



บรรณานุกรม

1. Kirsch, E.J., " Studies on the Enumeration and Isolation of Obligate Anaerobic Bacteria from Digesting Sewage Sludge", Developments in Industrial Microbiology , Vol.10,(1969) : 170-176
2. Mah, R.A. and Susman, C., "Microbiology of Anaerobic Sludge Fermentation -1- Enumeration of Nonmethanogenic Anaerobic Bacteria ", Applied Microbiology ,Vol.16,(1968): 358-361
3. Thiel, P.G., " The Effect of Methane Analogues on Methanogenesis in Anaerobic Digestion ", Water Research, Vol.3, (1969): 215-223
4. Toerien, D.F., et al., " The Bacterial Nature of the Acid-Forming Phase of Anaerobic Digestion ", Water Research, Vol.1 (1967) : 497-507
5. Novaes, R.F.V. , " Microbiology of Anaerobic Digestion " , Water Science and Technology, Vol.18 , No.12 (1986): 1-10
6. Wood, W.A., " Fermentation of Carbohydrates and Related Compound ", The Bacteria, Vol.11 : Metabolism, Academic, Press, New York, (1962) : 59-149
7. Jeris, J.S. and McCarty, P.L., " The Biochemistry of Methane Fermentation Using C14 Traces " , J. WPCF ,Vol.37,No.2, (1962) : 178-192

8. Peck, M.P. ,et al., " Effect of Temperature Shock Treatments on the Stability of Anaerobic Digesters Operated on Separated Cattle Slurry ", Water Res., Vol.20, No.4, (1986) : 453-462
9. Hungate, R.E., " Microbiology of Anaerobic Digestion : Anaerobic Treatment in Tropical Countries ", Water Science and Technology, Vol.18, No.12, (1986) : 2
10. Toerien, D.F. and Hattingh, W.H.J., " Anaerobic Digestion -I- The Microbiology of Anaerobic ", Water Res., Vol.3, (1969), 385-416
11. McInerney, M.J. , et al., " Metabolic Stage and Energetic of Microbial Anaerobic Digestion ", Proc. 1st Sym. on Anaerobic Digestion, Cardiff, Wales, (1979) : 91-98
12. Balch, W.E., et al., " Methanogens : Re-evaluation of a Unique Biological Group ", Microbiological Reviews, Vol. 3, No.2, (1979)
13. Pine, M.J. and Barker, H.A., " Studies on the Methane Formation-XII-The Pathway of Hydrogen in the Acetate Fermentation ", Journal of Bacteriology, Vol.71, (1956) : 644
14. McCarty, P.L., " Anaerobic Waste Treatment Fundamentals ,Part 1, Chemistry and Microbiology ", Public Works, Vol.95, (1964) : 107

15. Kotze, J.P., et al., " Anaerobic Digestion-11-Characteristic and Control on Anaerobic Digestion ", Water Res., Vol.3, (1969) : 459-494
16. Kotze, J.P., et al., " A Biological-Chemical Study of Several Anaerobic Digestion", Water Res., Vol.2,(1969) : 195,221
17. Lawrence, A.W. and McCarty, P.L., " Kinetics of Methane Fermentation in Anaerobic Treatment ", J.WPCF, Vol.41, No.2 , (1968) : R1-R17
18. Barker, H.A.," Biological Formation of Methane " in : Bacterial Fermentation, John Wiley & Sons, Inc.,New York, (1956) :1
19. Zoetemeyer, J.C.,et al., " Influence an Acidiogenic Dissimiation of Glucose in Anaerobic Digester ", Water Res., Vol.16, (1982) : 303-311
20. McCarty, P.L., " Anaerobic Waste Treatment Fundamentals : Part Two ", Public Works, October, (1964) : 123-126
21. Albertson, O.E.,"Ammonia Nitrogen and the Anaerobic Environment ", J.WPCF, Vol.33, No.9, (1961) : 978-995
22. Speece, R.L. and McCarty, P.L., " Nutrient Requirements and Biological Solids Accumulation in Anaerobic Digestion ", Proceeding of the Conference on Water Pollution Research, Pergamon Press, New York, Vol.2, (1964) : 305

23. Sanders, F.A. and Bloodgood, D.E., " The Effect of Nitrogen to Carbon Ratio on Anaerobic Digestion ", J.WPCF, Vol.37, No.12, (1965) : 1741-1752
24. McCarty, P.L., " Anaerobic Waste Treatment Fundamentals : Part Three ", Public Works, November, (1964) : 91-94
25. McCarty, P.L. and McKinney, R.E., " Volatile Acid Toxicity in Anaerobic Digestion " J.WPCF, Vol.33, No.3, (1965) : 223-232
26. Longworth, L.G. and McInnes, D.A., " Apparent Oxidation Reduction Potential Acid and Population Studies of *L* : *Acidophilus* under Anaerobic Conditions", J.Bacteriol., Vol.32, (1936) : 567
27. Blanc, F.C. and Molof, A.H., " Electrode Potentials and Electrolytic Control in the Anaerobic Digestion Process", Proc. 24th Ind. Waste Conf., Purdue Univ., (1969) : 1040-1059
28. Reed, G.B. and Orr, J.B., " Cultivation of Anaerobes and Oxidation Potentials ", J.Bacteriol., Vol.45, (1934):309
29. Dirasian, H.A., Molof, A.H. and Borchardt, J.A., " Electrode Potentials Developed During Sludge Digestion ", J.WPCF, Vol.35, No.4, (1963) : 424-439
30. นิพนธ์ ชื่นชมชาติ, " การนำเครื่องกรองไร้ออกซิเจนที่มีตัวกลางเติมถังและครึ่งถัง มาประยุกต์ใช้กับน้ำเสียที่มีความเข้มข้นต่ำ ", วิทยานิพนธ์ปริญญาโทมหาวิทยาลัยเกษตรศาสตร์

ภาควิชาวิศวกรรมสุขาภิบาล บัณฑิตวิทยาลัย จุฬาลงกรณ์มหาวิทยาลัย, 2529

31. Ovano, E.A.R., " Lagoons " in : Principles of Waste Treatment, Vol.1, Biological Process, Manila, Philippines, (1983):148
32. McGarry, M.G. and Pescod, M.B., " Stabilization Pond Design Criteria for Tropical Asia ", 2nd International Lagoon Sym., Kasas City, (1970) : 114-130
33. Oswald, W.J., " Fundamental Factors in Oxidation Pond Design ", Conf. on Biological Waste Treatment at Manhattan College, (1960)
34. Coerver, J.F., " Industry's Idea Clinic, J.WPCF, Vol.36, No.8, (1964) : 944
35. Enders, K.E., Hammer, M.J. and Weber, C.L., " Field Studied on an Anaerobic Logoon Treating Slaughter House Waste ", Proc. 22nd Ind. Waste Conf., Purdue Univ., (1967)
36. Van Eck, H. and Simpson, D.E., " Anaerobic Ponds " in : Ponds as a Wastewater Treatment Alternative, Water Resources Sym. No.9, CRWR, The Univ. of Texas at Austin, (1976):131-141
37. Uddin, M.S., " Anaerobic Pond Treatment for Tapioca Strach Waste ", Mater's Thesis, AIT, (1970)
38. Loehr, R.C. and Ruf, J.A., " Anaerobic Lagoon Treatment of Milking-Parlor Wastes, J.WPCF, Vol.40, (1968) : 83-94

39. Alivio, G.M., " Studies on High Rate Anaerobic Stabilization Ponds ", Master's Thesis, AIT, (1968)
40. Etzel, J.E., " Industry's Idea Clinic ", J.WPCF, Vol.36, (1964) : 931
41. Dornbuush, J.N., " State of the Art-Anaerobic Lagoons ", 2nd International Lagoon Sym., Kansas City , (1970) : 384
42. Ghosh, S., Conrd, J.r. and Klass, D.L., " Anaerobic Acidogenesis of Waste Water Sludge", J.WPCF, Vol.47, No.1, (1975):30-45
43. Ghosh, S. and Henry, M.P., " Stabilization and Gasification of Soft-Drink Manufacturing Waste by conventional and Two-Phase Anaerobic Digestion ", Proc. 36th Ann Purdue Ind. Waste Conf., Lafayette, Ind., May 12-14, (1981)
44. Ghosh, S., et al., " Methane Production from Industrial Wastes by Two-phase Digestion ", Paper presented at Energy from Biomass and Wastes VI, Lake Buena Vista Florida, January 25-29, (1982)
45. Xu Jie-guan, et al., " Pilot studies on Two - Phase Methane Fermentation Pig Manure at Ambient Temperature, in Proceedings of the Fourth International Symposium on Anaerobic Digestion, held in Guanzhou, China, 11-15 November, (1985) : 125-134

46. ธาดา ฉัตรธานี, " การบำบัดน้ำเสียจากโรงงานแป้งมันสำปะหลังโดย กระบวนการใช้ออกซิเจนอิสระแบบสองขั้นตอน ", วิทยานิพนธ์ปริญญาโทบัณฑิต ภาควิชาวิศวกรรมสุขาภิบาล บัณฑิตวิทยาลัย จุฬาลงกรณ์มหาวิทยาลัย, 2530
47. Dilallo, R., and Albertson, O.E., " Volatile Acids by Direct Titration ", J.WPCF, Vol.33, No.14, (1961) : 356-365
48. " Standard Methods for the Examination of Water and Wastewater ", 15th Ed. Amer. Pub. Health Assn., Washington D.C. (1980)

ภาคผนวก

ตารางที่ พ1 ค่าพีเอชที่ตำแหน่งต่างๆ ของการทดลองที่ 1 และ 2

Date	Day of operation (day)	pH (Run # 1)			Date	Day of operation (day)	pH (Run # 2)		
		Two - Phase Pond		Single Pond			Two - Phase Pond		Single Pond
		Acid	Methane				Acid	Methane	
16/9/30	1	4.0	7.2	7.0	11/1/31	1	4.70	7.25	7.20
17/9/30	2	4.1	6.9	6.9	12/1/31	2	4.60	6.90	6.90
18/9/30	3	4.2	6.9	6.7	13/1/31	3	4.60	7.00	7.00
19/9/30	4	4.2	7.3	7.1	14/1/31	4	4.60	7.00	7.10
20/9/30	5	4.2	7.2	7.1	15/1/31	5	4.75	7.00	7.20
21/9/30	6	4.2	7.1	7.2	16/1/31	6	4.70	6.80	7.00
22/9/30	7	4.0	7.4	7.6	17/1/31	7	4.65	7.05	7.20
23/9/30	8	4.0	7.1	7.4	18/1/31	8	4.65	7.00	7.20
24/9/30	9	3.9	7.4	7.4	19/1/31	9	4.75	7.10	7.20
25/9/30	10	3.9	7.4	7.4	20/1/31	10	4.70	6.75	6.75
26/9/30	11	3.9	7.5	7.5	21/1/31	11	4.70	6.90	6.90
27/9/30	12	4.0	7.5	7.4	22/1/31	12	4.75	7.10	7.00
28/9/30	13	4.0	7.5	7.4	23/1/31	13	4.75	7.00	6.90
29/9/30	14	4.0	7.6	7.5	24/1/31	14	4.60	7.00	7.00
30/9/30	15	4.0	7.4	7.3	25/1/31	15	4.60	7.00	7.00
1/10/30	16	3.9	7.5	7.4	26/1/31	16	4.50	7.00	7.00
2/10/30	17	4.0	7.3	7.2	27/1/31	17	4.60	6.90	7.00
3/10/30	18	3.9	7.2	7.3	28/1/31	18	4.55	7.05	7.00
4/10/30	19	4.0	7.0	7.1	29/1/31	19	4.30	7.10	7.00
5/10/30	20	4.1	6.9	7.0	30/1/31	20	4.30	7.10	7.00
6/10/30	21	4.4	7.0	6.8	31/1/31	21	4.40	7.00	7.00
7/10/30	22	4.0	6.9	6.9	1/2/31	22	4.55	7.00	7.00
8/10/30	23	4.0	7.0	7.1	2/2/31	23	4.55	7.15	7.00
9/10/30	24	4.0	7.1	7.2	3/2/31	24	4.50	7.00	7.00
10/10/30	25	4.3	7.1	7.0	4/2/31	25	4.55	6.95	7.00
11/10/30	26	4.0	7.2	7.2	5/2/31	26	4.50	6.90	6.85
12/10/30	27	4.0	6.8	6.9	6/2/31	27	4.60	6.90	6.70
13/10/30	28	4.0	6.8	7.0	7/2/31	28	4.60	7.10	7.10
14/10/30	29	4.4	6.6	7.0	8/2/31	29	4.60	7.10	7.00
15/10/30	30	4.5	7.0	7.0	9/2/31	30	4.55	7.10	6.95
16/10/30	31	4.0	6.7	6.9	10/2/31	31	4.65	7.10	7.10
17/10/30	32	4.3	7.0	6.6	11/2/31	32	4.60	7.00	7.00
18/10/30	33	4.5	7.0	6.7	12/2/31	33	4.60	7.00	7.10
19/10/30	34	4.0	5.8	5.7	13/2/31	34	4.50	7.00	7.00

ตารางที่ ๗1 (ต่อ)

Date	Day of operation (day)	pH (Run # 1)			Date	Day of operation (day)	pH (Run # 2)		
		Two - Phase Pond		Single Pond			Two - Phase Pond		Single Pond
		Acid	Methane				Acid	Methane	
20/10/30	35	3.9	5.8	5.3	14/2/31	35	4.50	7.00	6.95
21/10/30	36	3.8	6.0	5.4	15/2/31	36	4.40	7.00	6.80
22/10/30	37	3.8	5.4	5.0	16/2/31	37	4.55	6.95	6.90
23/10/30	38	4.0	7.4	7.3	17/2/31	38	4.50	7.00	6.95
24/10/30	39	4.0	7.5	7.5	18/2/31	39	4.60	6.90	6.90
25/10/30	40	4.3	7.3	7.2	19/2/31	40	4.55	6.90	7.00
26/10/30	41	4.2	7.2	7.3					
27/10/30	42	4.3	6.7	6.7					
28/10/30	43	4.3	7.0	7.2					
29/10/30	44	4.4	7.0	7.0					
30/10/30	45	4.5	7.2	7.2					
31/10/30	46	4.4	7.2	7.3					
1/11/30	47	4.5	7.1	7.4					
2/11/30	48	4.3	6.8	7.0					
3/11/30	49	4.5	7.0	7.4					
4/11/30	50	4.4	6.8	7.1					
5/11/30	51	4.2	7.0	7.2					
6/11/30	52	4.2	6.9	7.1					
7/11/30	53	4.2	6.9	7.0					
8/11/30	54	4.2	7.0	7.2					
9/11/30	55	4.3	6.9	7.0					
10/11/30	56	4.3	6.7	6.9					
11/11/30	57	4.3	6.8	7.0					
12/11/30	58	4.3	6.6	7.0					
13/11/30	59	4.4	6.6	6.9					
14/11/30	60	4.4	6.7	6.7					
15/11/30	61	4.4	6.7	7.0					
16/11/30	62	4.5	6.7	6.9					
17/11/30	63	4.3	6.6	6.9					
18/11/30	64	4.4	6.6	6.9					
19/11/30	65	4.5	6.8	7.1					
20/11/30	66	4.4	6.7	6.7					
21/11/30	67	4.5	6.8	6.9					
22/11/30	68	4.5	6.9	6.9					
23/11/30	69	4.5	6.7	6.8					
24/11/30	70	4.5	6.9	7.0					
25/11/30	71	4.4	6.9	7.0					
26/11/30	72	4.5	7.0	7.1					
27/11/30	73	4.6	7.0	7.2					
28/11/30	74	4.6	7.0	7.2					
29/11/30	75	4.5	7.0	7.1					

ตารางที่ ผ2 ค่าพีเอชที่ตำแหน่งต่างๆ ของการทดลองที่ 3 และ 4

Date	Day of operation (day)	pH (Run # 3)			Date	Day of operation (day)	pH (Run # 4)		
		Two - Phase Pond		Single Pond			Two - Phase Pond		Single Pond
		Acid	Methane				Acid	Methane	
31/3/31	1	3.95	7.10	7.10	18/3/31	1	4.65	7.95	7.85
1/4/31	2	3.90	7.00	7.10	19/3/31	2	4.15	7.50	7.70
2/4/31	3	3.90	7.00	7.10	20/3/31	3	4.05	7.55	7.60
3/4/31	4	3.80	7.00	7.00	21/3/31	4	4.05	7.70	7.85
4/4/31	5	3.80	7.00	7.00	22/3/31	5	3.35	7.05	7.20
5/4/31	6	3.65	7.00	7.10	23/3/31	6	3.30	7.20	7.00
6/4/31	7	3.70	7.20	7.10	24/3/31	7	3.25	7.05	7.05
7/4/31	8	3.70	7.35	7.35	25/3/31	8	3.45	7.10	7.10
8/4/31	9	3.65	6.80	6.70	26/3/31	9	3.50	7.00	7.00
9/4/31	10	3.60	7.00	7.30	27/3/31	10	3.60	7.20	7.30
10/4/31	11	3.70	7.00	7.20	28/3/31	11	3.80	7.25	7.30
11/4/31	12	3.70	7.00	7.10	29/3/31	12	3.95	7.35	7.35
12/4/31	13	3.70	7.00	7.00	30/3/31	13	3.80	7.40	7.40
13/4/31	14	3.55	6.75	6.60	31/3/31	14	3.75	7.50	7.40
14/4/31	15	3.70	7.10	6.75	1/4/31	15	3.80	7.50	7.40
15/4/31	16	3.65	6.75	5.80	2/4/31	16	3.90	7.40	7.40
16/4/31	17	3.65	7.10	6.00	3/4/31	17	3.80	7.40	7.40
17/4/31	18	3.70	6.90	5.40	4/4/31	18	3.70	7.40	7.50
18/4/31	19	3.70	6.90	5.20	5/4/31	19	3.45	7.50	7.30
19/4/31	20	3.65	7.00		6/4/31	20	3.50	7.50	7.30
20/4/31	21	3.65	7.00		7/4/31	21	3.60	7.50	7.40
21/4/31	22	3.60	6.90		8/4/31	22	3.60	7.40	7.20
22/4/31	23	3.60	7.00		9/4/31	23	3.50	7.80	7.20
23/4/31	24	3.60	7.00		10/4/31	24	3.50	7.50	7.30
24/4/31	25	3.65	7.40		11/4/31	25	3.60	7.50	7.40
25/4/31	26	3.70	7.40		12/4/31	26	3.50	7.40	7.50
26/4/31	27	3.70	7.00		13/4/31	27	3.40	7.25	6.90
27/4/31	28	3.70	7.20		14/4/31	28	3.45	7.15	7.20
28/4/31	29	3.80	7.20		15/4/31	29	3.45	7.00	7.00
29/4/31	30	3.70	7.20		16/4/31	30	3.45	7.20	6.95
30/4/31	31	3.50	7.15		17/4/31	31	3.45	7.00	7.00
1/5/31	32	3.70	7.00		18/4/31	32	3.45	7.35	7.30
2/5/31	33	3.80	6.90		19/4/31	33	3.50	7.40	7.20

ตารางที่ ๗๒ (ต่อ)

Date	Day of operation (day)	pH (Run # 3)		Single Pond	Date	Day of operation (day)	pH (Run # 4)		Single Pond
		Two - Phase Pond					Two - Phase Pond		
		Acid	Methane				Acid	Methane	
3/5/31	34	3.80	6.90		20/4/31	34	3.50	7.35	7.10
4/5/31	35	3.80	6.90		21/4/31	35	3.45	7.00	6.90
5/5/31	36	3.70	6.75		22/4/31	36	3.45	7.35	7.30
6/5/31	37	4.05	6.75		23/4/31	37	3.40	7.30	7.00
7/5/31	38	4.10	6.80		24/4/31	38	3.40	7.35	7.30
8/5/31	39	4.15	6.85		25/4/31	39	3.40	7.35	7.30
9/5/31	40	4.25	7.15		26/4/31	40	3.45	7.10	7.00
10/5/31	41	4.25	6.80		27/4/31	41	3.40	7.10	7.00
11/5/31	42	4.25	6.75		28/4/31	42	3.40	7.35	7.30
12/5/31	43	4.25	6.80		29/4/31	43	3.55	7.45	7.35
13/5/31	44	4.25	7.00						
14/5/31	45	4.25	7.15						
15/5/31	46	4.30	6.90						
16/5/31	47	4.30	7.15						
17/5/31	48	4.20	6.90						
18/5/31	49	4.35	6.90						
19/5/31	50	4.30	7.00						

ตารางที่ ๗3 ค่าโออาร์พีที่ตำแหน่งต่างๆ ของการทดลองที่ 1 และ 2

Date	Day of operation (day)	ORP (Run # 1)			Date	Day of operation (day)	ORP (Run # 2)		
		Two - Phase Pond		Single Pond			Two - Phase Pond		Single Pond
		Acid	Methane				Acid	Methane	
11/10/30	26	-200	-300	-340	11/1/31	1	-200	-200	-100
12/10/30	27	-90	-280	-300	12/1/31	2	-230	-230	-160
13/10/30	28	-100	-270	-270	13/1/31	3	-260	-230	-190
14/10/30	29	-70	-260	-260	14/1/31	4	-300	-260	-210
15/10/30	30	-150	-270	-270	15/1/31	5	-310	-250	-200
16/10/30	31	-180	-260	-260	16/1/31	6	-300	-140	-100
17/10/30	32	-200	-290	-230	17/1/31	7	-300	-220	-150
18/10/30	33	-210	-280	-260	18/1/31	8	-300	-210	-140
19/10/30	34	-170	-280	-250	19/1/31	9	-300	-200	-140
20/10/30	35	-110	-170	-150	20/1/31	10	-270	-200	-150
21/10/30	36	-100	-160	-140	21/1/31	11	-260	-200	-150
24/10/30	39	-80	-200	-220	22/1/31	12	-270	-200	-190
25/10/30	40	-90	-210	-240	23/1/31	13	-270	-190	-150
26/10/30	41	-10	-190	-170	24/1/31	14	-280	-200	-170
27/10/30	42	-130	-210	-260	25/1/31	15	-280	-220	-210
28/10/30	43	-80	-230	-270	26/1/31	16	-250	-150	-140
29/10/30	44	-90	-250	-250	27/1/31	17	-240	-180	-150
30/10/30	45	-50	-210	-210	28/1/31	18	-240	-150	-140
31/10/30	46	-160	-230	-230	29/1/31	19	-240	-160	-140
1/11/30	47	-200	-250	-250	30/1/31	20	-240	-160	-150
2/11/30	48	-50	-160	-150	31/1/31	21	-250	-180	-160
3/11/30	49	-180	-220	-230	1/2/31	22	-240	-200	-190
4/11/30	50	-10	-170	-200	2/2/31	23	-240	-190	-170
5/11/30	51	-30	-190	-170	3/2/31	24	-240	-190	-170
6/11/30	52	-30	-190	-190	4/2/31	25	-250	-190	-160
7/11/30	53	-50	-190	-190	5/2/31	26	-250	-200	-170
8/11/30	54	-10	-180	-170	6/2/31	27	-320	-240	-210
9/11/30	55	-40	-170	-170	7/2/31	28	-300	-230	-190
10/11/30	56	-50	-180	-190	8/2/31	29	-300	-220	-200
11/11/30	57	-40	-160	-190	9/2/31	30	-310	-220	-200
12/11/30	58	-40	-160	-190	10/2/31	31	-310	-220	-210
13/11/30	59	-30	-140	-170	11/2/31	32	-310	-220	-200
14/11/30	60	-30	-100	-160	12/2/31	33	-320	-220	-210
15/11/30	61	-10	-90	-160	13/2/31	34	-310	-210	-210

ตารางที่ พ3 (ต่อ)

Date	Day of operation (day)	ORP (Run # 1)			Date	Day of operation (day)	ORP (Run # 2)		
		Two - Phase Pond		Single Pond			Two - Phase Pond		Single Pond
		Acid	Methane				Acid	Methane	
16/11/30	62	50	-70	-100	14/2/31	35	-320	-220	-200
17/11/30	63	30	-90	-70	15/2/31	36	-320	-210	-200
18/11/30	64	30	-150	-150	16/2/31	37	-320	-220	-200
19/11/30	65	80	-120	-130	17/2/31	38	-300	-200	-190
20/11/30	66	20	-110	-120	18/2/31	39	-300	-200	-190
21/11/30	67	40	-140	-130	19/2/31	40	-300	-200	-200
22/11/30	68	30	-110	-130					
23/11/30	69	40	-110	-160					
24/11/30	70	50	-110	-190					
25/11/30	71	50	-170	-190					
26/11/30	72	60	-180	-190					
27/11/30	73	60	-180	-190					
28/11/30	74	60	-190	-190					
29/11/30	75	50	-170	-170					

ตารางที่ ๗4 ค่าโออาร์พีที่ตำแหน่งต่างๆ ของการทดลองที่ 3 และ 4

Date	Day of operation (day)	ORP (Run # 3)			Date	Day of operation (day)	ORP (Run # 4)		
		Two - Phase Pond		Single Pond			Two - Phase Pond		Single Pond
		Acid	Methane				Acid	Methane	
31/3/31	1	-65	-240	-260	18/3/31	1	40	-200	-200
1/4/31	2	-50	-280	-290	19/3/31	2	30	-200	-210
2/4/31	3	-40	-300	-300	20/3/31	3	50	-220	-230
3/4/31	4	-30	-280	-300	21/3/31	4	50	-180	-150
4/4/31	5	-20	-270	-280	22/3/31	5	70	-190	-160
5/4/31	6	-50	-290	-300	23/3/31	6	50	-190	-180
6/4/31	7	10	-270	-280	24/3/31	7	50	-260	-270
7/4/31	8	-40	-290	-300	25/3/31	8	-10	-250	-250
8/4/31	9	-80	-310	-320	26/3/31	9	90	-240	-260
9/4/31	10	-100	-310	-300	27/3/31	10	40	-290	-300
10/4/31	11	-100	-300	-290	28/3/31	11	0	-280	-270
11/4/31	12	-100	-260	-280	29/3/31	12	0	-260	-240
12/4/31	13	-110	-300	-300	30/3/31	13	0	-270	-270
13/4/31	14	-90	-260	-270	31/3/31	14	0	-280	-260
14/4/31	15	-90	-270	-270	1/4/31	15	0	-280	-250
15/4/31	16	-80	-270	-240	2/4/31	16	-10	-280	-240
16/4/31	17	-70	-210	-130	3/4/31	17	-15	-300	-270
17/4/31	18	-80	-230	-120	4/4/31	18	-20	-320	-300
18/4/31	19	-70	-260	-130	5/4/31	19	-40	-310	-300
19/4/31	20	-80	-240	-100	6/4/31	20	-70	-320	-310
20/4/31	21	-90	-160	-90	7/4/31	21	-70	-320	-300
21/4/31	22	-70	-260		8/4/31	22	-60	-310	-300
22/4/31	23	-80	-280		9/4/31	23	-90	-360	-310
23/4/31	24	-70	-270		10/4/31	24	-80	-340	-300
24/4/31	25	-70	-260		11/4/31	25	-80	-320	-280
25/4/31	26	-60	-240		12/4/31	26	-80	-330	-290
26/4/31	27	-60	-280		13/4/31	27	-80	-270	-270
27/4/31	28	-80	-270		14/4/31	28	-90	-320	-290
28/4/31	29	-90	-280		15/4/31	29	-90	-280	-270
29/4/31	30	-80	-270		16/4/31	30	-70	-290	-290
30/4/31	31	-70	-280		17/4/31	31	-70	-310	-220
1/5/31	32	-60	-250		18/4/31	32	-70	-300	-280
2/5/31	33	-40	-230		19/4/31	33	-80	-300	-290

ตารางที่ ๗4 (ต่อ)

Date	Day of operation (day)	DRP (Run # 3)			Date	Day of operation (day)	DRP (Run # 4)		
		Two - Phase Pond		Single Pond			Two - Phase Pond		Single Pond
		Acid	Methane				Acid	Methane	
3/5/31	34	-40	-230	20/4/31	34	-80	-290	-290	
4/5/31	35	-50	-240	21/4/31	35	-70	-290	-290	
5/5/31	36	-60	-210	22/4/31	36	-90	-320	-320	
6/5/31	37	-30	-180	23/4/31	37	-70	-300	-300	
7/5/31	38	-40	-170	24/4/31	38	-50	-290	-280	
8/5/31	39	-60	-190	25/4/31	39	-50	-290	-280	
9/5/31	40	-80	-180	26/4/31	40	-60	-300	-300	
10/5/31	41	-100	-180	27/4/31	41	-70	-290	-280	
11/5/31	42	-90	-190	28/4/31	42	-70	-290	-280	
12/5/31	43	-90	-180	29/4/31	43	-70	-290	-290	
13/5/31	44	-90	-180						
14/5/31	45	-80	-160						
15/5/31	46	-90	-170						
16/5/31	47	-100	-160						
17/5/31	48	-100	-160						
18/5/31	49	-100	-180						
19/5/31	50	-90	-170						

ตารางที่ ๗5 ค่ากรดโวลลาไทล์ที่ตำแหน่งต่างๆ ของการทดลองที่ 1 และ 2

Date	Day of operation (day)	VFA as CH ₃ COOH (Run # 1)			Date	Day of operation (day)	VFA as CH ₃ COOH (Run # 2)		
		Two - Phase Pond		Single Pond			Two - Phase Pond		Single Pond
		Acid	Methane				Acid	Methane	
16/9/30	1	455	716	607	11/1/31	1	518	165	338
19/9/30	4	548	772	375	13/1/31	3	548	110	300
21/9/30	6	363	180	83	15/1/31	5	548	345	160
24/9/30	9	465	98	55	17/1/31	7	593	165	125
26/9/30	11	690	145	88	19/1/31	9	525	180	120
29/9/30	14	585	153	90	22/1/31	12	615	133	130
1/10/30	16	565	220	120	24/1/31	14	615	125	140
4/10/30	19	540	278	140	26/1/31	16	563	120	105
7/10/30	22	495	343	175	28/1/31	18	630	113	90
9/10/30	24	450	290	115	30/1/31	20	593	127	115
11/10/30	26	390	180	90	2/2/31	23	675	95	108
13/10/30	28	465	145	120	4/2/31	25	600	155	105
16/10/30	31	405	140	150	7/2/31	28	700	118	150
18/10/30	33	300	150	160	9/2/31	30	698	100	140
21/10/30	36	360	258	375	10/2/31	31	735	140	160
23/10/30	38	380	322	345	12/2/31	33	750	160	180
25/10/30	40	398	70	155	15/2/31	36	720	120	180
27/10/30	42	278	90	155	16/2/31	37	760	180	160
28/10/30	43	308	100	90	17/2/31	38	753	125	140
30/10/30	45	345	115	95	18/2/31	39	763	160	140
1/11/30	47	398	120	103	19/2/31	40	743	130	150
3/11/30	49	465	138	150					
5/11/30	51	375	105	80					
7/11/30	53	353	135	95					
8/11/30	54	398	125	108					
10/11/30	56	405	105	110					
12/11/30	58	390	145	115					
13/11/30	59	443	175	110					
14/11/30	60	525	250	120					
15/11/30	61	510	180	115					
17/11/30	63	533	143	90					
19/11/30	65	375	133	90					
20/11/30	66	390	180	155					
21/11/30	67	375	175	165					
23/11/30	69	503	180	135					
24/11/30	70	425	180	110					
26/11/30	72	430	125	95					
28/11/30	74	405	135	100					
29/11/30	75	413	110	105					

ตารางที่ ๗6 ค่ากรดโวลลาไทล์ที่ตำแหน่งต่างๆ ของการทดลองที่ 3 และ 4

Date	Day of operation (day)	VFA as CH ₃ COOH (Run # 3)				Date	Day of operation (day)	VFA as CH ₃ COOH (Run # 4)			
		Inf.	Two - Phase Pond		Single Pond			Inf.	Two - Phase Pond		Single Pond
			Acid	Methane				Acid	Methane		
16/9/30	1	900	3120	165	375	18/3/31	1	828	6082	454	123
19/9/30	3	900	2100	180	390	20/3/31	3	890	3165	514	223
21/9/30	5	848	1279	360	465	22/3/31	5	860	1774	165	125
24/9/30	8	848	1545	277	386	24/3/31	7	828	1463	125	120
26/9/30	10	1027	1288	367	308	26/3/31	9	772	1280	165	375
29/9/30	14	945	1320	495	652	29/3/31	12	900	1373	270	180
1/10/30	16	923	1455	382	1102	31/3/31	14	900	1320	120	150
4/10/30	17	990	1538	390	1098	2/4/31	16	848	1380	140	180
7/10/30	18	990	1283	472	1890	5/4/31	19	848	1560	360	322
9/10/30	19	1042	1448	540	1849	7/4/31	21	950	1690	105	160
11/10/30	21	1042	1512	345	2138	9/4/31	23	1027	1388	120	150
13/10/30	23	1267	1575	345		11/4/31	26	923	2070	125	128
16/10/30	26	1005	1553	250		13/4/31	27	945	2070	125	128
18/10/30	28	990	1455	465		14/4/31	28	945	2029	390	278
21/10/30	29	818	1433	390		16/4/31	30	990	1988	352	465
23/10/30	31	860	1185	435		18/4/31	32	990	1740	341	135
25/10/30	33	960	1440	307		20/4/31	34	1042	1852	285	70
27/10/30	35	727	1095	532		22/4/31	36	1267	2002	367	135
28/10/30	36	780	1102	525		25/4/31	39	1005	1762	300	300
30/10/30	37	820	1118	697		27/4/31	41	990	1635	197	155
1/11/30	39	892	833	367		28/4/31	42	818	1852	274	168
3/11/30	40	892	1027	375		29/4/31	43	990	1807	180	155
5/11/30	42	743	953	330		30/4/31	44	818	1762	197	168
7/11/30	45	825	880	290							
8/11/30	47	825	953	360							
10/11/30	48	780	885	360							
12/11/30	49	780	885	382							
13/11/30	50	825	910	370							

ตารางที่ ๗ ค่าสภาพความเป็นด่างที่ตำแหน่งต่างๆ ของการทดลองที่ 1 และ 2

Date	Day of operation (day)	ALK as CaCO ₃ (Run # 1)			Date	Day of operation (day)	ALK as CaCO ₃ (Run # 2)		
		Two - Phase Pond		Single Pond			Two - Phase Pond		Single Pond
		Acid	Methane				Acid	Methane	
16/9/30	1	0	875	670	11/1/31	1	135	593	690
19/9/30	4	50	1220	743	13/1/31	3	90	575	600
21/9/30	6	0	733	730	15/1/31	5	125	528	560
24/9/30	9		723	700	17/1/31	7	118	515	520
26/9/30	11		695	700	19/1/31	9	120	520	500
29/9/30	14		563	690	22/1/31	12	130	515	475
1/10/30	16		448	560	24/1/31	14	90	485	430
4/10/30	19		448	490	26/1/31	16	100	520	425
7/10/30	22		425	465	28/1/31	18	140	470	405
9/10/30	24		580	490	30/1/31	20	60	485	400
11/10/30	26		510	380	2/2/31	23	105	470	365
13/10/30	28		145	120	4/2/31	25	110	435	360
16/10/30	31		140	150	7/2/31	28	115	480	365
18/10/30	33		150	160	9/2/31	30	105	425	340
21/10/30	36		258	375	10/2/31	31	115	420	355
23/10/30	38	0	322	345	12/2/31	33	115	335	335
25/10/30	40	40	465	655	15/2/31	36	110	410	320
27/10/30	42	50	378	535	16/2/31	37	110	400	325
28/10/30	43	60	360	515	17/2/31	38	110	395	320
30/10/30	45	85	370	485	18/2/31	39	125	335	315
1/11/30	47	75	325	435	19/2/31	40	133	370	345
3/11/30	49	78	320	375					
5/11/30	51	30	285	345					
7/11/30	53	35	260	310					
8/11/30	54	25	265	317					
10/11/30	56	40	250	295					
12/11/30	58	40	235	255					
13/11/30	59	52	250	287					
14/11/30	60	65	270	270					
15/11/30	61	75	265	260					
17/11/30	63	80	235	250					
19/11/30	65	85	235	270					
20/11/30	66	55	230	240					
21/11/30	67	60	210	200					
23/11/30	69	110	235	235					
24/11/30	70	115	230	215					
26/11/30	72	105	205	200					
28/11/30	74	100	205	175					
29/11/30	75	90	190	190					

ตารางที่ ๗๘ ค่าสภาพความเป็นด่างที่ตำแหน่งต่างๆ ของการทดลองที่ 3 และ 4

Date	Day of operation (day)	ALK as CaCO ₃ (Run # 3)			Date	Day of operation (day)	ALK as CaCO ₃ (Run # 4)		
		Two - Phase Pond		Single Pond			Two - Phase Pond		Single Pond
		Acid	Methane				Acid	Methane	
16/9/30	1		1070	1080	18/3/31	1	100	1430	1195
19/9/30	3		1070	1080	20/3/31	3	78	1440	1200
21/9/30	5		1120	1279	22/3/31	5	0	1415	1185
24/9/30	8		1110	1075	24/3/31	7		1335	1270
26/9/30	10		1030	1070	26/3/31	9		1440	1270
29/9/30	14		1010	1075	29/3/31	12		1485	1355
1/10/30	16		990	1065	31/3/31	14		1515	1340
4/10/30	17		1000	1025	2/4/31	16		1520	1320
7/10/30	18		960	1145	5/4/31	19		1565	1390
9/10/30	19		945	1025	7/4/31	21		1565	1370
11/10/30	21		983	1000	9/4/31	23		1595	1400
13/10/30	23		975		11/4/31	26		1590	1480
16/10/30	26		920		13/4/31	27		1612	1475
18/10/30	28		910		14/4/31	28		1570	1413
21/10/30	29		920		16/4/31	30		1525	1320
23/10/30	31		900		18/4/31	32		1562	1325
25/10/30	33		930		20/4/31	34		1562	1405
27/10/30	35		895		22/4/31	36		1562	1410
28/10/30	36		865		25/4/31	39		1538	1335
30/10/30	37	0	870		27/4/31	41		1500	1330
1/11/30	39	130	855		28/4/31	42		1527	1305
3/11/30	40	175	855		29/4/31	43		1535	1330
5/11/30	42	175	850		30/4/31	44		1527	1305
7/11/30	45	145	860						
8/11/30	47	185	845						
10/11/30	48	125	815						
12/11/30	49	210	825						
13/11/30	50	180	860						

ตารางที่ ๗๑ ค่าตะกอนแขวนลอยที่ตำแหน่งต่างๆ ของการทดลองที่ 1 และ 2

Date	Day of operation (day)	SS, mg/l (Run # 1)			Date	Day of operation (day)	SS, mg/l (Run # 2)		
		Two - Phase Pond		Single Pond			Two - Phase Pond		Single Pond
		Acid	Methane				Acid	Methane	
16/9/31	1	206	152	204	12/1/31	2	85	293	205
18/9/31	3	116	107	186	14/1/31	4	132	168	122
20/9/31	5	15	40	44	17/1/31	7	128	176	106
23/9/31	8	20	36	55	20/1/31	10	147	250	255
25/9/31	10	18	42	41	22/1/31	12	48	86	104
27/9/31	12	16	24	70	24/1/31	14	112	76	86
30/9/31	15	20	36	50	27/1/31	17	194	170	168
4/10/31	19	46	78	24	29/1/31	19	143	82	98
7/10/31	22	38	28	22	1/2/31	22	124	146	164
10/10/31	25	64	20	44	4/2/31	25	56	120	120
12/10/31	27	74	44	12	7/2/31	28	88	94	94
15/10/31	30	80	18	16	10/2/31	31	72	80	100
17/10/31	32	28	10	28	12/2/31	33	80	72	86
19/10/31	34	38	12	10	14/2/31	35	76	84	140
21/10/31	36	44	10	11	15/2/31	36	100	116	152
28/10/31	43	108	68	94	17/2/31	38	76	132	130
30/10/31	45	110	50	64	18/2/31	39	64	166	166
1/11/31	47	105	18	68	19/2/31	40	74	110	142
3/11/31	49	65	12	26					
6/11/31	52	72	34	36					
8/11/31	54	74	22	52					
10/11/31	56	80	20	52					
12/11/31	58	76	26	60					
16/11/31	62	70	22	70					
19/11/31	65	90	42	86					
21/11/31	67	50	54	100					
23/11/31	69	62	32	74					
27/11/31	73	42	46	70					
29/11/31	75	38	40	86					

ตารางที่ ผ10 ค่าตะกอนแขวนลอยที่ตำแหน่งต่างๆ ของการทดลองที่ 3 และ 4

Date	Day of operation (day)	SS ,mg/l (Run # 3)			Date	Day of operation (day)	SS ,mg/l (Run # 4)		
		Two - Phase Pond		Single Pond			Two - Phase Pond		Single Pond
		Acid	Methane				Acid	Methane	
31/3/31	1	170	160	162	18/3/31	1	430	208	242
2/4/31	3	142	155	200	20/3/31	3	480	220	270
4/4/31	5	178	160	134	23/3/31	6	430	237	205
6/4/31	7	138	352	364	25/3/31	8	462	208	242
7/4/31	8	190	312	348	28/3/31	11	524	218	198
10/4/31	11	164	160	162	31/3/31	14	450	285	250
13/4/31	14	218	214	202	2/4/31	16	600	250	215
15/4/31	16	198	155	245	4/4/31	18	530	172	306
18/4/31	19	163	105	165	6/4/31	20	622	406	262
20/4/31	21	170	140	100	8/4/31	22	748	234	290
23/4/31	24	204	275		10/4/31	24	600	548	330
26/4/31	27	153	116		13/4/31	27	650	356	438
28/4/31	29	202	118		15/4/31	29	560	542	358
30/4/31	31	196	288		18/4/31	32	827	380	280
2/5/31	33	150	136		20/4/31	34	797	406	222
4/5/31	35	138	206		23/4/31	37	897	502	400
6/5/31	37	100	140		26/4/31	40	793	430	328
8/5/31	39	60	164		28/4/31	42	875	535	521
10/5/31	41	66	100		29/4/31	43	740	505	510
11/5/31	42	82	92						
12/5/31	43	108	94						
15/5/31	46	156	166						
16/5/31	47	124	272						
17/5/31	48	150	222						
18/5/31	49	170	270						
19/5/31	50	130	190						

ตารางที่ พ11 ค่าซีโอดีที่ตำแหน่งต่างๆ ของการทดลองที่ 1 และ 2

Date	Day of operation (day)	COD , mg/l (Run # 1)			Date	Day of operation (day)	COD , mg/l (Run # 2)		
		Two - Phase Pond		Single Pond			Two - Phase Pond		Single Pond
		Acid	Methane				Acid	Methane	
16/9/31	1	2035	1250	1060	12/1/31	2	4135	311	462
18/9/31	3	2265	940	875	14/1/31	4	4591	295	455
20/9/31	5	2482	740	464	17/1/31	7	4571	277	436
23/9/31	8	2352	346	408	20/1/31	10	5136	474	612
25/9/31	10	2496	365	510	22/1/31	12	5203	419	705
27/9/31	12	2203	394	550	24/1/31	14	5106	428	715
30/9/31	15	2895	304	228	27/1/31	17	5268	390	429
4/10/31	19	2399	268	648	29/1/31	19	5085	285	264
7/10/31	22	1987	202	442	1/2/31	22	5538	264	410
10/10/31	25	2550	450	376	4/2/31	25	5244	262	484
12/10/31	27	2472	402	460	7/2/31	28	5085	224	456
15/10/31	30	2595	370	554	10/2/31	31	5073	260	476
17/10/31	32	2543	318	382	13/2/31	34	5223	237	484
19/10/31	34	2513	593	663	15/2/31	36	5094	396	584
21/10/31	36	2104	379	589	17/2/31	38	4632	247	494
28/10/31	43	2170	167	209	18/2/31	39	5200	330	356
30/10/31	45	2003	209	250	19/2/31	40	5094	232	310
1/11/31	47	2169	201	241					
3/11/31	49	2008	121	161					
6/11/31	52	2142	198	278					
8/11/31	54	2143	198	198					
10/11/31	56	2381	198	198					
12/11/31	58	2361	275	198					
16/11/31	62	2514	305	229					
19/11/31	65	2359	207	166					
21/11/31	67	2380	369	246					
23/11/31	69	2285	326	245					
27/11/31	73	2240	320	280					
29/11/31	75	2360	240	240					

ตารางที่ ข12 ค่าซีโอดีที่ตำแหน่งต่างๆ ของการทดลองที่ 3 และ 4

Date	Day of operation (day)	COD ,mg/l (Run # 3)				Date	Day of operation (day)	COD ,mg/l (Run # 4)			
		Inf.	Two - Phase Pond		Single Pond			Inf.	Two - Phase Pond		Single Pond
			Acid	Methane					Acid	Methane	
1/4/31	2	23800	17615	583	594	19/3/31	2	22925	15761	537	537
3/4/31	4	24511	17810	500	545	23/3/31	6	22154	16820	492	410
5/4/31	6	23795	16552	476	496	25/3/31	8	21153	15051	468	417
7/4/31	8	24421	17664	342	332	27/3/31	10	22400	16000	530	450
10/4/31	11	24611	17615	583	594	29/3/31	12	23795	16340	360	313
13/4/31	14	26182	22691	676	1287	2/4/31	16	24511	15523	368	347
15/4/31	16	26189	24436	633	2642	5/4/31	19	23795	18051	515	410
18/4/31	19	23564	20073	884	4552	7/4/31	21	24421	18526	484	632
20/4/31	21	23564	20945	850		10/4/31	24	24661	18211	440	396
23/4/31	24	23564	22691	829		13/4/31	27	26182	25309	436	349
26/4/31	27	28364	21429	771		15/4/31	29	26182	23564	611	611
28/4/31	29	29064	24660	704		18/4/31	32	23564	17455	545	545
30/4/31	31	26515	22260	649		20/4/31	34	23564	21382	338	622
2/5/31	33	25112	21551	510		23/4/31	37	23564	19636	458	458
4/5/31	35	16000	22588	965		26/4/31	40	28364	16286	514	492
6/5/31	37	16320	16320	944		28/4/31	42	29064	24660	440	374
8/5/31	39	13856	13865	792		29/4/31	43	29064	21138	440	386
10/5/31	41	13856	10400	560							
11/5/31	42	12000	10000	720							
12/5/31	43	10170	8644	612							
14/5/31	45	10170	8949	528							
15/5/31	46	10890	9356	610							
16/5/31	47	10890	9277	686							
17/5/31	48	10900	9681	870							
18/5/31	49	10900	9238	682							
19/5/31	50	10890	9423	730							



ประวัติผู้วิจัย

ชื่อ นางสาวลัดดา สาครมณีรัตน์

เกิด 16 มกราคม 2505 , สมุทรสาคร

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