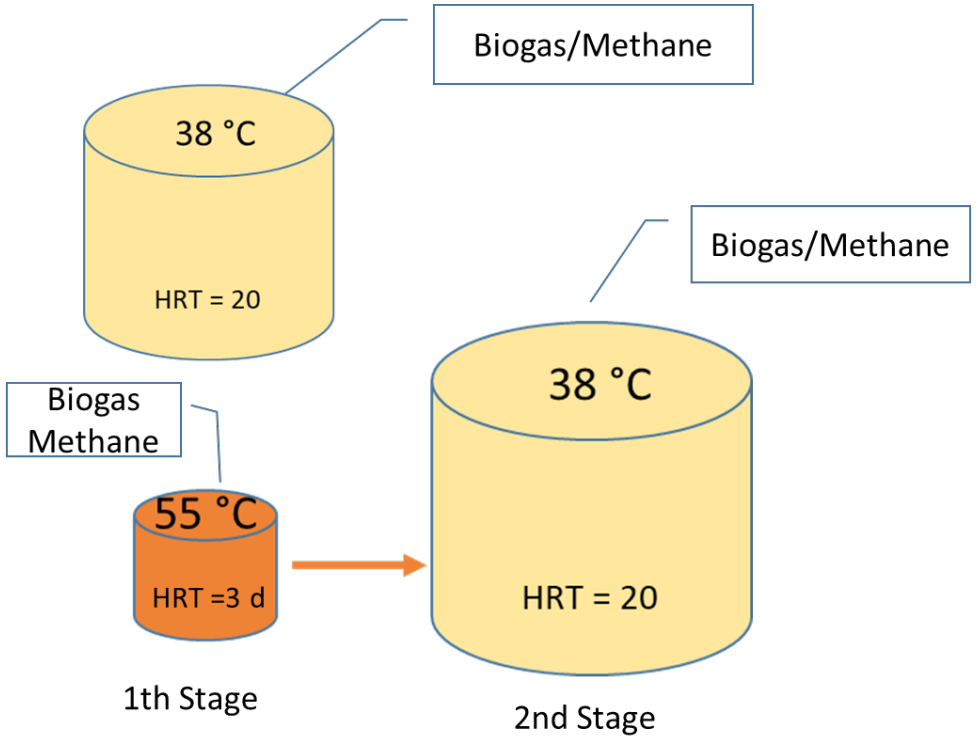


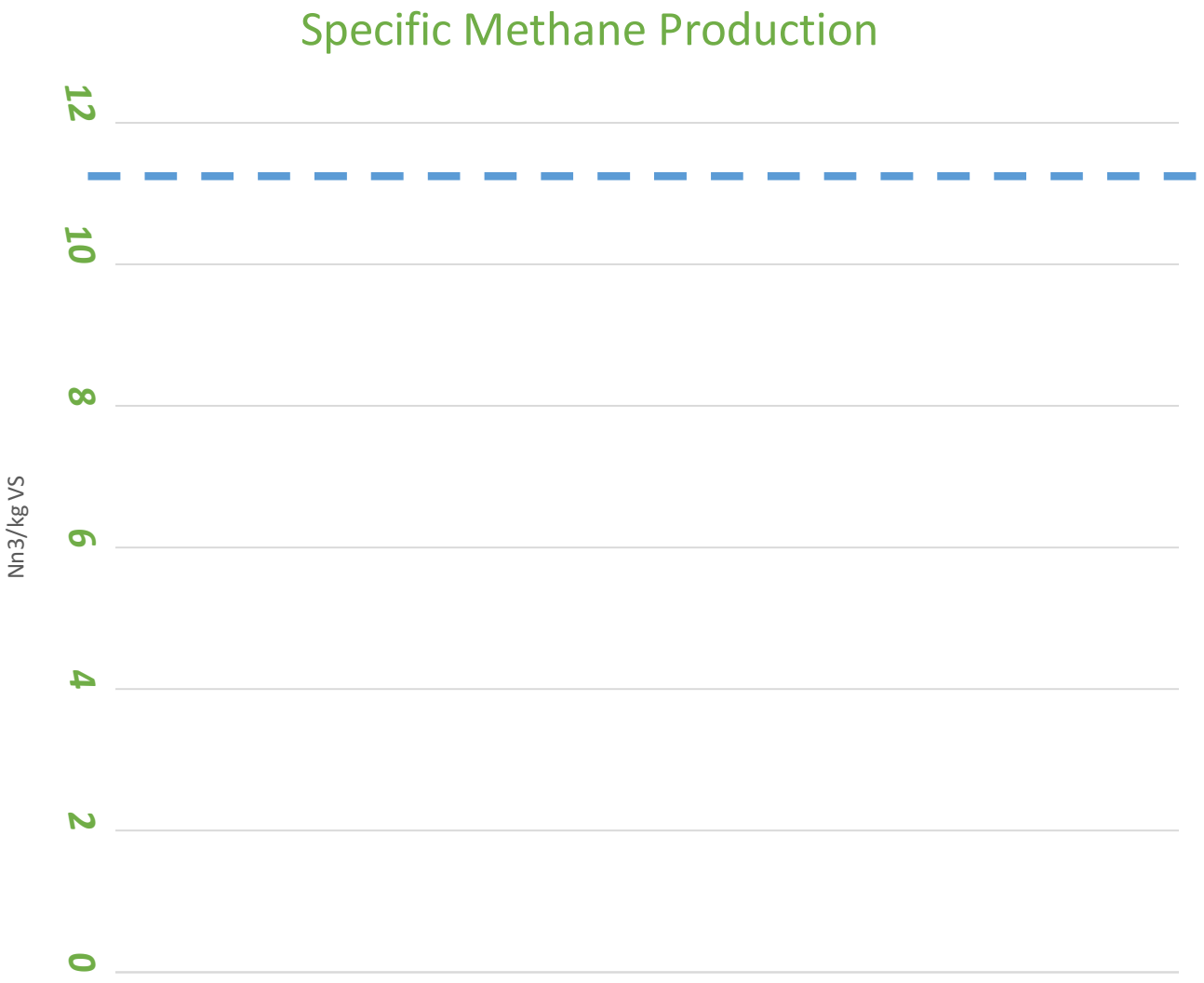
Results: TPAD WAS



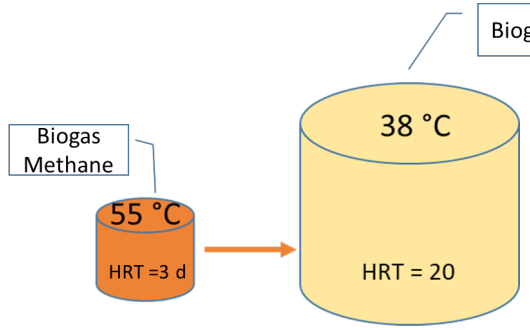


Results:


Biogas/Methane
38 °C
HRT = 20
Biogas/Methane
Biogas
Methane
55 °C
HRT =3 d
38 °C
HRT = 20
1th Stage
2nd Stage


Specific Methane Production
Nn3/kg VS
12
10
8
6
4
2
0

TPAD – Primary Sludge



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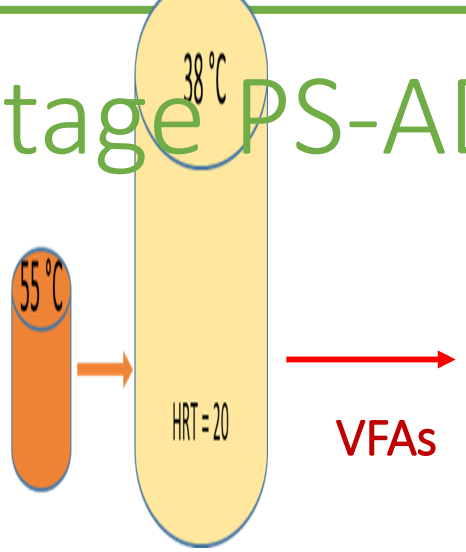
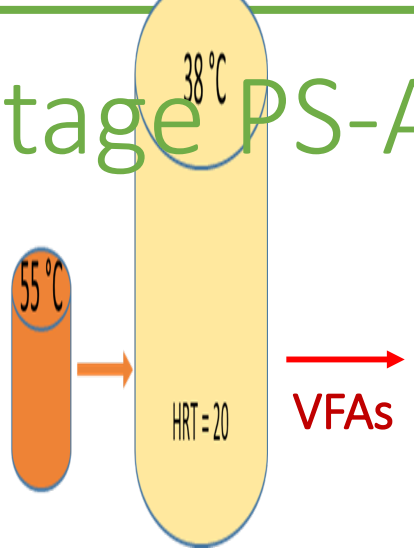
1st Stage PS-AD



1st Stage

VFAs Yield vs Specific Methane Production

1st Stage PS-AD



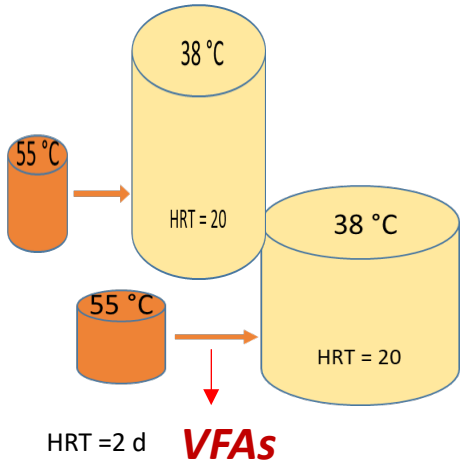
1st Stage

VFAs Yield vs Specific Methane Production

Temperature Phased Anaerobic Digestion (TPAD)

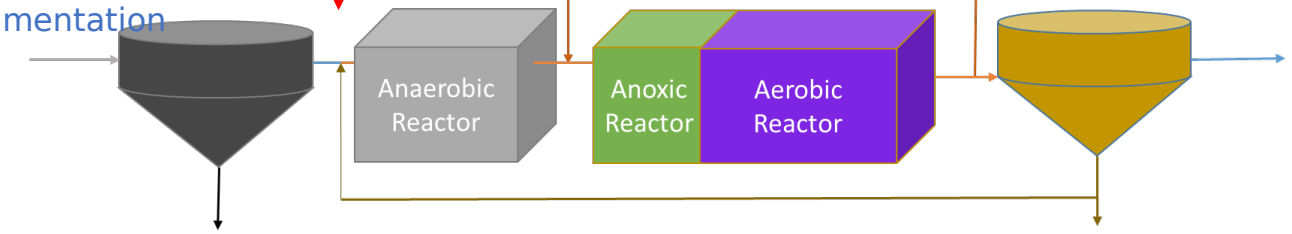
On Going Research Activity (B-Stage)

Primary sludge

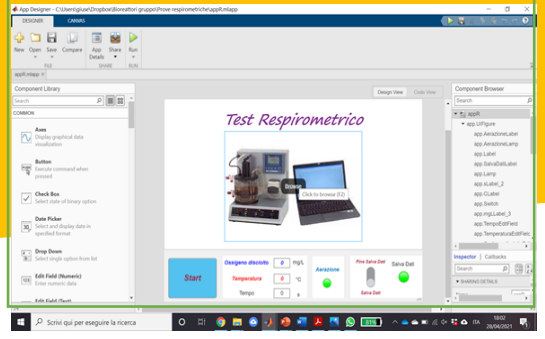


Enhanced biological phosphorus and nitrogen removal (EBPNR)

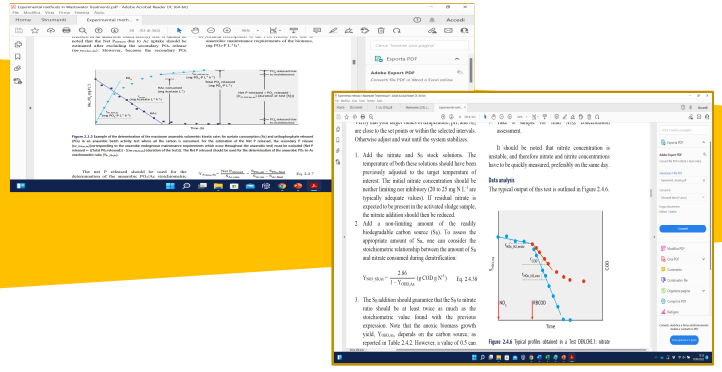
Chemically enhanced primary sedimentation

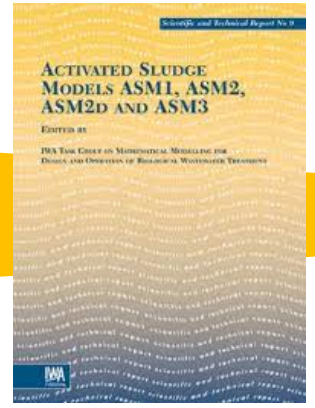


Biological Activity Tests



PAO batch activity tests





Denitrification batch activity tests

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smat CENTRO RICERCHE

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Thanks for your attention