Two-phase thermophilic anaerobic digestion of biowaste for bio-hythane production: yields and feasibility of the process

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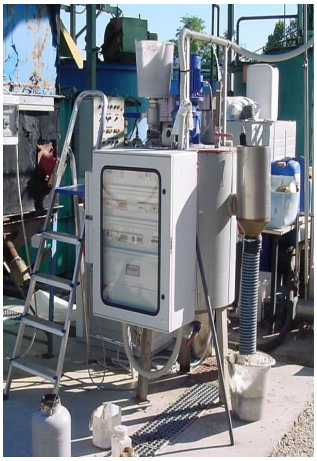
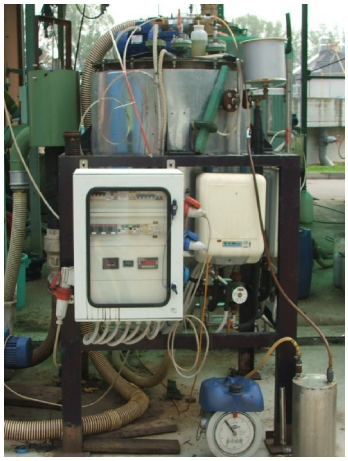
This experimental work deals with the optimization of a two phase anaerobic process treating organic waste for hydrogen and methane production. Nor physical neither chemical pretreatments were used to treat the inoculum or the substrates to optimize the process. The work was carried out at pilot scale, using two CSTRs (200 l and 380 l working volume respectively) both maintained at thermophilic temperature (55°C) and fed semi-continuously with organic waste collected in the wastewater treatment plant of Treviso City.



a)



b)

Figure 1: Pilot plant reactors: a) first phase reactors; b) second phase reactors.

Table 1: operative conditions applied during the experimental test

	Run I	Run II	Run III-a	Run-III-b
HRT 1phase (d)	6,6	3,3	3,3	3,3
HRT 2 phase (d)	12,6	12,6	12,6	12,6
OLR 1 phase (kgVS/m^{3}d)	21,20	21,46	16,13	21,11
OLR 2 phase (kgVS/m^{3}d)	10,63	5,65	4,26	5,56

The experiment was divided in three Run: during Run I and Run II the OLR was maintained at about 21 kgTVS/m3d in the first phase reactors, and the HRT was changed from 6.6 to 3.3 days in order to avoid the shift from acidogenic to solventogenic reactions. During Run III the pH was controlled by sludge recirculation from A.D. The OLR applied in this last Run were 16 and 21 kgTVS/m3d.

Table 2: gas yields of the experimental test

	u.m.	RUN I		RUN II		RUN III-a		RUN II-b	
		1° phase	2° phase	1° phase	2° phase	1° phase	2° phase	1° phase	2° phase
GPR	m3/m3d	0,27	6,00	0,16	3,40	2,26	2,71	1,22	3,35
SGP	m3/kgTVS	0,014	0,58	0,007	0,62	0,136	0,64	0,059	0,63
SHP	lH2/kgTVS	2,7	-	2,6	-	51,2	-	20,4	-
H2	%	19,7	-	34,8	-	37,1	-	34,0	-
CH4	%	-	65,2	-	59,8	-	64,9	-	65,4

The yields during Run I and Run II were low compared to the yields found in literature, in fact the pH values of both Runs were lower than the optimal pH range for hydrogenase enzyme (5,5), with a SHP of about 2,6 lH_2/kgTVSfeed. The best yield was obtained in Run III-a with lower OLR conditions (16 kgTVS/m^{3}d), where a SHP reach 51,16 lH_2/kgTVS$_{feed}$, with a H_2 content in biogas of 37%. During Run III-b, at 21 kgTVS/m^{3}d of OLR the SHP decrease to 20,44 lH_2/kgTVS$_{feed}$ with an hydrogen content of 34%. The A.D. process was able to convert the organic matter into biogas without any stability problem. Observing the biogas yields obtained in all the Runs, the SGP was between 0,58 and 0,64 m^3/kgVSfed, and the overall organic removal above 90%. The mixture of gas obtained from the two reactors, met the biohythane mix only in Run III-a with a composition of 6,7% of H_2, 40,1% of CO_2 and 52,3% of CH_4.

Conclusions

The recirculation of digested sludge into the first phase shows the feasibility of the approach, in fact the pH was kept at about 5,5 with a consequent higher hydrogen yield. Appling two different organic loading, the results shown a better hydrogen yields at 16 kgTVS/m3d instead that higher loading.

Acknowledgements

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