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

Cristina Cavinato^{1,*}, David Bolzonella², Paolo Pavan¹, Franco Cecchi²

¹ University of Venice, Department of Environmental Science, Calle Larga, Dorsoduro, 30123 Venice, Italy

² University of Verona, Department of Biotechnology, Strada le Grazie 15, 37134 Verona, Italy

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The increasing interest on hythane, a highly efficient and ultra clean burning alternative fuel (a mixture of hydrogen and methane) led many researchers to attempt hydrogen production by anaerobic fermentation of biomass. Biomass with a high carbohydrate content can be converted to hydrogen and organic acids through the action of fermentative bacteria. Then, the treated organic waste can be further treated in anaerobic conditions to produce methane.

The aim of this experimental work is to evaluate the hydrogen and methane production efficiency of the organic fraction of municipal solid waste (OFMSW, Table 1) treatment through the two-phases anaerobic digestion process. The work was carried out at pilot scale, using two CSTRs (200 l and 380 l of working volume respectively) both maintained at thermophilic temperature (55 °C) and fed semi-continuously with organic waste diluted with tap water. The experiment was divided in four periods where different organic loading rates to the first phase were tested (20, 30 and 40 kgTVS/m³d) (Table 2).

This paper deals with the results coming from the first two experimental runs while the other two will be performed in next months. A complete set of parameters, including the gas yields, hydrogen from the fermentative reactor and methane from the anaerobic digester, were monitored. An hydrogen rich biogas production of 7,4 and 15,9 l/kgTVSf was reached respectively in the first and second period, in the fermentative reactor, showing CO₂ content of 65% (period 1) and 85% (period 2). The methanogenic phase showed constant stability parameters and a specific gas production of 0,64 m³/kgTVSf. These results will be enforced in the full paper together with the complete discussion of the reactors operational conditions.

Table 1: Characterization of the organic fraction of municipal solid waste.

	Unità di misura	media	min	max	d.s.
TKN	(mgN/L)	5738	2178	8436	2280
P _{tot}	(mgP/L)	198.7	140.7	250.0	39.6
COD	(gCOD/L)	217.2	151.9	273.6	41.02
TS	(g/L)	242.9	145.3	304.7	71.3
TVS	(g/L)	179.5	150.0	220.9	40.13
TVS	(%TS)	73.8	61.5	88.4	10.6

Table 2: Operational conditions of whole experimental work.

Working period:	1	2	3	4
HRT fermentative step, d	3.3	6.7	3.3	3.3
HRT methanogenic step, d	12.6	12.6	12.6	12.6
OLR fermentative step, kgTVS/m ³ d	20	20	30	40
OLR methanogenic step, kgTVS/m ³ d	5	10	15	20