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Review on Wastewater Treatment Technologies Adopted for Operation of Milk Based Food Industry

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ABSTRACT

Industry based on milk products is one of the major industries causing water pollution. Wastewater production rate in India from dairy industry about 6-10 L wastewater/L of milk processed. Depending upon the requirement of products, waste generation and related environmental problems, various unit processes and operations are adopted for safe disposal. Samples were collected from effluent disposal points and characterize for parameters BOD, COD, Nitrogen, Phosphorus, Nitrogen, Oil & grease, pH, Acidity, Alkalinity etc. Depending upon the pollutants strength, treatment technologies are adopted in order to reuse water for irrigation purpose.

Key words: Industry based on milk products, treatment technologies, disposal, unit operations and processes

INTRODUCTION

Options for wastewater of Milk based food industry includes

- Treatment with the help of various unit processes and operations to a suitable standards for reuse or recycling
- Discharge to local authority sewers under a trade waste agreement (with pretreatment as necessary)
- After treatment, effluent disposal on land wherever practicable and environmentally beneficial

Segregation

Rain water should be managed separately from contaminated water and discharge directly into water drainage system. Wastewater streams generated from the process operations should also be segregated and treated. Spent cleaning solutions should be separated from other wastewater streams as they can be treated to recover cleaning agents. Disposal of highly saline wastewater to an evaporation pond where the salts can be removed and recycled.

Pre-treatment

Pretreatment of wastewater from milk based food industry consists of various unit operations i.e. screening, grit separation, flow balancing, pH control and removal of coarse solids. The settleable suspended solids and particulate organic compounds, can be settled with the help of primary clarifier. Primary treatment is treatment method adopted prior to secondary treatment in order to reduce to load of various pollutants on biological processes.

Screening

Perforated plates or removed suspended impurities and also to prevent blockage of drains, particularly in bottling dairies to retain broken bottles, caps, labels and other solid material. Screens are also necessary at the cheese factories to remove cheese curd.

Fat removal

Coarse milk solids should be removed by screening. Fats can constitute up to 50% of the organic load. Its recovery is therefore significant in any treatment process. Dissolved air flotation is very effective method.

Equalization of Flow

Wide fluctuations in strength and volume of wastewater generated has been observed in the dairy industry. In order to attain maximum efficiency it is necessary to operate it at constant flow rates with constant composition of pollutants with the help of equalization tank. To achieve this objective a balance or equalization tank is essential. Aeration has been provided in order to avoid anaerobic conditions and subsequent protein coagulation developing. Diffusers as well as agitators can be used to avoid anaerobic conditions.

Primary Treatment

Settlement

Primary clarifiers are adopted in order to remove settleable material in the wastewaster; waste from a bottling dairy or collecting depot contains very little settleable solids, whilst the waste from a milk products manufacturing creamery can contain sufficient settleable material which will interfere if not removed before secondary treatment. Retention time of 4-6 hrs is sufficient for the removal of easily settleable material, thereby reducing the BOD of the waste by some 10-20% and protecting the biological filter beds from overloading.

In more recent schemes, employing activated sludge treatment and biofilters, initial settlement has been eliminated to ensure that aerobic conditions are maintain all times [28].

Secondary Treatment or Biological treatment

There are basically two types of biological wastewater treatment systems; aerobic and anaerobic systems. In view of high BOD load in the wastewater from milk based food industry, aerobic processes (for low organic load) and anaerobic processes (for high organic loads) are adopted for the treatment of wastewater from milk based food industry. The selection of processes for any particular plant plant will depend upon the size of the problem, location of the plant and the necessary degree of treatment.

Anaerobic systems do not remove such nutrients as ammonium-nitrogen .If liquid and slurry are used as fertilizer, this does not need to pose specific problem. So nutrient removal system should be applied only if water authorities set limits for the discharge of nutrients.

The majority of Biological treatment methods can be applied to effluent from Milk based food industry

- If land is available, land treatment and pond systems
- Other biological treatment systems
    - Aerated lagoons
    - Activated Sludge Process
    - Extended aeration
    - Sequencing Batch Reactor
    - Biofiltration
    - Up flow anaerobic sludge blanket

Both aerobic and anaerobic processes have been used by various researchers for the treatment of wastewater from milk based food industry.

Lab scale aerobic treatment of dairy wastewater by the three stages of ASP, investigated by Fang and Herbert (1990) [12] . Dairy plant average BOD_5 of 1060 mg/L and an average TKN of 109 mg/L within the overall retention time of 19.8 hrs, the final effluent contained 9mg/L of BOD_5 and 10 mg/L of TKN, corresponding to respective reduction of 99% and 91%. Treatment of wastewater from whey processing plant using ASP and anaerobic process was investigated by Fang and Herbert (1990) [13]. He found ASP was more efficient in removing BOD_5. ASP removes 99% of BOD_5 as compared to 87% by anaerobic reactor. The chemical–biological treatment was carried out on dairy wastewater using ASP, TF and UASB by Nasr *et al*. (1996) [34]. ASP removed 64% of VOM, 71% COD and 70% BOD_5. 90% of VOM was removed by TF. Removal of COD and BOD by UASB was found to be 97% and 96% respectively.

A bench scale aerobic SBR was investigated by Mohseni-Bandpi *et al*. (2004) [31] to treat the dairy wastewater. Easy operation low cost and minimal sludge bulking condition make the SBR system an interesting option for the biological medium strength industrial wastewater treatment . The study demonstrated the capability of aerobic SBR for COD removal from dairy industry wastewater. The reactor was feed with milk factory and synthetic wastewater under different operating conditions. The highest COD removal efficiency was more than 90% and the sludge settling properties for milk factory wastewater were obtained at high sludge (20 days) and aerated period 6 hrs.

The study done by Banu *et al*. (1996) [4] aimed to treat the dairy wastewater by using anaerobic photocatalytic oxidation treatment. The optimum pH and catalyst loading for the solar photochemical oxidation was found to be 5 and 300 mg/L, respectively. The secondary solar photocatalytic oxidation using TiO_2 removed 62% of the COD from primary anaerobic treatment. Integration of anaerobic and solar photocatalytic treatment resulted in 95% removal of COD from the dairy wastewater. The findings suggest that anaerobic treatment followed by solar photocatalytic oxidation would be a promising alternative for the treatment of dairy wastewater.and solar photocatalytic oxidation methods. The anaerobic treatment was carried out in a laboratory scale hybrid up flow anaerobic sludge blanket reactor (HUASB) with a working volume of 5.9 L. It was operated at organic loading rate (OLR) varying from 8 to 20 kg COD/m^3 day for a period of 110 days. The maximum loading rate of the anaerobic reactor was found to be 19.2 kg COD/m^3 day and the corresponding chemical oxygen demand (COD) removal at this OLR was 84%. The anaerobically treated wastewater at an OLR of 19.2 kg COD/m^3 day was subjected to secondary solar.

Omil *et al.* (2003) [35] investigated anaerobic filter (AF) reactor, performance for the treatment of complex dairy wastewater. A full scale plant comprising of 12m^3 anaerobic filter (AF) reactor and a 28 m^3 sequential batch reactor (SBR) was used. The organic loading rates maintain in AF reactor were 5-6 kg COD/ m^3.d, with COD removal being higher than 90%. The effluent of the AF reactor was successfully treated in SBR reactor, and final effluent with COD content below 200 mg/L and total Nitrogen below 100mgN/L was obtained.

Durate *et al.* (2005) [33] assesses the possibility of using flocculated sludge in UASB reactors for the treatment of dairy wastewater and studies the effect of HRT (6, 8, 12, 16 hrs) on the performance of the reactor. UASB reactors were used with a height of 1170 m and a working volume of 31.71. The reactors were kept at temperature of 35ºC in a climate room. Initially the reactors were feed with wastewater from a dairy industry (COD 700-1200 mg/L; fats 75-150 mg/L; pH 9.5-11) supplemented with alkalinity and nutrients. It was observed by raising HRT from 6-12 hrs the performance of the system improved concerning the maximum applicable load, the COD removal efficiency and methane production, but by raising the HRT from 12-16 hrs the differences are not meaningful to attain soluble COD removals, VFA removals and protein mineralization near 80% and fat removal above 60%.

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