REUSE IN IRRIGATION: SECONDARY TREATED INDUSTRIAL EFFLUENT

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ABSTRACT

Untreated effluent generated from industries cause environmental problems like water and soil pollution. In the present work attempt has been made to study the parameters like Salinity, Residual Sodium Carbonate, Chloride, Organic loading, pH and Oil & grease were used to access the suitability of secondary treated effluent from dairy industry for reuse in irrigation. The secondary treated effluent is reused for eco-plantation site. The plants which are grown are Eucalyptus, Poplar, Teak and Jatropha. The high transpiration capacity of plants grown in soil matrix enables the system to serve as biopump. The plants transpire water equivalent of 7 to 13 times the potential evapo-transpiration from the soil matrix alone. Nutrients present in the water are used by the plants and partially retained in the soil matrix without affecting the soil eco. The suitability of effluent for irrigation purpose after primary and secondary treatment which involves Oil & grease trapping unit, Equalization tank, Aeration tanks (Activated sludge process), Secondary clarifier than reuse in irrigation. The excess sludge generated during treatment is dried at sludge drying beds.

Keywords: *Industrial Effluent, Wastewater Treatment, Characterization, Land Disposal, Reuse for Irrigation.*

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INTRODUCTION

India is the second largest milk producing country with a production of about 78 million tons during 1999-2000 (CPCB). There has been a remarkable growth in milk production and milk processing centres (dairies) in India during the past decades. Dairy industry is an important economic sector, but the pollution potential of this activity may be considered high, mainly when recovery of proteins, lipids and lactose is not performed [5]. A dairy has a water requirement for washing and cleaning operations, in the range of 0.2 to 10 L of water/ litre of milk processed [6]. Consequently, the quantity of effluent discharged is also high with a high proportion of biodegradable organics in it. Therefore, this industry poses a major threat to the environment, unless such effluents are subjected to proper treatment [3]. The dairy industry, like most other agro-industries, generates strong effluent characterized by high Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) reflecting their high organic content. Dairy effluent is invariably high in nutrients (i.e. Nitrogen, Phosphorus and Potassium) and Organic material (e.g. oils and fat, dissolved lactic acid, etc.) and consequently has a high BOD. Furthermore, dairy processing effluent also has high concentrations of Total Dissolved Solids (TDS). The use of acid and alkaline cleaners and sanitizers in the dairy industry additionally influences effluent characteristics and typically results in a highly variable pH [6]. Considering the above stated implications an attempt has been made in the present paper to evaluate one of the ETP for dairy waste. The objective of the paper is to monitor the performance of ETP of dairy plant and reuse the secondary treated effluent for irrigation purpose. The objective of the present study is to monitor treatment efficiency of wastewater treatment plant and to address treated effluent compliance issues related to irrigation.

MATERIALS AND METHODS

The effluent generated from dairy industry is rich in BOD, COD, Oil and grease, Nitrogen, Phosphorous, Total suspended solids and Chloride. In the present case effluent generated from dairy industry is treated aerobically. The effluent treatment facility consist of equalization tank for equalization of influent from industry, after equalization tank oil and grease trapping unit, after removing oil and grease the treatment facility consist of activated sludge process. After evaluating the treatment efficiency of aerobic units the study is done on suitability of treated effluent for irrigation purpose. The parameters to be analysed for aerobically treated effluent are like Salinity, Residual Sodium Carbonate, Total Dissolved Solid, Chloride and organic loading. Samples were collected in plastic bottles. Procedure in

Standard Method was followed for samples collection, preservation and transportation. Parameters were analyzed in accordance with the procedure laid down in Standard Methods for the Examination of Water and Wastewater (APHA 1996).

RESULTS & DISCUSSIONS

Key pollutants in the wastewater generated from dairy industry are organic compound, fats, solids and biogeneous elements. The COD, BOD_5 at 20^oC and TSS removal efficiency of aerobic unit were 96%, 95% and 94% respectively. Irrigation agriculture is dependent upon adequate good quality irrigation water. Treated industrial effluent from treatment unit and irrigation water quality guidelines are summarized below in table 1.

Table 1: Secondary treated effluent from treatment unit and irrigation water quality guidelines

Properties	Secondary effluent	EPA Guidelines
pH	8	5.5-9
Oil & grease	9 (mg/L)	10 (mg/L)
TDS	966.7 mg/L	2100 mg/L
SS	52 mg/L	200 mg/L
Fecal Coli forms	-	2.2-23/100ml
BOD_5 at 20^oC	34.5 mg/L	100 mg/L
Ammonical Nitrogen	3 mg/L	-

Source: Ayers and Westcot (1985)

The suitability of treated effluent is judged from the parameters Total Dissolved Solids (TDS), Residual carbonates, Sulphate Salinity, pH, Chloride, Organic loading for irrigation purpose.

Total Dissolved Solid (TDS) concentration can be estimated indirectly by measuring electrical conductivity by using the empirical relationship

$$\textbf{TDS (mg/L)} = \textbf{0.64 * EC} (\mu \textbf{ mho/cm})$$

The main effect of high EC and TDS water on crop productivity is the inability of the plant to compete with ions in the soil solution for water. The higher the EC and TDS, the less water is available to plants, even through a Field may appear wet.

Table 2: Suitability of water for irrigation

Electrical Conductivity (µ mhos/cm)	Salinity	Uses
<250	Low	Suitability for crops on most soils
250-750	Medium	Suitability in most cases with moderate drainage
750-2250	High	May be used for Salt tolerant crops on adequate drained soils
2250-5000	Very High	May be used with very tolerant plants and with excess leaching

Source: Ayers and Westcot (1985)

TDS concentration in the treated effluent was found to be 966.7 mg/L and EC was 151 µ mhos/cm. Its value is below the Indian Standard Guidelines as shown in Table 2.

Residual Sodium Carbonate (RSC) – Large amount of bicarbonates tends to precipitate out the Calcium, as Calcium Carbonate from water and soil. Magnesium enters the exchange complex of the soil, replacing the precipitated Calcium. As Calcium and Magnesium are lost from the soil water, the relative proportion of sodium is increased, with an attendant increase in sodium hazard. This is general evaluation in terms of RSC defined as in table 3.

$RSC = (CO_3^{2-} + HCO_3^{-}) - (Ca^{2+} + Mg^{2+})$

Table 3: Typical recommended values for irrigation water are as follow

Water Quality	RSC (meq /L)
Safe	Less than 1.25
Marginal	1.35-2.5
Unsuitable	Over 2.5

Source: Ayers and Westcot (1985)

RSC value (-2.1meq/L) of secondary effluent from milk based food industry was found to be safe.

Chlorides are said to have no effect on a soil's physical properties. Certain plants, however, are sensitive to chloride ions. In Israel, for citrus fruits, chloride up to 15 meq/L on sandy-loamy soils and up to 7.5 meq /L on clayey soils is considered to be of low risk. In India some irrigation water standards allow up to 600meq/L (i.e.16.92 meq/L) but the soil conditions are not satisfied.

In our case, chloride = 209.9 mg/L (standards allow up to 600 mg/L)

Sulphates – The term 'Potential Salinity' of water has been suggested in terms of (Cl^- + 0.5 SO_4^{2-}) in meq/L and following values have been proposed to ensure sustainability.

Table 4: Potential Salinity of water

Potential salinity (meq/L)	Desirable soil permeability
5-20	Good
3-15	Medium
3-7	Low

Source: Ayers and Westcot (1985)

The Potential Salinity was observed to be 10.7 meq/L. Permeability of soil was found to be good.

pH- Soil pH affects the availability of nutrients to plant. Effluent pH was in the range of 6.5-9 is acceptable for irrigation. In our case pH=8, acceptable.

Organic Content- Organic matter in effluent can be measured as BOD, COD or TOC. Organic matter when applied on an appropriate rate, can contribute to soil fertility. Ordinarily, concentrations are low enough to preclude short-term detrimental effects on the soil or vegetation.

Continued overloading with organic matter can physically clog soil pores, favours anaerobic soil microbes and slimy bacterial scum coating the soil, blocking pores and closing up cracks. These changes could limit the effective life of the application site. Table 5 summarizes a few typical organic loading acceptable on land.

Table 5: Typical organic loading acceptable on land

Waste	Organic Loading (Kg BOD_5/hac/day)
Dextrose	1026
Raw domestic & Industrial Waste (India)	25-150
Secondary effluents	2-5
Milk wastes	12-125

Source: Ayers and Westcot (1985)

In the present case BOD load applied to land is 4 Kg/hac/day which is below loading rate acceptable.

CONCLUSION

Present study concerned with the treatment efficiency of effluent treatment plant and compliance with the standards for irrigation. The COD, BOD and TSS removal efficiency of effluent treatment plant was observed to be 96%, 95% and 94% respectively. The current result suggest that the secondary effluent is complying with the standards for unrestricted irrigation based on Chloride, Sulphates, Electrical conductivity, pH, TDS and organic loading.

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