CORFU2022

ANAEROBIC CO-DIGESTION OF AGRICULTURAL RESIDUES PRODUCED IN SOUTHERN GREECE DURING SPRING/SUMMER SEASON

Vasiliki P. Aravani[1], Konstantina Tsigkou[2], Michael Kornaros[3], Vagelis G. Papadakis[4]




[1]Environmental Engineer, PhD Candidate, Department of Environmental Engineering, University of Patras, Greece
[2]Chemist, PhD in Chemical Engineering, Department of Chemical Engineering, University of Patras, Greece
[3]Professor, Department of Chemical Engineering, University of Patras, Greece
[4]Professor, Department of Environmental Engineering, University of Patras, Greece

9th International Conference on Sustainable Solid Waste Management
15-18 June 2022, Corfu, Greece

SYNAGRON

INTRODUCTION

Increasing of energy utilization by using conventional fuels

Driven attention of energy production via

renewable energy sources such as biomass

Greece: high biomass potential

Anaerobic digestion (AD) is one of the most environmentally friendly technologies, able to convert organic wastes to valuable energy sources.

AIM OF THE STUDY

AD: well-known biological process that has been investigated for few decades

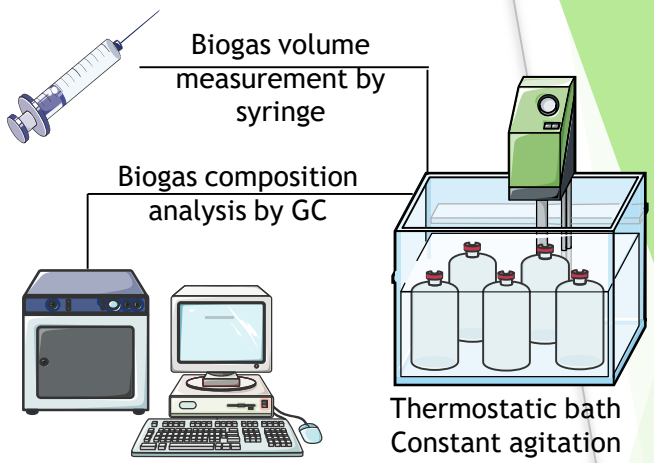
Greece: lack of experimental knowledge on the valorization of locally available substrates

performance of anaerobic co-digestion experiments in lab-scale valorizing the optimum Southern Greece spring/summer mixture that resulted from conducting Biochemical Methane Potential Assays (BMP) in previous study of our research team

MATERIALS AND METHODS (1/2)

Collection of the samples

From the region of Western Greece. Storage at the freezer at -18°C.



developed to determine the maximum methane potential of a given organic substrate during its anaerobic decomposition

The anaerobic sludge, which was used as inoculum for the experiments, was obtained from a biogas plant in Messolonghi (Western Greece).

MATERIALS AND METHODS (2/2)

Southern Greece (spring/summer)

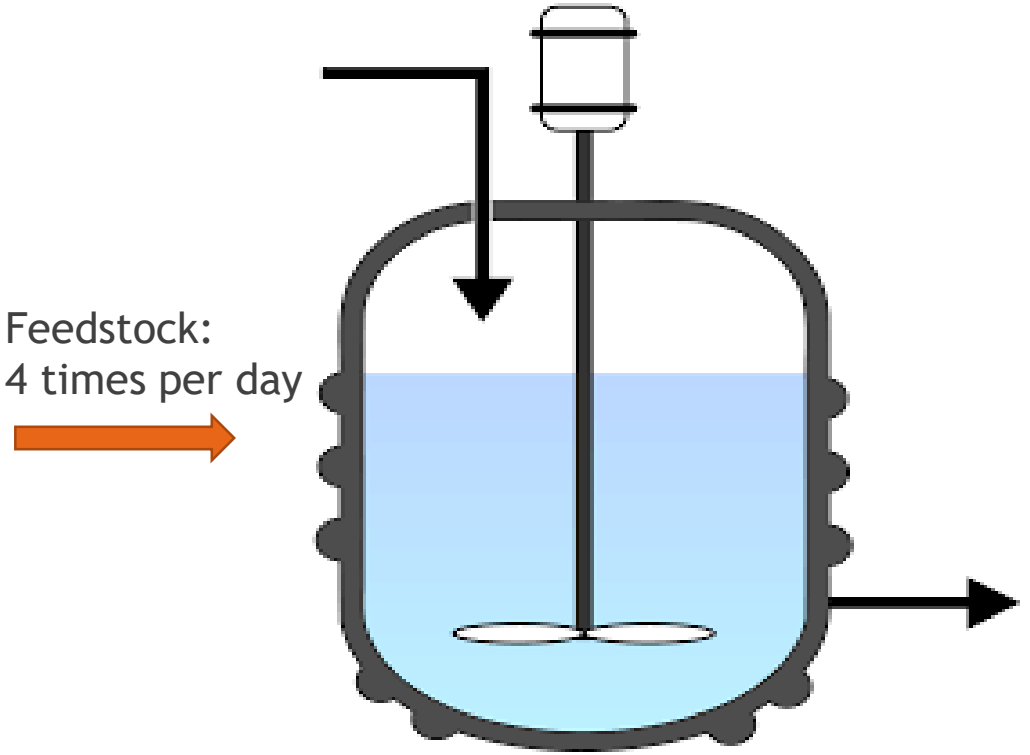

10%


14%


10%


66%

Feedstock:
4 times per day

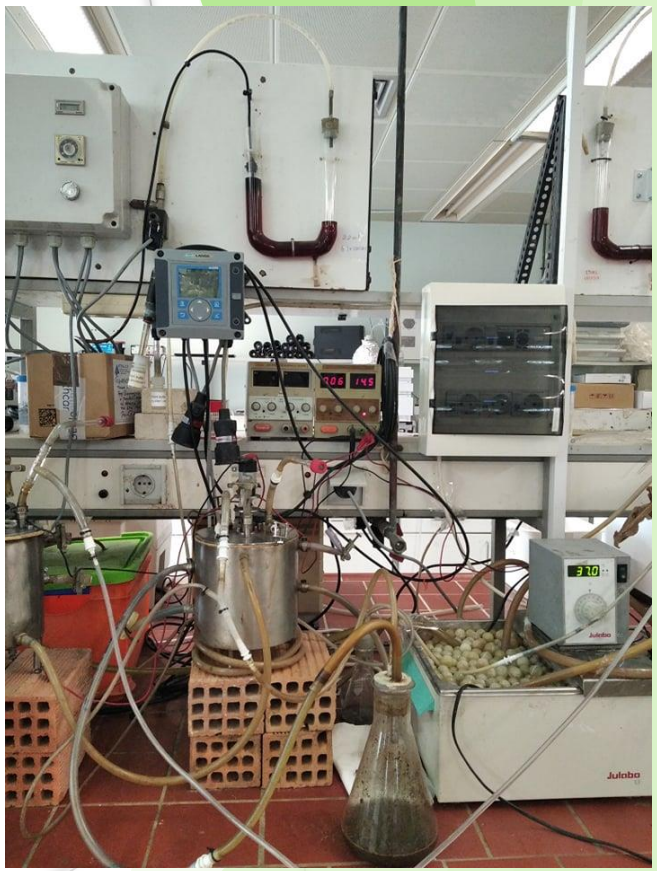


Determination:
pH, alkalinity, TS, VS, TSS, VSS, COD, CH, VFA, CH_4, biogas

The biogas composition analysis was determined by a gas chromatographer with a thermal conductivity detector (TCD), while the physicochemical parameters were measured according to the "*Standard Methods for the Examination of Water and Wastewater*".

PERFORMANCE OF ANAEROBIC CO-DIGESTION REACTOR

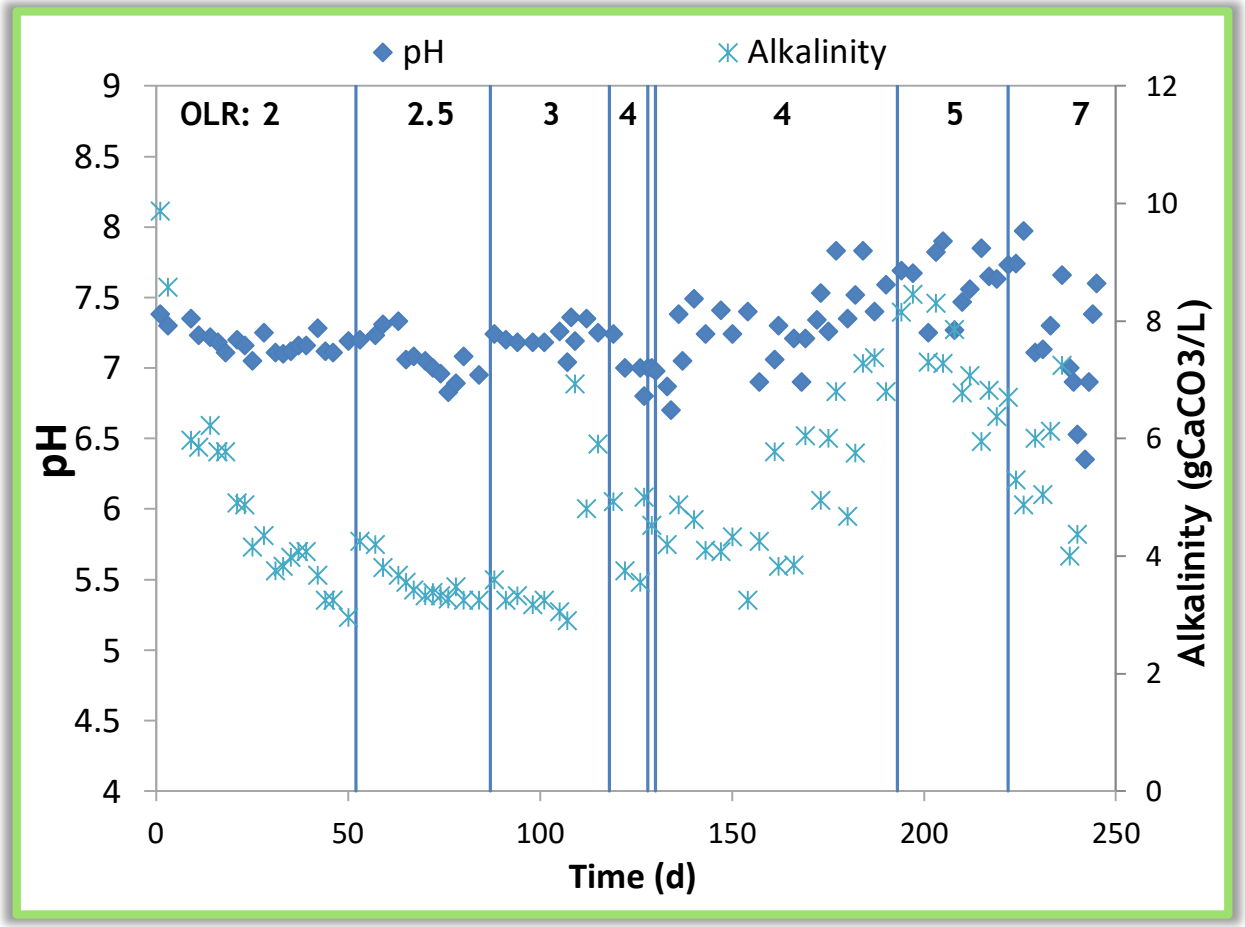
- One mesophilic single-stage continuous anaerobic digestion system with operational volume of 0.75 L
- Initial hydraulic retention time (HRT): 20 days
- Tested organic loading rate (OLR): 2-7 g COD/(L·d)
- The OLR was further increased after the system reached steady state conditions
- After reaching the maximum OLR, the HRT was reduced

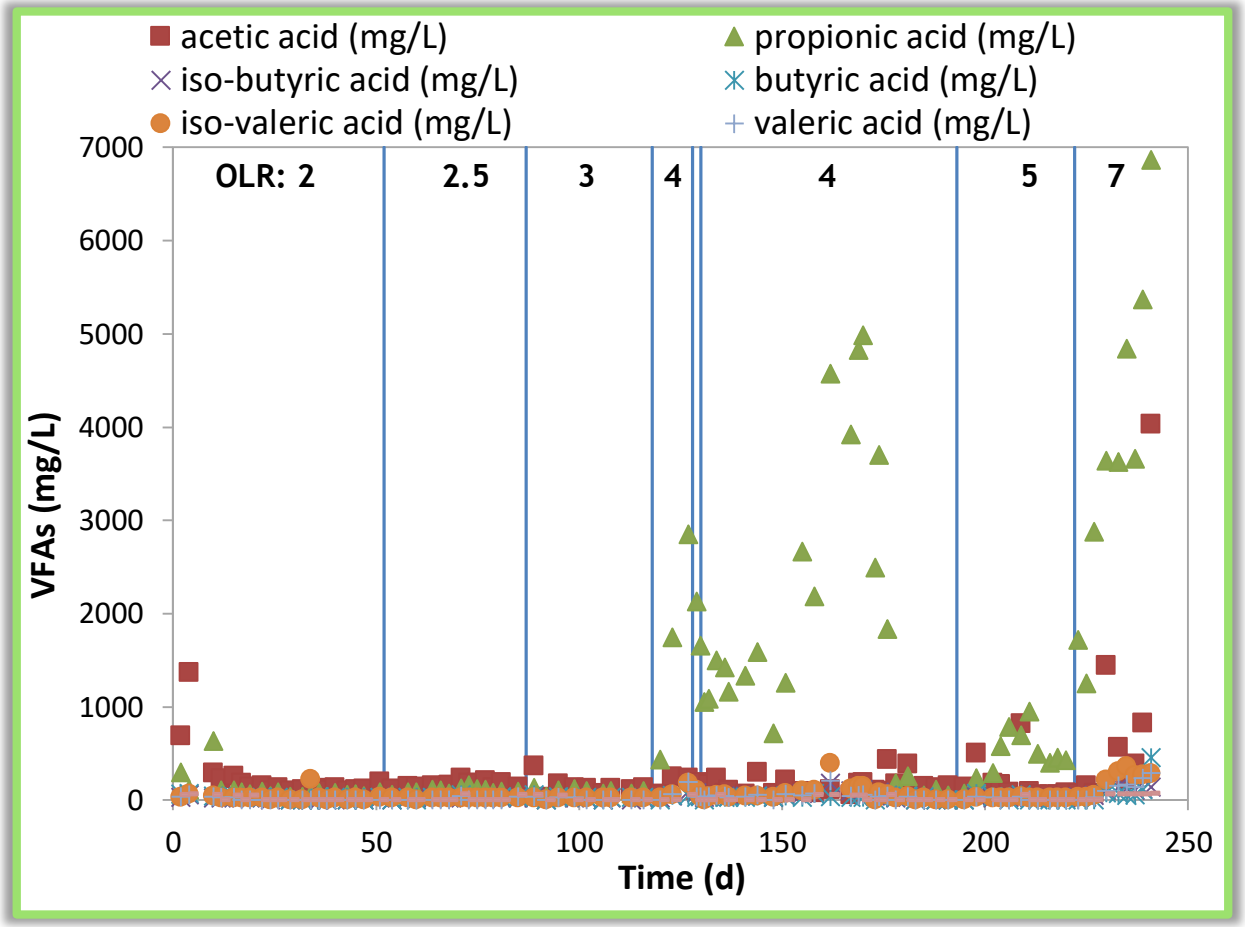


MIXTURE (FEEDSTOCK) CHARACTERISTICS

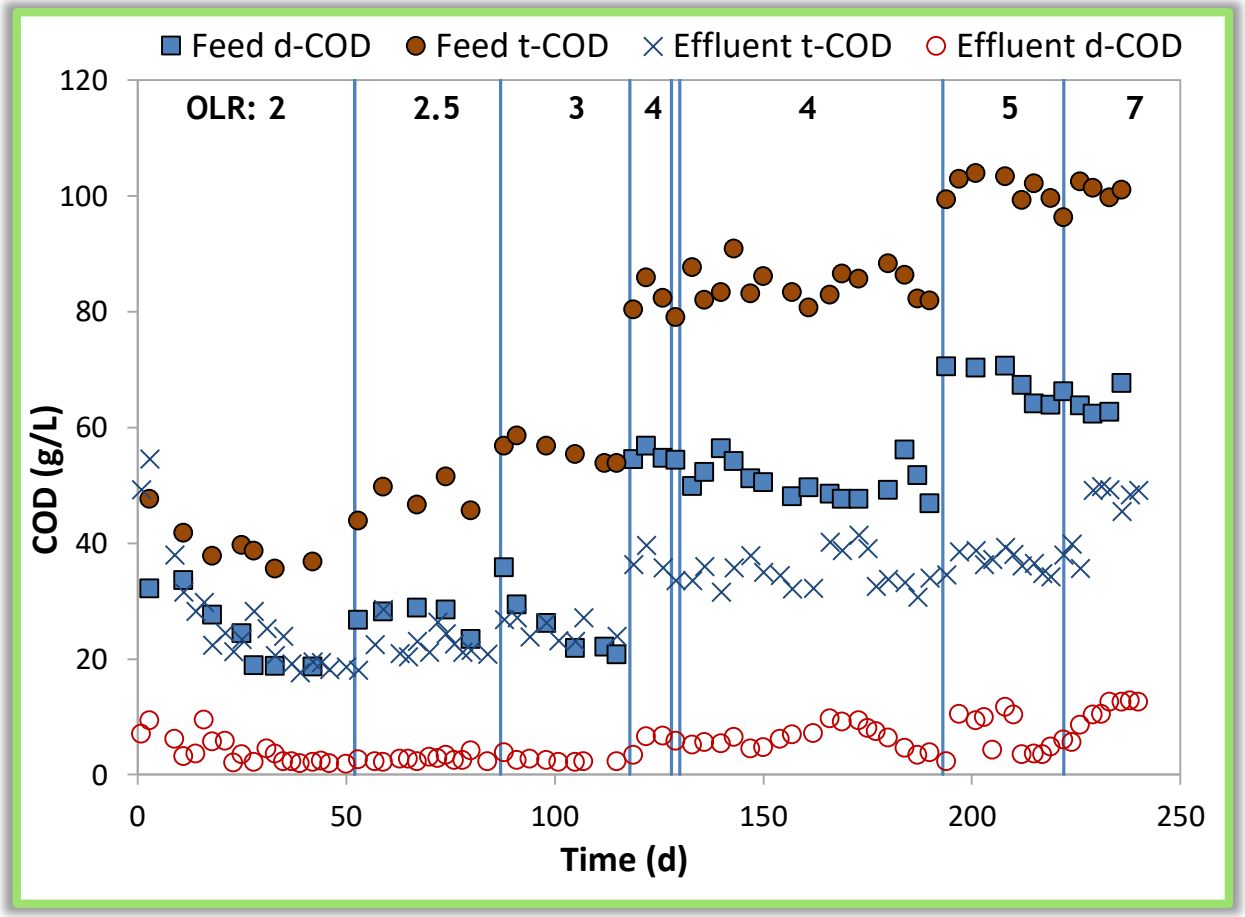
OLR (g COD/ (L·d))	pH	t-COD (g/L)	TS (g/L)	VS (g/L)	Humidity (%)	t-CH (g COD/L)	TKN (g/L)	Proteins (g/L)	NH_3-N (g/L)	Fats and oils (g/L)	t-P (g/L)	Phenols (g/L)
2	5.26	39.65	38.13	35.71	96.19	34.08	1.04	6.51	0.18	1.05	1.03	0.14
2.5	5.31	47.43	52.55	49.43	94.75	44.32	1.30	8.14	0.22	1.31	1.29	0.17
3	5.20	55.82	57.96	54.20	94.20	56.62	1.56	9.77	0.27	1.58	1.55	0.21
4	4.90	83.02	88.22	81.92	91.18	65.09	2.08	13.02	0.35	2.10	2.07	0.28
5 (without dilution)	4.92	100.79	112.97	104.19	88.70	70.17	2.60	16.28	0.44	2.63	2.59	0.35

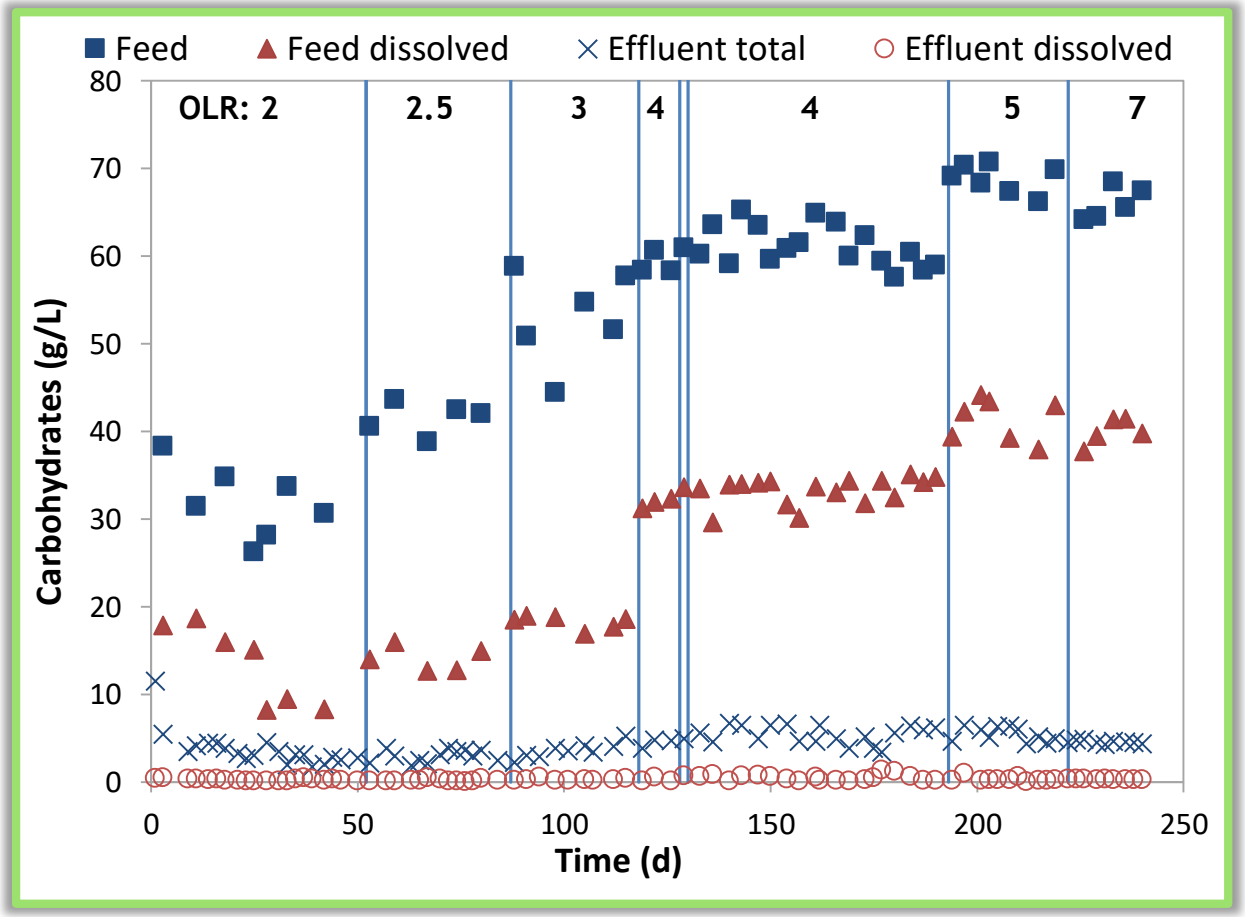
RESULTS (1/4)


pH
Alkalinity
OLR: 2
2.5
3
4
4
5
7
pH
Alkalinity (gCaCO3/L)
Time (d)

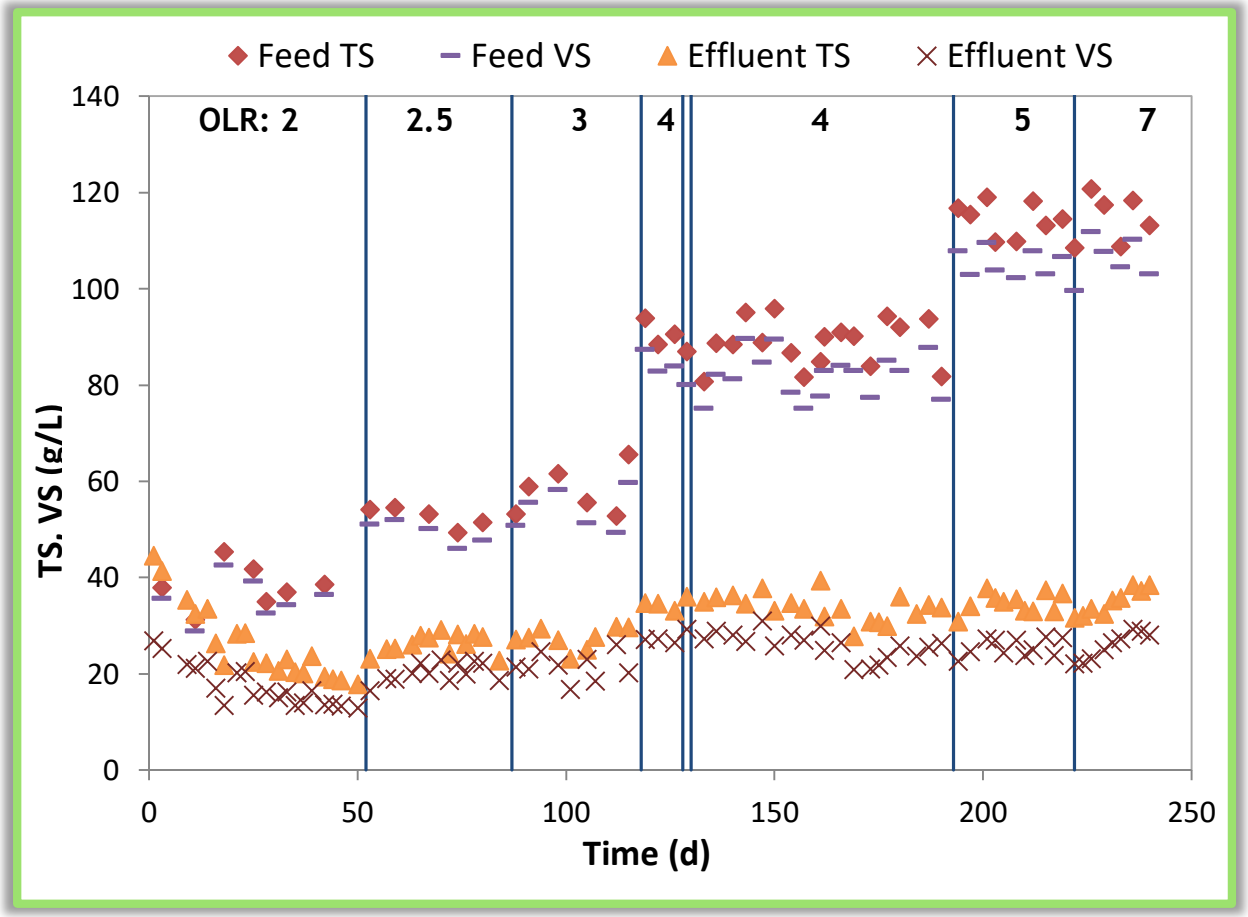

acetic acid (mg/L)
propionic acid (mg/L)
iso-butyric acid (mg/L)
butyric acid (mg/L)
iso-valeric acid (mg/L)
valeric acid (mg/L)
OLR: 2
2.5
3
4
4
5
7
VFAs (mg/L)
Time (d)

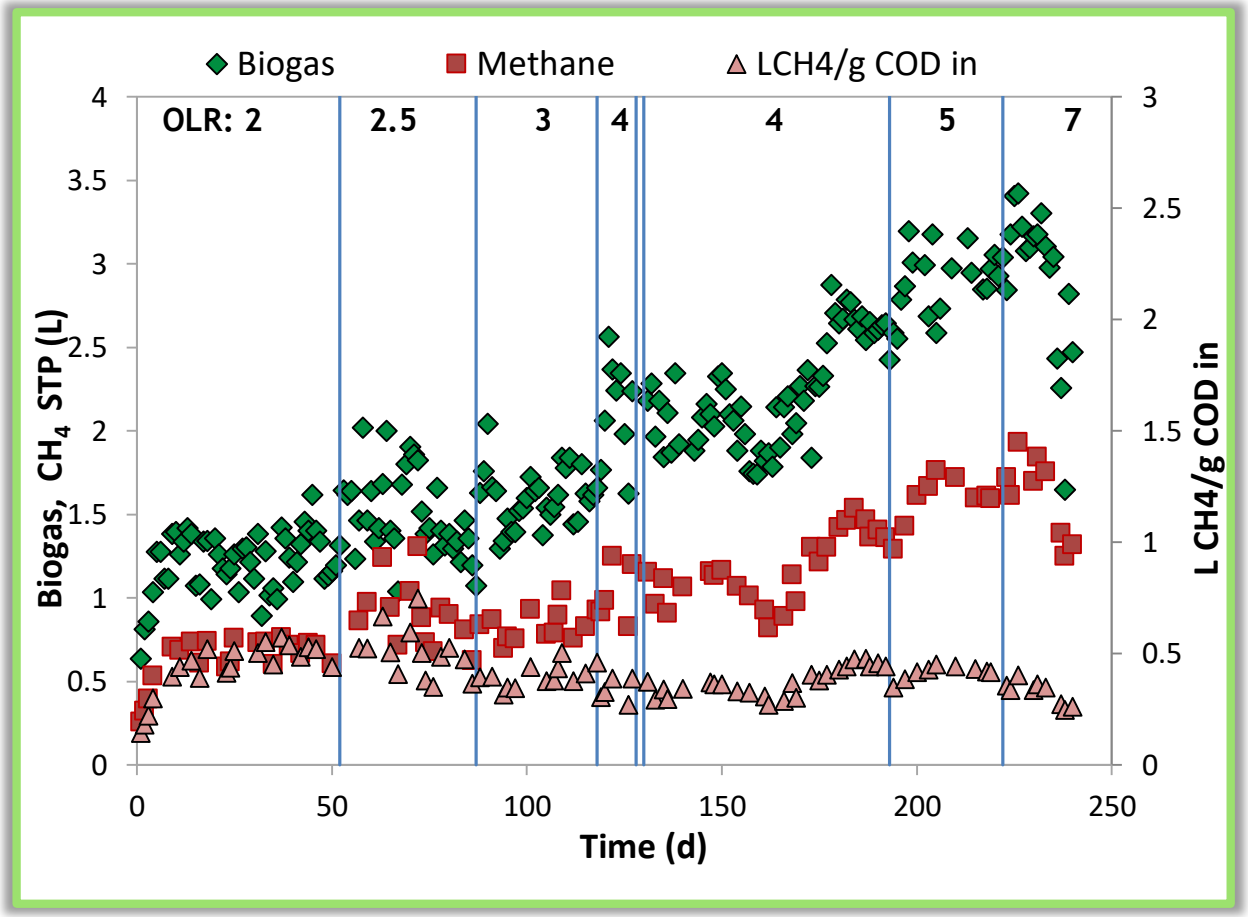
RESULTS (2/4)


Feed d-COD
Feed t-COD
Effluent t-COD
Effluent d-COD
OLR: 2
2.5
3
4
4
5
7
COD (g/L)
Time (d)
0
20
40
60
80
100
120
0
50
100
150
200
250


Feed
Feed dissolved
Effluent total
Effluent dissolved
OLR: 2
2.5
3
4
4
5
7
Carbohydrates (g/L)
Time (d)
0
10
20
30
40
50
60
70
80
0
50
100
150
200
250

RESULTS (3/4)


Feed TS
Feed VS
Effluent TS
Effluent VS
OLR: 2
2.5
3
4
4
5
7
TS. VS (g/L)
Time (d)
0
20
40
60
80
100
120
140
0
50
100
150
200
250


Biogas
Methane
LCH4/g COD in
OLR: 2
2.5
3
4
4
5
7
Biogas, CH4 STP (L)
L CH4/g COD in
Time (d)
0
0.5
1
1.5
2
2.5
3
3.5
4
0
50
100
150
200
250

RESULTS (4/4)

Run	Southern Greece (spring/summer)
OLR (g COD/(L·d))	5
HRT (d)	20
pH	7.61 ± 0.22
t-COD Removal (%)	63.93 ± 1.60
t-CH Removal (%)	91.79 ± 1.34
CH_4 in Biogas (%)	54.86 ± 1.96
L CH_4/(L_R·d)	2.12 ± 0.19
L biogas/(L_R·d)	3.85 ± 0.26

Mean values of the optimum scenario of the methanogenic reactor

CONCLUSIONS

- The reactor operated successfully at OLR 2, 2.5, 3, 4 and 5 g COD/(L·d).
- At OLR 7 g COD/(L·d) and HRT 15 d VFA accumulation and pH decrease (<7) were observed resulting to methane production drop.
- The system's efficient operation paved the way for residual biomass treatment in single one-stage reactors, without substrate dilution, at high OLRs.

FUTURE WORK

- Comparison of experimental results with predictions of mathematical model of anaerobic digestion
- Life Cycle Assessment (LCA) of the process
- Technoeconomic analysis

AKNOWLEDGEMENTS

- This work has derived and financed from project SYNAGRON, a joint RT&D project under Greece – China Call for Proposals launched under the auspices of the Ministry of Science and Technology (MOST) of the People's Republic of China and the Ministry of Development & Investments/ General Secretariat of Research and Technology (GSRT) of the Hellenic Republic.

- Takes place at the Laboratory of Biochemical Engineering and Environmental Technology at University of Patras

THANK YOU FOR YOUR ATTENTION

Contact email: vasiliki.arav@gmail.com