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# An Evaluation of Physicochemical Properties to Assess Quality of Treated Effluents from Jaipur Dairy

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**ABSTRACT**

The characteristics of industrial waste water vary from industry to industry and taking into consideration an important agro based sector; dairy industry, its waste are primarily composed of highly biodegradable and putrescible organic matter. This industry thereby contributes to water pollution. The effluents so generated are subjected to treatment prior its release into environment.
The present study is aimed to assess the quality of effluent after treatment from the effluent treatment plant of (Saras) Jaipur Dairy. The study was carried out in months of October 2011 and January 2012. The parameters taken into consideration were colour, temperature, pH, DO, BOD, COD, alkalinity, chloride, nitrate, phosphate, hardness. The results obtained from the physicochemical analysis of treated effluent revealed optimum temperatures(19.9°C-21.6°C) for biological activity to take place, neutral to alkaline pH, low DO, high BOD, COD, nitrates and phosphates. Though, the parameters like pH, DO, Chloride, COD were in compliance with the range prescribed by ISI for the dairy sector. The ratio between $BOD_{5:}$ COD in the month of October -2011 was found to be 0.42 for influent and 0.66 for effluent (aeration tank) which represents effective biodegradation; hence an eco friendly effluent, whereas in the month of January-2102, it was found to be 0.4 for both influent and effluent.
The values of different parameters were expressed as Mean ± standard deviation.

**Keywords:** Dairy Industry, Effluent treatment plant, ISI standards, Physicochemical parameters



## INTRODUCTION

Effluents are the wastes produced from industries and they differ with respect to the industry they are generated from. The volume and composition of treatment plant depends upon the type of wastes produced, types of cleansers. Different types of milk based products are produced and consequently waste streams may vary on a daily basis thereby, reflecting a change in physico-chemical parameters. Dairy industry is growing at a substantial rate in India and it generates enormous volumes of effluents through its different operations like pasteurization, bottling, whey generation, washing of utensils etc. To comply with the discharge standards, the dairy projects in India are practicing an elaborate effluent treatment protocol. The main objective of treating dairy waste is reduction of organic load so that pollution load may be reduced to a considerable level and to remove pathogenic microbes so that an eco-friendly effluent could be generated. As per different research findings carried out at national and international levels, a typical untreated dairy effluent is characterized by high organic loads as milk is its basic constituent with high levels of biological oxygen demand (BOD), chemical oxygen demand (COD), oil, grease, nitrogen, phosphorous content and whey may also contribute to high organic loads in wastewater . The waste water of dairy contain large quantities of milk constituents such as casein, lactose, fat inorganic salt, besides detergents and sanitizers used for washing.[1,2] The effect of physico-chemical parameters of untreated effluent generated by Mahalakshmi sugar mill, Iqbalpur, Roorkee on seed germination has also been reported by[3]. A similar finding was reported in which different concentrations of treated effluent from Amul dairy, Anand, Gujarat were studied for agricultural practices [4].

Effluent from equalization tank and from other treating tanks of dairy plant at Nabha, Dist.Patiala, Punjab was studied[5]. The quality of treated effluent is expressed in terms of $BOD_{5:}$ COD which represents biodegradability. The literature suggests that for dairy industry, the ratio ranges between 0.47-0.67. A ratio less then 0.6 reflect a less efficient biological oxidation of milk products [6]. Microbial degradation and oxidation of waste takes place in presence of oxygen by utilizing processes like activated sludge, trickling filters, aerated lagoons or a combination of these [7].The present study is an attempt to analyse the quality of treated effluent which would remarkably reveal the performance of the effluent treatment plant in autumn and winter months.

## MATERIALS AND METHODS

**Area of Study**

The study was carried out in the months of October -2011 and January- 2012. The untreated wastewater was sampled after the screening of particulate matter. Treated wastewater was sampled from aeration tank. (ETP, Jaipur dairy) in accordance with standard procedures [8]. All the samples were analyzed for colour, pH and temperature DO, COD, BOD, alkalinity, hardness, chloride, and nitrogen as nitrate and phosphorus as phosphate in accordance with standard procedures [8]. Color, temperature and pH of the effluents were recorded at the sampling point. Clean and pre sterilized plastic bottles were used for sample collection.

The samples were designated as-

1. DIFUO: Dairy influent (Untreated)October, 2011
2. DEFTO: Dairy effluent (Treated)October, 2011
3. DIFUJ: Dairy influent (Untreated)January, 2012
4. DIFTJ: Dairy effluent (Treated) January, 2012

## RESULTS AND DISCUSSION

The color of untreated influents in both October and January was white and that of effluent was orange in month of October and grey in January. The removal of colour from wastewater is often more important than the removal of soluble colourless organics, which normally contribute to the major BOD load. Use of coagulants to remove colour from effluent of paper and pulp industry has been reported [9].


Fig.-1: Influent: ETP, Jaipur Dairy

Fig.-2: Effluent (Aeration Tank) Jaipur Dairy

Most biological activity occurs when the water temperature is between 10°C-30°C.In the present study, the range of temperature for influent was 18.1°C-21.6°C and the temperature ranged from 19.9°C-22°C for effluent. This slight increase in temperature may be attributed to vigorous biological activity primarily because of mesophils during the secondary treatment. Changes in the treatment process must be made during the winter months to compensate for the drop in water temperature in the treatment processes. The effect of timings of collection of sample and influence of season on variation in the effluent temperature has also been studied [10].pH gives an idea about the concentration of carbonate, bicarbonate and $CO_2$ in water. The pH of waste water indicates the acidic nature of effluent. The obtained range of pH for influent was 6.3-6.6 and it may be attributed to decomposition of lactose into lactic acid under aerobic conditions and may cause corrosion of sewers [11]. and 7.6-8.2 for effluent. This increase in pH may be attributed to alkalophilic micro-organisms which are a part of indigenous micro-flora. These observations were quite similar (6.2-7.4) to previous findings [12]. Dissolved Oxygen (DO) is found as microscopic bubbles of oxygen that are mixed in the water and occur between water molecules.


Fig.- 3: Influent and effluent; October, 2011

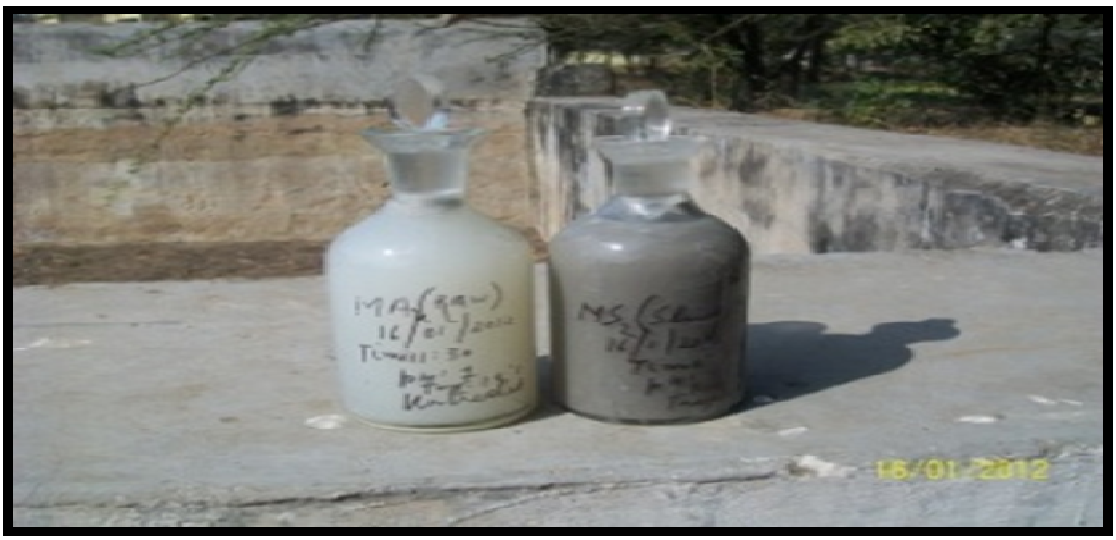

Fig.- 4: Influent and effluent; January, 2012

It is an important parameter to assess the quality of water. Oxygen is removed from the water by respiration and decomposition of organic matter by indigenous micro flora present in effluent. DO of influent ranged from 2.3mg/l-2.6mg/l and that of effluent was found to be in range 4.5mg/l-4.6mg/l, which is in compliance with ISI guidelines. Presumably, slight increase in DO of effluent is due to degradation of organic matter by indigenous micro flora and the biofilms which is of phenomenal importance during secondary treatment. Dissolved oxygen concentration in unpolluted water normally range between 8 to 10 mg/l and concentration below 5 mg/l adversely affect aquatic life [13].

Biochemical oxygen demand (BOD) is defined as amount of oxygen required by microorganisms to degrade organic matter while stabilizing biological decomposable organic matter in waste water by aerobic oxidation. BOD of influent was 309mg/l -316.6 mg/l- and that of effluent was 236mg/l-289 mg/l Since, the micro-organisms readily utilize the biodegradable organic matter, the value of BOD for treated effluent is low and during winter months, low values may be attributed to lesser quantity of total solids, suspended solids in water as well as to the quantitative number of microbial population [14].

Chemical oxygen demand is an indicator of oxidizable matter present in waste water. In the present study, COD of influent was in the range 741.7mg/l-754.6mg/l and that of effluent was 432.5mg/l-578.1. Lowering of COD in secondary treatment is attributed to anaerobic digestion which converts COD to biogas and could be used as an in-plant fuel [15].

Alkalinity is a measure of buffering capacity of water. It is an important parameter which indicates the ability of water to neutralize acids from wastewater. The higher values of alkalinity are associated with increase in the presence of bicarbonates and carbonates from effluents. In the present study, alkalinity of influent was found be in the range 160.8mg/l-190mg/l and that of effluent was 234.6mg/l-289mg/l which may be attributed to the higher pH value obtained (7.6-8.2). Higher values 408mg/l-452mg/l of effluent from aeration tank of milk processing unit at Nabha, Dist. Patiala, Punjab has been reported [5].

Total Hardness is the property of water which prevents the lather formation with soap and increases the boiling point of water. Hardness of water mainly depends upon the amount of calcium and magnesium salts or both. In the present study, value of hardness for influent was 231.7mg/l-278.7mg/l and the values for effluent were 210.6mg/l-233.2mg/l. Low values of hardness after treatment may be attributed to the presence of micro-algae [16].

Table-1: Physicochemical parameters of influent and effluent generated from Jaipur dairy

| S.No | Parameters | Units | October-2011 | | January-2012 | | ISI Standards |
|---|---|---|---|---|---|---|---|
| | | | DIFUO | DEFTO | DIFUJ | DEFTJ | |
| 1 | Colour | - | White | Orange | White | Gray | - |
| 2 | Temperature | °C | 21.6±0.003 | 22±0.002 | 18.1±0.006 | 19.9±0.04 | - |
| 3 | pH | - | 6.3±0.05 | 8.2±0.03 | 6.6±0.8 | 7.6±0.1 | 6.5-8 |
| 4 | DO | mg/l | 2.3±0.04 | 4.5±0.08 | 2.6±0.04 | 4.6±0.06 | 4-6(mg/l) |
| 5 | BOD | mg/l | 316.6±0.9 | 289±3.8 | 309±0.9 | 236±2.6 | 50(mg/l) |
| 6 | COD | mg/l | 741.7±1.2 | 432.5±0.4 | 754.6±0.9 | 578.1±1.2 | 250(mg/l) |
| 7 | Alkalinity | mg/l | 160.8±0.63 | 289±0.2 | 190±0.02 | 234.6±0.5 | - |
| 8 | Hardness | mg/l | 231.7±1.53 | 210.6±0.1 | 278.7±1.3 | 233.2±0.7 | - |
| 9 | Chloride | mg/l | 336.3±1.3 | 391.8±2.2 | 357.3±1.9 | 402 ±5.6 | 600(mg/l) |
| 10 | Nitrate | mg/l | 26±0.52 | 14.9±0.3 | 19±1.1 | 11.2±0.1 | 10(mg/l) |
| 11 | Phosphate | mg/l | 3.4±0.01 | 2.7±0.8 | 3.2±0.05 | 1.6±0.5 | 2(mg/l) |
| 12 | $BOD_5$:COD | - | 0.4 | 0.66 | 0.4 | 0.4 | - |

Chloride is one of the major inorganic anions in waste water. Salty whey and brine contributes to higher chloride content in dairy waste. The levels exceeding 400mg/l cause toxicity to aquatic eco-systems [17]. In the present study, Chloride content of influent was found be in the range 336.3mg/l-357.3mg/l and that of effluent was in the range 391.8mg/l -402mg/l. Chloride present in effluent of aeration tank in the range 129mg/l-166.6mg/l has been reported [5].

Nitrogen either in the form of nitrate, nitrite, or ammonia can be health hazard. The presence of nitrates in dairy waste waters may be attributed to milk containing 3.7% fat content [18].In the present study, nitrate value for influent was in the range was 19mg/l-26mg/l and that of effluent 11.2mg/l -14.9mg/l and this reduction in nitrate content of treated effluent may be attributed to the heterotrophic nitrifying bacteria which forms a part of indigenous

micro flora. The lower values 0mg-5mg/l of effluent from aeration tank was reported [5]. Phosphate is the soluble form of phosphorous mainly contributed through detergents and soaps widely used for cleaning purposes in milk processing unit. In the present study, values for phosphate were in the range 3.2mg/l-3.4mg/l for influent and 1.6mg/l 2.7mg/l for effluent. This lowering of phosphate level of effluent may be attributed to presence of micro-algae which are efficient phosphate solubilisers and scavenge phosphates. A similar result 3 mg/l of the effluent from aeration tank was reported [19]. Degree of wastewater pollution is expressed as mg/l for pollution indicators: DO, COD, BOD, alkalinity, chloride, nitrates and phosphates except for pH, temperature and $BOD_5$: COD ratio.The values are expressed as Mean ±S.D and all the experiments were conducted in triplicates (Table- 1).

## CONCLUSIONS

Dairy industry is one of the most important agro-based industries in India, which uses enormous amounts of fresh water for processing of milk and other purposes and releases huge amount of effluent every day. Waste water quality can be maintained within safe limits by better handling of plant. The values of treated effluent for pollution indicators like DO, COD, chloride were in compliance with ISI guidelines, so it could be concluded that the functioning of effluent treatment plant is average and it needs to be monitored at regular basis so that the other pollution indicators like BOD, nitrate and phosphate may be within the permissible limits as prescribed by ISI for this sector and an effluent generated after the treatment may be eco-friendly and could be used for irrigational purposes. The $BOD_5$: COD ratio of effluent of aeration tank was 0.66 in the month of October-2011, which reflects effective biodegradation of organic compounds and hence effective treatment. Bacterial diversity of secondary treatment strategy could be studied to develop indigenous bacterial consortium which would lower the values of physico-chemical parameters to permissible standards.

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