

Table 1- Distribution of components in the separation of dairy manure by flocculation and screening.

	Mass (g)	TS (g kg ⁻¹)	VS (g kg ⁻¹)	VS/TS	TKN-N (g kg ⁻¹)	P _T (g kg ⁻¹)
Manure	1000	119.25	91.22	0.76	4.824	0.847
PPS (3 g/l)	665	n.r.	n.r.	n.r.	n.r.	n.r.
Solid Fraction	524	189.91	150.69	0.79	5.148	1.415
Liquid Fraction	1123	19.93	12.99	0.65	1.698	0.114

n.r.: not relevant

Table 2- Characteristics of the liquid fraction employed as feeding of the UASB reactor.

Parameter	Mean $\pm$ SD
pH	7.2 $\pm$ 0.2
COD _T (mg l ⁻¹)	14281 $\pm$ 1703
COD _{sup} (mg l ⁻¹)	13225 $\pm$ 1652
COD _{VFA} (mg l ⁻¹)	10221 $\pm$ 1092
TS (mg l ⁻¹)	14678 $\pm$ 1648
VS (mg l ⁻¹)	8651 $\pm$ 1032
NH ₄ ⁺ -N (mg l ⁻¹)	892 $\pm$ 178
TKN-N (mg l ⁻¹)	1140 $\pm$ 221
P _T (mg l ⁻¹)	86 $\pm$ 26

Parameter	Mean $\pm$ SD
pH	7.2 $\pm$ 0.2
COD _T (mg l ⁻¹)	14,281 $\pm$ 1703
COD _{sup} (mg l ⁻¹)	13,225 $\pm$ 1652
COD _{VFA} (mg l ⁻¹)	10,221 $\pm$ 1092
TS (mg l ⁻¹)	14,678 $\pm$ 1648
VS (mg l ⁻¹)	8651 $\pm$ 1032
NH ₄ ⁺ -N (mg l ⁻¹)	892 $\pm$ 178
TKN-N (mg l ⁻¹)	1140 $\pm$ 221
P _T (mg l ⁻¹)	86 $\pm$ 26

Parameter	Mean $\pm$ SD
pH	7.2 $\pm$ 0.2
COD _T (g/L)	14.28 $\pm$ 1.70
COD _{sup} (g/ L)	13.23 $\pm$ 1.65
COD _{VFA} (g/L)	10.22 $\pm$ 1.09
TS (g/L)	14.68 $\pm$ 1.65
VS (g/L)	8.65 $\pm$ 1.03
NH ₄ ⁺ -N (mg/L)	892 $\pm$ 178
TKN-N (mg/L)	1140 $\pm$ 221
P _T (mg/L)	86 $\pm$ 26

Table 3- Performance data of the UASB reactor and mean characteristics of effluents and effluents.

HRT (days)	1.3	1.0	0.74	0.58	0.50	0.35	0.26	0.22
<u>Affluent</u>								
pH	7.5	7.1	6.9	7.2	7.1	7.1	7.4	7.6
COD (mg l⁻¹)	15735	13003	12602	15005	14126	14480	13486	15608
COD_{sup} (mg l⁻¹)	14966	12054	12012	13830	12764	13280	12200	14269
COD_{VFA} (mg l⁻¹)	11747	10466	9682	9768	9351	10348	9487	10585
Acetic (mg l⁻¹)	5513	4659	4448	4687	4769	5234	4898	5394
Propionic (mg l⁻¹)	1926	1592	1616	1496	1334	1480	1387	1559
Butyric (mg l⁻¹)	1155	1042	846	673	814	885	724	796
TS (g l⁻¹)	16.284	13.891	12.069	12.983	14.277	15.134	15.253	16.657
VS (g l⁻¹)	9.294	7.348	7.079	7.830	8.707	9.344	9.133	9.779
<u>Effluent</u>								
pH	8.7	8.3	8.2	8.4	8.3	8.2	8.2	8.5
COD (mg l⁻¹)	2580	2085	1702	2909	3885	3684	3957	6751
COD_{sup} (mg l⁻¹)	2350	1950	1591	2704	2700	2845	3464	5888
COD_{VFA} (mg l⁻¹)	42	199	135	385	113	137	518	2214
Acetic (mg l⁻¹)	21	97	46	210	75	73	167	773
Propionic (mg l⁻¹)	30	37	36	66	20	34	203	693
Butyric (mg l⁻¹)	1	22	28	20	1	4	1	18
TS (g l⁻¹)	8.583	8.302	6.909	6.956	8.126	8.938	9.093	10.738
VS (g l⁻¹)	2.884	2.932	2.805	2.952	3.606	4.106	4.077	5.036
<u>Reactor performance</u>								
HRT (days)	1.3	1.0	0.74	0.58	0.50	0.35	0.26	0.22
OLR (g COD (L·d⁻¹))	12.3	13.1	17.0	25.9	28.5	40.8	51.7	72.5
% COD rem	83.6	84.0	86.5	79.8	72.8	73.9	70.4	57.5
% COD_{sup} rem	84.3	83.8	86.8	79.6	78.8	78.7	71.4	60.5
% VS rem	70.3	59.9	60.0	62.2	58.6	54.7	55.3	48.7
L CH₄ g⁻¹ COD	0.275	0.281	0.284	0.274	0.265	0.254	0.241	0.194
L CH₄ g⁻¹ VS	0.466	0.498	0.506	0.524	0.435	0.392	0.358	0.309
L CH₄ (L·d)⁻¹	3.37	3.68	4.85	7.10	7.54	10.34	12.46	14.06
% CH₄	84.7	85.7	85.5	82.1	84.6	81.0	80.6	81.1

HRT (days)	1.3	1.0	0.74	0.58	0.50	0.35	0.26	0.22
<u>Affluent</u>								
pH	7.5	7.1	6.9	7.2	7.1	7.1	7.4	7.6
COD (g/L)	15.74	13.00	12.60	15.01	14.13	14.480	13.49	15.61
COD_{sup} (g/L)	14.97	12.05	12.01	13.83	12.76	13.28	12.20	14.27
COD_{VFA} (g/L)	11.75	10.47	9.68	9.77	9.35	10.35	9.49	10.59
Acetic (g/L)	5.51	4.66	4.45	4.69	4.77	5.23	4.90	5.39
Propionic (g/L)	1.93	1.59	1.62	1.50	1.33	1.48	1.39	1.56
Butyric (g/L)	1.16	1.04	0.85	0.67	0.81	0.89	0.72	0.80
TS (g/L)	16.28	13.89	12.07	12.98	14.28	15.13	15.25	16.66
VS (g/L)	9.29	7.35	7.08	7.83	8.71	9.34	9.13	9.78
<u>Effluent</u>								
pH	8.7	8.3	8.2	8.4	8.3	8.2	8.2	8.5
COD (g/L)	2.58	2.09	1.70	2.91	3.89	3.68	3.96	6.75
COD_{sup} (g/L)	2.35	1.95	1.59	2.70	2.70	2.85	3.46	5.89
COD_{VFA} (g/L)	0.04	0.20	0.14	0.39	0.11	0.13	0.52	2.21
Acetic (g/L)	0.02	0.10	0.05	0.21	0.08	0.07	0.16	0.77
Propionic (g/L)	0.03	0.04	0.04	0.07	0.02	0.03	0.20	0.69
Butyric (g/L)	0	0.02	0.03	0.02	0	0	0	0.02
TS (g/L)	8.58	8.30	6.91	6.96	8.13	8.94	9.09	10.74
VS (g/L)	2.88	2.93	2.81	2.95	3.61	4.11	4.08	5.04
<u>Reactor performance</u>								
HRT (days)	1.3	1.0	0.74	0.58	0.50	0.35	0.26	0.22
OLR (g COD (L·d⁻¹))	12.3	13.1	17.0	25.9	28.5	40.8	51.7	72.5
% COD rem	83.6	84.0	86.5	79.8	72.8	73.9	70.4	57.5
% COD_{sup} rem	84.3	83.8	86.8	79.6	78.8	78.7	71.4	60.5
% VS rem	70.3	59.9	60.0	62.2	58.6	54.7	55.3	48.7
L CH₄ g⁻¹ COD	0.275	0.281	0.284	0.274	0.265	0.254	0.241	0.194
L CH₄ g⁻¹ VS	0.466	0.498	0.506	0.524	0.435	0.392	0.358	0.309
L CH₄ (L·d)⁻¹	3.37	3.68	4.85	7.10	7.54	10.34	12.46	14.06
% CH₄	84.7	85.7	85.5	82.1	84.6	81.0	80.6	81.1

Table 4- Volumetric methane production rate data reported in past studies.

Reference	Substrate	Reactor type	L CH ₄ /(L·d)
Dugba and Zhang (1999)	Screened dairy manure	CSTR	0.82
Karim et al. (2005)	Dairy manure slurry	CSTR	0.45
Demirer and Chen (2005)	Dairy manure	CSTR	1.20
Wen et al. (2007)	Liquid dairy manure	CSTR	0.88
Kavacik and Topaloglu (2010)	Dairy manure + Cheese whey	CSTR	0.60
Kalyuzhnyi et al. (1999)	Diluted decanted dairy manure	UASB	0.70
This study	Liquid fraction of dairy manure	UASB	10.3

Table 5- Composition of precipitate containing struvite as percentage dry matter.

Nitrogen % as NKT	Magnesium % as MgO	Potassium % as K₂O	Phosphorus % as P₂O₅	Calcium % as CaO
2.90	14.6	9.1	25.2	0.05