Treatment of Dairy waste water using UASB Reactor and generation of energy

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ABSTRACT

In recent years we have been moving towards more and more industrial development. As a result we are facing many environmental pollution problems. The waste water emanating from this highly processed industrial processes which are putrescible in nature. Hence treatment of such waste water is essential before disposal of river, stream etc.

The quality of wastewater decides the line of treatment. The study undertaken involved the characterization of wastewater and the dairy waste is selected for this purpose. The model study gives the approximate idea about the usability and function of the treatment of the waste water of industry by UASB method.

UASB being the anaerobic treatment many other processes also exists but with comparison to UASB it has certain advantages which are also made here. Thus trying to bring out the best and foremost means to use the UASB against others.

The anaerobic treatment results in formation of methane (CH₄) which can be used as an energy source. Therefore anaerobic process followed by aerobic process has proved to be economical in waste treatment.

The degree of removal of organic matter is in direct proportion to the amount of methane produced. If gas production trend is downward continually the digestion process is failing. Gas produced after degradation of organic matter contains about nearly 75-80% CH₄ by volume, 15 to 25% CO₂ & small of N₂, H₂ other gases. Since methane gas has high calorific value. This gas is collected & can be used as an alternative source of energy. Thus, this process becomes economical and effective for high BOD wastes.

1. INTRODUCTION

India is one of the fast developing countries with growing number of industries. The situation is similar to that prevailing in most of the developing countries, which have not been able to develop adequate civic infrastructure even when their number of citizens and industries have increased rapidly. As a result many of cities have grown into overcrowded and ill-equipped settlements with a highly polluted environment prone to frequent epidemics and hardships. Dairy industry has become one of the major food processing industries of the world in current century after the inversion of milk preservation techniques and pasteurization and powderisation technique.

In India near about in 273 dairy plants processing and supplying 18.33 million liters milk sold per day through arranged sales. But in whole process large amount of waste water generates, that’s why it is necessary to treat that water by using sustainable method like UASB reactor (i.e. Upflow Anaerobic Sludge Blanket reactor).

The Upflow Anaerobic Sludge Blanket (UASB) process is one of the recent developments in field of anaerobic treatment. In this process the use of primary treatment and the filter bed is completely eliminated. The UASB process is seen as one of the most cost effective & efficient anaerobic treatment. The anaerobic treatment results in formation of methane (CH₄) which can be used as an energy source. Therefore anaerobic process followed by aerobic process has proved to be economical in waste treatment.

2. LITERATURE REVIEW

In any dairy plant, the quantity and characteristics of effluent is depending upon the extent of production activities, pasteurization of several milk products. The anaerobic digesters are used in the first phase of treatment, which is followed by high rate aerobic treatment.

Upflow Anaerobic Sludge Blanket reactors are designed. UASB is a hybrid type of reactor, involving both suspended and attached growth...
process. This study involves the treatment of dairy industry wastewater by UASB reactor by varying the retention times in days for a particular organic loading rate. This has effectively removed BOD, COD and other parameters because of the combined suspended and attached growth processes. [1]

Anaerobic wastewater treatment differs from conventional aerobic treatment. The absence of oxygen leads to controlled conversion of complex organic pollutions, mainly to carbon dioxide and methane. Anaerobic treatment has favourable effects like removal of higher organic loading, low sludge production, high pathogen removal, biogas production and low energy consumption. Application of anaerobic systems for municipal sewage treatment is so far very limited. The predominant reason given for is, that municipal sewage are to weak (to low BOD or COD) to maintain high biomass (in the form of granules – suspended solids or fixed film) content in reactor.[2]

3. CHARACTERISTICS OF WASTE WATER

3.1 Physical characteristics:
   a) Colour  b) Odour  c) Temperature  d) Solids:

3.2 Chemical characteristics:
   a) Chloride  b) Alkalinity  c) Acidity  d) Hydrogen Concentration  e) Biochemical Oxygen Demand (BOD)  f) Chemical Oxygen Demand (COD)

3.3 COMPOSITION OF TYPICAL DAIRY WASTEWATER:

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Parameters</th>
<th>Value</th>
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<tr>
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<tr>
<td>2</td>
<td>Alkalinity</td>
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<tr>
<td>3</td>
<td>Total Dissolved Solids</td>
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<td>4</td>
<td>Suspended solids</td>
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<td>5</td>
<td>BOD</td>
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<td>6</td>
<td>COD</td>
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<td>8</td>
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<td>9</td>
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<tr>
<td>10</td>
<td>Chlorides</td>
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4. ANAEROBIC SUSPENDED GROWTH TREATMENT PROCESSES

In the post ten years a number of different anaerobic processes have been developed for the treatment of sludges and high-strength organic wastes. Some commonly use anaerobic suspended growth treatment processes are given as follows: A) Anaerobic digestion, B) Anaerobic contact process, C) UASB blanket.

- **Up-flow anaerobic sludge-Blanket process**
  In the up flow anaerobic sludge-blanket (UASB) process, the wastewater flows upward through a sludge blanket composed of biologically formed granules or particles. Treatment produced under anaerobic conditions (principally Methane and carbon dioxide) cause internal circulation, which helps in the formation and maintenance of the biological granules. Some of the gas produced within the sludge blanket becomes attached to the biological granules. The free gas and the particles with the attached gas rise to the top of the reactor.

4.1 Factors Affecting Anaerobic Digestion

A. Environmental factors:
   1) PH & Alkalinity  2) Volatile acid concentration  3) Temperature  4) Nutrient Availability  5) Toxic materials

B.Basic Factors:
   1) Bacteria  2) Food  3) Contact  4) Time.

5. UASB PROCESS AND EXPERIMENTAL SETUP

- **Brief History UASB:**
  The UASB process was developed by Dr. Gatze Lettinga (and colleagues in the late 1970's at the Wageningen University. Inspired by publications of Dr. Perry McCarty, Lettinga's team was experimenting with an anaerobic filter concept. The anaerobic filter (AF) is a high rate anaerobic reactor in which biomass is immobilized on an inert porous support material. During experiments with the AF, Lettinga had observed that in addition to biomass attached on the support material, a large proportion of the biomass developed into free granular aggregates. The UASB concept crystallized during a trip Gatze Lettinga made to South Africa, where he observed at an anaerobic plant treating wine vinasse, that sludge was developing into compact granules. The reactor design of the plant he was visiting was a "clarigestor", which can be viewed as an ancestor to the UASB. The upper part of the "clarigestor" reactor design has a clarifier but no gas cap.
Internal three-phase GSL device:

Installed at the top of the tank, the GSL device constitutes an essential part of an UASB reactor with following functions:

1) To collect, separate and discharge the biogas formed.
2) To reduce liquid turbulences, resulting from the gas production, in the settling compartment.
3) To allow sludge particles to separate by sedimentation, flocculation or entrapment in the sludge blanket.
4) To limit expansion of the sludge bed in the digester compartment.
5) To reduce or prevent the carry-over of sludge particles from the system.

6. CASE STUDIES

Thorat Milk Production: Sangamner

Dairy has set up on UASB reactor by March 1998, the reactor was the first UASB treatment for dairy in the state of Maharashtra. The reactor was designed by Netherlands technology. This reactor made the table of waste water treatment much easier effective and also was much economical giving good end-result.

Dimensions: Ht – 6.5 m.
a) Equalization tank:
At first the waste water gets collected so that the waste substrate can be equalized and the pH is maintained strictly processing to the UASB reactor.

b) Oil skimming tank:
The waste water after being neutralized is passed through the oil skimming tank in order to remove the oils fats, grease remained in the waste; because if this goes without skimming then if chock up the UASB and proper working will not be done.

c) Buffer tank:
It is a storage tank where the waste water from oil skimming tank comes and from the here is supplied is the UASB reactor. Also the excess of waste-waste that is present in UASB is again brought to the buffer tank.

d) UASB Reactor: It is a reactor where sludge from and waste is treated at the bottom of reactor. The wastewater blows up through a sludge blanket composed of biologically formed granules. Thus treating under anaerobic condition gives out geese which are collected to the dome shaped structure and the waste water is collected in the side way hoods. The up flow velocity is in the range of 0.6-0.9 m/hr.

Figure 6.2: UASB Reactor (Plan)

There is a small pipe attached through which is goes down in to the tank. The gas collected in transferred to the foam trap

Figure 6.3: UASB Blanket Process

Figure 6.4: Bottom Distribution System

7. CONCLUSION
• This anaerobic system of digestion can be used in small scale for the treatment of domestic waste water.
• An arrangement can be made for the continuous loading of digesters and a better gas collection system.
• After the treatment Dairy waste water can be used for agriculture purpose and the formed methane (CH4) which can be used as an energy source.
• In this process the use of primary treatment and the filter bed is completely eliminated.
• The UASB process is seen as one of the most cost effective & efficient anaerobic treatment.

9. REFERENCES:

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[2]. Department of Civil Engineering, Sri Ramakrishna Institute of Technology
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