Anaerobic Digestion of Dairy Waste Scum for Biogas Production

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Abstract:
Dairy scum waste has high oxygen demand because it is composed of organic matter. In streams it is consumed at very rapid rate in the process of aerobic digestion causing depletion of oxygen and in some cases exhaustion resulting in serious pollution, if it is disposed to the sanitary landfill site, it causes problems like odor and land pollution, the study presents utilization of dairy scum through anaerobic digestion and control of water, land and air pollution as well as generation of biogas from dairy effluent. It solves dairy scum treatment and disposal problem and provides clean energy like biogas as well.

Keywords: *Anaerobic Digestion, Dairy Scum*

1. Introduction

As dairy waste scum is composed of high organic matter, it causes high oxygen demand in the water body where it is disposed or causes land pollution at sanitary landfill site. Dairy waste is generated from various sections of dairy like milk receiving section, pasteurization plant, manufacture of butter and ghee, manufacture of cheese, casein plant, bottle washing plant, etc. all the effluents are mixed and sent for treatment. The floating matter is collected by mechanical scrapper and it is called dairy scum. It is a low density floating solid mass usually formed by mixture of fat, lipids, proteins, packing materials, etc. Prior to disposal, treatment of dairy effluent is carried out by various physico-chemical and biological treatment process.

Table 1. Characteristics of dairy scum used

Sr.	Parameter	Dairy Scum
1	pH	5.45
2	TS (%)	16.23
3	VS (% D.W.)	82.42
4	Organic Carbon (% D.W.)	42
5	Nitrogen (% D.W.)	1.624
6	Phosphorus (% D.W.)	1.184
7	Carbohydrates (% D.W.)	2.04
8	Fats/Lipids (% D.W.)	14%

Anaerobic digestion is a process which is carried out by microorganisms that can only live in an oxygen free environment. Anaerobic digestion is the most common process for dealing with waste water sludge containing primary sludge. Anaerobic decomposition creates considerably less biomass than the aerobic process. Anaerobic digestion converts as much of the sludge as possible to end products, such as, liquid and gases like methane and carbon dioxide while producing as little residual biomass as possible.

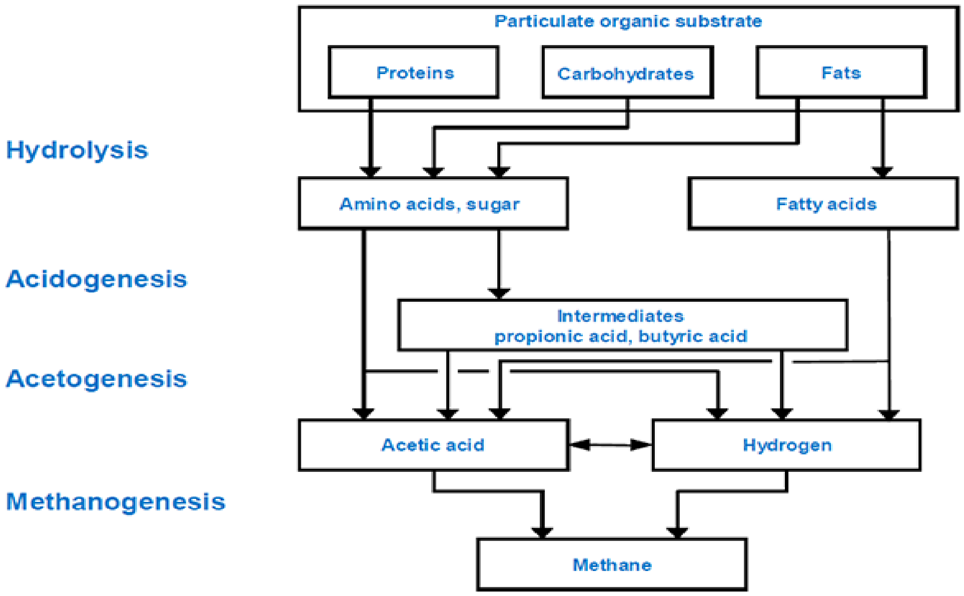


Fig 1. Flow Chart Explaining Anaerobic Digestion

For studying anaerobic digestion of dairy waste at lab scale, the experimental setup is made up for semi-continues process.

2. Experimental Setup

In the semi-continues process, organic matter is fed every day. The amount of biogas generated can be known by measuring displacement of water. Two semi-continuous reactors are operated of **Total Solid Content of 5% and 10%.** Effective volume of rectors is **3.5 liters**. Hydraulic retention time of reactors is **40 days**. Reactors are fed daily. Biogas production is measured by water displacement method on daily basis. Two Reactors A and B are used for this experiment. Total solid contents of the reactors are 5% and 10% respectively. Digested cattle dung is used as inoculum. Gas production is measured by water displacement method on daily basis. pH of feed and the drained samples is also measured daily. Experimental setup of semi- continuous reactors is as shown in the figure below:

Fig. 2. Experimental Setup

Fig. 3. Experimental Setup

3. Results and Discussion

Table 2. Reactor a

Day	pH (Feed)	Gas Production (ml)	Cumulative Gas Production (ml)	pH (Drained Samples)
1	6.12	710	710	7.03
2	6.76	800	1510	6.87
3	6.71	1160	2670	7.2
4	6.52	1390	4060	7.11
5	6.36	0	4060	7.3
6	6.23	0	4060	7.12
7	6.43	2400	6460	7.13
8	6.32	900	7360	7.1
9	6.59	1400	8760	7.14
10	6.55	1750	10510	7.1
11	6.54	1650	12160	7.11
12	6.37	1260	13420	7.23
13	6.12	1680	15100	6.81
14	6.02	0	15100	6.84
15	5.8	0	15100	6.87
16	5.76	0	15100	6.96
17	6.07	3970	19070	6.955679
18	6.04	0	19070	6.943643

19	6.01	0	19070	6.931607
20	5.98	1860	19070	6.919571
21	5.94	1910	19070	6.907536
22	5.91	2100	21170	6.8955
23	5.88	0	21170	6.883464
24	5.85	4510	25680	6.871429
25	5.82	1450	27130	6.859393
26	5.79	1975	29105	6.847357
27	5.75	3550	32655	6.835321
28	5.72	0	32655	6.823286
29	5.69	1960	34615	6.81125
30	5.66	2360	36975	6.799214
31	5.67	0	36975	7.1
32	6.03	0	36975	7.01
33	5.93	5150	42125	7.11
34	6.06	4460	46585	7.16
35	6.12	4280	50865	7.16
36	5.81	3410	54275	7.16
37	5.81	2765	57040	7.14
38	5.8	0	57040	7.15
39	5.45	3030	60070	7.17
40	5.78	3690	63760	7.24
41	5.86	3330	67450	7.29
42	6.15	3200	70780	7.26
43	5.98	2680	73980	7.28
44	5.82	2880	76660	7.16
45	6.35	3205	79540	6.91
46	5.86	3700	82745	7.29
47	6.15	3460	86445	7.26
48	5.98	4350	89905	7.28
49	5.82	2700	94255	7.16
50	6.35	2570	96955	6.91
51	5.46	2290	99525	7.36

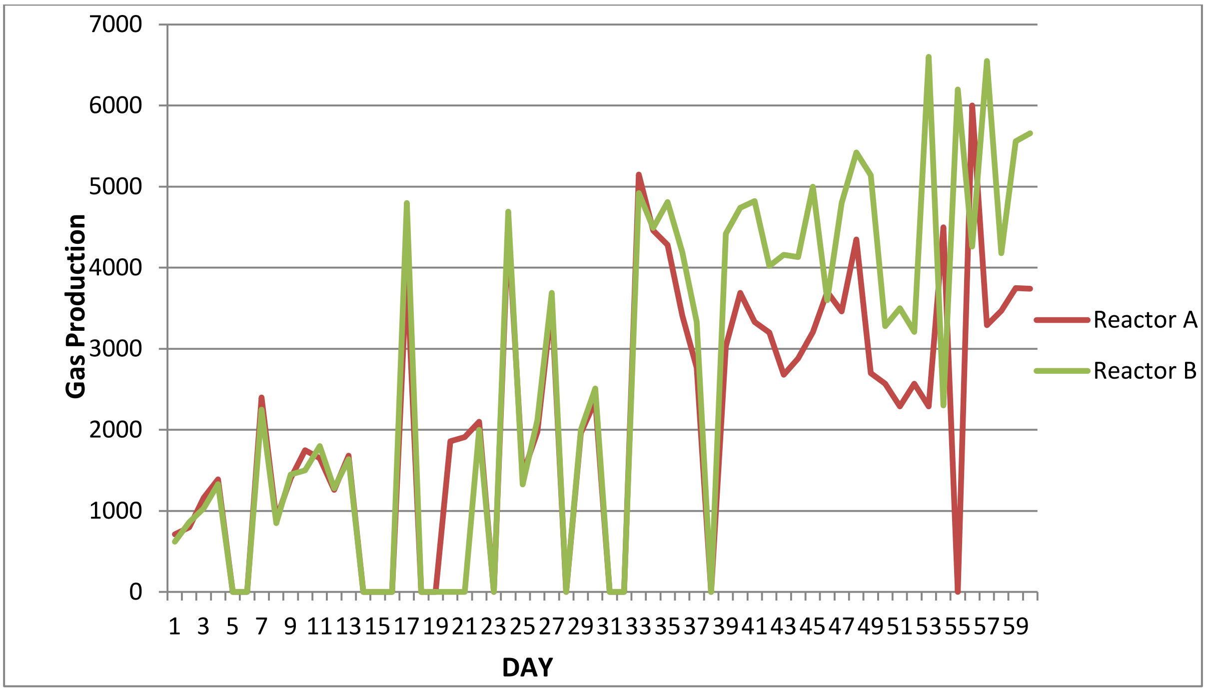
52	5.68	2570	101815	7.38
53	5.56	2290	4500	7.26
54	6.61	4500	0	7.23
55	6.44	0	6000	7.31
56	6.54	6000	3290	7.39
57	5.48	3290	3470	7.24
58	6.14	3470	3750	7.16
59	6.6	3750	3740	7.18
60	6.69	3740		7.26

Table 3. Reactor B

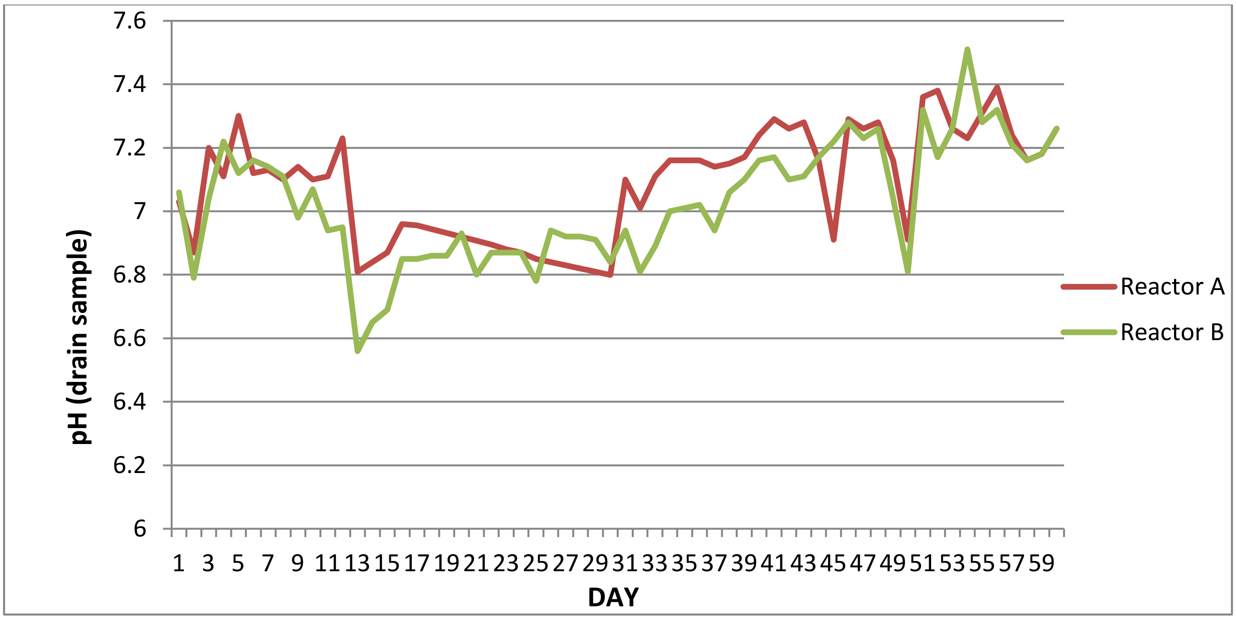
Day	pH	Gas Production (ml)	Cumulative Gas Production (ml)	pH (Drained Sample)
1	6.04	620	620	7.06
2	6.44	860	1480	6.79
3	6.51	1030	2510	7.04
4	6.33	1330	3840	7.22
5	6.26	0	3840	7.12
6	6.34	0	3840	7.16
7	6.45	2250	6090	7.14
8	6.58	850	6940	7.11
9	6.36	1450	8390	6.98
10	6.34	1500	9890	7.07
11	6.27	1800	11690	6.94
12	6.16	1280	12970	6.95
13	5.81	1640	14610	6.56
14	5.65	0	14610	6.65
15	5.56	0	14610	6.69
16	5.52	0	14610	6.85
17	5.52	4800	19410	6.85
18	5.53	0	19410	6.86
19	53	0	19410	6.86
20	5.53	0	19410	6.93
21	5.51	0	19410	6.8

22	6.86	2000	21410	6.86
23	5.56	0	21410	6.87
24	5.57	4690	26100	6.87
25	5.48	1325	27425	6.78
26	5.44	2120	29545	6.94
27	5.59	3690	33235	6.92
28	5.56	0	33235	6.92
29	5.56	2000	35235	6.91
30	5.57	2510	37745	6.84
31	5.56	0	37745	6.94
32	5.66	0	37745	6.81
33	5.52	4920	42665	6.89
34	5.41	4490	47155	7
35	5.47	4810	51965	7.01
36	5.67	4190	56155	7.02
37	5.68	3330	59485	6.94
38	5.58	0	59485	7.06
39	5.75	4420	63905	7.1
40	5.78	4740	68645	7.16
41	5.46	4820	73465	7.17
42	5.48	4020	77485	7.1
43	5.45	4160	81645	7.11
44	5.19	4130	85775	7.17
45	5.46	5000	90775	7.22
46	5.62	3600	94375	7.28
47	6.03	4800	99175	7.23
48	5.76	5420	104595	7.26
49	5.68	5140	109735	7.04
50	6.07	3280	113015	6.81
51	6.02	3500	116515	7.32
52	5.79	3210	119725	7.17
53	5.7	6600	126325	7.26
54	5.78	2300	128625	7.51

55	5.78	6200	134825	7.28
56	5.89	4260	139085	7.32
57	5.67	6550	145635	7.21
58	5.78	4180	149815	7.16
59	5.98	5560	155375	7.18
60	5.79	5660	161035	7.26



Graph 1. Representing gas production (ml) of reactor A and B



Graph 2. Representing pH (drain sample) of reactor A and B

4. Conclusion

Biogas can be produced by the anaerobic digestion of dairy waste scum. Initially we found comparatively less gas production by the anaerobic digestion of dairy scum but eventually it increases significantly. By the present study, we can say that anaerobic digestion of dairy waste can solve disposal problem of dairy waste scum and we can produce significant amount of one of the green fuels biogas from it.

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