ENERGY EFFICIENT & RECOVERY TREATMENT TECHNIQUES IN DAIRY WASTE WATER TREATMENT – A REVIEW

Chandrasekar K.

Environmental, Health & Safety in M/s.Hatsun Agro Product Ltd.,

Abstract

The Indian dairy industry is stated to have the growth at more than 15% and poised to cross the 150 million tones per annum. In any dairy plant, the quantity and characteristics of effluent is depending upon the extent of production activities, pasteurization to several milk products.The requirement for milk and milk products is kept growing in steady pace, making a significant impact on the Indian agriculture domain. The dairy industries require large quantity of water for the purpose of washing of cans, machinery and floor, the liquid waste in a dairy originates from manufacturing process, utilities and service section. The various waste generated from a dairy are spilled milk, spoiled milk, skimmed milk, whey. Whey is the most difficult, high strength waste product of cheese manufacture. The anaerobic digesters in the first phase of treatment, is followed by high rate aerobic treatment. The present study was initiated for evaluating a need based experimental work on Upflow Anaerobic Sludge blanket for treating dairy effluent.

Key words: COD, UASBR, Hydrolyzing bacteria Acetogenic bacteria, Methanogenic bacteria

I. INTRODUCTION

Water management in the dairy industry is well documented,but effluent production and disposal remain a problematic issue for the dairy industry. To enable the dairy industry to contribute to water conservation, an efficient and cost-effective effluent treatment technology has to be developed. To effect this, anaerobic digestion offers a unique treatment option to the dairy industry. Along with COD reduction in the effluent, the anaerobic digester would also produce little microbial biomass. The biggest advantage is energy recovery in the form of methane and up to 95% of the organic matter in a waste stream can be converted into biogas.Many UASBR's designs are currently available and some have successfully been used for the treatment of dairy effluents.

The anaerobic digestion of organic compounds will be carried out using different bacteria.Generally the three main groups used are

- Hydrolyzing bacteria (Solubilising bacteria)
- Acetogenic bacteria (Acetate forming bacteria)
- Methanogenic bacteria (Methane forming bacteria)

The anaerobic digestion process is divided into four separate, but closely related steps as shown in Fig 1.

The methanogenic bacteria convert acetate or hydrogen plus carbon dioxide to methane. They can also convert formate (HCOOH), methanol (CH_3OH) and carbonmonoxide (CO) into methane.

Acidifying bacteria are active until a pH of about 4. The optimum pH however, is around 6.0.

II REACTIONS AND PRODUCTS

COD removal does not take place during hydrolysis and acetogenesis, the actual elimination of organic matter occurs in the methanogenic step in which the COD in the form of methane is separated from the waste water. The reactor effluent Volatile Fatty Acids(VFA) is an important parameter to be monitored daily, to operate anaerobic reactors efficiently.

Acetogenic Reactions

$$\text{Lactate}+2H_2O \longrightarrow \text{Acetate} + CO_2 + H_2O$$

$$\text{Ethanol} + H_2O \longrightarrow \text{Acetate} + 2\ H_2$$

$$\text{Butyrate} + 2H_2O \longrightarrow 2\ \text{Acetate}+2\ H_2$$

$$\text{Propionate} + 2H_2O \longrightarrow \text{Acetate}+3H_2O_2 + CO_2$$

Methanogenic Reactions

$$\text{(Acetate)}\ CH_3COOH \longrightarrow CH_4 + CO_2$$

$$\text{(Hydrogen)}\ 4H_2+ CO_2 \longrightarrow CH_4+ 2H_2O$$

$$4CH_3OH_2 \longrightarrow 3CH_4 + CO_2 + 2H_2$$

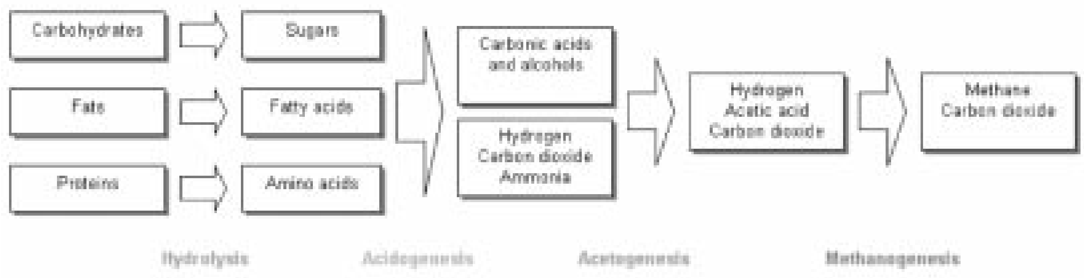

Fig. 1 Steps in Effluent Treatment Technology

III. UPFLOW ANAEROBIC SLUDGE BLANKET REACTOR (UASBR)

UASBR system is the anaerobic reactor based on Upflow Anaerobic Sludge Blanket process. The reactor consists of a large corrosion resistant tank which incorporates a unique 3-phase settler called as GLSS, to separate the sludge, biogas and effluent as shown in Fig 2.

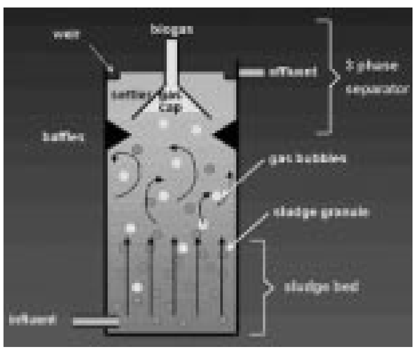

Fig. 2. UASBR

The settler is located at the top of the reactor and is designed for specific COD reactor loadings and hydraulic throughput.

A flow distribution network is located at the base of the reactor. This network is designed to distribute the flow evenly throughout the bottom of the reactor.This eliminates short -circuiting and promotes the proper formation of the sludge flocs which is a critical factor in reactor operation. The distribution network is designed to facilitate easy cleaning, thereby eliminating potential plugging problems.

New bacterial cells formed in the reactor aggregate into tiny flocs with extremely good settling characteristics.

The biogas produced by the bacteria in the form of small bubbles rises upward through the sludge bed / blanket zones and provides a natural mixing action.

When the biogas reaches the top of the reactor, it is removed by gas collectors. A gas-free zone above the collector makes possible the settling of finely dispersed solids to the reactor bottom.

Advantages of UASBR

- ❖ Efficient in the removal of organic material especially for tropical regions.
- ❖ High Organic Loading rate (OLR) than Conventional systems.
- ❖ Robust working performance than other conventional systems.
- ❖ Energy consumption is low.
- ❖ Biogas is produced for heat or electrical power.
- ❖ Waste heat can be used to meet the heating and cooling requirements of the dairy.
- ❖ Concentrating nutrients to a relatively small volume for export from the site can reduce the land required for liquid waste application.
- ❖ The rich fertilizer can be produced for sale to the public, nurseries, or other crop producers.
- ❖ Income can be obtained from the processing of imported wastes, the sale of organic nutrients, greenhouse gas credits, and the sale of power.

IV. CONCLUSION

Low construction, operation and maintenance costs, small land requirements, Lower sludge production as compared to aerobic treatment processes and the Biogas produced make UASBR a suitable effluent treatment technology.

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