International Journal of Engineering Applied Sciences and Technology, 2016
Vol. 1, Issue 11, ISSN No. 2455-2143, Pages 77-88
Published Online September-October 2016 in IJEAST (http://www.ijeast.com)

STUDY ON CHARACTERISATION OF INDIAN DAIRY WASTEWATER

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I. INTRODUCTION

With the growing consciousness of nutrition and health, organized efforts to enhance milk production has given rise to large scale production, processing and distribution of milk through a large number of dairies. With the objective of hiking milk production in India, a program named "Operation Flood" was started with the assistance of International agencies. To give initial thrust to dairy development activities "National Dairy Development Board." was established in 1970. Under the programme, Operation flood I (1970-80), Flood II (1980-85), Flood lll (1985-90) significant achievements have been made and progress is on in improving per capita availability of milk and its products all round the country. To day, most of the large cities are receiving their milk supplies through large dairies. Gujrat state, for example, has well developed. dairies - mostly processing centres, some organised on co-operative lines .Anand experiment revolutionized the procurement, storage and distribution of milk. It has brought in millions of small dairy farmers all over the country into a vast network of co-operatives. There are more than 1,01000 milk co-operatives functioning in the country (Govt of India,2002)helping in production and marketing.

The dairy Industry in India has grown from an almost unorganized into a vastly complex organized industry of large magnitude during the last 45 years. India with an animal milk production of 84.5 million tonnes in 2002 and with a 4-5 % annual growth has an expected milk production of 155.2 million Tonnes in 2016-17.India has since long been ranking first in the world in terms of milk production.

India has a unique pattern of production, processing and marketing/consumption of milk, which is not comparable with any large milk producing country. Only a small part of milk produced in India is processed. The organized sector (large scale dairy plants) processes about 25-28 million tonnes annually, which is 18-20 per cent of the total production. (140)/ 3,800 LLPD of milk. Organised sector is expected to grow to 25% of total production by 2018.

In the organized sector, there are 1000+ dairies(678, March 2002) in the Co-operative/Government and private Sector which process nearly 100 million liters of milk per day (ww.thehindubusinessline.com ,27 oct / 21 Dec 2015)one single organization with brand AMUL has presently an aggregate national processing capacity of 28.0 million litres per day & expected to be 32 million litres per day by 2017. Most of the Dairy plants are in the co-operative or private sector. The processing capacity is expected to grow many fold through external investments in the future to cater to a large market in the Indian cities Besides this there are many small dairies all around the country.

Effluents are generated in dairy plants, from washing of tankers/cans/storage tanks, cleaning in place of processing equipment, floor washing, spoilage, manufacturing wastes & other wastes. Hygienic requirements of the industry result in huge amount of waste water .Nearly 2% of the milk handled in a dairy goes out as waste water & the volume of waste water generated is 2- 10 time the milk processed. The dairy effluents have a high organic content and are readily putricible resulting in high BOD & COD. Therefore dairy industry with its wide dispersal and high pollution potential requires due attention.Dairy wastes are generally dilution of milk products. The strength of the waste varies very widely depending upon the products. From literature it is seen that the dairy wastes from U.S.A has COD in the range (80-95000) mg/1 (Marshall &Harper, 1984). A typical strength from most of the western countries will be a COD of 4000 mg/l. In India, however the dairy industry COD range is much lower at (800-500)mg/l.

In view of the current Water Pollution Control regulations, the dairy industry has to comply with the norms for effluent discharge. Therefore characterization, appropriate treatment and disposal

International Journal of Engineering Applied Sciences and Technology, 2016
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of Dairy effluents are an important concern. There is a considerable difference between dairy effluents of USA, Europe, rest of the world and Indian dairies, because of portfolio of dairy products produced and recycle/reuse /water conservation practices. Present Study is aimed at characterization of Indian dairy effluents.

II. MILK

2.0.1 Composition of milk

Milk fat is a complex mixture of triglycerides (98-99%) phospholipids (1-2%) and traces of sterols, carotenoids and the fat soluble vitamins A,D,E and K exists as an oil in water emulsion in small globules 2-5(μm) in the milk serum. The milk proteins. comprise two major classes, the casein and whey proteins. The caseins (80% of the total proteins) are of four major types namely α,β,k,γ caseins.The casein exists mainly as suspended agglomerates known as micelles. The micelles are a colloidal calcium phosphate complex containing all types of casein and about 7% inorganic material. Together with lactose and minerals they form the milk serum in which the milk fat globules and casein micelles are suspended. Lactose, a disaccharide molecule, is a carbohydrate comprising one molecule of glucose and one of galactose. The major salts in the the mineral component are those of calcium ,sodium, potassium and magnesium which occur as phosphates, chlorides, nitrates, and caseinates, sulphur, zinc, rubidium, silicon, bromine, aluminium, iron etc. are also present in trace quantities.A typical composition of milk in three countries is shown in table 2.0.1.1

Table2.0.1.1 Composition in % (Barnes, 1984 ; Mohan Rao *etal.*, 1972)

	USA	NEWZEALAND	INDIA
Milk fat	3.6	4.7	3.9
Protein	3.5	3.6	3.2
Lactose	4.9	5.0	5.1
Minerals	0.7	0.75	0.6
Total Solids	13.0	14.30	9.5

The variation in composition for different classes of milk is as in the following Table 2.0.1.2& 2.0.1.3

Table 2.0.1.2 ,Chemical Composition (%) of milk of different animal species (Sukumar De,1980)

Species	Water	Fat	Protein	lactose	Ash
Buffalo	84.2	6.6	3.9	5.2	0.8
Cow	86.6	4.6	3.4	4.9	0.6
Goat	86.5	4.5	3.5	4.7	0.8

Table 2.0.1.3 Composition (%)milk &bye-products in India (Mohan Rao *etal* ., 1972)

	Protein	Fat	Lactose	TS*	OS**	pH
Whole milk	3.2	3.9+	5.1	9.5	8.7	7.2
Skim milk	3.3	0.1	5.3	9.4	8.7	7.2
Butter milk	3.4	0.4	4.3	6.9	6.3	3.5
Whey	0.9	0.3	4.9	12.9	12.2	10.3

@Casein about 80 %., *Total Solids **Organic Solids +Cow Milk

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2.0.2 Milk Products

- Flavoured milk
- Whole milk & skimmed milk powder.

Indian products such as Khoa, Paneer, Curd, Srikhund, Rosgulla & milk cake etc.A variety of products can be made from milk. The most common products manufactured in India are the following

- Homogenised and pasteurised milk
- Skim milk
- Butter, Butter milk and Ghee
- Cheese
- Casein
- Toned milk

2.1 Dairy product manufacture

The milk is transferred to storage tanks which are usually insulated tanks,and refrigerated.

- Thermization:

A technique used by some large dairies, in which milk is given a mild heatCommon procedures used in manufacture of all dairy products include: (Barnes, 1984)

- Receiving of milk:

From the farm or receiving station the milk is delivered in cans or tanks, although cans are much less common to-day.

- Storage of milk:

Treatment (63-65^{o}C) for 15 sec. immediately after delivery so that it can be stored in silo tanks for four hours or even days without deterioration of quality.

- Pasteurization:

A heat treatment designed to kill non-spore-forming or vegetative pathogenic micro-organism to a level which will minimize the adverse effects on milk quality. Older plants use batch pasteurization, heating of Milk to 63°C in a vat holding for 0.5 hours. Modern plants use high temperature short time {HTST;72- 75°C for 15Sec} or ultra high temp (UHT :135-150°C For 5-3 Sec) continuous techniques.

- Clarification

It is a operation to get rid of foreign particles and sediments .Centrifugal force about 6000 g is applied for skimming the cream from the milk.

- Standardization

It is the standardization of the milk fat concentration, by separating a part of the milk, removing the cream and returning the skim milk to storage tank

- Homogenization

Process to reduce the size of milk fat globules so that they will remain dispersed instead of rising to form a cream line on the surface .

Major milk products:

Market milk:
Market milk (Also known as liquid milk or drinking milk) is a liquid product made
from whole milk, skim milk and cream and is directly used by consumers.
Cultured products:
Cultured products that are frequently manufactured include yoghurt, acidophilus milk, kefir, cultured buttermilk. Koumiss, sour milk and sour creams. The viscosity of cultured product is very high and a considerable quantity of product remains on the surface. of the processing equipment with subsequent high waste loads in rinsing and cleaning solutions. The wastes are of relatively low pH(4.5-4.7).
Butter:
Butter is essentially the fat of milk and is available in two main `categories', sweet cream butter and acidulated cream butter. Butter may also be salted or unsalted. Whey butter is manufactured from the cream separated from the whey after cheese making, The principal constituents of a normal salted butter are milk fat (80-82 %), water (15.5-17.5%), salt (1-2%) and small quantities of milk proteins, calcium, phosphorus and vitamins.
Cheese:
Cheese is the fresh or ripened product obtained after coagulation of milk or cream and on separation of whey. Cheese contains proteins, milk fat, water and minerals in varying amounts.
Dried milk:
A major method of processing milk is to remove the water to produce a powder containing 2.5-5.0% moisture. The most common method is to remove water from clarified standardized milk by evaporation followed by drying. Whole milk powder is produced by standardised whole milk, skim milk powder from the skim milk remaining after cream separation from whole milk and butter milk powder is made from the butter milk which is produced during butter making from cream.
Toned milk:
It is obtained by addition of water and skim milk powder to whole milk to bring down the fat content, while still maintaining the non fat solid concentration. Toned milk can also be composed by using Cream/ fat with appropriate quantity of skim milk/ whole milk or powder.

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2.2 PROCESS EQUIPMENT**:**

Equipments common to most processes include storage tank, processing vessels, buffer or balance tanks, heat exchanger for heating & cooling, pumps piping and associated valves, control equipment, instrumentation and equipment required for packaging, water supply and treatment, steam raising and compressed air.

2.3 UNIT OPERATIONS

Unit operations in dairy processing (Barnes, 1984)

• Transportation of fluids • Mechanical separation• Mixing •Evaporation•Heat transfer • Gas absorption.• Drying • Leaching• Distillation • Crystallization• Extraction• Filtration• Humidification • Reverse osmosis • ultrafiltration • Electrodialysis•Ion - exchange • Fluidisation• Size reduction • Settling• Enzyme reaction • Fermentation •Centrifugation

2.4 DAIRY PLANT WASTES

Dairy food plant wastes are generally dilutions of milk or milk products together with detergents, sanitizers cleaning chemical such as caustic soda, nitric acid, lubricants, washing from tank trucks and domestic wastes. The wastes are characterized by a relatively high organic concentration and high initial total oxygen demand.

2.4.1 Sources of dairy plant wastes

The process and other sources of wastes that have a significant effect on the liquid effluent from dairy plant operations include:

- Rinsing and washing of bulk tanks or cans in receiving operations.

- Rinsing of residual product remaining in or on the surfaces of all pipelines, pumps, tanks, vats, processing equipments& filling machines etc.

- Washing of all processing equipments.

- Water-milk solids mixture discharged to drain during start up, product changeover and shutdown of pasteurisers, heat exchangers, separators, clarifiers, and evaporators.

- Sludge discharge from clarifiers.

- Fines from cheese and casein operations.

- Spills and leaks due to improper equipment operation and maintenance, overflows, freezing on and incorrect handling.

- Wilful waste of unwanted by-product (e.g. whey, butter milk)or spoiled materials

- Loss in packaging operations through instrument break down and broken packs

- Lubricants from equipment, stackers, and conveyors.

- Washing from the outside of tank trucks including dirt, and farm debris.

- Dust from coal and wood fuel and spills of fuel oils.

- Powder deposits from discharges from dryers.

- Dust from coal and wood fuel and spills of fuel oils

- Ash from boilers

- Water and boiler treatment chemicals

- Chemicals from the regeneration of ion-exchanger resins.

2.4.2 Composition of dairy fluids and products

If domestic wastes are excluded, the principal contaminants of dairy wastes are milk, milk fraction and milk products. It is generally conceded that 90% of organic loading (BOD_5) in dairy processing wastes come from these materials. Estimates of the average daily equivalent quantity of milk in the wastes vary from 0.4 to 6% of the milk received at the plant. The knowledge of the composition of milk dairy fluids and dairy products and BOD/ COD.(Table, 2.4.2.1 , 2.4.2.2 are a helpful guide for determining the the typical composition of dairy waste .The BOD: COD for raw Dairy waste is mostly 0.5- 0.7. Milk and its products are organic materials and the organic waste parameters normally measured include the biochemical oxygen demand ($B.O.D_5$), chemical oxygen demand (C.O.D) and total organic carbon (T.O.C). The whole milk has a high BOD (table 2.4.2.1), therefore ,even dilute milk solutions have a marked polluting effect. The major constituents contributing to BOD of the dairy waste are lactose , milk fat , protein and lactic acid. The reported values are 0.65, 0.89, 1.03 and 0.63 kg BOD/kg respectively. The ratio of COD and TOC to BOD varies considerably with the chemical composition of the milk and wastes. Ratios established in one Dairy can not be used in another plant, values as high as 0.8 that are outside the range 0.5- 0.7 probably indicate solutions. The values that are outside the range 0.5-0.7 probably indicate contamination by refrigerant leaks or the presence of some compound toxic to BOD test.

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Table 2.4.2.1 B.O.D. & C.O.D of some dairy fluids (EPA 1971 in Barnes, 1984)

	B.O.D (mg/l)	C.O.D. (mg/l)
Skim milk	67000	100,000
Whole milk	104000	210.000
Cream	399000	860,000
Cultured butter milk	64000	n.a.
Ice-cream	292,000	n.a.
Sweet whey	34000	75000

Table2.4.2.2 Some values of BOD / COD (Barnes, 1984)

	BOD / COD
Whole milk	0.69
Skim milk	0.63
Butter milk	0.66
Whey	0.52
Milk fat	0.79
Casein	0.46
Lactose	0.53
Whey protein	0.23
Chedder cheese	0.33-0.78
Dairy waste (raw)	0.5- 0.48 & 0.45- 0.8
Treated effluent	0.15 -0.35

2.4.3 Composition and characteristics of dairy plant wastes:

2.4.3.1 General characteristics of dairy wastewaters

Major effluents are generated in dairy plants, from washing of cans/tankers, cleaning in place of process equipment(such as pasteurizers, separators, pipelines, chillers, vats, storage tank and silos, sachet filling machines),floor washings, spillages/leakages of milk/milk products, boiler blow down , softner regeneration water & bleed from the condenser etc. Dairy processing effluents are generated in an intermittent way (because of batch operations and product changes) and the flow rates& characteristics of these effluents change significantly Section /unit wise.

Dairy industry produces different products, such as Processed milk, butter/Ghee , yogurt, ice-cream, and various types of desserts and cheese, the characteristics of these effluents also vary widely both in quantity and quality, depending on the type of system and the methods of operation used .

Significant fractions of the organic components and nutrients in dairy waste streams are derived from milk and milk products. Dairy wastewater contains milk solids, detergents, sanitizers, milk wastes, and cleaning water. It is characterized by, high concentrations of easily degradable carbohydrates(mainly lactose) and lipids as well as less biodegradable proteins- present in various forms as organic nitrogen (proteins, urea, nucleic acids) or as ions such as NH_4 , NO_3 &NO_2. Phosphorus is found mainly in inorganic forms; as orthophosphate and poly-phosphate , as well as organic forms . Concentrations of suspended solids (SS) and volatile suspended solids (VSS) are also used to evaluate wastewater strength. Suspended solids in dairy wastewaters originate from coagulated milk, cheese curd fines or flavoring ingredients . Concentrations of selected elements, namely sodium (Na), potassium (K), calcium (Ca), magnesium (Mg), iron (Fe), cobalt (Co), nickel (Ni) and manganese (Mn), are also found. Particularly high Na concentrations point out the use of large amount of alkaline cleaners at dairy plants. The concentrations ofheavy metals, such as copper (Cu), nickel (Ni) and zinc (Zn) are also reported .

Significant variations in COD and BOD have been

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reported by various investigators of dairy wastewater. The total COD of dairy wastewater is mainly influenced by the milk, cream, or whey . The pH varies in the range of 4 –11,whereas the concentration of suspended solids (SS) varies in the range of 0.024–4.5g/l. Significant amount of nutrients, 14–830 mg/l of total nitrogen and 9-280 mg/l of total phosphorus are found.

Table 2.4.3.1 Characteristics of the Combined Wastes from a small size Dairy

	*Mohanrao &Subrahmanyam,1972	#Agarwal, 1981
Volume of Milk Processed l/d	12800	1500
Waste water Volume l/l of milk	3.6	4.7
pH	8.1	7.3-8.4
Totalsolids mg/l	2730	1600-2000
Volatilesolids mg/l	2,205	1070
Suspendedsolids mg/l	1,810	300-400
Volatilesuspended mg/l	1,660	----------
Alkalinity as $CaCO_3$ mg/l	220	----------
Volatileacids (CH_3COOH) mg/l	20	----------
COD mg/l	4510	800-1400
BOD_5 mg/l	3070	360-700
BOD rate constant /d	0.19	----------
Totalnitrogen mg/l	1080	150
Total P mg/l	110	25-30
Sulphates mg/l	45	----------
Fat mg/l	1390	----------

* Average values of 10 composite samples(dairy is primarily a pasteurisation and bottling plant) # Small dairy(Allahbad Military dairy farm)

Table 2.4.3.2 Characterisitics of the Individual Wastes from a Large Dairy (Mohanrao and Subramanyam, 1972) * A product oriented dairy processing about 360, 0001/d of milk. Flow: 6-8 liters of waste/liter of milk processed (All values except pH are expressed in mg/l)

.	Receiving & Pasteurizing unit	Cheese plant	Butter/Ghee unit	Casein plant	Combined Effluent
pH	8.2	6.7	7.1	7.7	8.0
Colour	White	White	Brown	Clear	White
Total Solids	3640	2300	3460	680	1690
VolatSolid%	77	29	72	62	67
S.S	1320	600	2240	160	690
Alk CaCO3	500	490	450	490	590
Oxygen Abs	437	483	90	09	120
BOD	1820	2150	1377	200	816
COD	2657	3188	3218	372	1340
Total N					84
Phosphate	10	12	2	5	12
O&G	690	520	1320	Nil	290
Chlorides	105	105	105	70	112
COD:BOD	1.46	1.48	2.33	1.86	1.65

Table 2.4.3.3 Characteristics of Individual Wastes) (Mohanrao and Subrahamanyam, 1972), Medium-Size Dairy * 60,0001 of Milk /d (* Mostly bottling, preparation of butter and casein from sourced milk).All,except pH, mg/l

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	ButterWashings	Rejected Milk	Milk Bottling Waste
pH	4.7	6. 6	7.8
Alkalinity(to pH 8.3	Nil	Nil	Nil
Alkalinity (pH4.50)	100	10,350	256
Total Solids	13,820	85,920	2560
Total volatilesolids	10,640	75,500	2000
Fixed Solids	3,180	10,420	560
Suspended solids	5,112	34,904	1380
Volatile S.S	4,832	33,280	1220
BOD at 37°C	10,000	62,000	620
COD	16,000	88,000	1000
Ca++	180	900	140
Mg++	12	474	49
COD:BOD	1.60	1.33	1.61

Table 2.4.3.4 Characteristics of wastewater mother dairy(Delhi) , Delhi milk scheme(Naresh kumar,1992)&UDSDairy, Ujjain (Datar & Kale ,1997)

ITEM	RAW EFFLUENT			TREATED EFFULENT		
	MOTHER DAIRY	DMS	UDS	MOTHER DAIRY	DMS	UDS
Avg. flow m^3/d	800 -900	1600-1800	600	----------		----------
.BOD_5 mg/l	1200	1000	1180	10	10	68
COD mg/l	2500	2000	2328	100	36	359
Suspended Solids mg/l	700	600	693	10-30	17	122
Dissolved Solids mg/l	1500	1200	3738	1500	----	204
pH	7.0-7.5	12	7.5	7.5-8.0	7.5-7.8	7.28
O&G mg/l	40-50	350	293	Negligible	3.0	18
Total Nitrogen mg/l	70-80	25		30-40	-	
Phosphate mg/l	10-15	30		7-8	-	

Table 2.4.3.5 Characteristics of wastewater of Five Indian Dairies

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ITEM	RAW EFFLUENT					TREATED EFFULENT				
	A	B	C	D	E	A	B	C	D	E
Avg. flow m^3/d	60	100	2000	650	480					
.BOD_5 mg/l	150	810	820	1150	1400	30	30	40	152	-
COD mg/l	400	1500	2100	2500	1700	220	250	150	385	
Susp.Solids mg/l	350	500	450	1257	450	Nil	100	60	-	
Total Solids mg/l	750	1000	1800	3750	1500	-	-	-	-	-
pH	5-9	7.7-8.	9- 6.5	9.3	7-8.5	7	5.5-9	6.5-7	7.3	-
Oil & Grease mg/l	50	400	100	130	--	10	10	10	10	-
Total " N" mg/l	-	-	-	-	160				42	-
Total PO_4 mg/l	-	-	-	-	16				30	-

Dairy A: Sri Ganga Nagar Zila Dugdh Utpadak Sehkari sangh, Hanumangarh JN;Dairy B : Udaipur Dugdh Utpadak Sehkari sangh, Udaipur;Dairy C : Sabarkantha dist Co-operative milk producers Union, Saber Dairy;Dairy D: Banglore Dairy, Housur Road;Dairy E: Feeder Balancing Dairy, Patna (Roy,B etal,1996)

Table 2..4.3.6 Combined Wastewater Characteristics of Dairy (CPCB, 1993)

Country Parameter	U.S.A	New Zealand	Milk Processing Lit	CPCB	India Integrated Dairy Lit	CPCB	India Chilling Plant Lit	CPCB
BOD_5	40- 48000	90-12400	1100	657-1016	236-1540	1634-4953	290-4926	55-5034
COD	80-95000	180-23000	2400	1341-2195	502-2290	3800-8631	520-6318	121- 6877
SS	244500	7-7200	850	538-657	160-810	89- 4953	200-618	36-899
TS	135- 8500	-	2100	--	902-1340		-	
Nitrogen	1-180	1-70	-	50.25-126.2	84-105	96.32	-	49.25-72.5
carbohydrt	250-930	-	-					
Fat	35-500	0-2100	-		-	100-6070	-	
Calcium	55-115	-	-					
Sodium	60-810				105			
Potassium	10-160							
Phosphorus	9-210	4-150	110	2.6-4.8	12	0.3-0.8	-	0.14-0.2
Chloride	48-1930				104			
Temp ^{0} C	18-55	11-72						
pH	4.4-9.4	3-13.2	7.3	6.6-6.9	7.5-8.0	5.6-6.8	3.2-7.8	2.9-10.7
O&G	-	-	150		194-601	280-2207	56-426	5-176

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Table 2.4.3.7: Characteristics of Indian dairy industry wastewaters (in mg/l, except pH)

WASTE TYPE	COD	BOD	pH	TSS	TS	**REFERENCES**
Dairy effluent, Karnataka	1900-2700	1200-1800	7.2-8.8	500-740	900-1350	Deshannavar, *et al* .,2012
Bhandara Co- operative Dairy wastewater, Mah	1400-2500	800-1000	7.1-8.2	1045-1800	1100-1600	Gotmare, *et al* .,2011
Dairy industry wastewater, TN	2100	1040	7-8	1200	2500	Arumugam *et al* .,2008
(Whey) Warna milk dairy,Kohlapur	71526	20000	4.1	22050	56782	Deshpande ,*etal.*, 2012
Aavin, TN dairy, industry washwater	2500-3300	-	6.4-7.1	630-730	1300-1400	Sathyamoorthy *etal.*, 2012
Cuddalore district Co-operative Dairy Industry Ltd Sethiyathope-TN	3786	1112	8.45	514	2451	Dhanam,2009
Jalgaon Jila Dudh utpadak Sangh mdt, Jalgaon	790-810	530-585	6.5-6.7	696-729	2532-2608	Swati Patil *etal.*, 2014
Yashodhara Milk & Food Products MIDC, Amaravti	2144	1295		680	-	Kadu *etal.*,2013
Kolhapur Zillah Sahakari DhudhUtpadak Sangh Ltd., Gokul Shirgaon, Kolhapur	1330-2100	1200	7.26-8.8	650	-	Bhavsar Swati R *etal.*,2013.
Mother Dairy,Yelahanka, Bangluru	1172	635	8.33	450	1183	Manu,*etal.*,2011
Dairy sample 2002 in Chennai	300-1630	260-490	4.5-9	20-700		Noorjahan *etal.*,2004
Kolhapur dairy, Mah	1448	672	9.9	267	5950	Shivsharan *etal.*,2013a
ShivamrutDudhMaryadit, vijaynager	1457-1599	548-650	9.52-10.06	237-262.6	1373-1876	Shivsharan *etal.*,2013b
AP dairy, Hyderabad	1500-3000	350-600	5.5-7.5	250-600	-	Sarkar *etal.*,2006
Sangam Dairy,Vadlamudi Guntur District,AP	2500	1200	6.23	145	1990	Y.Harika *etal.*,2014
Government Milk Scheme of Dairy Ind, Distt. Nagpur	1243	480		420	-	Chaiudhari *etal.*, 2010
Parag Dairy(Lucknow producers coop milk union)	2580.00	1139.00	6.93	1233	-	Singh *etal.*,2014
Shakti Dairy at Kashti Tal Shrigonda .	1400	890	8.2	-	-	Pachpute *etal.*,2014
Jaipur Dairy	741.7-754.6	309-316.6	6.3-6.6			Sharma, N *etal.*, 2013

Pune Dairy	2332-2398	1210-1268	6.03-6.06	601.6-626.6	1964-2342	Porwal *etal.*, 2015

Table 2.4.3.8 Characteristics of International dairy industry wastewaters (composition in mg/l, except for pH){Kaushik etal.,2011+}DI: Dairy Industry; CI: Cheese Industry; YB: Yogurt and buttermilk.=_ :TS = 135–18500, R: TS = 675

Type	COD	BOD	pH	TSS	VSS	TN	TP	Cl	Fats	References
$DI^{=-}$	80–95000	40–48000	4.5–9.4	24–4500	–	15–180	12–132	48–559	–	Rico Gutierrez et al., 1991
DI^{-R}	4000	2600	8.0-11	–	635	55	35	–	400	Kasapgil et al., 1994
DI	4000	2000	–	800	–	60	–	–	–	Koyuncu et al., 2000
YB	1500	1000	7.2	191	–	63	–	–	–	Koyuncu et al., 2000
CI	4430	3000	7.32	1100	–	18	14	–	–	Monroy et al., 1995
DI	1745	–	–	400	355	75	9.1	–	–	Koyuncu et al., 2000
DI	980–7500	680–4500	–	300	–	–	–	–	–	Kolarski & Nyhuis, 1995
CI	–		4.7	2500	–	830	280	–	–	Gavala et al., 1999
DI	18045	8239	–	7175	–	329	–	593	48 90	Arbeli et al. 2006
DI	2000-6000	1200–4000	8.0–11	350–1000	330–940	50–60	–	–	–	Ince, 1998a
DI	430–15200	650–6240	4.7–11	250–2750	210–890	14–90	–	–	160–1760	Passeggi et al., 2009
DI	2800	1600	–	–	–	140	30	–	–	Schwarzenbeck etal.,2005
DI	4500	2300		800		60			350	Koyuncu et al., 2000
DI	3383 ± 1345	1941± 864	7.9 ± 1.2	831± 392	746± 214	51 ± 5.7	22 ± 4.8		263± 23	Tawfik et al., 2008
DI	2500-3000	1300-1600	7.2-7.5	8000-10000	800-1000	-	-	-	20-70	Qazi et al., 2011
CI	80000-90000	53333 -60000	6.0	8000-11000		600-1000	-	-	500	Kabbout et al., 2011

2.4.3.2 Characteristics **of Dairy Wastewaters in Present Study**

The nature of wastes generated by various processes operated by dairy industry reflects the overwhelming effect of the wasted milk and dairy products Characteristics. However, volume of waste water from different dairies seems to vary (2-8) times the volume of milk processed depending upon the

process used, product made, care taken in the use of water, housekeeping and quantity of water available.

The characteristics of waste water are shown in table 2.4.3.1to 2.4.3.8. The characteristics of dairy waste water from New Zealand, U.S and India are presented in table2.4.3.6. Similarly table 2.4.3.8 details dairy waste water from all over the world.

It is found in table2.4.3.6 that there is a wide difference between the characteristics with respect to BOD, COD, S.S Close examination confirms that fat and grease content in Indian Dairy waste is high in comparison with U .S.A and New Zealand. However, the BOD and COD of Indian Dairy waste is much lower. From table 2.4.3.8, it is observed that Rico Gutierrez et al., 1991, Kolarski & Nyhuis, 1995, Arbeli et al. 2006 have reported about High strength dairy wastes with BOD:(40-48000)and COD : (80-95000). The general range for BOD and COD in case of western countries is BOD-(1000-6250) and COD-(1500-15000), which is much greater than Indian dairy Effluents.

- Among Indian dairies, from table 2.4.3.3, it is observed that the waste water characteristics vary widely for Butter washing, milk bottling and rejected milk streams. For butter washing stream COD & BOD are high because some fats and other volatile solids get washed out. Table 2.4.3.2 shows 1320 mg/l O&G in effluent, even the pH is slightly acidic. For rejected milk (curdled with acidic pH)all the constituents will be going in effluent stream, therefore the COD, BOD and Suspended solids are nearly equal to sourced milk diluted with wash water.

  There are some Integrated dairy plants producing combined effluents from sections that may include milk pasteurization, Creamery, butter/ ghee production, flavoured milk/ yogurt production, cheese production, Ice cream unit besides Indian sweet dishes. Characteristics of Combined effluents from plants with variety of products will vary with the wastes being released from specific product manufacturing.
- In the case of milk receiving, pasteurisation and milk bottling sections, the only milk loss is in cleaning/washing vessels. Therefore, the COD, BOD are 1-2 % of milk COD,BOD and remains in range of BOD- (500-3000) mg/l and COD-(1000-4500) mg/l (depending upon quantity of wash water used) this is supported with data of table 2.4.3.1-2.4.3.7. In Indian dairy industry market milk production is 80% of all the milk processing.
- Deshpande etal (2012) has reported about Cheese production unit in Kolhapur (table-2.4.3.7) discharging Whey and found BOD and COD at 20000mg/l and 71500 mg/l respectively.
- Most Indian dairies are primarily a pasteurisation and milk bottling/ packing plants with some producing cream/ butter/ghee. There is some producing skim milk powder besides producing cream/ butter/ghee. Dairy plants producing Yogurt and other milk products like Ice cream are also there. Production of Cheese is very uncomm on. However, there are some large plants which have production facility for variety of milk products

III. CONCLUSION

- Indian dairy waste water is having of BOD- (500-3000) mg/l and COD- (1000-4500) mg/l (depending upon quanity of wash water used)
- The dairy waste water from USA, Europe and New Zealand etc are stronger because of the product mix that include cheese-processing wastewater and other processed milk products.
- In India more than 80 % of the milk produced does not go to organized Dairy processing Plants .Most Indian dairies cater to production of Market milk (pasteurized milk in various grades – Full cream, standardized, Toned etc). In keeping with milk demand in times of low fresh milk production, powder milk and butter are used for milk blending to produce larger volumes of market milk. There is some Production of butter/Ghee, milk powder during milk flush seasons (when milk is surplus).
- In organized Indian dairy plants Production of Yogurt, ,lassi, butter/ ghee, Khoya, Cheese, Ice cream, sweets and other value added products is very small. The composition of effluents from such units reflect the wastes of product manufacture and could have high O&G, cream, sugar or whey contents . As milk pasteurization is the basic operation/ process that is essential in all Dairy processing plants(exceptChillingplants) there is additional pollutant load with every additional dairy product manufacture. In a typical a pasteurisation and milk bottling/ packing plants the COD is not likely to be above 2500 mg/l and the BOD not above 1500 mg/l. Whereas , in an Integrated dairy processing plant the combined effluent could reach a COD- 10000 mg/l and BOD – 5000 mg/l, depending upon product mix.

IV. REFERENCES

Agarwal, I.C . and Suria Pandian , P.S. (1981). Removal of dairy waste organics by rotating biological contactors. *Indian Journ. Environ. Hlth*., Vol.23(1), pp. 27-40

Barnes, D., Forster, C. F. and Hrudley , S. E {eds}.(1984) *Surveys in Industrial Waste water treatment*, Vol 1, pp 296-376. Pitman Adv Publishing Ltd, London

Bhavsar, Swati R., Pujari, Vedavati R. and Diwan, V.V(2013) Potential of Phytoremediation for dairy wastewater treatment *IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE).*, vol**6**, PP: 16-23

Chaiudhari, Dipali. H. and Dhoble, R.M. (2010) Performance evaluation of effluent treatment plant of dairy industry ,*Current World Environment* .,Vol. **5(**2), 373-378

Comprehensive Industry document- Dairy Industry,(!993) *CPCB*, N Delhi

Datar, M.T and Kale, S.B. (1997). Performance of a Dairy Effluent Treatment Plant.*Indian Journ. Environ. Hlth*., Vol 39 (1), pp 52-60

De , Sukumar (1980) . Outline of Dairy Technology, Oxford Univ Press

Deshannavar, U. B., Basavaraj, R. K and. Naik, Nandini M(2012)High rate digestion of dairy industry effluent by upflow anaerobic fixed-bed reactor‖, *Journal of Chemical and Pharmaceutical Research.*, **4**(6):2895-2899

Deshpande, D.P., Patil, P.J. and Anekar S.V., (2012) . Biomethanation of Dairy Waste, *Research Journal of Chemical Sciences, ISSN 2231-606X*.,Vol. 2(4), 35-39.

Gotmare, Monali.,Dhoble, R.M and Pittule A.P(2011). Biomethanation of Dairy Waste Water Through UASB at Mesophilic Temperature Range,*IJAEST* ., Vol.8 Issue 1, 001-009

Harika ,Y and Siri ,G.Sai.(2014**)** Removal Of COD Of Dairy Effluent. ,docslide.us**,** Nov 2014

Kushwaha Jai Prakash, Srivastava Vimal Chandra & Mall Indra Deo (2011): An Overview of VariousTechnologies for the Treatment of Dairy Wastewaters, Critical Reviews in Food Science and Nutrition, 51:5, 442-452

Manu K. J., Mohana V. S. and Ganeshaiah K. N(2011)Effluent Generation by the Dairy Units: Characterization and Amelioration forIrrigation*International Journal ofResearch in Chemistry and Environment*.,Vol. 1 Issue 2 ,(173-182)

Mohanrao, G.J and Subramanyam (1972) Sources, Flows and characteristics of Dairy Waste water. *Indian Journ. Environ. Hlth* ., Vol.14(3), pp. 207-217

Pachpute A.A., Kankal S. B, Jadhav,M.V(2014**)** Use of Artificial Wetland for Treatment of Dairy Industry Waste Water for Analysis of BOD and COD *International Journal of Scientific Engineering and Research (IJSER) www.ijser.in* .,Volume 2 Issue 6, pp 38-41

Roy, B and Chaudhuri, N (1996). Appropriate Treatment Option for Dairy Waste Water in India. *Jour of IAEM*, Vol 23, No.1,pp 1-8.

Sarkar, B., Chakrabarti, P.P., Vijaykumar, A., and Kale, V. (2006). Wastewater treatment in dairy industries — possibility of reuse. *Desalination* **195**: 141–152

Sathyamoorthy, G.L. and Saseetharan, M.K(2012)Dairy Wastewater Treatment by Anaerobic Hybrid Reactor – a study on the Reactor Performance and Optimum Percentage of Inert Media Fill inside Reactor *Res. J. Chem. Environ* ., Vol.**16** (1) ,pp 51-56

Shivsharan, Vishakha Sukhadev ., Wani, Minal and Khetmalas, M. B. (2013a), Characterization of Dairy Effluents byPhysicochemical Parameters.*British Biotechnology Journal* ., 3(4):575-80.

Shivsharan, Vishakha Sukhadev ., Kulkarni S W andWani, Minal (2013b) Physicochemical Characterization Of Dairy Effluents Int. J. LifeSc. Bt & Pharm. Res. Vol.2, 2No.,pp182-191

Singh, N. B., Singh Ruchi and Imam, Mohammed Manzer (2014)Waste Water Management In Dairy Industry: Pollution Abatement And Preventive Attitudes, *International Journal of Science, Environment and technology* Vol. **3**, No 2, , 672 – 683