Environment Conservation Journal 4 (1-3) 1-7, 2003
(ISSN 0972-3099)

Pollution abatement and environmental preservation

Ashutosh Gautam and D.R. Khanna*

India Glycols Ltd., A-1 Industrial Area, Bazpur Road, Kashipur 244713,
*** Department of Zoology and Environmental Sciences, Gurukul Kangri University Haridwar**

Abstract

In the recent years there has been a growing concern over the problem of municipal and industrial waste disposal. In India city sewage, distilleries, tanneries, breweries, sugar mill and food processing units are the major source of organic pollution in water resources. Our growing concern about the availability of clean environment/water makes us more conscious to develop effective and beneficial treatment technologies for the liquid wastes. Anaerobic treatment of liquid waste, having high concentration of biodegradable organic matter, is a competent method to overcome this problem. With the aid of anaerobic treatment technology such wastes can be used to extract some useful products/by products and energy, like-biogas. Biogas is a clean and effective substitute of other conventional energy sources, i.e. coal. The paper highlights major issues of anaerobic treatment along-with the cost economics.

Key Words ***Wastewater; Anaerobic Treatment; Biogas***

Introduction

Water is the elixir of life. In our day to day life we are using this vital natural resource for a variety of purposes, like drinking and other domestic uses, irrigation, power generation, industrial cooling and finally for waste disposal. Continuous practice of our society to use water resources as a natural dustbin is creating the greatest problem of this century-The water pollution. Water pollution may be of

different types depending upon the constituents causing pollution, for example, organic pollution is mainly caused by the discharge of organic wastes of wastes containing organic material. Such wastes when enter a water body, dissolved oxygen is consumed in their oxidation or breakdown by microorganisms. The more the oxygen required for oxidation, the greater will be the deoxygenating, which can cause adverse impacts on the existing flora and fauna of the water body. Pollutants in the category of organic pollution generally comes from such sources as : domestic/city sewage, food processing units, distilleries, pulp & paper mill, sugar mill, breweries, dairy, slaughter house, etc. Thewater pollution problems in developing countries, like India, are still at a stage where effects can be abate if action is taken in time. Always, it is easier and advantageous to control pollution at the early stages rather than investing huge capital to protect and purify the water resources at later stages like-Ganga Action Plan.

Waste

Waste is the disposal/discharge of material, residues and energy into the environment. Of these, some are unconvertible raw materials, some are un-recovered final products and some are by products. Thus discharge of waste in the environment creates a problem of environmental pollution. In other words it can be considered that we are loosing by two ways. Firstly, we are loosing our valuable material and secondly we are polluting our environment, thereby our natural resources.

Liquid waste containing biodegradable organic matter can be used to produce some useful products/energy like-methane rich fuel gas commonly termed as Biogas.

Water Pollution Control

On the discharge of untreated organic waste to aquatic environment:-

1. Dissolved oxygen level of the receiving aquatic body diminishes and results into subsequent damage to the aquatic organisms.
2. High turbidity hinders the penetration of sunlight which adversely affects the photosynthetic activity.
3. Floating impurities and foul smell due to the presence of organic matter makes water unsuitable for recreational purposes.
4. Water no longer remains suitable for domestic/irrigation purpose.

Bioaccumulation / Biomagnification / Bioamplification of toxic material takes place which ultimately attack the human population.

Therefore, the control of water pollution is essential and require instant attention and devotion. The most effective way to control water pollution is the treatment of waste water in an efficient and suitable effluent treatment plant before its discharge. The main objective is to minimize harmful constituents to an acceptable level with or without by-product recovery. Various suggested methods are:-

1. Physico-Chemical Methods.
2. Biological Treatment Methods.
3. Production of Green Manure (Composting).

1. Physico-Chemical methods are generally used in separating the heavy materials and to neutralize the acidity. These are-Screening, Sedimentation, Floculation. \ Neutralization etc.
2. The objective of biological treatment is to remove oxygen consuming organic matter by the help of microorganisms, capable in oxidizing the organic matter. Biological treatment is often the most competent method.

These are of two types:-

(i) Aerobic: microorganisms require oxygen to oxidize the organic matter and produce carbon dioxide as a by-product.
(ii) Anaerobic: microorganisms does not require oxygen and produce biogas as a by product.

3 Incineration is the drying of organic wastes and the dried material may be disposed off on land.
4. Liquid organic waste can be utilized to produce green manure by treating with solid wastes (composting). The production of green manure with this method is highly beneficial and the manure produced is always better than the chemical manure.

Anaerobic Treatment of Organic Wastes

Anaerobic digestion with methane recovery is indeed the most rational approach in present times of

energy crisis. This treatment of organic wastes is also known as methanization or methane fermentation. Methane generation from the rotting or organic matter has been known since the 18th century. Volta identified this as marsh gas. The first use of this valuable gas as a fuel was recorded in

1875, when it was used for lightening the street light of a city in England. Due to various advantages (with few drawbacks) this method has gained a paramount interest and widespread acceptability. Several technologies are available in the market to produce biogas from organic wastes. Process design alternatives for anaerobic treatment of organic wastes may be identified as anaerobic filter process, anaerobic single stage process and acid methane segregation process.

Anaerobic filter process:- has been developed to treat strong wastes, having high concentration of organic matter. The reactor contains a solid support, usually plastic matrix or stones. In this process microorganisms grow attached to the support material or as free blocks in the interstices.

Single stage anaerobic process:- is a conventional anaerobic treatment process. This is a combined one step process of all activities (acid formation and methane formation) required to recover methane rich fuel gas from organic waste. In this process only a single reactor is required.

Acid methane segregation process:- is a microbial segregation process where acid producing and methane producing microorganisms are allowed to grow in different reactors under different environmental conditions. This process enhanced the activity of microorganisms to utilize organic compounds more effectively.

Identification of Organic Wastes for Anaerobic Treatment

The liquid waste have high concentration of biodegradable organic material with adequate nutrients and micro-nutrients these are quite suitable for anaerobic treatment and can be utilized to produce biogas. These wastes should be free from toxic substances. In terms of BOD the wastes from distillery, starch, pharmaceutical, city, pulp and paper, slaughter house, tannery, brewery, sugar mill, etc. are highly suitable for the production of biogas with the help of anaerobic treatment. It is essential to know the status of organic waste before adopting the technology.

Process Parameters for Anaerobic Treatment

Every process depends upon several environmental conditions. For the anaerobic treatment

temperature, pH, nutrients and the presence of toxic substances are important.

Temperature

The most suitable temperature range is 30-40^{o}C. In the lower range of the temperature the process remain low due to low activity of the microorganisms, whereas in the higher range it initially touches the peak but after that is slows down due to the sudden fall in the activity and the number of microorganisms. Sudden variations in temperature results in temporary shut of the activity, but a long hold can cause degradation in the treatment process. On the basis of temperature range the process and the microorganisms are of three types i.e. Cryophilic (between 0-25 ^{o}C), conversion rates are slow. Mesophilic (between 30-40 ^{o}C) and Thermophilic (between 50-70 ^{o}C), the conversion rates are high due to high microbial activity. Normally the mesophilic range of temperature is most suitable and cost effective for the anaerobic treatment.

pH

The most suitable pH range for anaerobic treatment is 7.0-7.5, but it can be operated upto 8.0, the experimentation shows that in the higher pH range biogas have increased concentration of methane of the two bacteria, involved in anaerobic treatment, acidogens are capable of performing their activity between 5.0-6.0 pH range whereas 7.0-8.0 is suitable for methanogens.

Nutrients

Various studies showed that Organic waste must be rich in nutrients and micronutrients for better anaerobic treatment. The main nutrients are N and P. In different technologies the rate of nutrients varies as per the COD/BOD loading rate.

Toxic substances
Like other biological process anaerobic treatment may also be affected by the presence of toxic substances. For this process sulphide, ammonia and higher fatty acids are the most consequential.

These compounds always try to inhibit the microorganisms activity which ultimately end in the lowering of BOD/COD reduction and biogas production.

Advantages of Anaerobic Treatment

Anaerobic treatment process has several advantages from other biological processes. Few important are discussed hereunder.

1. This can accept high organic loading since oxygen requirement is nil.
2. This produces a useful by-product, viz., Biogas.
3. This can be operated after a long non-operating gap.
4. Since the reactor is closed no offensive odour exists.
5. Sludge production is low.
6. Possible direct utilization of sludge as a manure.
7. Treated effluent can be used for aquaculture. The main advantage is the production of biogas, which can be used as a clean and environment friendly fuel.

Biogas

Biogas is a composite mixture of methane, carbon dioxide and hydrogen sulphide produced naturally by the decomposition of organic matter. The composition of all the three gases differ from time to time and technology to technology. The main composition is - Methane (CH_4)-50-70%, Hydrogen sulphide (H_2S) - 2-5% and Carbon dioxide (CO_2) - rest. The calorific value of the biogas is approximately 5000 K.cal/NM^3. Biogas is a good substitute of conventional energy sources like wood, coal, kerosene, etc. Biogas production from organic wastes varies from waste to waste. Generally, it ranges from 0.1 M^3 to 0.55 M^3/Kg. of COD reduced.

Benefits from Biogas

There is an assumption to know exactly how much biogas is beneficial to us.

Let us consider a strong organic waste i.e. waste from distillery (Spentwash). 1 M^3 of distillery waste can produce 25-35 NM^3 of biogas.
(The variation is due to technology difference.)

Methane percentage	-70%
Calorific Value	-5000 K.Cal/NM^3
Calorific value of coal	-4500 K.Cal/NM^3
Combustion efficiency of coal -	-75%
Combustion efficiency of gas	-90%
Equivalent coal	-1.33 Kg/NM^3

therefore,

$1M^3$ of distillery waste can save 33-50 Kg of coal. Other than this,saving of transportation cost of coal,

saving of energy in terms of diesel and conservation of environment are indirect benefits.

Conclusion

The foregoing discussion evidently revealed that biogas is highly beneficial. It can reduce the problem of energy crises and environmental pollution. Therefore, it is essential to popularize anaerobic treatment as an obligatory step to all, producing/discharging organic wastes into the water bodies.

References

Gautam, Ashutosh 1992 Energy from waste and pollution control. **Chemical EngineeringWorld** : 28(9), 89-90.

Kaul, S.N., Nandy, T and Trivedy, R. K. 1995 Pollution Control in Distilleries. **Enviro Media**, Karad, India.

Sastry, C.A. 1989 Water pollution control. **Industrial Safety Chronical** : Oct.-Dec.89, 48-61.