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Studies on Waste Water Characteristics of Dairy Effluent and Evaluation of Kinetic Parameters

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Abstract: **- Dairy effluent is easily amenable to biodegradation. However if the dairy effluents are discharged without treatment, the foul smell will be generated and spoils environment. So it is very much essential to properly treat the dairy effluent. The solid wastes from the effluent coming out from the dairy plant can be used as fertilizer and treated liquid water.i,e. clear water is used for irrigation purpose. The kinetic coefficient for the activated sludge process for dairy effluents has been calculated. These kinetic parameters are very essential for the design of effluent treatment plant. We have to reduce capacities of the existing plants and encourage small scale units in the rural areas for uniform development in the small scale industries will meet total requirements which shall go as long way resolving solution problems of developing countries including India in a big way. In the present study the effluent characteristics have been studied for a period of two months. The inlet BOD varied from 520 to 580 mg/l. the inlet pH varied from 4.9 to 5.3. The inlet TSS varied from 750 to 930 mg/l. the kinetic parameters like Y, K_d have been evaluated. The hydraulic retention time from the design calculations is 15hours. Whereas the actual HRT is 16hrs.The effluent treatment has a very good potential for biogas generation.**

Keywords: Activated Sludge Process, Biodegradation, BOD, Hydraulic retention time.

1. INTRODUCTION:

Milk is one of the most important stuffs and is must in quality as it reaches consumer. Primary milk was stored in dehydrated state by drying. But the study of causes for deterioration was paved way method, called pasteurization. The study revealed that chemical internally by enzymes and externally due to micro-organisms are responsible for milk spoilage and deterioration [1]

It is common practice to collect milk of several milking in a bulk tank before transportation of the milk to the dairy.. To prevent microbial growth in the farm bulk tank, milk has to be cooled during storage. Hygienic milk production can be done by healthy animals, good feed and asceptic operations which were explained in "Milk processing and quality management" edited by A.Y.Tamime., 2009 Blackwell publishing Ltd', ISBN: 978-1- 405- 14530-5 [2].

To know the quality of milk, different brands of milk was taken and analyzed. Their physical, chemical and microbial quality was analysed by M.Asaduzzaman.,et al [3].

Foster et al reported that the principal involved in preservation of milk product depends on the concentration increases in milk by which there is a raise in osmotic pressure and binding water [4]. Radeva et al reported that the rancidness in the condensed milk was caused by lipase when the viscosity of the milk is low [5].

2. ANALYTICAL PROCEDURE:

The samples had collected were analyzed for conductivity, color, BOD, turbidity, COD and TDS present in the permeate sample at the analytical division. The conductivity of permeate and concentrate samples are analyzed by using digital conductivity meter, pH of the feed sample was analyzed by pH meter. Buffer tablets with pH 4.0, 7.0 & 9.2 were taken as reagents.

First rinse the electrode with distilled water and dry them using a soft tissue paper. Standardize using buffer solution. Remove the buffer, rinse and blot dry. The difference should be within 0.1 units. Check the pH of the effluent.

A. Oxygen demand analysis:

1) Biological oxygen demand analysis
2) Chemical oxygen demand analysis

Chemical oxygen demand (COD): the organic matter gets oxidized completely by $K_2Cr_2O_7$, in the presence of H_2SO_4 to produce CO_2 and H_2O. The excess $K_2Cr_2O_7$, remaining after the reaction is titrated with the Fe (NH4) 2 (SO4)2.

The dichromate consumed gives the O2 required for the oxidation of the organic matter.10 ml glass vials with lids ensuring no leakage and Electric sand bath

B. Experimental Procedure

The glass vials are thoroughly cleaned using distilled water. A pinch of mercuric sulphate is taken into the glass vial.3ml of potassium dicloromate is accurately measured and added into the vial.2ml of a mixture of sulfuric acid and silver sulphate is added very slowly into the vial after which the sample is added into the vial. if it is permeate then 1ml of the sample is taken and incase of concentrated samples, 0.5ml of the sample with 0.5ml of distilled water is taken. The lid is tightly closed and shaken vigorously. Mix well if the colour turns green, either take fresh sample or add more dichloromate and acid. The vial is now placed on the sand bath and heated. The temperature of the sand bath is adjusted to around 105^{o}C. After two hours the vial is collected. it is diluted to about three times and titrated against an excess of $K_2Cr_2O_7$ with 0.1N Fe($NH_4)_2$ $(SO_4)_2$

using ferrous ion indicator. A sharp color change from blue green to wine red indicates the end or completion of titration. The same procedure is repeated for the blank using distilled water. The COD is calculated from the following equation.

COD(mg/l) = (a-b)N * 8000/ Vol.Sample (ml)

Where 'a'= Vol.(ml) of Fe($NH_4)_2$ ($SO_4)_2$ for blank

'b' = Vol.(ml) of Fe($NH_4)_2$ ($SO_4)_2$

'N' = the normality of Fe($NH_4)_2$ ($SO_4)_2$

The test is mainly bioassay procedure involving measurement of O_2 consumed by bacteria while stabilizing organic matter under condition. Hence, it is necessary to provide standard condition of nutrient supply, pH, absence of microbial growth inhibiting substances and temperature. The strong wastes are diluted to ensure that the demand does not increase the available oxygen. A mixed group of organism should be present in the sample or the sample has to be seeded artificially. The temperature is controlled at 20^{o}C and the test is conducted generally for 5days as 70 to 80% of the waste is oxidized during this period.BOD bottles of 300ml capacity and Incubator controlled at 20^{o}C.

C. Preparation of dilution water:

The required volume of distilled water is prepared in a container by bubbling compressed air for 1-2 days to attain DO saturation. The temperature is maintained at 20^{o}C. 1ml each of phosphate buffer magnesium sulphate calcium chloride and ferric chloride id added to the solution for each liter of dilution water and the solution is mixed well. In the case of the waste, which are not expected to have, sufficient bacterial population is added with a seed to the distillation water. Generally, 2ml of settled sewage is considered sufficient for 100ml of dilution water.

D. Dilution of Sample:

The sample is neutralized to pH around 7.0 .if it is highly alkaline or acidic. The sample should be free residual chlorine and if any is present it should be removed by using Na_2SO_3 solution as follows. 50ml of the sample is taken and acidified with addition of 10ml acetic acid. About 1g KI is now added and the mixture is titrated against Na_2SO_3 (0.025N) using starch indicator. The volume of Na_2SO_3 required per ml of the sample is calculated and accordingly added to the sample. In case of samples having high dissolved oxygen content due to reasons like algae growth, the DO content is reduced by aerating and agitating the sample. Several dilutions of the prepared sample are made so as to obtain about 50% depletion of DO in dilution water but not less than 2mg with the residual oxygen after 5days of incubation not being less than 1mg/l. the second dilution water is siphoned out into a measuring cylinder or volumetric flask. The required quantity is carefully added to the mixed sample, to dilute it to the desired volume siphoning dilution water and mix well. In general, 5% to 25% dilution is suggested for treated effluent.

The diluted sample prepared is siphoned into four labeled BOD bottles and one bottle is kept for the determination of initial DO. The other three bottles are incubated at 20^{o}C for three days. A blank is prepared in duplicate by siphoning plain dilution water to measure the O_2 consumption in dilution water. The bottle is fixed for immediate DO determination and blank by adding 2ml MnSO4 followed by 2ml of NaOH + KI + NaN3 mixture as described in the estimation of DO. Determine the DO sample in the initial and final day (5th Day).

BOD mg/l = (D_o – D_1) – (C_o – C_1) mg * Decimal fraction of sample used.

Let D_o = DO in the sample bottle on 0th day

D_1 = DO in the sample bottle on 5th day

C_o = DO in the blank bottle on 5th day

C_1= DO in the blank bottle on 5th day

C_o – C_1 = DO depletion in the dilution water alone

D_o – D_1 = DO depletion due to microbes.

D_o – C_1 = DO depletion in sample – dilution water

III. SOLID CONTENT ANALYSIS:

Total solids are considered to be sum of dissolved and suspended solid in the effluent. The dissolved solids usually consist of inorganic salts, small amount of organic matter and dissolved gases. The suspended solids contain much of the organic matter and any increase thereof tends to increase the degree of pollution of the effluent. TDS analysis was done by TDS meter.

Filter the required amount of effluent through a pre weighed filter paper (W1 g). Dry the paper and at 103 to 105^{o}C and cool it in a desiccators before weighing (W2 g)

Total suspended solids (mg/l) = (W2-W1) * 1000 * 1000/ ml of sample (1)

A. Determination Of Kinetic Parameters

The kinetic parameters are very essential for the design of effluent treatment plant. The normal range of yield coefficient for activated sludge plant process is around 0.4 to 0.8 where as the present studies the Y is 0.5. It lies in the standard literature value. The K_d for activated sludge process is around 0.025 to 0.075d^{-1} the present value is 0.05 which lies in the normal range of desired parameters this clearly indicates that this process is amenable to activated sludge process.

IV. RESULTS AND DISCUSSION

The existing plant in Anantapur is having capacity to handle 25,000lit/day. The milk received from nearby villages and excess buffer fat is taken out and cream, ghee is prepared. The kinetic coefficient for the activated sludge process for dairy effluent has been calculated. The normal range of yield coefficient for activated sludge plant process is around 0.4 to 0.8 where as the present studies Y is 0.5. . The K_d for activated sludge process is around 0.025 to 0.075d^{-1} the present value is 0.05 which lies in the normal range of desired parameters which clearly shows that the process is amenable to activated sludge process. The settled solids for the secondary settling tank are recycling to maintain MLSS 3500 mg/l. the BOD removal efficiency is 97.5% and overall plant efficiency is 93%. The reactor volume of the aeration tank is 38m^3 when design from the kinetic parameters evaluated by considering actual plant waste water. This will be about 2m^3 less than the actual aeration tank of the actual effluent treatment plant of the

Anantapur dairy plant. This will reduce the hydraulic retention time by 1hr. the treated effluent from the plant can be discharged. Where the discharge standard is 35mg/l. the actual plant waste characteristic is given in table 1. Which are meeting the sewage brine discharge standards but the plant will be run on typical activated sludge process as per our design. The BOD removal efficiency as per the design is above 95%.

The experimental data collected from the literature shown in the table.1.is considered for simple aeration tank with recycle.

The samples are collected for every three days to analyze characteristics of the effluent that are shown in table 2. The variation in inlet and outlet waste characteristics is shown in fig-3 and fig-4.

By using the standard data, the yield coefficient (Y) and decay coefficient (K_d) are calculated by the equations below

$1/\theta_c = -Y * (r_{SU} / X) - K_d$ (2)

$1/\theta_c = Y * (S_o - S)/ X - K_d$ (3)

S.No	S0 mg/l BOD5	S mg/l BOD5	Θ = Θc days	X mg TSS/l
1	300	7	3.2	128
2	300	13	2.0	125
3	300	18	1.6	133
4	300	30	1.1	129
5	300	41	1.1	121

Table1. Experimental data for determination of kinetic coefficients.

S.No	Time in days	pH	TSS Inlet	BOD Inlet	COD Inlet
1	1	5.13	890	540	550
2	4	4.89	920	560	590
3	7	4.9	780	580	630
4	10	5.3	760	560	650
5	13	5.15	850	540	520
6	16	5.1	900	540	520
7	19	4.8	910	560	550
8	22	4.7	890	580	580
9	25	5.2	790	580	650
10	28	4.99	810	580	680
11	31	5.1	820	520	550
12	34	4.79	800	540	570
13	37	4.98	890	540	650
14	40	4.9	790	540	560

Table-2. Inlet waste characteristics

S.No	Time in days	pH	TSS Outlet	BOD Outlet	COD Outlet
1	1	6.96	750	320	350
2	4	6.89	780	300	340
3	7	6.9	600	300	410
4	10	8.1	650	290	440
5	13	7.5	700	280	380
6	16	7.2	720	300	420
7	19	6.9	690	300	400
8	22	6.9	700	290	380
9	25	7.21	720	300	360
10	28	7.01	730	350	420
11	31	6.9	740	300	390
12	34	7.1	720	300	420
13	37	6.8	740	290	380
14	40	6.9	650	300	330

Table-3 The outlet characteristics

S.No	$1/\theta_c$ d^{-1}	(So- S) / θ X, d^{-1}
1	0.313	0.715
2	0.500	1.156
3	0.625	1.325
4	0.909	1.901
5	0.909	1.946

Table-4 calculated values obtained from equation 1 and 2

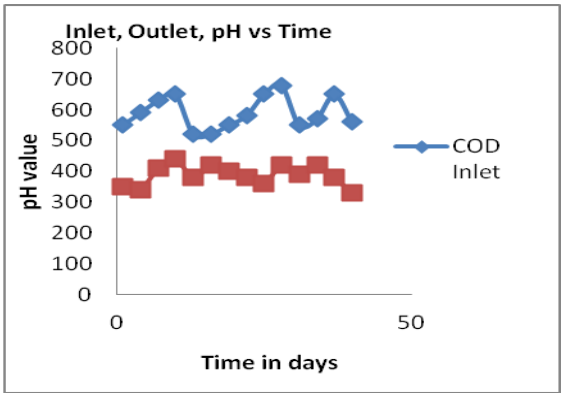

Fig-1. Inlet, Outlet, pH vs Time

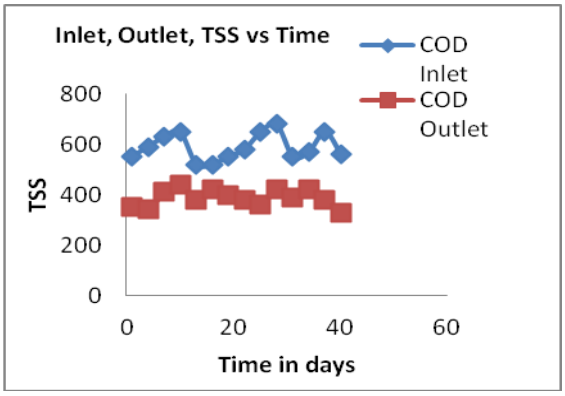

Fig-2. Inlet, Outlet, TSS vs Time

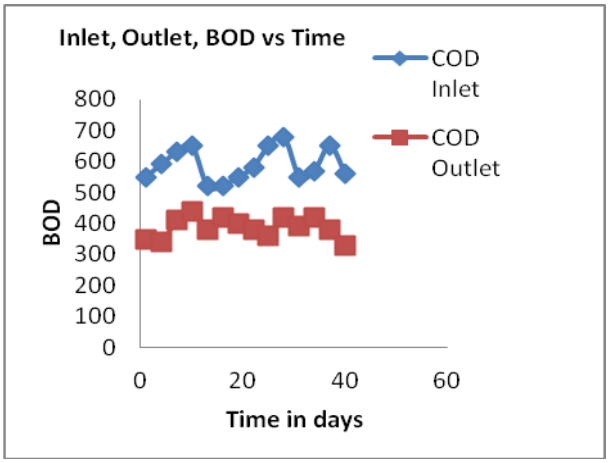

Fig-3.Inlet, Outlet, BOD vs Time

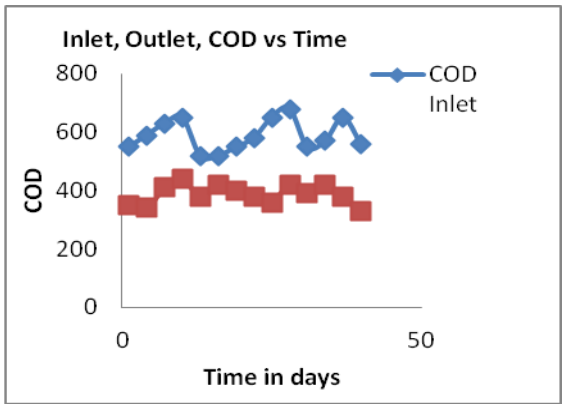

Fig-4.Inlet, outlet, COD vs Time

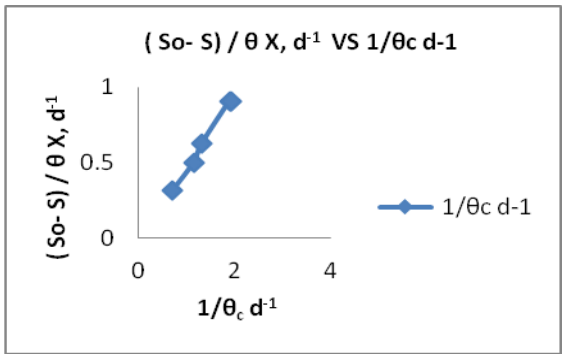

Fig-5 Determination of coefficients

V. CONCLUSION

The effluent character has been studied as a period of two months. The inlet BOD varied from 520mg/l to 580mg/l. the inlet pH varied from 4.9 to 5.3. The inlet TSS varied from 750 to 930 mg/L. The kinetic parameters obtained in table-4 and the values of Y is 0.5 and K_d is 0.05 from the fig-5.. The hydraulic retention time from the design calculation is 15hrs where as the actual HRT is 16 hrs.

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