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Biomethanation of Dairy Waste

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Abstract

The treatment of waste water emerging from industries has always proved to be difficult task for disposal because of its typical characteristics. The careless discharge of industrial effluent and sewage in land surface waters has created environmental hazards. To meet the standards specified by the water pollution control authorities, of waste-water if treated properly and efficiently it could be a source of energy. Hence the innovative and alternative technology for the treatment of industrial wastes has become main challenge for environmental prevention and protection of public health. The UAPBR is a recent and advanced technique for waste water treatment. It proves to be very useful for the dilute wastes containing significant amount of suspended solids. In present work an attempt has been made to study the performance, evaluation of UAPBR for the treatment of dairy waste (whey).

Keywords: Biomass**,** methanogenic bacteria**,** dairy waste, UAPB reactor.

Introduction

The rapid growth in the size of dairy operations has resulted in new laws and regulations governing the handling and disposal of manure. Requirements for nutrient management plans, manure solids disposal, and odor control make it necessary that new manure management approaches be considered. One of the more promising methods is anaerobic digestion[1]. The biggest advantage is energy recovery in the form of methane and up to 95% of the organic matter in a waste stream can be converted into biogas[2]. The anaerobic process removes a vast majority of the odorous compounds. It also significantly reduces the pathogens present in the slurry. Over the past 25 years, anaerobic digestion processes have been developed and applied to a wide array of industrial and agricultural wastes.

G. Srinivasan et.al[2] have carried out experiments on Diphasic Fixed Film Fixed Bed (FFFB). Anaerobic digester using waste water in order to reduce the COD of dairy waste water and for the production of gas. They have reported maximum removal of COD as 70.40 % at a flow rate of 0.006 m3/day for an overall OLR of 1.265 Kg COD/m3.day.

E.V. Ramasamy et.al[3] have studied treatment of low-strength effluents by using upflow anaerobic sludge blanket(UAPB) reactor. They have reported that the reactors achieved treatment efficiency of the order of 75- 85%. A. A. Azimi et.al[4] has investigated the design principal for the UAPB reactor by studying the pilot plant for dairy waste water. H.N. Gavala et.al[5] has studied the digester efficiency of treating cheese whey at various organic loading rates using UAPB reactor. They have reported that the operation at an organic loading rate of 6.2 g COD/l d found to be satisfactory and could be increased to a maximum of 7.5 g COD/l d with 85-90% of reactor efficiency.

T.H. Ergudcr et.al[6] have investigated the effect of nutrient and trace metal supplementation on the batch anaerobic treatment, and the high-rate anaerobic treatability of cheese whey in Up flow anaerobic sludge blanket (UAPB) reactors. Operational parameters such as hydraulic retention time (HRT), Influent chemical oxygen demand (COD) concentration and loading rate has also investigated. Sunil Anekar and C.R. Rao reported that dairy waste water can be treated by ultra filtration. They have studied ultra filtration using flat sheet poly ether sulfone (PES) to recover valuable constituent from dairy waste water.

S. Venkata Mohan[7] et.al studied biological hydrogen (H_2) production in conjugation with wastewater treatment in a suspended growth sequencing batch reactor (AnSBR). D.E. Akretche et.al[8] has studied the purification of water by ultra filtration using both gamma alumina and TiO_2 membranes. They have reported that, the influence of the pressure and the variations of the water flux have shown an improvement of the process through the use of the local clay support.

Material and Methods

The whey used in the study was obtained from "Warna Milk Dairy". The sample were provided from factory in 20 lit containers and transported to the laboratory and maintained to avoid the acidification and the change of the chemical composition of the whey. At the adaptation phase dilute whey at pH 5.5 was fed into the reactor .Based on the necessity of the experiment various dilute solution of whey were prepared using distilled water. The characteristic and chemical composition of the whey is shown in table -1. The effluent possessed high COD content of the cheese way.

Table -1
Characteristic and chemical composition of the whey

Volume of milk processed	600000 l/Day (Average)
Waste volume	3.6 l/lit of milk
pH	4.1
Total solids	56782 mg/lit
Volatile solids	34732 mg/lit
Suspended solids	22050 mg/lit
COD	71526 mg/lit
BOD	20000 mg/lit
COD : BOD	3.57

Experimental Setup: Figure-1 represent the schematics diagram of the pilot scale UAPB bio-reactor was fabricated with an internal diameter of 20cm and a height of 45 cm. The total volume of reactor was 30 lit. The column was packed with packed with a seashell. The void volume of the packed reactor was 65%. A 1000 ml funnel shaped gas separator was used to liberate the generated biogas from the effluent, and then the gas was led to the gas collector tank. The gas tank was cylindrical glass pipe with an internal diameter of 80mm and height of 1m. The liberated gas frequently measured at constant HRT and the gas volume was recorded with respect to time. The gas tank was initially filled with water which was saturated with methane. The volume of librated gas was demonstrated by the displacement of water in the gas tank.

The UAPB reactor was operated at room temperature (20°C). Whey as a suitable substrate was continuously fed to the reactor using a peristaltic pump; the fed was introduced from the bottom of the column and the uniformly distributed through the column using a perforated plate. The effluent sample was collected from the top of the column in a polyethylene container.

Reactor Operation: The reactor was started with a 20 lit culture contained anaerobic sludge which was originated from the waste-water treatment plant, Warna-Milk dairy. In the packed bed bioreactor, to create sticky surface on seashell, 250ml of 1g/l nutrient agar was introduced from top of the column for the fast development of bacteria. In order to accumulate the sludge with whey the reactor was batch wise with diluted whey (5000-18000mg COD/l). For first three days operation, the bio-reactor was continuously fed in full recycle mode. Then the feed tank was gradually loaded with fresh whey. Continuous feeding the reactor was started with an initial organic loading rate (OLR) of 0.66g COD/(lh) and the HRT was maintained constant throughout the start up period for duration of 5 days. The influent COD concentration was 15000mg/l for the first 5 days, and then it was stepwise increase to 60000 mg/l (OLR=2.47g-COD/(lh)) from 5 to 15 days of operation. The reactor was continuously operated for 65 days.

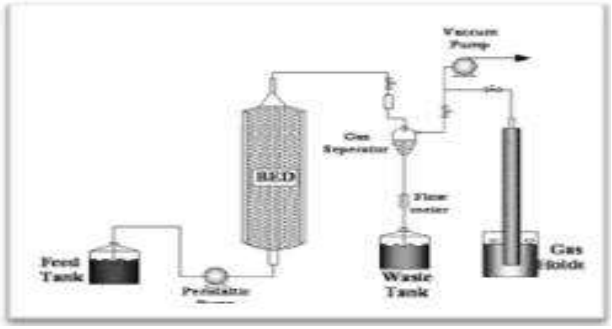


Figure-1
Methane Production from Dairy waste

Results and Discussion

The run was carried for the period of 56 days. The variations of COD, BOD, pH, % fat content, total dissolved solids, total suspended solids, protein content and methane have been determined.

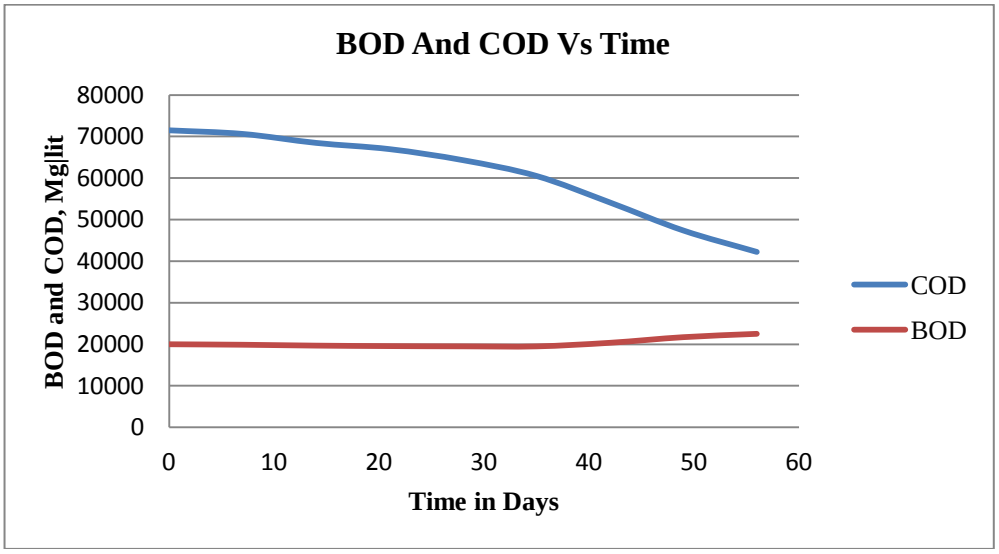
The Following tables gives the variation of COD, BOD, pH, % fat content, total dissolved solids, total suspended solids, protein content and methane along with time, time taken is in day. The run was carried for the period of 56days for first Reactor and Second reactor.

Table-2
Variation of COD, BOD, Ph, and % Fat content, Total Dissolved Solids, Total Suspended Solids, Protein Content and Methane along with time

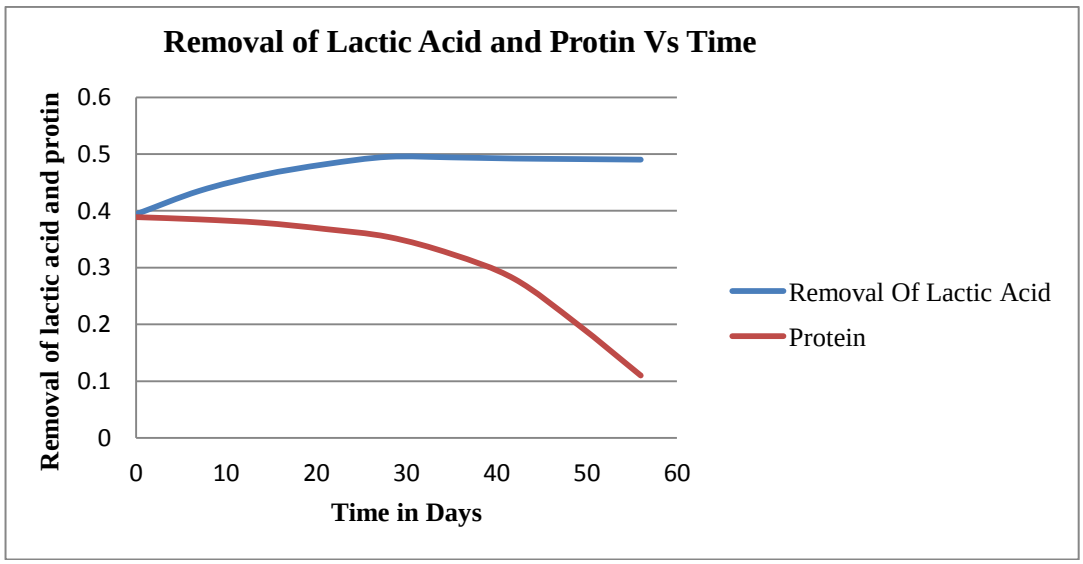
Time in Days	COD Mg/ Lit	BOD Mg/ Lit	% lactic Acid	pH	% Fat content	Total Dissolved Solids	Total Suspended Solids	Protein Content	Methane
0	71526	20000	0.394	7.20	0.389	56782	5423	3.265	0
7	70654	19882	0.435	6.90	0.385	54351	5648	3.259	0.05
14	68492	19675	0.463	6.73	0.379	51987	5956	3.221	0.113
21	66987	19556	0.482	6.40	0.368	47233	6423	3.064	0.183
28	64322	19502	0.495	6.10	0.354	40567	7011	2.867	0.236
35	60520	19495	0.494	6.84	0.324	33678	8845	2.514	0.297
42	54125	20354	0.492	6.71	0.28	23854	9321	2.164	0.374
49	47365	21700	0.491	6.60	0.2	15224	10121	1.665	0.412
56	42200	22500	0.490	6.40	0.11	8270	10870	1.067	0.472

Variation of COD and BOD with Time (in Days): The graph no. 1 gives the variation of BOD and COD with time (in days). From the graph it is observed that the value of COD decreases from 71526mg/lit to 42200mg/lit as the time increases from first day to the 56th day of the experiment. While value of BOD is almost constant up to 40th day of experiment and after that BOD value is slightly increase from 19495Mg/lit to 22500mg/lit**.**

Variation of Lactic Acid and Protein with Time: The graph 2 shows the variation of removal of lactic acid and protein with time in days. It observed that Percent of lactic acid increases from 0.394 to 0.495as the time passes from 1st day to 28th days of experiment and then remain all most constant in the remaining part of the experiment. Whereas the protein content decreases from 3.265 to 1.067 from 1st day to 56th days of experiment.



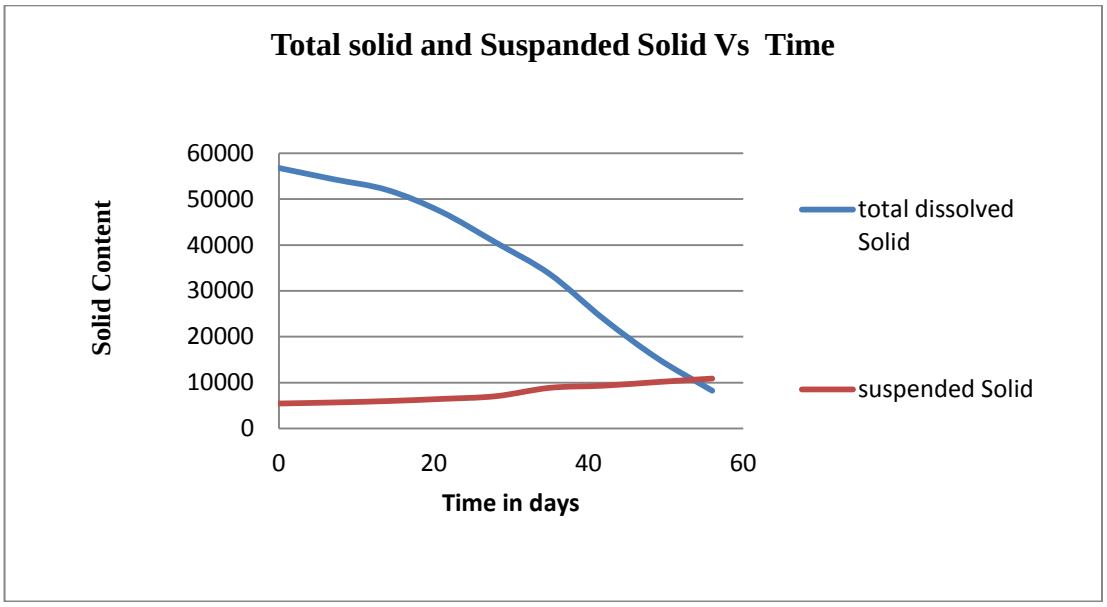
Graph-1
Variation of BOD and COD with time



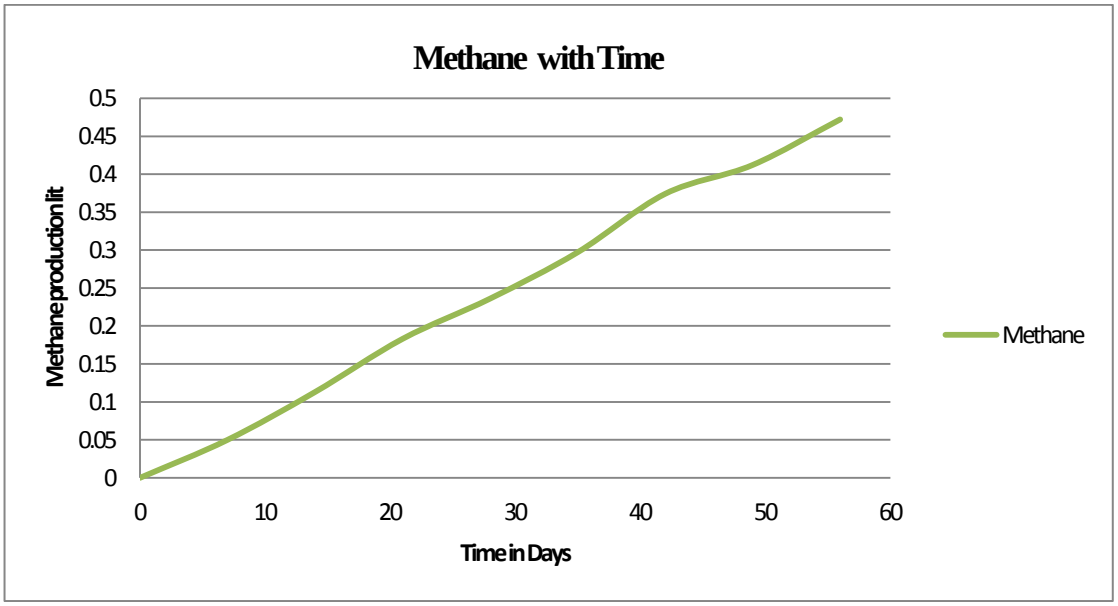
Graph-2
Variation of Lactic Acid and Protein with Time

Variation of Lactic Acid and Protein with Time: The graph no. 3 shows that total dissolved solid decreases from 56782 to 8270 during 1st day to 56th day of experiment, while amount of suspended solid is almost increases from 5423 to 10870 from 1st day to 56th day of experiment.

Variation of Methane with time: The graphs no. 4 deals with the rate of production of methane; it is observed that during the course of experiment the methane production increases from 0 to 0.457lit from 1st day to 56th day of experiment. Maximum production of methane is observed as 0.457lit at 56th day of experiment.

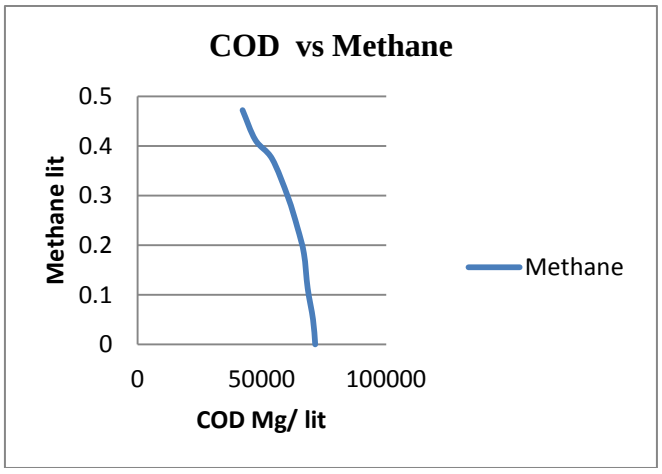


Graph-3
Variation of Lactic Acid and Protein with Time



Graph-4
Variation of Methane with time

Variation of Methane with COD: It is observed from graph 5 that the methane production is increases from 0lit to 0.457lit as the value of COD decrease from 71526mg/lit to 42200 mg/lit. It's observed that, the maximum production of methane occurred at 56th day as 4.57lit, while the value of COD is minimum at 56th day of experiment. The value of COD at 56th day is 42200 mg/lit.



Graph-5
Variation of Methane with

Conclusion

From Above discussion it can be concluded that as the time passes the methane production goes on increasing with decreasing of COD value. The maximum methane production is observed to be 0.457lit at the End of 56th day of the experiment. Also the COD vale at 56th day is found to be 42200mg/lit. As the process of anaerobic digestion is slow process still it have the beigest advantage of production of methane and also this process reduces the COD of the effluent. From above discussion one can say that, the effluent from dairy industry is very good raw material for production of methane gas, commercially known as BIO-GAS, which can be use as a fuel and can replace the other fuel

Acknowledgement

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References

1. Dennis A. and Burke P.E., Options for Recovering Beneficial Products From Dairy Manure, Dairy Waste Anaerobic Digestion Handbook, **1** (**2001)**

2. *Srinivasan G., et.al*, A Study on Dairy Wastewater Using Fixed-Film Fixed Bed Anaerobic Diphasic Digester, *American-Eurasian Journal of Scientific Research,* **4(2),** 89-92, (**2009)**

3. Sankar Ganesh P. and Ramasamy E.V., Studies on treatment of low-strength effluents by UASB reactor and its application to dairy industry wash waters, *Indian Journal of Biotechnology*, **6**, 234-238 (**2007)**

4. Azimi A.A. et.al, Determination of design criteria for UASB reactors as a wastewater pretreatment system in tropical small communities, *Int. J. Environ. Sci.Tech.,* **1(1),** 51-57 **(2004)**

5. Kopsinis H., et.al, Treatment of Dairy Wastewater Using an Up flow Anaerobic Sludge Blanket Reactor, *J. Agric. Engng Res.*, **73,** 630 **(1999)**

6. Ergudcr T.H. et.al., Anaerobic biotransformation and methane generation potential of cheese whey in batch and UASB reactors, *Waste Management*, **21**, 643-650 **(2001)**

7. Venkata Mohan S., Anaerobic Bio hydrogen production from dairy wastewater treatment in sequencing batch reactor (AnSBR), Effect of organic loading rate, Bioengineering and Environmental Centre, Indian Institute of Chemical Technology, Hyderabad

8. Akretche D.E., Purification of water effluent from a milk factory by ultrafiltration using Algerian clay support, Faculté des Sciences, Département de Chimie, Université Mohamed Bouguerra, 35000 Boumerdes, Algérie

9. Ahring B.K., Ibrahim A.A., et.al, Effect of temperature increase from 55 to 65°C on Performance and Microbial Population Dynamics of an anaerobic reactor treating cattle manure, *Water Research,* **35**(**10),** 2446-2452, **(2001)**

10. Berg Van den L. and Kennedy K.J., Dairy waste treatment with anaerobic tationary fixed film reactors, *Water Science Technol.*, **15,** 359-68 (**1983)**

11. Orhon D., Gorgum E., Germirli F. and Artan N., Biological tretability of dairy wastewaters, *Water Research,* **27(4),** 635-633 **(1993)**

12. Michal Perle, Shlomo Kimchie and Gedaliah Shelef, Some biochemical aspects of the anaerobic degradation of Dairy Industries, *Water Research*, **29(6),** 1549-1554 **(1995)**