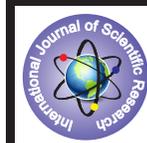


Minimization of COD Level in Dairy Effluent



Engineering

KEYWORDS : COD, Open reflux, Optimum dosage, pH

Dr. B. Sarath Babu

Department of Chemical Engineering, S.V.University College of Engineering, S.V.University, Tirupati. Andhra Pradesh.India.

C. Baradwaj Kumar

Department of Chemical Engineering, S.V.University College of Engineering, S.V.University, Tirupati. Andhra Pradesh.India.

P. Sreedhar

Department of Chemical Engineering, S.V.University College of Engineering, S.V.University, Tirupati. Andhra Pradesh.India.

ABSTRACT

Environmental problem is the major concern for any industry and there is a great need to that along green lines. Sangam Dairy being one of the most famous and widespread dairies in India, it produces wide spectrum of milk products. The Chemical Oxygen Demand (COD) levels of effluent water of this industry with MIF treatment were found to be around 900 ppm.

The main objective of the present study is to minimize the COD level to the required level stipulated by the environmental standards by employing various surface active materials like ferric chloride, alum and commercial coal and to evaluate various parameters affecting the COD level during the treatment. Initial and final COD were determined before and after the treatment. Characteristics of COD levels were determined by using open reflux method.

INTRODUCTION:

Sangam Dairy is situated at Vadlamudi, 15km to Guntur city in Andhra Pradesh. This is run by Guntur District milk producers mutually aided Co-Operative society. Sangam Dairy collects on average one-lakh liters of milk per day. How ever in seasons it handles up to 2.5 lakh liters per day.

Sources of Waste Water in the Dairy

The liquid waste from a large dairy originates from the following section or plants:

- Receiving station
- Condensed milk plant
- Bottling plant
- Dried milk plant
- Butter plant
- Bottle and can washing plants

At the bottling plant the raw milk arrived by the receiving station is stored. The processing includes cooling, clarification, filtration, pasteurization and bottling.

The dairy wastes are very often discharge intermittently. The nature and composition of waste also depend on the type of products produced and the size of the plant. The typical Indian dairy handling about 3,00,000 to 4,00,000 liters of milk in a day.

DAIRY WASTE VOLUMES:

Process	Volume (lit/day)
Receiving station	805
Bottling	1150
Cheese making	920
Condensing	690
Creaming	506

Table.1 Physical and chemical characteristics of dairy effluent:

The large constituents of dairy effluent, which includes phosphorous, nitrogen, sulphates, and different minerals which can change the physical and chemical properties of water. The physico and chemical composition of dairy effluent as per literature review is as follow.

Parameter	Value
pH	6.23
Total solids (mg/l)	1990
Total dissolved solids (mg/l)	1845
Sulphates (mg/l)	920
Total nitrogen (mg/l)	84
Phosphorous (mg/l)	11.7
BOD (mg/l)	1200
COD (mg/l)	2500

Table.2 Adverse Effects of Dairy Effluent:

The organic content present in effluents can cause excessive growth of bacterial and fungal slimes. These growth and their associated effects, can change the quality of aquatic ecosystems and affect its environment such as rise in pH of water and causing the death of sensitive aquatic animals and plants. Further discharge of effluents into water way can pose a health treat to down stream users, since disease-causing microorganisms can be transmitted through water. And these microorganisms make water unsafe for drinking or recreational use.

The sediment may offer the color, turbidity or temperature of waterway as well as cause erosion. This can upset aquatic ecosystems as well as reduce the aesthetic value of water, sediment will smother water plants may reduce light infiltration and adversely affecting the plant photosynthesis. Sediment can also smother animals on streambeds and clog up the gills of fish.

Treatment of Dairy Effluent:

The dairy waste contains sufficient bacterial growth. This waste may be treated by any or all of the following methods.

1. Physical treatment.
2. Chemical treatment.
3. Biological treatment.

Physical treatment:

The removal of suspended solids by physical methods before subsequent biological treatment will considerably reduce the BOD of the resulting effluent.

Chemical treatment:

Fine suspended particles in an effluent may be removed by co-

agulation. It is essentially instantaneous where as flocculation requires some more time and gentle agitation to achieve the particles.

Biological treatment:

Most organic waste material may be degrading biologically. This process may be achieved aerobically. The most widely used aerobic processes are trickling filters, activated sludge process, oxidation pond etc.

COD Determination by Open Reflux Method:

Most types of organic matter are oxidized by a boiling mixture of chromic acid and sulphuric acid. A sample is refluxed in strongly acid solution with a known excess of potassium dichromate ($K_2Cr_2O_7$). After digestion, the remaining unreacted $K_2Cr_2O_7$ is titrated with ferrous ammonium Sulphate to determine the amount of $K_2Cr_2O_7$ consumed and the oxidisable matter is calculated in terms of oxygen equivalent. Keep ratios of reagent weights, volumes and strengths constant when sample volumes other than 50 ml are used. The standard 2-h reflux time may be reduced if it has been shown that a shorter period yields the same results. Some samples with very low COD or with highly heterogeneous solids content may need to be analyzed in replicate to yield the most reliable data. Results are further enhanced by reacting a maximum quantity of dichromate, provided that some residual dichromate remains.

CALCULATION:

$COD \text{ as } mg \ O_2/L = (A-B) \times M \times 8000$

ml sample

Where A=ml FAS used for blank.

B= ml FAS used for sample.

M= molarity of FAS.

8000= milli equivalent weight of oxygen x1000ml/L

REDUCTION OF COD:

Let us check whether COD can be reduced or not by using surface-active materials like $FeCl_3$, alum. After choosing the surface-active materials, they are for the operation, three parameters should be evaluated. They are

Optimum time of contact

Optimum dosage

3. Optimum pH

Reduction of COD using $FeCl_3$:

Determination of optimum contact time:

3.5g/l of $FeCl_3$ is added to five samples of raw effluent

Stirred for different contact times

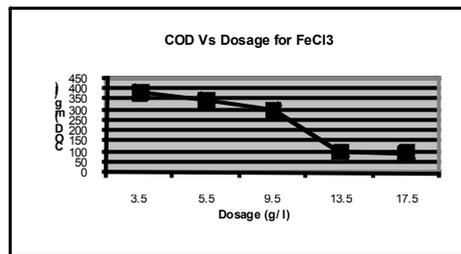
Filtered the solutions

Analyzed the filtrates for COD

S.No	DOSAGE (g/l)	TIME (min)	C.O.D (mg/l)
1	3.5	10	580
2	3.5	20	520
3	3.5	30	440
4	3.5	40	388
5	3.5	50	384

Table.3

Above results shows that 40 min is optimum contact time for this operation. Beyond 40 min reduction of COD is very less, which is shown in Fig 1.



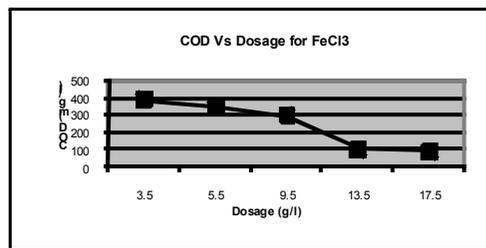
Determination of Optimum Dosage:

- To get optimum dosage, time of stirring is kept constant and the dosage is varied from sample to sample.
- Different dosages of $FeCl_3$ from 3.5 g/l to 17.5 g/l are added
- Stirred them all for the same time (optimum time=40min)
- Filtered the each sample and analyzed the filtrates for COD

S. No	TIME (min)	Dosage (g/l)	C.O.D (mg/l)
1	40	3.5	388
2	40	5.5	348
3	40	9.5	298
4	40	13.5	100
5	40	17.5	92

Table.4

Above results show that dosage =13.5 g/l can be taken as optimum dosage for this operation. Beyond 13.5 g/l reduction in COD is not appreciable, which is shown in the Fig2.



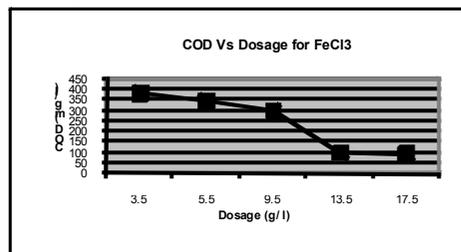
REDUCTION OF COD USING ALUM:

Determination of optimum time of stirring:

To determine the optimum time of stirring, the same procedure, which was there for $FeCl_3$, is followed. Dosage added to all five samples of raw effluent is 12 g/l.

S.NO.	DOSAGE (g/l)	TIME (min)	C.O.D (mg/l)
1	12	30	416
2	12	60	348
3	12	90	180
4	12	120	171
5	12	150	168

From the above COD values it is clear that the optimum stirring time is 90 min for this operation. Beyond 90 min there is no much reduction in COD, which is shown by an almost flat line in the Fig 3.



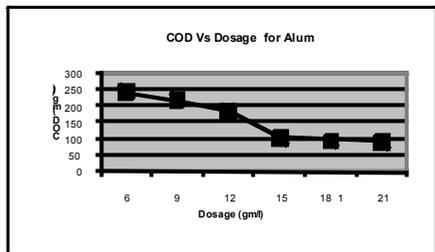
Determination of optimum dosage:

As mentioned before, time of stirring 90min is kept constant with varying dosages from sample to sample ranging from 6 g/l to 21g/l.

Volume of FAS consumed in blank titration = 22 ml

S.NO.	TIME (min)	DOSAGE (g/l)	C.O.D mg/l
1	90	6	244
2	90	9	220
3	90	12	184
4	90	15	104
5	90	18	96
6	90	21	92

Clearly 15 g/l can be taken as optimum dosage from COD values in the above table, because beyond 15 g/l dosage change in COD is insignificant (Fig 4). From the above results it can be confirmed that the value of COD present in the dairy effluent can be effectively reduced using surface-active materials. Now the reduction of COD using commercial coal is studied by following the same procedure.



REDUCTION OF COD USING COMMERCIAL COAL:

Since the commercial coal is cheap and has adsorbing properties it can be used to reduce the COD of dairy effluent.

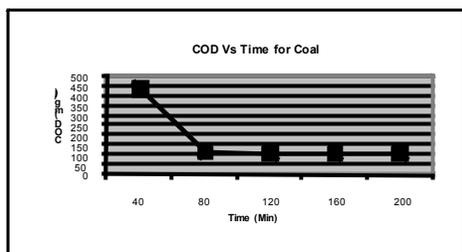
Determination of optimum contact time:

8 g/100ml of dosage is added to five samples of raw effluent taken

- Agitate them for different contact times ranging from 40 to 200 min.
- Filter the solutions and analyze the filtrates for COD
- Volume of FAS consumed in blank titration =22 ml

S.NO.	TIME (min)	DOSAGE (g/100ml)	C.O.D mg/l
1	40	8	440
2	80	8	120
3	120	8	116
4	160	8	112
5	200	8	112

Above results indicates 80 min is optimum contact time. Beyond 80 min time further reduction in COD is negligible (Fig 5).



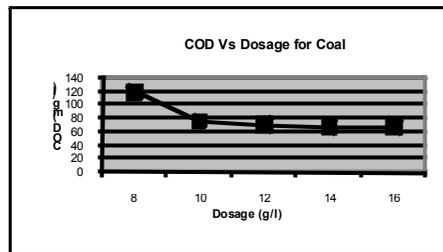
Determination of Optimum dosage:

- Time for stirring is kept constant at 80 min and varying dosage 8g/100ml to 16g/100ml.
- Filter the solution after 80 min stirring.
- Filtered solution is analyzed for COD

S.NO	TIME (min)	DOSAGE (g/100ml)	COD (mg/l)
1	80	8	120
2	80	10	76
3	80	12	72
4	80	14	68
5	80	16	68

Clearly, 10 g/100ml is the optimum dosage

For dosages more than 10 g/100ml there is no change in COD (Fig 6)



So far the effect of stirring time and dosage on reduction of COD is studied .

Variation of COD with pH:

- When FeCl₃ and alum are used as coagulants, reduction in COD increases as pH of solution increases.
- In basic region FeCl₃, alum form Fe (OH)₃ and Al (OH)₃
- Fe (OH)₃, Al (OH)₃ are good flocculants and results in much reduction of COD
- But for coal, COD reduction is more in the acidic range
- But the effect of pH is very less in adsorption by commercial coal
- Values of pH maintained are, 1.87, 6.5, 7.2, 9.18, 10, 11.72
- pH of raw effluent = 7.2

VARIATION OF COD WITH pH WHEN FeCl₃ IS USED FOR THE OPERATION:

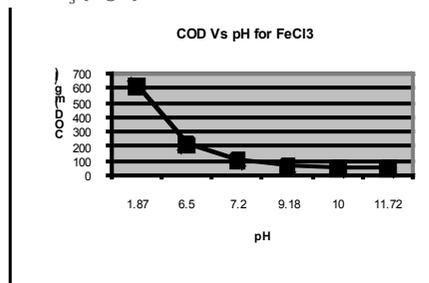
Take 6 samples of raw effluent

- Vary the pH according to the requirement and confirm the pH using pH meter
- Stir them for pre determined optimum contact time (40 min) by adding predetermined optimum dosage (13.5 g/l)
- Filter them and analyze each filtrate for COD

OBSERVATIONS:

pH	1.87	6.50	7.20	9.18	10.0	11.72
COD (mg/l)	616	208	100	56	48	44

From the results of above experiment, it is clear that reduction in COD increases as pH increases. Beyond pH=9.18 that reduction is insignificant. So, pH=9.18 can be taken as optimum pH for FeCl₃ (Fig 7).



VARIATION OF COD WITH p
VARIATION OF COD WITH pH WHEN ALUM IS USED FOR THE OPERATION:

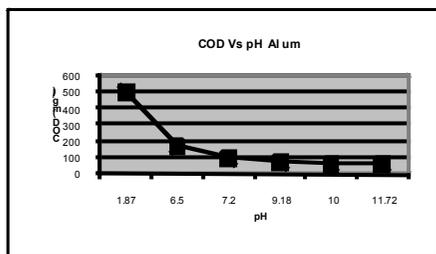
Take 6 samples of raw effluent

- Vary the pH according to the requirement and confirm the pH using pH meter
- Stir them for pre determined optimum contact time (90 min) by adding predetermined optimum dosage (15 g/l)
- Filter them and analyze each filtrate for COD.

OBSERVATIONS:

pH	1.87	6.5	7.2	9.18	10.0	11.72
COD (mg/l)	504	176	104	76	68	64

From the results of above experiment, it is clear that reduction in COD increases as pH increases. Beyond pH=9.18 that reduction is insignificant. So, pH=9.18 can be taken as optimum pH for Alum (Fig 8).



VARIATION OF COD WITH pH WHEN COMMERCIAL COAL IS USED FOR THE OPERATION:

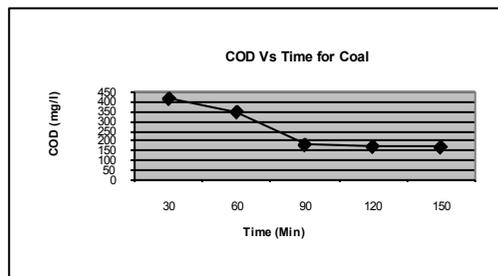
Take 6 samples of raw effluent

- Vary the pH according to the requirement and confirm the pH using pH meter
- Stir them for pre determined optimum contact time (80 min) by adding pre determined optimum dosage (10 g/100ml)
- Filter them and analyze each filtrate for COD

OBSERVATIONS:

pH	1.87	6.5	7.2	9.18	10.0	11.72
COD (mg/l)	44	68	72	88	92	96

From the results of above experiment, it is clear that reduction in COD increases as pH decreases continuously. But the change in COD with pH is very less when coal is used.



CONCLUSIONS

- Optimum values for operation using FeCl₃:
- Optimum time of contact: 40 min
- Optimum Dosage : 13.5 g/l
- Optimum pH : 9.18
- Optimum values for operation using Alum:
- Optimum time of contact: 90 min
- Optimum Dosage : 15 g/l
- Optimum pH : 9.18
- Optimum values for operation using Commercial Coal:
- Optimum time of contact: 80 min
- Optimum Dosage : 10g/100m

Studies showed that coagulant is more efficient than coal

- Coal is effective at low pH
- Coagulant are effective at high pH
- Non conventional adsorbent are easily available and cheap
- The disposal of adsorbent is easy than the coagulant
- The adsorbent can be reused disposed of safely after drying or burned

REFERENCE

1. Water quality sampling and analysis Prof S.A. Abbasi 2nd edition, 1974(28,29,30 pages) | | 2. American public health association standard methods for the examination of water and wastewater. 1st edition, 1992(11,12 pages) | | 3. Pollution prevention and abatement handbook WORLD BANK GROUP 3rd edition, 1989(31,32,33,34,42,43,44,45,46) | | 4. Standard methods for the examination of water and wastewater. American Public Health Association, New York. An extensive compendium of physical, chemical, and biological " standard methods" for the examination of water. 2nd edition, 1980(4,5,6,7,13,14,15,16) |