ISSN(Online) : 2319 - 8753
ISSN (Print) : 2347 - 6710

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 2, February 2015

Water and Wastewater Quality Analysis of Milk Dairy – A Case Study of KMF Dharwad

Rajkumar V. Raikar[1], Neha Santi[2]

Professor, Department of Civil Engineering, KLE Dr. M. S. Sheshgiri College of Engineering and Technology, Belgaum, India[1].

M. Tech. Scholar, Department of Civil Engineering, KLE Dr. M. S. Sheshgiri College of Engineering and Technology, Belgaum, India[2].

ABSTRACT: This paper presents the experimental results of a case study on the water and wastewater quality analysis of Karnataka cooperative Milk producers Federation limited (KMF) Dharwad Milk Union (DMU), Karnataka, India. Total seven quality parameters were analyzed in the study. These quality parameters were determined for input water and wastewater discharged from each of the milk processing sections as well as for influent and effluent of treatment plant. The milk processing sections considered are milk separation section, curd section, can washing section and paneer section. The parameters obtained at every section were compared with effluent standards for dairy industry as per the Environment (Protection) Rules, 1986. The results indicate that all the quality parameters are well within the permissible limits for the discharging effluent of every section. Further, the oil and grease content was below detectable limit. However, the temperature at can washing section was 40ºC, which was more as compared with other sections. The higher temperature was maintained for quick and easy drying of cans and for effective cleaning.

KEYWORDS: Auditing, Dairy, Milk products, Water and waste water, Quality analysis.

I. INTRODUCTION

Dairying is one of the branches of agriculture that encompasses the breeding, raising and utilization of dairy animals, primarily cows for the production of milk and the various dairy products processed from it. It is a water based industry consuming large quantity of water for various operations. Hence, wastewater generation is also very high. Further, milk being a good source of nutrients and having an ideal pH; it is most readily contaminated by microbes that may be spoilage microbes or pathogens. The consumption of unprocessed milk may lead to transmission of many diseases. In view of necessity of supplying hygienic milk to the consumers, it becomes essential to check and audit the milk producing units. Hence, the water and wastewater quality analysis plays a dominant role in auditing dairy industry.

The waste auditing of various industries is studied by many researchers. Jegatheesan et al. [1] carried out a case study on waste auditing of ice cream factory at Thailand and they observed that the generation of ice cream waste is attributed to the high consumption of water in the plant for washing and cleaning operations. As a result of waste auditing, methods like change in existing equipments, waste segregation were proposed to save water and to modify the existing wastewater treatment system of the ice cream plant for better treatment efficiency. Rames Seejuhn [2] conducted waste audit in a tapioca starch milk processing factory at Thailand. The syrup plant produced starch milk at an average rate of 524 ton roots/d while the water consumption was 3,860 m^3/d. Water was used at the rate of 16%, 75%, 4% and 5% in washing, extraction, separator units and floor, tool cleaning, respectively. Wastewater generated was 3,416 m^3/d, which had high concentration of COD (15,000-28,000 mg/l) and SS (5,300-9,900 mg/l). Solid waste generated was 5%, 1%, 86% and 8% of sieved peel, washed peel, pulp and sand, clay, respectively. Similarly, the auditing of paper and pulp industries [3-6], medical waste [7-9] and food processing factory [10] are available in literature. However, no studies were reported on the auditing of milk producing industry. In this context, the water and wastewater auditing was carried out for KMF-Dharwad milk factory, Karnataka, India. Dharwad Milk Union (DMU) was established in 1986 at Dharwad under co-operative act of Karnataka co-operative milk producers federation limited (KMF), the Apex Body in Karnataka. It is located at Lakamanahalli Industrial area between twin cities of Hubli and Dharwad. All the milk and milk products are marketed with the brand name *Nandini* both within and outside the State.

ISSN(Online) : 2319 - 8753
ISSN (Print) : 2347 - 6710

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 2, February 2015

The various products of DMU are different types of pasteurized milk (toned milk, standardized milk, shubam milk and full cream milk), curd, skimmed milk powder, butter, ghee, khoa, pedha, buttermilk, lassi and paneer. The DMU dairy encompasses three sections, namely, receiving section, chilling and storage section and processing section. The processing section consists of units such as plate heat exchanger, pasteuriser and cream separator. Other sections of the dairy include curd section, milk powder section, butter section, ghee and pedha section. At all these stages water is being used either for processing or for cleaning these sections along with water is required for refrigeration and generator units. Hence, huge amount of water is being used and accordingly equally large amount of waste water is generated. Therefore, the water and wastewater auditing of Dharwad Milk Union was carried out. The results of water and wastewater quality analysis obtained experimentally are presented in this paper. The quality parameters are compared with the effluent standards for dairy industry as per the Environment (Protection) Rules, 1986 [11].

II. METHODOLOGY

The methodology of the present study includes visit to all processing sections to understand the actual ongoing process and to collect the information about the waste water generations. After identifying the locations of waste water generation, the quantitative audit of waste water at all locations, was carried out at first phase. Then the waste water was collected for analyzing the impurity content at all these points.

II.A. QUANTITATIVE AUDITING OF WASTE WATER

The locations of wastewater generated throughout the industry were identified during the initial visit. The quantity of waste water was measured at milk receiving section, curd section, milk separation section, packing section, paneer section, can washing section, boiler section and condenser section. The flow rate was obtained either by volumetric method or by using notches and weirs that are being used in the dairy. The average flow rate of waste water generated at various sections of DMU milk dairy is shown in Fig. 1. The quantity of waste water generated from milk receiving section is 10,798 liters/day, curd section is 5275 liters/day, milk separation section 19,195 liters/day, packing section 1,741 liters/day and can washing section is 2,603 liters/day. However, the boiler section generated a maximum quantity of waste water of 144,000 liters/day which is due to boiling of water, which is required in dairy processes. On the other hand, the condenser section generates as low as 4000 – 5000 liters/week of waste water.

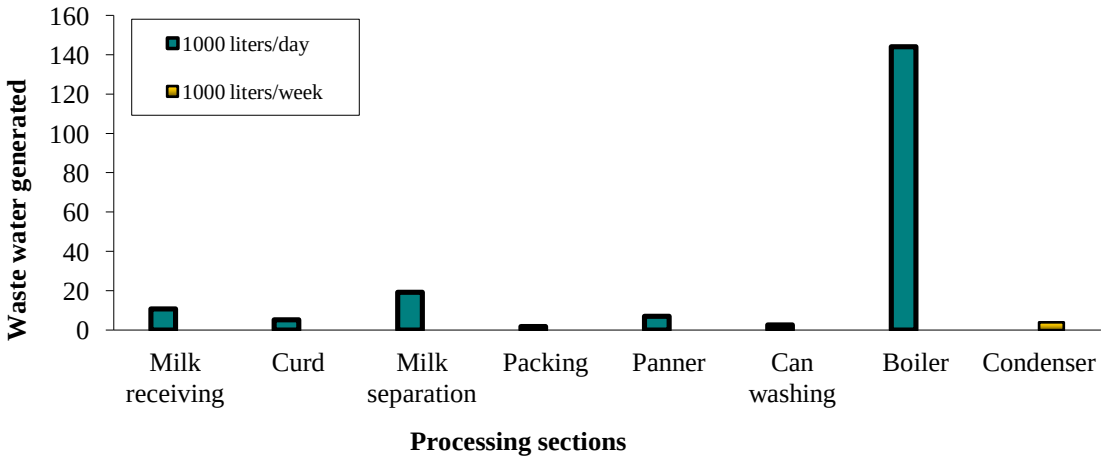

Fig. 1 Wastewater flow rate from different sections of dairy

II.B. QUALITATIVE ANALYSIS OF INTAKE WATER AND WASTE WATER

The analysis of the intake water and wastewater generated at various sections as well as before and after the effluent treatment plant present at the DMU milk dairy was carried out to determine the impurity levels of different parameters. Samples were analyzed for the parameters such as temperature, pH, Dissolved Oxygen (DO), Total Dissolved Solids (TDS), Total Suspended Solids (TSS), Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD) and

ISSN(Online) : 2319 - 8753
ISSN (Print) : 2347 - 6710

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 2, February 2015

oil and grease content. The samples were collected at a frequency of 11-17 days. All the parameters of the samples were analyzed in the laboratory by standard methods recommended by APHA (2012).

II.B.1. TEMPERATURE

The temperature of input water (raw) and wastewater varied from section to section due to the processes involved in the dairy. It was observed that the temperature of wastewater was more in can washing section as compared with other sections because the temperature was maintained more in order to obtain quick and easy drying of cans and to obtain effective cleaning. Fig. 2 shows the variation in temperature at different sections of the dairy.

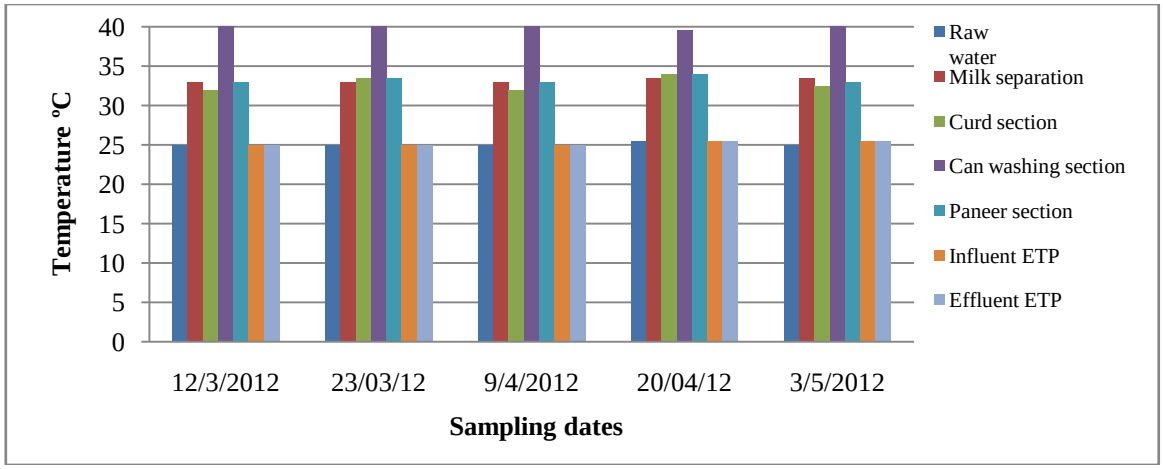

Fig. 2 Variation of temperature in dairy sections

II.B.2. PH

In the present study, the pH of raw water was in the range of 6.6 to 7.1 where as the pH of waste water from influent ETP and effluent ETP were in the ranges of 6.6 - 7.3 and 6.9 - 7.1, respectively. All these values were well within the permissible limits of effluent standards for dairy industry that is 6.0 – 8.5 [11]. The variation of pH in dairy sections of waste water coming out of different sections is presented in Fig. 3.

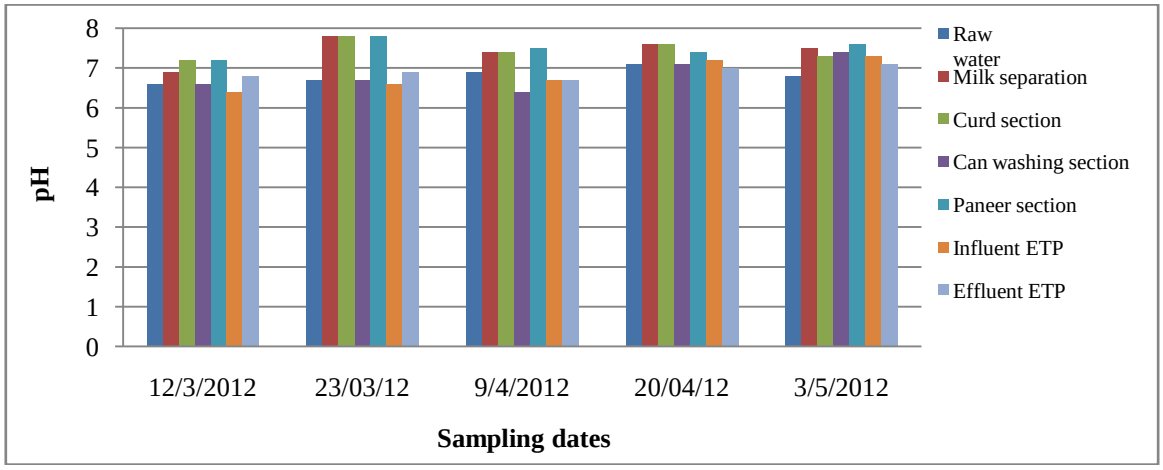

Fig. 3 Variation of pH in dairy sections

ISSN(Online) : 2319 - 8753
ISSN (Print) : 2347 - 6710

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 2, February 2015

II.B.3. DISSOLVED OXYGEN

The dissolved oxygen (DO) of raw water varied from 6.8 mg/l to 6.9 mg/l. In can washing section the DO was observed to be less due to the high temperature in wastewater. The values of dissolved oxygen obtained during present study at different sections are illustrated Fig. 4.

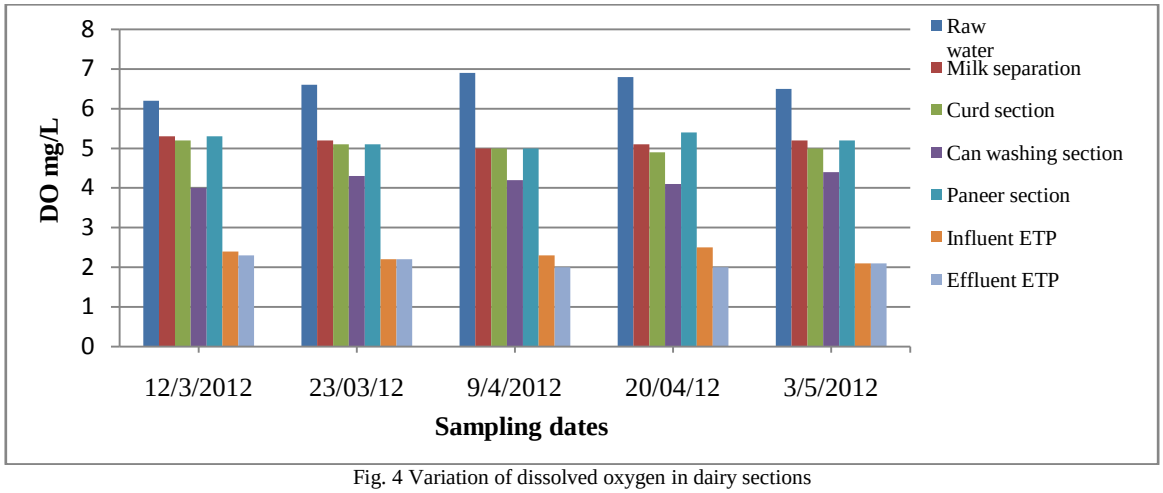

Fig. 4 Variation of dissolved oxygen in dairy sections

II.B.4. TOTAL DISSOLVED SOLIDS

The total dissolved solids of raw water varied from 200 mg/l to 250 mg/l, and that of treated water from effluent treatment plant varied from 600 mg/l to 640 mg/l. This was due to different processes involved in treatment of wastewater in effluent treatment plant. All the above values are well within the permissible limits of effluent standards for dairy industry [11]. The variation of total dissolved solids at different times from various sections is presented in Fig. 5.

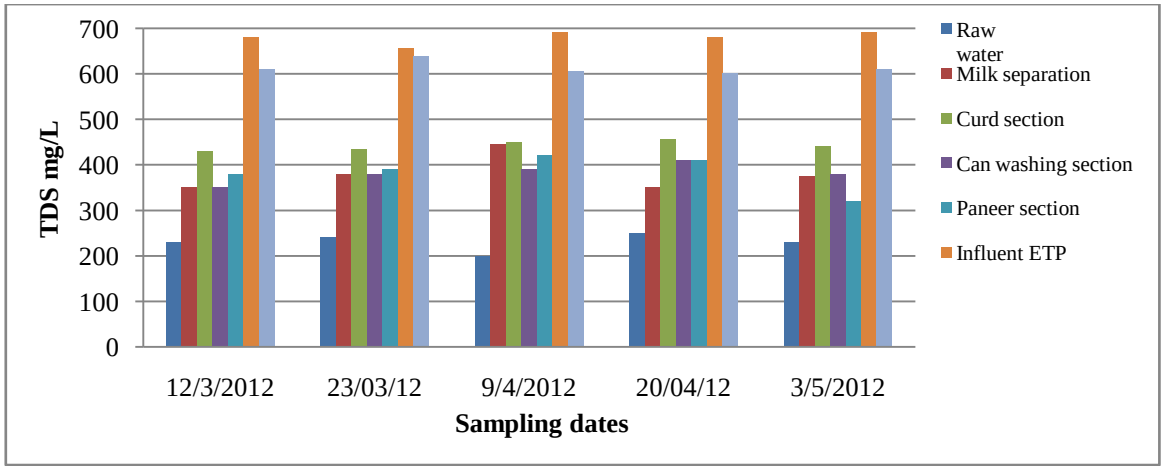

Fig. 5 Variation of total dissolved solids in dairy sections

II.B.5. TOTAL SUSPENDED SOLIDS

Total suspended solid of raw water sample was about 60 mg/l. The major contribution of total suspended solids was found to be from milk separation section and curd section where the total suspended solids varied from 105 mg/l to 115 mg/l and 120 mg/l to 135 mg/l, respectively. This was due to the major processes of dairy involved and due to cleaning

ISSN(Online) : 2319 - 8753
ISSN (Print) : 2347 - 6710

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 2, February 2015

of pipes. Further, the TSS of treated wastewater from ETP varied from 110 mg/l to 130 mg/l which was well within the permissible limits of 150 mg/l (effluent standards for dairy industry). Fig. 6 presents the variation of TSS in different sections of DMU dairy unit.

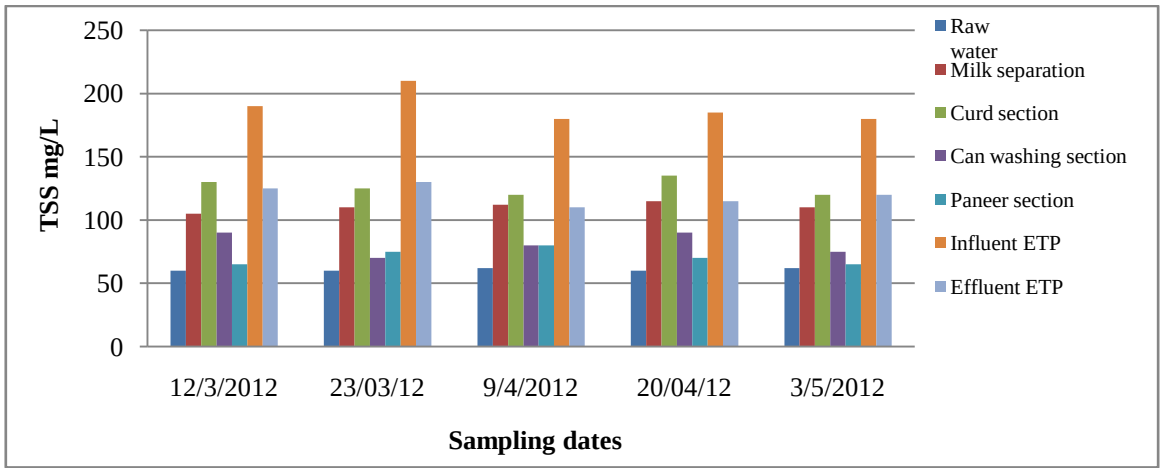

Fig. 6 Variation of total suspended solids in dairy sections

II.B.6. BIOCHEMICAL OXYGEN DEMAND

In the present study, BOD of raw water varied from 1.4 mg/l to 1.7 mg/l while that of treated wastewater from ETP varied from 45 mg/l to 55 mg/l, which is well within the limit of 100 mg/l [11]. The values obtained during the study for all the sections of dairy are shown in Fig. 7.

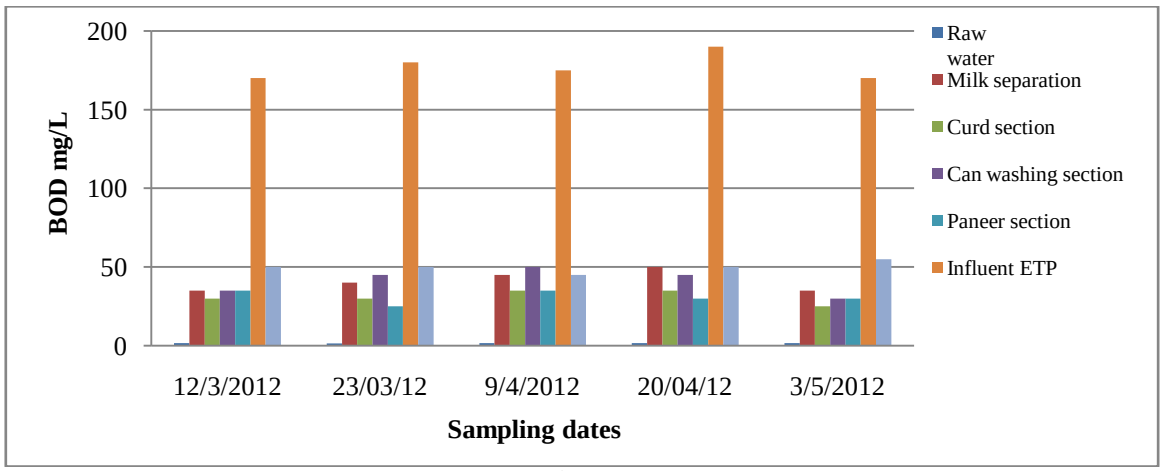

Fig. 7 Variation of BOD in dairy sections

II.B.7. BIOCHEMICAL OXYGEN DEMAND

The COD content of raw water was 20 mg/l to 23 mg/l while that of treated water COD was observed to be in range of 140 mg/l. Fig. 8 illustrates the COD values obtained at different sections during the study.

ISSN(Online) : 2319 - 8753
ISSN (Print) : 2347 - 6710

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 2, February 2015

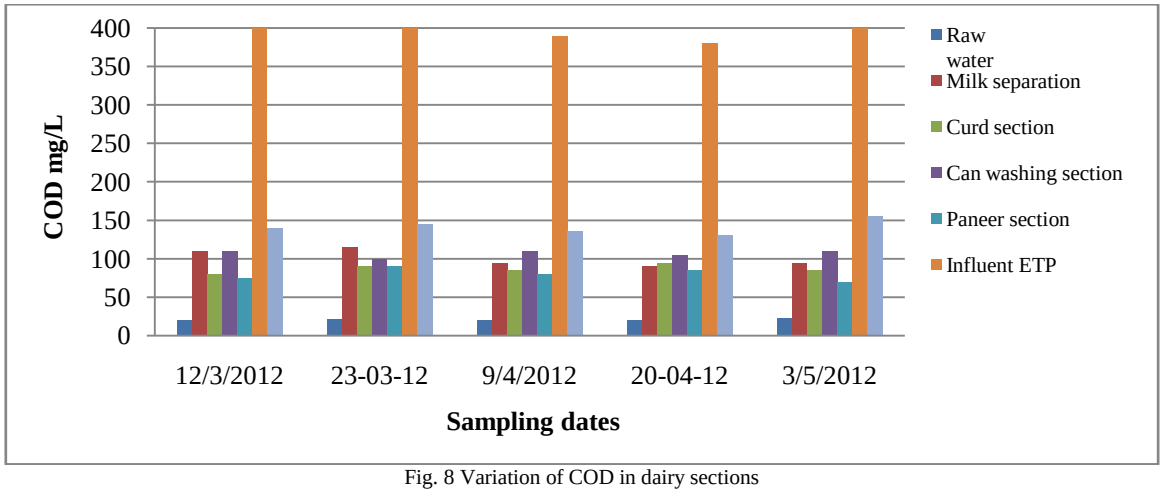

Fig. 8 Variation of COD in dairy sections

Table 1 furnishes the characteristics average value of water and wastewater at different sections of the dairy separately. The temperature varied from section to section from 25ºC to 40ºC. The pH of treated wastewater was 6.8 which is within permissible limit and all other parameter which were analyzed were all well within the permissible limits of effluent standards for dairy industry [11]. However, the oil and grease content was below detectable limit at all the sections.

Table 1: Water and wastewater quality analysis results

Sl No.	Parameters	Units	Average value of parameters at various sections						
			Raw water	Milk separation Section	Curd Section	Can washing w/w	Paneer Section	ETP Influent	ETP Effluent
1	Temperature	ºC	25	33	33	40	33	25	25
2	pH	-	6.8	7.5	7.4	6.8	7.5	6.8	6.9
3	DO	mg/L	6.6	5.1	5.0	4.2	5.2	2.3	2.1
4	TDS	mg/L	230	380	440	350	380	680	610
5	TSS	mg/L	60	110	125	80	70	190	120
6	BOD_5 20º C	mg/L	1.6	40	30	40	30	175	50
7	COD	mg/L	20	100	85	105	80	400	140
8	Oil and grease	mg/L	BDL	BDL	BDL	BDL	BDL	BDL	BDL

BDL- Below detectable limit

III. CONCLUSIONS

The following conclusions were drawn based on the audit and experimental results:

1. The overall water consumption of the dairy was 190,539 liters/day.
2. The average quantity of waste water generated from milk receiving section is 10,798 liters/day, curd section is 5275 liters/day, milk separation section is 19,195 liters/day, packing section is 1,741 liters/day and can washing section is 2,603 liters/day. The maximum quantity of waste water generated from boiler section is 144,000 liters/day while the condenser section generates as low as 4000 – 5000 liters/week of waste water.
3. The water and waste water quality analysis of the dairy was carried out. It was observed that the temperature in can washing waste water was 40ºC, which was more as compared with other section. The temperature was maintained more in order to obtain quick and easy drying of cans and to obtain effective cleaning. Oil and grease was below detectable limit.

ISSN(Online) : 2319 - 8753
ISSN (Print) : 2347 - 6710

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 2, February 2015

4. The raw water and wastewater samples from different sections of dairy indicate that all the analyzed parameters were well within the permissible limits for the discharge of effluent [11].

IV. RECOMMENDATIONS

The following recommendations were made to reduce the generation of waste water:

1. The wastewater generated at the boiler milk tank can be reused for curd mud pot washing tank or for the same purpose after cooling by a suitable method. The estimated quantity of water reduction from this proposal is 200 liters/day. To implement this there should be a separate tank.
2. Metered water supply can be adopted for each and every section of the dairy, so that a required quantity of water can be supplied and used at every section without wasting water.
3. Regular inspection of nozzles must be done to check clogging and fogging nozzles can also be adopted to cool product.
4. Treated wastewater from effluent treatment plant can be used for floor washing operations in different processing units.
5. Training and awareness program for employees for proper usage of water.

V. ACKNOWLEDGEMENT

The authors take this opportunity to acknowledge the officials of Karnataka Co-operative Milk Producers Federation Limited (KMF) Dharwad Milk Union (DMU), Karnataka for carrying out the case study as a part of Master Thesis of second author.

REFERENCES

1. Jagatheesan, V., Lee, S. H., Visvanathan, C., Tariman, C. A., Shu, L., and Maria Marzella, "A case study on waste auditing in an ice cream factory", Environmental Engineering Research, vol.4, no. 2, pp. 103- 111, 1999.
2. Rames Seejuhn, "Waste audit in a tapioca starch milk processing factory", Asian Institute of Technology, School of Environment, Resources and Development Thailand, 2002.
3. Perera, L. A. K., "Waste and Energy audit in a paper mill", Asian Institute of Technology, Bangkok, Thailand, 1996.
4. Vu Tuong Anh., "Cleaner production audit in the pulp and paper Industry - A case study in Vietnam" Asian Institute of Technology, Bangkok, Thailand, 1996.
5. Avsar, E., and Demirer, G N., "Cleaner Production Opportunity Assessment Study in SEKA Balikesir Pulp and Paper Mill", Middle East Technical University, Department of Environmental Engineering, Ankara, Turkey, 2001.
6. Abbasi, G.Y., and Abbassi, B. E., "Environmental assessment for paper and cardboard industry in Jordan - a cleaner production concept", Journal of Cleaner Production, vol. 12, no. 4, pp. 321–326, 2004.
7. Chitnis, V., Vaidya, K., and Chitnis, D. S., "Biomedical waste in laboratory medicine: Audit and management", Indian Journal of Microbiology, Vol. 1, pp. 6-13, 2005.
8. Abor, P. A., "Medical waste management at Tygerberg hospital in the western cape, South Africa" Cape Peninsula University of Technology, Africa, 2007.
9. Erasmus, R T., and Zemlin, A. E., "Clinical audit in the laboratory", Journal of Clinical Pathology, vol. 62, pp. 593-597, 2009.
10. Visvanathan, C., "Multimedia environmental audit in a rice cracker factory in Thailand: a model case study", Journal of Cleaner Production, vol. 6, no. 2, pp. 93–101, 1998.
11. The Environment (Protection) Rules, 1986.