

Process Performance

SUMMARY OF RESULTS OF CASE STUDIES ON UASB PROCESS

REACTOR PARTICULARS									REFERENCE
Sr	Category	COD (mg/L)	VOLUME(L)	HEIGHT(m)	HLR(cum/cum/d)	OLR(kgCOD/cum/d)	SLR(kgCOD/kgVSS/d)	Gas Production	
1	Animal carrion waste	3000	60	2	**	30	**	**	Lettinga G. et al,1983
	Animal carrion waste	7000	60	2	**	30	**	**	Lettinga G. et al,1983
	Animal carrion waste	3500	60	2	**	60	**	**	Lettinga G. et al,1983
2	Apple Process waste	2500	9	1.2	4.4	12	**	**	Dold P. L. et al,1987
	Apple Process waste	2500	9	1.2	6.2	16	**	**	Dold P. L. et al,1987
3	Bean Blanching waste	5000	2.7	0.3	1.6--1.85	8--10	0.6-0.8	**	Lettinga G. et al,1980
	Bean Blanching waste	10000	3--4	*	**	14--20	**	4--8^a	Berg L. V. et al,1982
	Bean Blanching waste	10000	4	0.8	**	30	**	10^a	Hanoda M. F. et al,1984
4	Biomass Gasification waste	4500	0.4	0.38	**	1.44	**	0.12--0.15^b	Maxham J. V. et al,1981
5	Chemical Indl. waste	1400	3--4	**	**	16--19	**	4--5^c	Berg L. V. et al,1982
6	Dairy waste	1500	18	0.7	4.8	7--8	0.4--0.6	**	Lettinga G. et al,1980
	Dairy waste	4000	6	0.7	**	15	**	1--3^a	Berg L. V. et al,1983
	Dairy waste	2500	400	**	**	7.5	**	2.5^d	Samson et al,1983
7	Potato Processing waste	2000	6000	3	1.2	3--5	1.0--1.4	**	Lettinga G. et al,1980
	Potato Processing waste	5000	6000	30	1.2	3--5	1.0--1.5	**	Lettinga G. et al,1980
	Potato Processing waste	2000	6000	3	3	10--15	1.0--1.4	6^e	Lettinga G. et al,1980
	Potato Processing waste	5000	6000	3	3	10--15	1.0--1.4	6^e	Lettinga G. et al,1980
	Potato Processing waste	2000	6000	3	4	15--18	1.0--1.4	6.8^e	Lettinga G. et al,1980
	Potato Processing waste	5000	6000	3	4	15--18	1.0--1.4	6.8^e	Lettinga G. et al,1980
	Potato Processing waste	4000	6000	3	6--7	25--45	1.0--1.4	12--16^e	Lettinga G. et al,1980
	Potato Processing waste	16500	6000	3	6--7	25--45	1.0--1.4	12--16^e	Lettinga G. et al,1980
	Potato Processing waste	4300	2200	**	1.4	6	**	3386^f	Christesen et al,1982
8	Sauerkraut waste	10000	2.7	0.3	1	8--9	0.8--1.2	**	Christesen et al,1982
	Sauerkraut waste	200000	2.7	0.3	1	8--9	0.8--1.2	**	Christesen et al,1982
9	Sewage	400	6000	3	1.09	**	**	**	Lettinga G. et al,1981
	Sewage	480	30	1	3.8	**	1	0.1--0.22^b	Lettinga G. et al,1983
	Sewage	660	30	1	3.8	**	1	0.1--0.22^b	Lettinga G. et al,1983
	Sewage	700	30	1	1.2	**	1	0.1--0.22^b	Lettinga G. et al,1934
	Sewage	860	30	1	1.2	**	1	0.1--0.22^b	Lettinga G. et al,1983
	Sewage	700	120	1.75	2	**	1	0.1--0.22^b	Lettinga G. et al,1983
	Sewage	1200	120	1.75	2	**	1	0.1--0.22^b	Lettinga G. et al,1983
	Sewage	420	120	1.75	1.6--2.4	**	1	0.1--0.22^b	Lettinga G. et al,1983
	Sewage	550	120	1.75	1.6--2.4	**	1	0.1--0.22^b	Lettinga G. et al,1983
	Sewage	500*	12.4	**	8	**	**	0.15^b	Fernandes x. a. et al,1985
	Sewage	142	50	1.3	1.92	1.085	**	**	Pathe P.P. et al,1988
	Sewage	598	50	1.3	1.92	1.085	**	**	Pathe P.P. et al,1988

10	Sewage	500	1200000	4.5	4.17	**	**	0.12^g	Jal Nigam U. P.,1989
	Slaughter House waste	1500	30	1..3	**	10	**	**	Lettinga G. et al,1983
	Slaughter House waste	2000	30	1..3	**	10	**	**	Lettinga G. et al,1983
	Slaughter House waste	1500	30	1.3	**	6	**	**	Lettinga G. et al,1983
11	Slaughter House waste	2000	30	1.3	**	6	**	**	Lettinga G. et al,1983
	Sugar beet waste	5000	61	1.05	0.5--1	4--5	0.5--0.8	**	Lettinga G. et al,1980
	(unsoured)								
	Sugar beet waste	6000	61	1.05	0.5--1	4.5	0.5--0.8	**	Lettinga G. et al,1980
	(unsoured)								
	Sugar beet waste	6000	18	0.7	1--2	8--10	0.7--1.1	**	Lettinga G. et al,1980
	Sugar beet waste	(soured)							
	Sugar beet waste	9500	18	0.7	1--2	8--10	0.7--1.1	**	Lettinga G. et al,1980
	(soured)								
	Sugar beet waste	6000	30	1	1--2	8--10	0.7--1.1	**	Lettinga G. et al,1980
	(soured)								
	Sugar beet waste	9500	30	1	1--2	8--10	0.7--1.1	**	Lettinga G. et al,1990
	(soured)								
	Sugar beet waste	4000	6000	3	4	20--25	0.5	7.4^e	Lettinga G. et al,1980
	(unsoured)								
	Sugar beet waste	6000	6000	3	4	20--25	0.5	7.4^e	Lettinga G. et al,1980
	(unsoured)								
	Sugar beet waste	3500	6000	3	4--6	30--32	0.5	**	Lettinga G. et al,1980
	(soured)								
12	Sugar beet waste	4000	6000	3	4--6	30--32	0.5	**	Lettinga G. et al,1980
	(soured)								
	Sugar beet waste	3500	30000	6	5.45	11	1.3	3^e	Pette K.C. et al,1981
	(soured)								
	Sugar beet waste	4000	30000	6	5.45	11	1.3	3^e	Pette K.C. et al,1983
	(soured)								
	Sugar beet waste	3500	20000	4.5	3.38	14	1.3	4.7^e	Pette K.C. et al,1985
	(soured)								
	Sugar beet waste	4000	20000	4.5	3.38	14	1.3	4.7^e	Pette K.C. et al,1987
	(soured)								
12	Sugar beet waste	3000	800000	4.5	7.2	16.25	**	6.4^e	Pette K.C. et al,1989
	Sugar waste	600	11.4	1.18	6	10	1.25	0.5^b	Manjunath D. L. et al,1988
	Sugar waste	2500	11.4	1.18	6	10	1.25	0.5^b	Manjunath D. L. et al,1988
13	Paper & Board mill	1600	30	**	9.6	19	**	0.43^g	Habets LHA et al,1985
	Paper & Board mill	2000	30	**	9.6	19	**	0.43^g	Habets LHA et al,1985
	Paper & Board mill	900	50000	**	9.6	18	**	0.39^g	Habets LHA et al,1985
	Paper & Board mill	2000	50000	**	9.6	18	**	0.39^g	Habets LHA et al,1985
	Paper & Board mill	530	50000	**	**	4	**	0.15^g	Habets LHA et al,1985

	Paper & Board mill	7000	70000	6	**	9--9.5	**	**	Habets LHA et al,1985
	Paper & Board mill	10000	1000000	**	**	6	**	**	Habets LHA et al,1985
	Paper & Board mill	28**	19000	**	**	19	**	0.31^h	Habets LHA et al,1988
	Paper & Board mill	60**	19000	**	**	19	**	0.31^h	Habets LHA et al,1988
	Paper & Board mill	4500	9	1.2	**	26	**	**	Russo SL et al,1989
14	Plump mill waste	630	3.6	**	10	15	**	0.19^b	Rongchu O et al,1980
	Plump mill waste	1738	3.6	**	10	15	**	0.19^b	Rongchu O et al,1980
15	Veg. Tanning waste	7133	7.7	0.55	1.07	7.6	**	1.9^a	Routh T. et al,1988
16	Wood ethanol stillage	25500	10	**	0.5	16	0.5	0.302^h	Callander I. J. et al,1987
17	Leactate	19560	35	0.9	**	14.5	**	4.6^e	Kindby et al,1988
18	Plump	8200	**	**	1.5	**	**	**	Kudo et al,1991

NOTE

a=cu.m CH4/cu.m/d
b=cu.m/kg COD fed
c=mPt3Pt CH4/cu.m/d
d=cu.m/cu.m/kg
e=cu.m/cu.m/d
f=cu.m/d
g=cu.m/kgCOD removed
h=cu.m CH4/kg COD removed
I=av .lit/h

Table 2 Anaerobic Digestion Treating Industrial Waste in Mexico														
Sr. No.	UASB reactor	Waste water type	Treated flow rate m3/d	COD, mg/L	Parameter	Operating temperature 0C	OLR, kg COD/ m3/d	HRT, days	COD % removal,	Post treatment	Bio production, m3/d	gas	Sludge treatment	Sludge use
1	4.5	Food processing	18	1000	None	38	4	0.25	80	Land infiltration	Vented		None	**
2	4.5	Industrial domestic goods	18	700	Grease interceptor tank	38	2.8	0.25	97	Aerobic biofilter	Vented		None	**
3	2400	Malting	3800	1700	Screen, Grit Chamber, Homogenization	30	2.69	0.63	77	Activated sludge	Flared		None	To land
4	480	Brewery	9072	4056	Screen,PST, Homogenization	25-30	7.66	0.53	80	Activated sludge	6480Flared		Thickening anaerobic digestion filter press	Fertilizer
5	300	Bakery &snacks	605	2119	DAF, grit chamber	26	4.77	0.5	85	Aerobic biodisc Chlorination	Vented		None	**
6	2*700	Brewery	3100	5100	Screening,PST, acidification tank	30-32	11.3	0.45	85	Activated sludge Chlorination	3000 flared		Anaerobic band filter digestion	Sold as inoculum
7	2*925	Brewery	5600	4200	Screening,PST, acidification tank	30-32	12.17	0.33	85	Activated sludge Chlorination	5900		Anaerobic band filter digestion	Sold as inoculum
8	380	Fruit packing	1140	3700	Screening, acidification	30	11.21	0.33	80	Aerobic biodisc secondary settler	1800		None	Sold as inoculum
9	1320	Paper factory	2200	9160	DAF, acidification	30-40	15.26	0.6	85	**	8500		**	Sold as inoculum
10	190	Paper factory	650	4000-6000	DAF, acidification	35	13--20	0.29	60	H2S oxidation tank	1000		**	Land fill
11	100	Paper factory	250	4000-6000	DAF, acidification	35	10--15	0.4	**	**	**		**	**
12	4000	Cheese	500	4300	Grease interceptor tank	26	0.55	8	85	aerobic & water hyacinth lagoons	**		**	**
13	2*88.4	Cheese	88	1874	Grease & solid tramps, homogenization DAF	29	0.94	2	75	Sand filter chlorination	**		**	**
14	85	Milk dehydration	260	2032	Neutralization grit chamber	24	6.21	0.33	75	ASP	138.6		**	Land fill
15	1700	Brewery	1800	7000	Screening, homogenization	32.4	7.45	0.94	85	Extended aeration ASP	**		**	Sold as inoculum
16	3000	Brewery	3816	7000	Screening, homogenization	35	8.9	0.78	85	ASP	**		**	Sold as inoculum
17	5000	Brewery	5016	6849	Screening, homogenization	30	6.87	0.99	85	Extended aeration ASP	**		**	Sold as inoculum
18	5000	Yeast	221	17000	homogenization tank	32	7.52	2.26	75	**	**		**	Sold as inoculum
19	2*2400	Petrochemical dimethyl T.	2028	18500	Screening, homogenization tank	30.4	7.5	2.37	95	Extended aeration ASP	Flared		Thickening anaerobic digestion filter press	**
20	1816	Brewery	5356	2690	Screening,PST, homogenization	25-35	7.93	0.34	8	ASP chlorination	Flared		Thickening anaerobic digestion filter press	**
21	2850	Brewery	13825	3000	Screening,PST, homogenization, acidification	38	14.55	0.21	75	ASP chlorination	10600		Thickening anaerobic digestion filter press	Sold
22	715	Paper	2200	4500	DAF, acidification	30-40	13.85	0.32	70	ASP	3000		**	Sold
23	191	Pig farm	140	5828	Screening, grit, settler, homogenization	20	4.28	1.36	70	**	**		**	**
24	945	Milk dehydration	1210	3000	Grease interceptor, neutralization	20	3.85	0.78	70	ASP, disinfection	889		**	**
25	1450	Fruit & chilly processing	4320	5500	Screening, homogenization DAF, acidification	30	13	0.33	90	ASP chlorination reverse osmosis	10000 boiler		**	Sold

26	1100	Corn starch	2700	5060	Water cooling		40	12.4	0.4	88	None	Flared	**	**
27	3*3000	Brewery	5143	6500	Screening		40	3.7	1.75	90^d	ASP	Boiler	**	**
28	2*1700	Brewery	1944	6500	Screening		40	3.71	1.75	90^d	ASP	Boiler	**	**
29	2*2500	Brewery	2856	6500	Screening		40	3.71	1.75	90^d	ASP	Boiler	**	**
30	2*1300	Brewery	1512	6500	Screening		40	3.78	1.72	90^d	ASP	Boiler	**	**
31	20808	Terephthalic acid	5000-6000	10000-15000	Solid homogenization cooling	tramp water	35-40	2--3	3--4	60^d	ASP	20000-25000 boiler	**	Land fill
32	110	Wet processing	coffee	29-43	8000-12000	PST	20	4	2.5--3.8	83	Asperation & lagoon	120	**	**
Source:				Monroy				et.al.,				2000		

Table 3 Anaerobic Digestion Treating Sewage in Mexico

Sr.	volume, m3	Waste water type	Treated flow rate, m3/d	COD, mg/L	Parameter	Operating temperature, 0C	OLR, kg COD/ m3.d	HRT, h	COD removal, %	Post treatment	Discharge	Biogas production, m3/d	Sludge treatment	Sludge use
1	50	Sewage	56	365	Screening, grit chamber	32	0.4	21.5	70	None	Sewer	Vented	**	**
2	2200	Sewage	2592	600	Screening, grit chamber	20	0.7	20.3	75-80 BOD	Aerobic & hyacinth lagoons	**	**	Drying	**
3	75	Sewage	86	800	Screening, grit chamber	23	0.9	20.8	80-85 BOD	**	**	**	Drying	**
4	4.25	Sewage	17	458	Screening, grit chamber	20	1.83	6	70	UV- disinfection	Reused in toilet	1.4	None	Land fill
5	21.6	Sewage	87	500	Homogenization tank	20	2	6	75	Anoxic reactor	Watering	Vented	**	**
6	5*16740	Sewage	108000	2400	Screening, grit	22.5	3	18.6	80	None	River	54000	Incineration	Land fill
7	130	Sewage	519	550	Screening, grit	21	2.2	6	75	Filtration & disinfection	Imigatin	38.5	None	Land fill
8	14	Sewage	47	500	none	28	1.7	7	75	Filtration & disinfection	Sewer	3--17	None	**
9	2.17	Sewage	9	500	none	20	2	6	70	Disinfection	Fish culture	**	**	**
10	48.4	Sewage	174	500	Grit chamber & homogenization	20	1.8	6.6	95	Anoxic & Aerobic submerged filter sedimentation,	Imigatin	**	Sludge tank	**
11	105	Sewage	420	500	Screen, Grit	20	2	6	75	Slow filtration, chlorination	**	**	**	**
12	25	Sewage	86	590	Grease interceptor, screen, Homogenization	20	2.04	7	90	Aerobic submerged filter, sedimentation, chlorination	Imigatin	Vented	Sludge tank	**
13	87	Sewage	346	500	Screen, homogenization	Grit, 20	2	6	75	Slow filtration, chlorination	Imigatin	Vented	Sludge tank	**
14	339	Sewage	272	533	Screen, homogenization	Grit, 20	0.43	30	70	SST, chlorination	**	Vented	**	**
15	100	Sewage	200	500	Screen	20--25	1	12	70-80	Aerobic submerged filter, SST, chlorination	Watering	23--25	**	Cultivation
16	50	Sewage	100	375	Screen	20--25	0.75	12	80	Rapid sand filter	Watering	23	**	Land fill
17	43.2	Sewage	86	200(BOD)	Screen, homogenization	20	0.4	12	80-85 BOD	Rapid sand filter, chlorination	Watering	**	Drying	**
18	75	Sewage	225	280	Screen, grit, grease interceptor, homogenization	20	0.8	8	70	Secondary settler, chlorination	Watering	2.8	**	Soil fertilizer
19	135.36	Sewage	406	300	Screen, grit, grease interceptor, homogenization	20	0.8	8	70	Secondary settler, chlorination	Watering	5	**	Soil fertilizer
20	21.32	Sewage	49	300	Screen, grit, grease interceptor, homogenization	16	0.7	10	70	Secondary settler, chlorination	Watering	0.6	**	Soil fertilizer
21	97	Sewage	290	300	Screen, grit, grease interceptor, homogenization	15	0.9	8	70	Secondary settler, chlorination	Watering	2.66	**	Soil fertilizer
22	200	Sewage	572	540	Screen, grit	22	1.54	8.4	70	Chlorination	Watering	93	**	Land fill
23	68	Sewage	204	250	Screen, Grit, grease, homogenization	20	0.75	8	70	SST, chlorination	Watering	Vented	**	Fertilizer
24	350	Sewage	1200	500	Screen, grit	21	1.71	7	55	Aerobic lagoon	River	98	**	Land fill

25	117	Sewage	400	500	Screen, grit	**	1.71	7	55	Chlorination	River	41	**	Land fill
26	101	Sewage	397	600	Screen, grit	20	2.36	6	50	Chlorination	Well injection	Vented	**	**