Impact Factor (SJIF): 4.542

International Journal of Advance Research in Engineering, Science & Technology

e-ISSN: 2393-9877, p-ISSN: 2394-2444

Volume 4, Issue 4, April-2017

Fat Degradation Of Dairy Industry Effluent Using Anaerobic Treatment.

Falguni P Mistry[1] , Minarva J Pandya[2]

1. Student of Master in Environmental Management, L. D. College of Engineering.
2. Head of Department, Environmental Engineering, L.D. College of Engineering.

Abstract:

Biodegradation of fats, oil and grease (FOG) in dairy wastewaters has been a major challenge for the industry. Many treatment processes have been tried to solve the issue of environmental degradation caused by the wastewater effluents from the dairy industry. The anaerobic reactor has been suggested by several researchers with some success in the degradation of FOG. Biodegradation of dairy effluent by using selected microbial cultures. So single culture was proved to be the most effective in reducing selected physiochemical parameters of water. And mixed culture was proved to be less effective in reducing selected physiochemical parameters of water. It gives % COD reduction 86.34% and % Oil and grease reduction 73.43%.

Key words: Fat degradation, Lipids, Oil and grease, Dairy effluent, Bacterial isolates, COD contents, Activated sludge.

Introduction:

The dairy industry wastewaters are primarily generated from the cleaning and washing operations in the milk processing plants. It is estimated that about 2% of the total milk processed is wasted into drains. The wastewater generated from milk processing can be separated into two groups, the first group concerns wastewater having high flow rates and the second concerns the effluents produced in small milk transformation units (cheese production for instance). Dairy wastewater is characterized by high biological-oxygen demand (BOD) and chemical oxygen demand (COD) concentrations, and generally contains fats, nutrients, lactose, as well as detergents and sanitizing agents. Nutrients lead to eutrophication of receiving waters, and detergents affect the aquatic life. Due to the high pollution load of dairy wastewater, the milk processing industries discharging untreated/partially treated wastewater cause serious environmental problems. Moreover, the Indian government has imposed very strict rules and Regulations for the effluent discharge to protect the environment. Thus, appropriate treatment methods are required so as to meet the effluent discharge standards [02, 04].

Dairy wastewaters are generally treated using biological methods such as activated sludge process, aerated lagoons, trickling filters, sequencing batch reactor (SBR), anaerobic sludge blanket (UASB) reactor, anaerobic filters, etc. Dairy industries are involved in the manufacturing of various types of milk products such as fluid milk, butter, cheese, yogurt, condensed milk, flavored milk, milk powder, ice cream, etc. Typical by-products obtained include buttermilk, whey, and their derivatives. A chain of operations involving receiving and storing of raw materials, processing of raw materials into finished products, packaging and storing of finished products, and a group of other ancillary operations (e.g., heat transfer and cleaning) are examples of some of the great variety of operations performed in the dairy industries. The initial operations such as homogenization, standardization, clarification, separation, and pasteurization are common to most plants and products. Clarification (removal of suspended matter) and separation (removal of cream for milk standardization to desired butterfat content), generally, are accomplished by specially designed large centrifuges [05]. Drying, condensing, etc. are also used in dairy industries for the production of various products. The types and size of processes and equipment used are determined by raw material inputs and the finished products manufactured. The dairy industry is one of the most polluting of industries, not only in terms of the volume of effluent generated, but also in terms of

its characteristics as well. In the dairy industry, some amount of wastewater gets produced during starting, equilibrating, stopping, and rinsing of the processing units (flushing water, first rinse water, etc.). However, a majority of wastewater gets produced during cleaning operations, especially between products changes when different types of products are produced in a specific production unit and clean-up operations.

The Biological treatment of Dairy wastewater includes both Aerobic and Anaerobic processes.

AEROBIC PROCESS:

Aerobic biological treatment involves microbial degradation and oxidation of waste in the presence of oxygen. Conventional treatment of dairy wastewater by aerobic processes includes processes such as activated sludge, trickling filters, aerated lagoons, or a combination of these. All compounds of dairy wastewater are biodegradable except protein and fats which are not easily degraded. Conventional treatment of dairy wastewater by aerobic processes includes processes such as activated sludge, trickling filters, aerated lagoons, or a combination of these. All compounds of dairy wastewater are biodegradable except protein and fats which are not easily degraded. Nitrogen and phosphorus removal were found to be 96 and 80%, respectively; whereas BOD removal was found to be in the range of 97-98%.

ANAEROBIC TREATMENT:

Dairy effluents have high COD and organic content and are warm, enabling them to be ideal for anaerobic treatment. Furthermore, no requirement for aeration, low amount of excess sludge production, and low area demand are additional advantages of anaerobic treatment processes in comparison to aerobic processes. UASB reactors have been widely used for the dairy wastewater treatment in full-scale applications. The basic elements of a typical UASB reactor are a sludge blanket, influent-distribution system, gas-solid separator, and the effluent withdrawal system. In the UASB reactor, the influent is distributed at the bottom and travels in up-flow mode.

Dairy wastewater contains fats and the inhibitory action of the fat to the anaerobic treatment does not allow fast and increased removal efficiency. The enzymatic hydrolysis of fats as pre-treatment may remove this problem. Due to the gas generation, all types of anaerobic reactor are well mixed but the reactor performance gets affected by the degree of mixing and the solid content in the waste [07].

The dairy industry on an average has been reported to generate 6-10 L of wastewater per liter of the milk processed [01]. Dairy wastewater are generally treated using biological methods such as activated sludge process, aerated lagoons, trickling filters, sequencing batch reactor (SBR), anaerobic sludge blanket (UASB) reactor and anaerobic filters [01]. Strains isolated from soil rich in organic matter degraded olive oil and tributyrin, and the most active strain belonged to the genus Bacillus. Other genera of bacteria, such as Pseudomonas, Burkholderia, Acinetobacter, Escherichia, and fungi (Candida, Rhodotorula, Yarrowia) are known to have the ability to degrade contaminants as well as Bacillus. However, the natural microbial degradation of FOGs is slow due to their low lipolytic activity.

Materials and Methodology:

- Initial fat sample analysis:

Fat sample was collected from Amul-Fed Dairy, (Bhat) Gandhinagar.

COD analysis for fat waste:

Fat sample	COD (g/kg) Set-1	COD (g/kg) Set-2
F1	75,024	75,292
F2	76,629	71,244
F3	79,838	74,483

Oil and grease analysis for fat waste:

Fat sample	Oil and grease(mg/l) Set-1	Oil and grease(mg/l) Set-2
F1	12.47	12.10
F2	14.30	14.93
F3	12.42	14.82

Experimental work for start-up of digesters:

Start-up preparation:

For preparation of different combination of cultures:

Flask no.	Contents :
Flask-1	UASB sludge + Fat waste + Water
Flask-2	UASB sludge + Fat waste + C_1 + Water
Flask-3	UASB sludge + Fat waste + C_2 + Water
Flask-4	Fat waste + C_1 + Water
Flask-5	Fat waste + C_2 + Water

Feed preparation:

Total amount of 10 % slurry is made.

Flask no.	Contents :
Flask-1	70g UASB sludge + 80g Fat waste + 650g Water
Flask-2	70g UASB sludge + 80g Fat waste + 50g C_1 + 600g Water
Flask-3	70g UASB sludge + 80g Fat waste + 50g C_2 + 600g Water
Flask-4	80g Fat waste + 50g C_1 + 670g Water
Flask-5	80g Fat waste + 50g C_2 + 670g Water

Nutrients Added:

Nutrients	In 100g Slurry
$(NH_4)_2SO_4$	1 %
K_2HPO_4	0.25 %
KH_2PO_4	0.25 %

Digester construction:

Experimental Setup:

Five anaerobic, semi-continues digesters are set up. The volume of each digester is 15 litres (L).

These digesters are made up of high density polyethylene.
The digesters are cylindrical in shape with conical or tapered bottoms, which are made to ensure better and more thorough mixing.

The digesters are constructed with a MS rod for proper mixing for digestion process and operating at an ambient temperature, a temperature optimal for mesophilic anaerobic digestion.

5 set-ups of digesters:

Feed in digesters:
Total amount of 10 % slurry is made.

Reactor no:	Contents :
R-1	1225g UASB sludge + 1400g Fat waste + 11375g Water
R-2	1225g UASB sludge + 1400g Fat waste + 875g C_1 + 10500g Water
R-3	1225g UASB sludge + 1400g Fat waste + 875g C_2 + 10500g Water
R-4	1400g Fat waste + 875g C_1 + 11725g Water
R-5	1400g Fat waste + 875g C_2 + 11725g Water

Results and discussion:

COD analysis during start-up period (30 days):

Flask No.	Initial COD (g/kg) (0) day	Final COD (g/kg) (30)day	% Reduction
1	25,856	20,200	21.875%
2	24,240	16,160	33.333%
3	22,624	8080	64.285%
4	25,048	12,120	51.612%
5	21,816	4040	81.481%

Oil and grease analysis during start-up period (30 days):

Flask No.	Initial Oil and grease (mg/l) (0) day	Final Oil and grease (mg/l) (30)day	% Reduction
1	49.87	1.47	97.05
2	57.21	1.4	97.55
3	49.67	1.03	97.92
4	221.52	2.68	98.79
5	223.45	2.21	99.01

- Flask 4 and 5 are taken as inoculum for anaerobic digesters as C_1 and C_2 respectively.

COD analysis for digesters

Reactor No.	(0) day (g/kg)	(7) day (g/kg)	(14) day (g/kg)	(28) day (g/kg)
R-1	72,762	72,054	71,808	36,422.4
R-2	64,074	63,148	60,384	49,430.4
R-3	56,110	53,433	50,592	39,024
R-4	69,866	68,006	66,912	9539.2
R-5	71,314	71,244	67,728	16,476.8

Oil and Grease analysis for digesters

Reactor No.	(0) day (mg/l)	(7) day (mg/l)	(14) day (mg/l)	(28) day (mg/l)
R-1	27.13	17.26	15.66	10.55
R-2	5.98	2.87	2.67	1.89
R-3	9.71	5.58	4.12	2.58
R-4	35.53	33.47	30.64	15.69
R-5	47.2	24.49	20.16	13.44

% Reduction of COD and Oil and grease analysis:

Reactor No.	Contents	% reduction of COD	% reduction of Oil and Grease
R-1	UASB sludge + Fat waste + Water	49.94	61.11
R-2	UASB sludge + Fat waste + C_1 + Water	22.85	68.39
R-3	UASB sludge + Fat waste + C_2 + Water	30.45	73.43
R-4	Fat waste + C_1 + Water	86.34	55.84
R-5	Fat waste + C_2 + Water	76.89	71.52

Conclusion:

Initial fat sample analysis was done. COD: 71,244 – 79,838 g/kg. Oil and grease: 12.10 – 14.93 mg/l. Preparation of bacterial cultures for start-up of digesters. Different combinations of bacterial cultures were prepared. After 30 days samples were analysed for COD and Oil and grease. Five digesters were fed with fat waste and prepared cultures and analysed for COD and Oil and grease for 0 day, 7 days and 14 days, 28 days. Maximum COD reduction was obtained for culture of C_1 for digester R-4 and oil and grease reduction was obtained for mix culture of C_2 for digester R-3. It gives % COD reduction 86.34% and % Oil and grease reduction 73.43%.

References:

[1] H.J. Porwal, A.V. Mane, S.G. Velhal, Biodegradation of dairy effluent by using microbial isolates obtained from activated sludge, Volume 9, March 2015, Pages 1–15.

[2] Vilma Cipinyte, Saulius Grigiskis, Egidijus Baskys, Selection of fat-degrading microorganisms for the treatment of lipid-contaminated environment, BIOLOGIJA. 2009. Vol. 55. No. 3–4. P. 84–92.

[3] Maghsoodi, Vida, Samadi, Akbar, Ghobadi, Zahra, Biodegradation of Effluents from Dairy Plant by Bacterial Isolates, Iran. J. Chem. Chem. Eng. Vol. 26, No.1, 2007.

[4] Adriano Aguiar Mendes, Ernandes Benedito Pereira, Agenor Furigo Jr., Heizir Ferreira de Castro, Anaerobic Biodegradability of Dairy Wastewater Pretreated with Porcine Pancreas Lipase, Vol.53, n. 6: pp.1279-1284, November-December 2010.

[5] Biological treatment of dairy industry wastewater and its comparison with other treatment techniques.

[6] Nayana Krishnan and Valsa A K, Biodegradation of Lipid Rich Dairy Effluent by Bacterial Consortium, IOSR Journal of Environmental Science, Toxicology and Food Technology, Volume 9, Issue 9 Ver. II (Sep. 2015), PP 16-20.

[7] R. V. Soundaryal, D. Justus Reymond, V. Karthikeyan, Biodegradation of Fat, Oil, and Grease by using an Up flow Anaerobic Sludge Blanket Reactor from Dairy Wastewater, International Journal of Innovative Research in Science, Engineering and Technology, Vol. 5, Issue 5, May 2016.

[8] Srikar Sai, Biological Treatment of Dairy Industry Waste water and its comparison with other Treatment Techniques, (https://www.academia.edu/5635632/Biological_Treatment_of_Dairy_Industry_Waste_water_and_its_comparison_with_other_Treatment_Techniques