10th International Conference on
Sustainable Solid Waste Management

Chania, Greece

Effects of carbon-based materials on the anaerobic co-digestion of the organic fraction of municipal solid waste and thickened sludge: preliminary results

F. Fazzino[1], A. Pedullà[2], A, Malara[2], P. Frontera[2], A. Gelsomino[3], M. Pittarello[3], P. S. Calabrò[2]

[1]Department of Civil Engineering and Architecture, University of Catania, Italy

[2]Department of Civil, Energy, Environmental and Materials Engineering, 'Mediterranea' University of Reggio Calabria, Italy

[3]AGRARIA Department, 'Mediterranea' University of Reggio Calabria, Italy

filippo.fazzino@unict.it

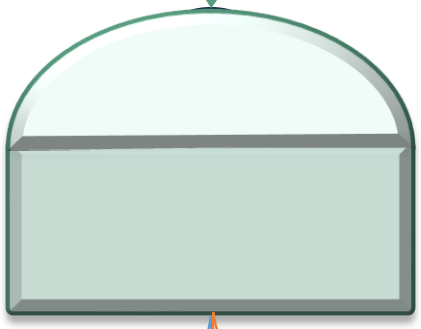
22 June 2023

Effects of carbon-based materials on the **AcoD of the OFMSW and TSL**: preliminary results

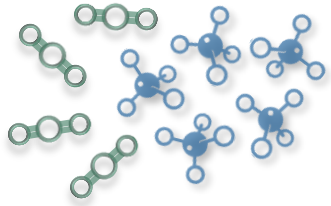
Organic Fraction of Municipal Solid Waste (OFMSW)

- High Total Solids (TS, 15-30%)
- High Carbon to Nitrogen ratio (C/N)
- Nutrients' (nitrogen, trace metals) deficiency
- Low buffering capacity

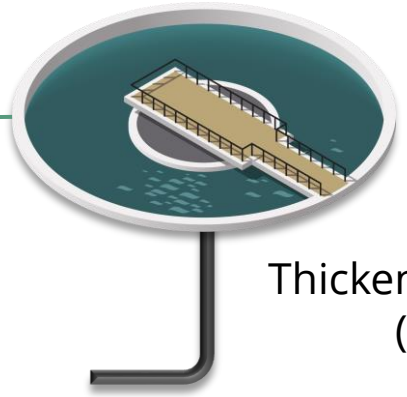
Anaerobic co-digestion (AcoD)



Biogas



Digestate

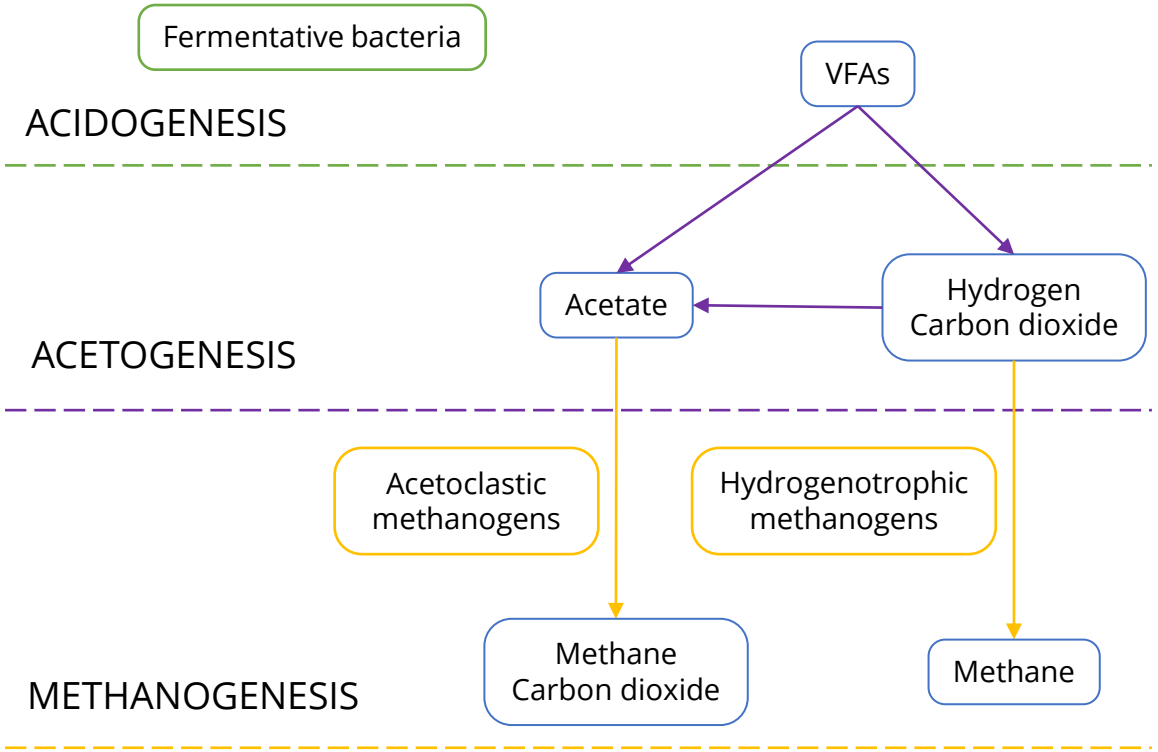


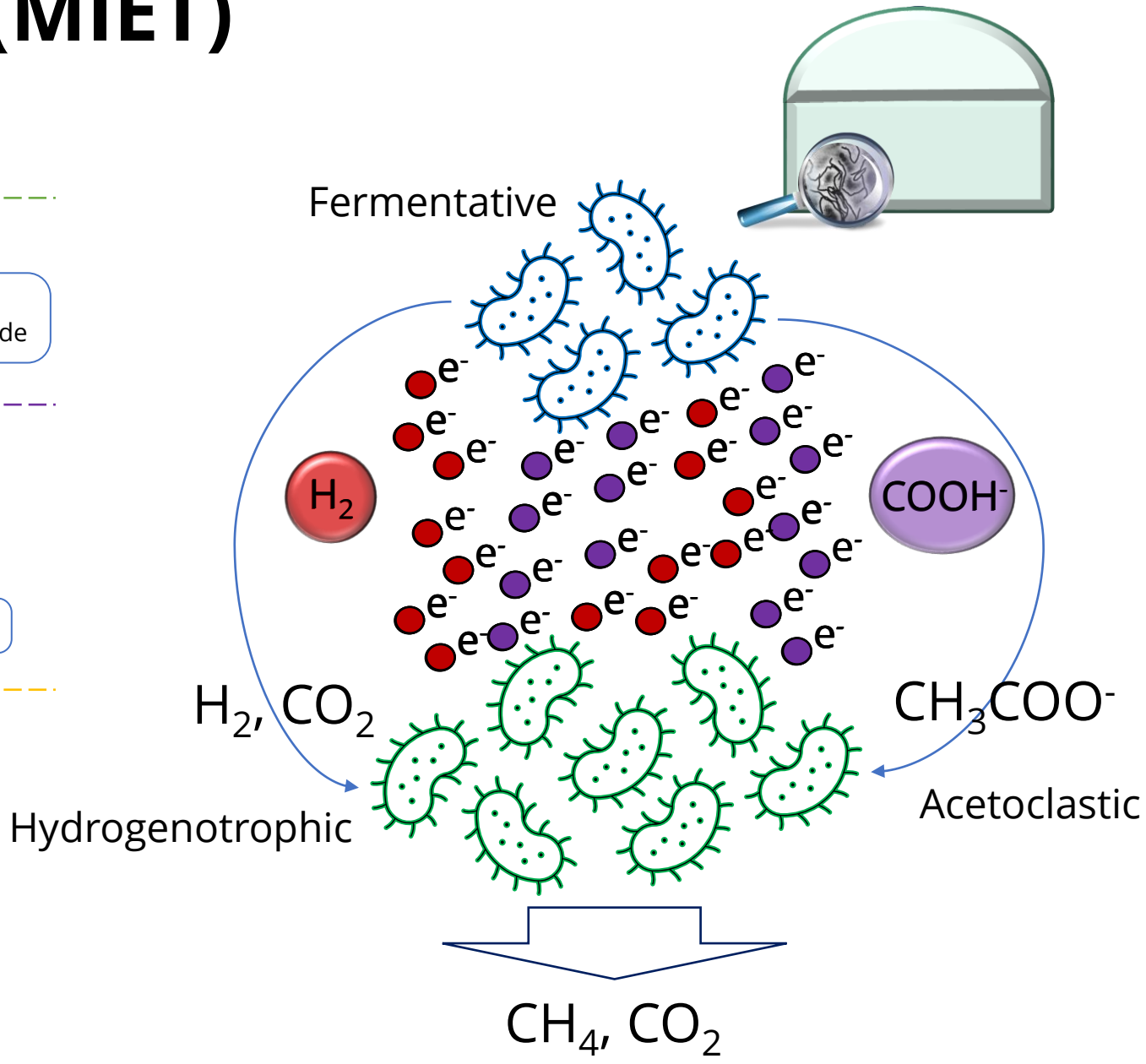
Thickened Sludge (TSL)

- Low methane potential
- High water content (95-98%)
- Presence of (bio)recalcintrant and toxic compounds (heavy metals)

How can process' performance be improved?

Mediated Interspecies Electron Transfer
(MIET)





Direct Interspecies Electron Transfer (DIET)

Faster electron transfer

⇩

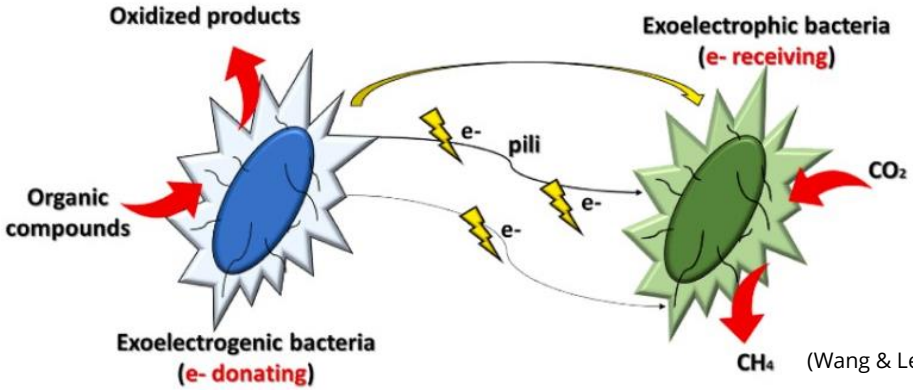
Higher reactions' rates

⇩

More efficient conversion of intermediates
(no VFAs' accumulation)

⇩

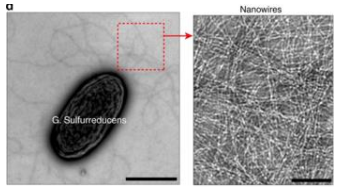
Shortening lag phase ✚ Increasing CH_4 yield

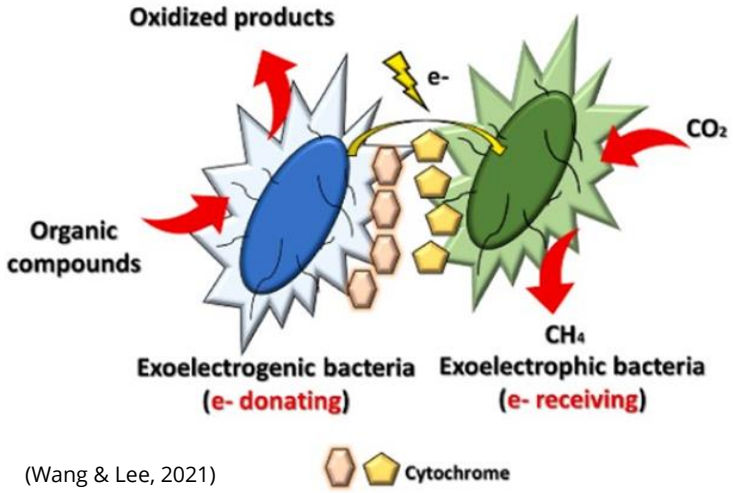


(Wang & Lee, 2021)

1. Conductive pili ("nanowires")

Geobacter ↔ *Methanosaeta*

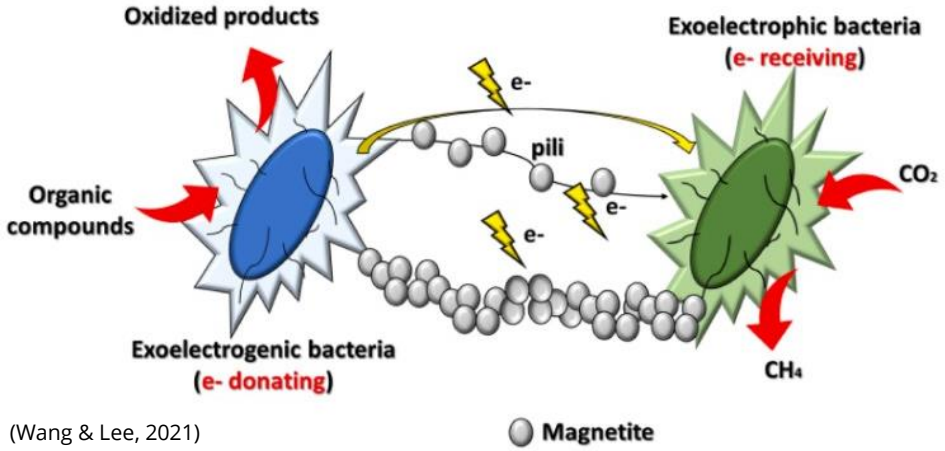




(Wang & Lee, 2021)

2. Cytochromes' chain

Direct Interspecies Electron Transfer (DIET)



(Wang & Lee, 2021)

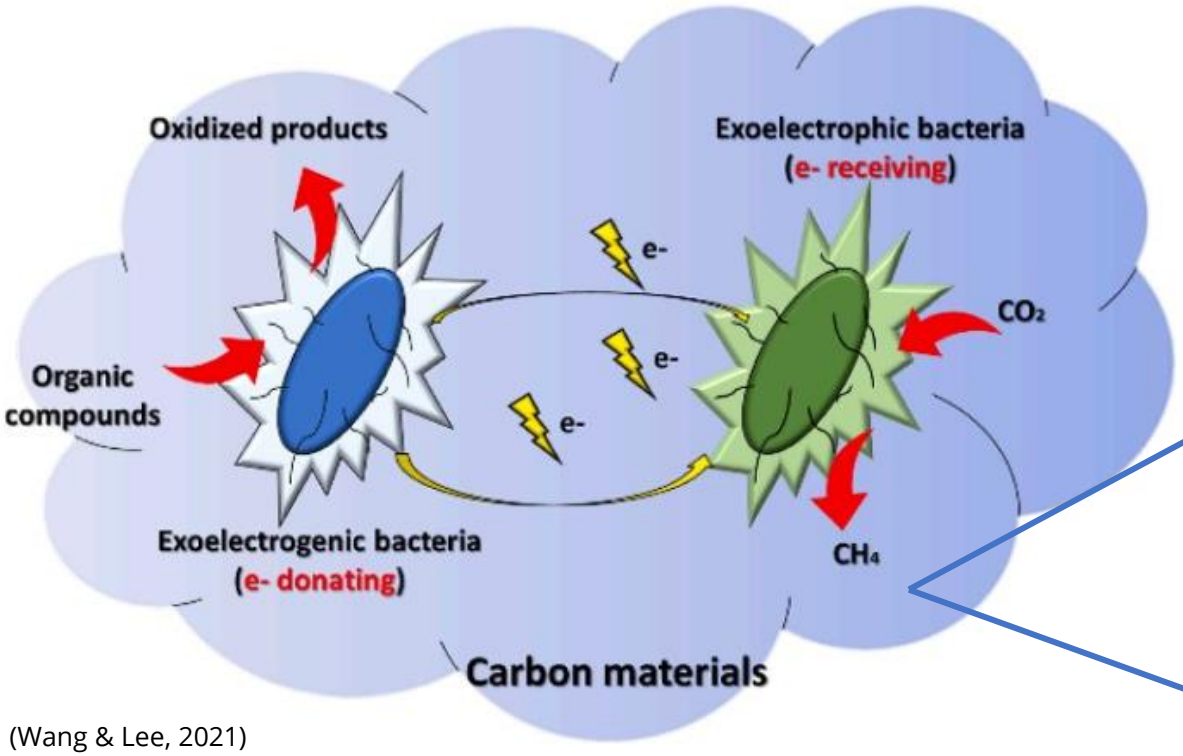
3. Iron corrosion

$$Fe^0 + 2H_2O \rightarrow Fe^{2+} + 2OH^- + H_2$$

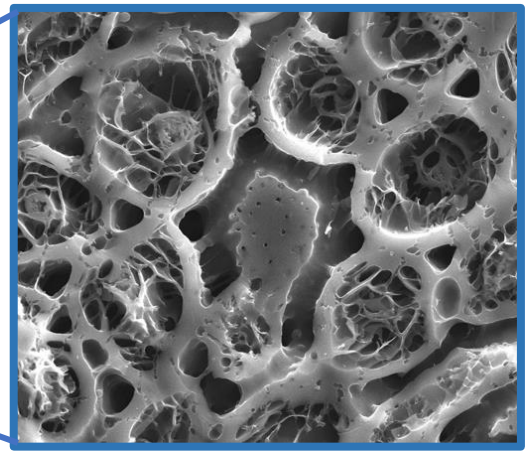
$$3Fe(OH)_2 \rightarrow Fe_3O_4 + H_2 + 2H_2O$$

magnetite

4. Carbon-based materials



(Wang & Lee, 2021)



MATERIALS AND METHODS

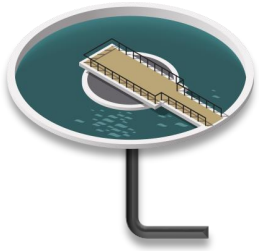
pH	6.1
Total Solids (TS)	21.7%
Volatile Solids (VS)	96.2%TS

Dried at 35°C and shredded

Fraction	% [w/w]
Vegetable waste (lettuce)	30
Fruit waste (peels)	20
Potato waste	10
Meat waste (bovine meat)	12
Fish waste (stockfish skin)	5
Dairy waste (cheese crust)	3
Dry bread	8
Cooked rice	6
Cooked pasta	6

Prepared OFMSW

TSL from WWTP



pH	6.6
Total Solids (TS)	2.2%
Volatile Solids (VS)	78.9%TS
Volatile Fatty Acids (VFAs)	226.4 mg/L
FOS/TAC	0.54

VS_{OFMSW}/VS_{TSL} [%]	50/50
OLR [g_{VS}/L·d]	1.5
HRT [d]	21

Granula Activated Carbon (GAC)

10 g/L (1st-63rd day)

5 g/L (78th-105th day)

Graphene Oxide (GO)

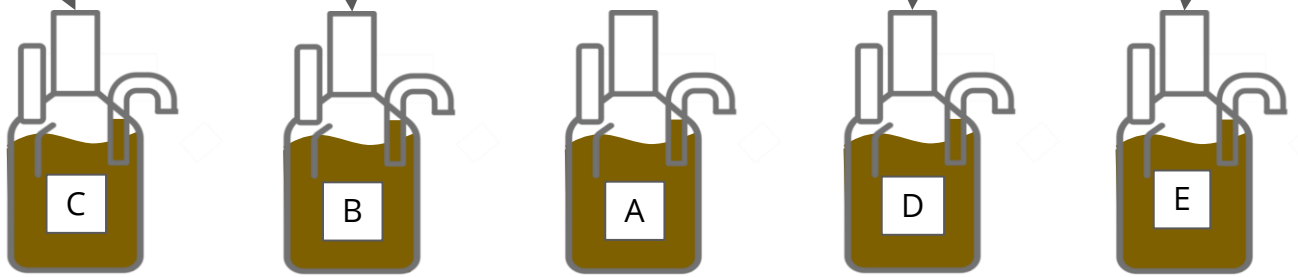
0.2 g/L (1st-63rd day)

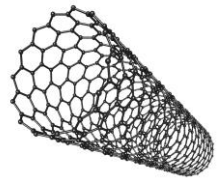
0.1 g/L (78th-105th day)

Graphite (GR)

10 g/L (1st-63rd day)

5 g/L (78th-105th day)



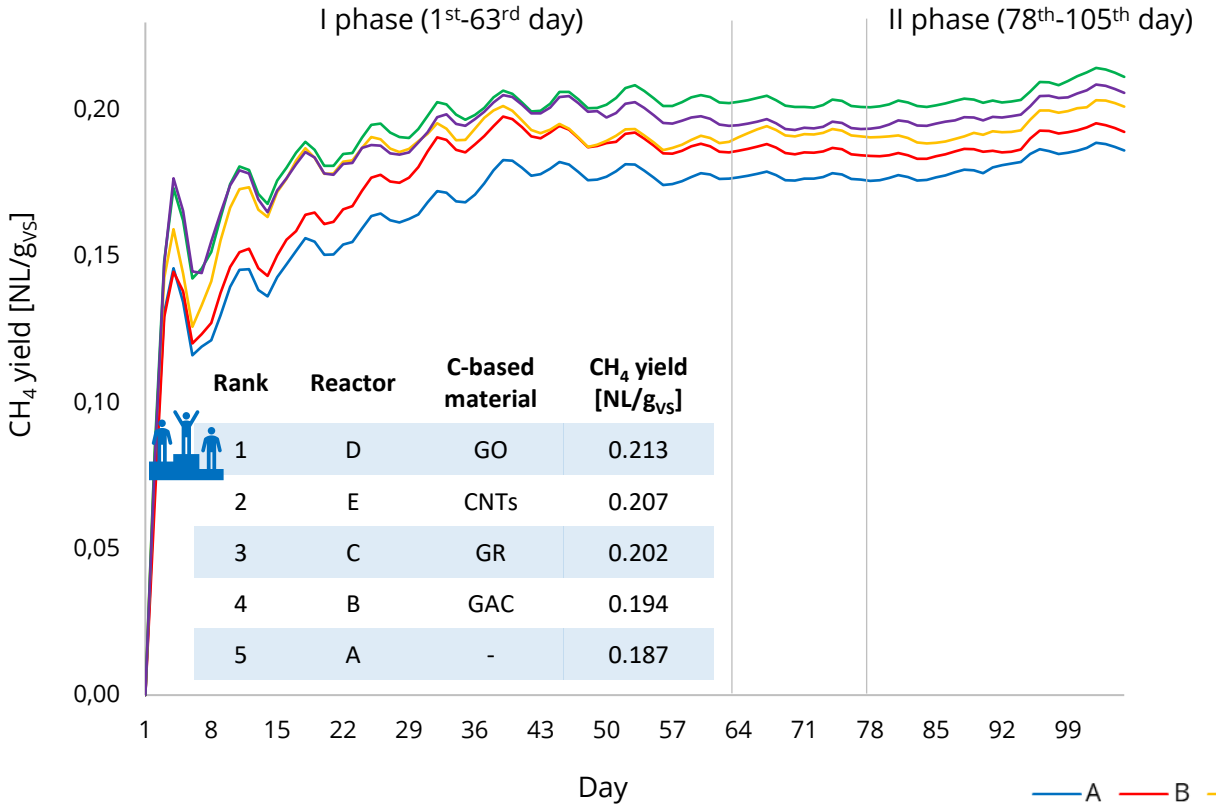


Carbon Nanotubes (CNTs)

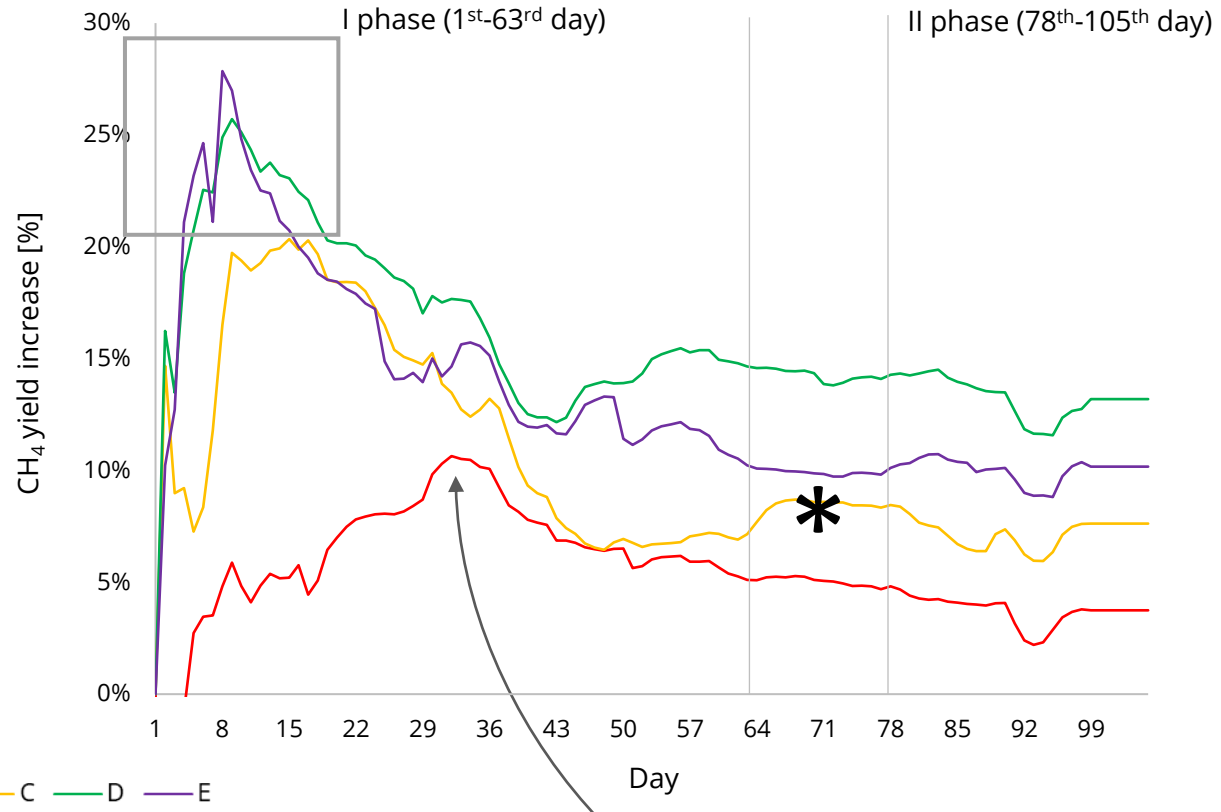
0.2 g/L (1st-63rd day)

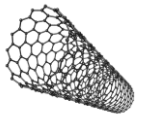
0.1 g/L (78th-105th day)

Effects of carbon-based materials on the AcoD of the OFMSW and TSL: **preliminary results**



Rank	Reactor	C-based material	CH_4 yield [NL/g_{VS}]
1	D	GO	0.213
2	E	CNTs	0.207
3	C	GR	0.202
4	B	GAC	0.194
5	A	-	0.187





CNTs, GO

- similar behaviour
- instant response of the system to virgin materials
- shortened the start-up phase

*** GR**

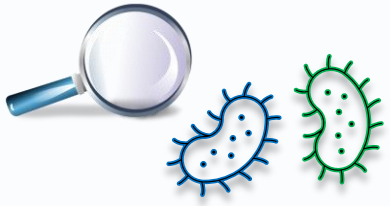
- good start then decrease with recover during no feeding period

GAC

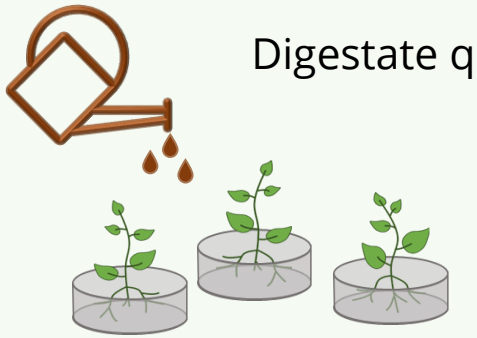
- needs time to be colonised by bacteria
- worst performance

FURTHER INVESTIGATIONS

Microbial communities' analyses

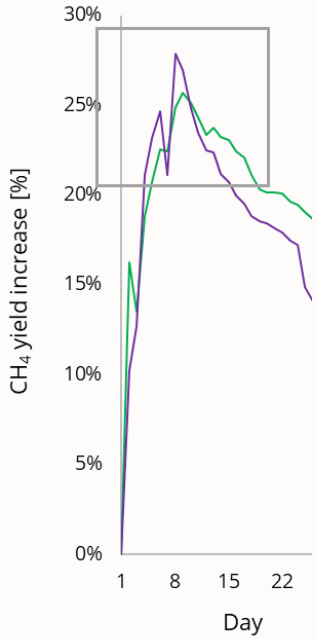


Digestate quality analyses



Investigating how maintaining CNTs and GO positive effects

Proving the economic convenience of the solution



Thank you for your attention

filippo.fazzino@unict.it

22 June 2023