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Treatment of Leachate by Anaerobic Digestion Method

Dr. Shashikanth R. Mise[1] Shilpa[2]

[1]Professor PG Environmental Engineering Course PDA College of Engineering. Kalaburagi 585102 Karnataka.
[2]M.Tech Scholar Environmental Engineering Division Civil Engineering Department PDA College of Engineering .Kalaburagi 585102 Karnataka India

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Abstract - *This paper related to the treatment of Leachate by anaerobic digestion method under controlled conditions. The Leachate is taken from municipal waste disposal site in Gulbarga. A laboratory scale models of anaerobic digester of 8L capacity, with gas collecting bottles were setup to treat leachate. The performance of the reactor in removing COD, BOD,Total Solids were studied, with reference to different organic loading rates of 1.6, 3.2, 4.8 and6.4 kg COD/m3.d. The highest yield of percentage COD, BOD, and Total Solid removal is 67.55%mg/L, 60.45% and 63.07% respectively at 6.4 kg COD/m3.d. Organic loading rate.*

Key Words: **Anaerobic Digestion, COD, Organic Loading Rates, Total Solids, Land filling, Leachate, Organic and inorganic constituents.**

1. INTRODUCTION

Increase in population along with urbanization and industrialization towards achieving high quality of life and well being of population, has resulted in high rate of solid waste being generated in India. Waste can be solid, liquid, or gaseous and each type has different methods. Solid waste is generated from households, offices, shops, markets, restaurants, public institutions, industrial installations. It is any garbage, refuse, sludge from a wastewater treatment plant, water supply treatment plant. Per capita generation is 0.16 to 5.7kg per person per day, and has average of 1.1kg per capita per day. The OECD (organization for economic cooperation and development) countries generate 572 million tones of solid waste per year. Municipal solid waste collected by municipalities or other authorities. Waste, garbage, trash, junk, debris, and refuse are all names given to that "stuff" that are no longer useful in its current form. In contemporary society, many of the items used daily are designed to be used and discarded. An everyday tonne of solid waste is disposed off at various landfill sites these landfill site produce foul smell if waste is not stored and treated properly. It can pollute surrounding air and can seriously affect health of humans, wildlife and our environment. These solid wastes are generally disposed of in low laying area called sanitary landfill area by the municipal authorities. These rules have specified many complains for the management of solid waste for the state committee and pollution board, which includes proper segregation of solid waste into biodegradable waste, recyclable and others that is non recyclable wastes are stored in colored bins at the source of generation and properly treated, recycled and disposed to landfill areas.

Substances that make up leachate can either be useful or harmful to the environment. An example of a useful component of leachate is water. Water is essential in plant and animal life. Without water there will be no life. However, there several other components of leachate that have adverse effect to the environment, plant and animal lives. The concentration of such substances in leachate has to be reduced before leachate is discharged to the environment. Leachate must be treated before discharging to environment. Many different physio-chemical techniques such as adsorption, chemical precipitation, coagulation/flocculation, chemical oxidation and biological methods have been being applied for the treatment of landfill leachate. Anaerobic digestion is one of the most useful method.

A. Anaerobic Digestion: Anaerobic digestion is the breakdown of organic material by microbial pollution that lives in oxygen free environment. When organic matter is decomposed an anaerobic environment the bacteria produce mixture of methane and carbon dioxide gas. Anaerobic digestions treat waste by converting putrid organic material into carbon dioxide and methane. The methane is referred as biogas. Anaerobic digestion treats waste by converting putrid organic materials to carbon dioxide and methane gas. This gas is referred to as biogas. During the anaerobic treatment process, organic nitrogen compounds are converted to Ammonia, Sulphur compounds are converted to hydrogen Sulphide, Phosphorus to Orthophosphates, and Calcium, Magnesium, and Sodium are converted to a variety of salts. Through proper operation, the inorganic constituents can be converted to a variety of beneficial products. The end products of anaerobic digestion are natural gas (methane) for energy production and heat, nutrient rich organic slurry, and other marketable inorganic products.

ADVANTAGES OF ANAEROBIC DIGESTER

1) Anaerobic digesters can handle higher organic loading rates.
2) Generate less biomass leading to less generation of digester sludge.
3) Can degrade some difficult to degrade organic chemicals.

4) Produce energy in the form of CH_4 gas as a useful by-product.

B. Anaerobic Digestion (Stages)

STAGE1: Hydrolysis-Complex organic molecules like proteins, polysaccharides, and fat are converted into simpler ones like peptides, saccharides, and fatty acids by exoenzymes like cellulase, protease, and lipase produced by hydrolytic and fermentative bacteria. End products are soluble sugars, amino acids, and glycerol and long-chain carboxylic acids.

STAGE 2: Acidogensis - The monomers produced in the hydrolytic phase are taken up by different facultative and obligatory anaerobic bacteria and are degraded further into short chain organic acids such as butyric acids, prop ionic acids, acetic acids, alcohols, hydrogen and carbon dioxide. In general, during this phase, simple sugars, fatty acids and amino acids are converted into organic acids and alcohols.

STAGE 3: Acetogenesis In this stage, Acetogenic bacteria, also known as acid formers, convert the products of the first phase to simple organic acids, carbon dioxide and hydrogen. The principal acids produced are acetic acid (CH_3COOH), prop ionic acid (CH_3CH_2COOH), butyric acid ($CH_3CH_2CH_2COOH$), and ethanol (C_2H_5OH). The products formed during Acetogenesis are due to a number of different microbes, e.g., syntrophobacter wolinii, a propionate decomposer and sytrophomonos wolfei, a butyrate decomposer. Other acid formers are clostridium spp., peptococcus anaerobes, lactobacillus, and actinomyces.

STAGE 4: Methanogenesis- Finally, in the third stage methane is produced by bacteria called methane formers (also known as methanogens) in two ways: either by means of cleavage of acetic acid molecules to generate carbon dioxide and methane, or by reduction of carbon dioxide with hydrogen. Methane production is higher from reduction of carbon dioxide but limited hydrogen concentration in digesters results in that the acetate reaction is the primary producer of methane. The methanogenic bacteria include methanobacterium, methanobacillus, methanococcus and Methanosarcina. Methanogens can also be divided into two groups: acetate and H_2/CO_2 consumers. Methanosarcina spp. and methanothrix spp. are considered to be important in AD both as acetate and H_2/CO_2 consumers

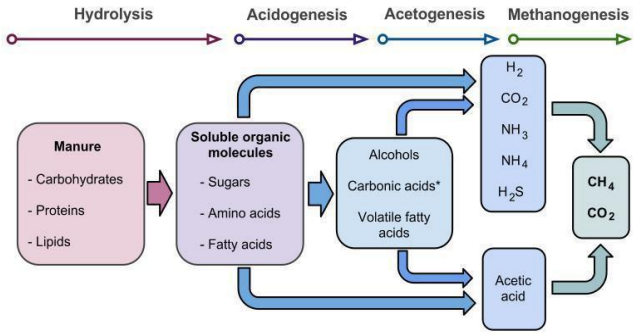

Figure -1: steps in anaerobic digestion

11.1 Objectives of the Study

1) Treatment of Leachate by Anaerobic digester method.
2) Comparison of removal efficiency of various parameters like BOD, COD Total solid.

2. Material and Methodology

2.1 Sampling

To determine the quality of Leachate, integrated samples was collected from landfill locations. Leachate sample for the study was collected from the land filling sites of Gulbarga city as shown in figure2 i.e. first land filling site is on ring Road at Udnoor Village having 28 acres of low lying land area. These sites are engineered low lying open dumps. They have bottom liner for Leachate collection system. These land filling sites were equipped with Leachate collectors. Leachate samples were collected from the base of solid waste heaps where the Leachate was drained out by gravity.

Figure -2: Showing the Location of Udnoor Site.

2.2. Fabrication and Experimental Setup

The schematic diagram of experimental setup used for the present study is shown in figure 3. Aspirator bottle no.1 of 10.0L capacity will be used as digester with working volume of 8.0L. The digester was connected with the bottleno.2 of 5.0L capacity, which will contain the brine solutions .The amount of gas collected in bottle no. 2 replaces the same amount of brine solution to bottle no. 3. The study was carried out for different organic loading rate of 1.6-6.4 kg COD/m3.d at ambient temperature (room temperature).

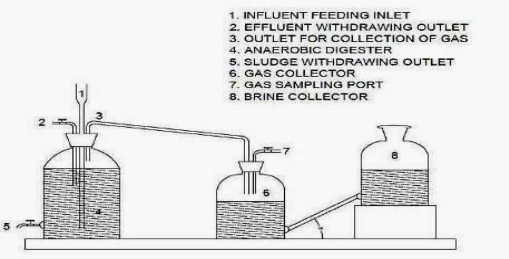

Fig -3: Experimental setup of anaerobic digester

3.3. Startup of Reactor

During the start-up of the reactor is initially loaded with a COD concentration of 2000 mg/L and seed sludge is used from UASB reactor. The reactor pH effluent sample was collected for analysis of various physico-chemical parameters such as pH, COD, BOD, total solids and the analysis were carried out as per the standard methods for the examination of water and waste water (AWWA) 20th edition.

3.3. General Characteristics of Leachate

The Leachate samples were brought from Udnoor sites Kalaburagi, Karnataka." to P.D.A Engineering College laboratory and preserved in deep freeze, to analyze the typical characteristics. The key pollutants in the wastewater are organic compounds and solids. Biodegradability may be estimated on the basis of BOD /COD ratio. This ratio ranges between 0.43-0.64, which indicates that the part of the organic compounds in the wastewater is not easily biodegradable. The BOD5 is 9748mg/L, COD is 16248mg/L & Total Solids in waste water was found to be 8490 mg/L. When Leachate contains high concentration of organic matter, dissolved oxygen depletes because of the breakdown of organic matter, in absence of oxygen sulphate acts as an electron acceptor to produce H_2S and odour.

4. Results and Discussion

The results of variation of percentage COD, percentage BOD and percentage Total solid removal are shown in Chart 1, Chart 2, Chart 3 and Chart 4 for varying Organic Loading Rate (1.6-6.4kgCOD/m3.d).

The reactor was started with an OLR of 1.6 kg COD/m3.d and operated for a period of 15 days till it attains stabilization. During this period the pH is maintained from7.20-7.40. The COD reduced from 1940-760 mg/L, BOD reduced from 1117-477mg/L and Total solid reduced from 2028-815 refer Figure 4. On 15th day the maximum COD, BOD and Total solid removal efficiency obtained is 62%, 60.21% and 60.4%. As the time increased, %COD removal increased& attained optimum value on 15th day.

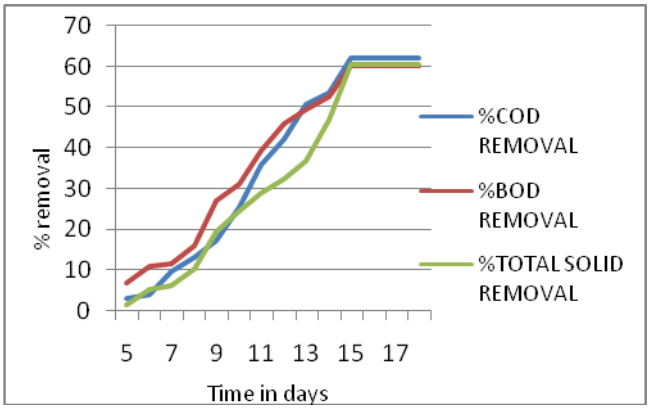

Chart -1: Variation of % COD, % BOD and Total solids for OLR=1.6 kg COD/m3.d

When the OLR was increased from 1.6 to 3.2 kg COD/m3.d &operated for a period of 18 days till it attains stabilization. Throughout the study period the pH is maintained from7.15-7.36, the COD reduced from 3880-1464 mg/L , BOD reduced from 2279-973mg/L and Total solid reduced from 3853-1549 refer Figure 5. On 15th day the maximum COD, BOD and Total solid removal efficiency obtained is 63.4 %, 59.4% & 62.2%. As the time increased, %COD removal increased & attained optimum value on 15th day.

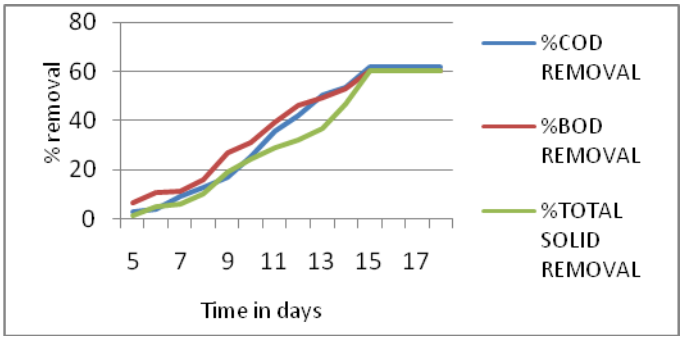

Chart -2: Variation of % COD, % BOD and Total solids for OLR=3.2 kg COD/m3.d

When the OLR was increased from 3.2 to 4.8 kg COD/m3.d &operated for a period of 18 days till it attains stabilization. Throughout the study period the pH is maintained from7.10-7.40, the COD reduced from 5874-1996 mg/L, BOD reduced from 3418-1500mg/L and Total solid reduced 5780-2280 refer Figure 6. On 15th day the maximum COD, BOD and Total solid removal efficiency obtained is 66.7 %, 58.3% & 62.3%. As the time increased, %COD removal increased & attained optimum value on 15th day.

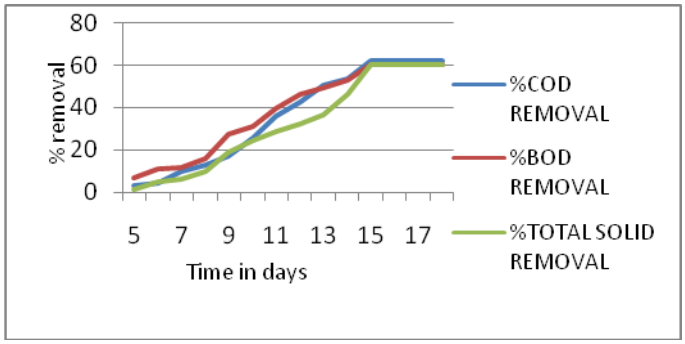

Chart -3: Variation of % COD, % BOD and Total solids for OLR=4.8 kg COD/m3.d

When the OLR was increased from 4.8 to 6.4 kg COD/m3.d &operated for a period of 18 days till it attains stabilization. Throughout the study period the pH is maintained from7.10-7.40, the COD reduced from 7795-2596 mg/L , BOD reduced from 4559-1848mg/L and Total solid reduced 7514-2964 refer Figure 7. On 15th day the maximum COD, BOD and Total solid removal efficiency obtained is 67.55 %, 60.45% & 63.7%. As the time increased, %COD removal increased & attained optimum value on 15th day.

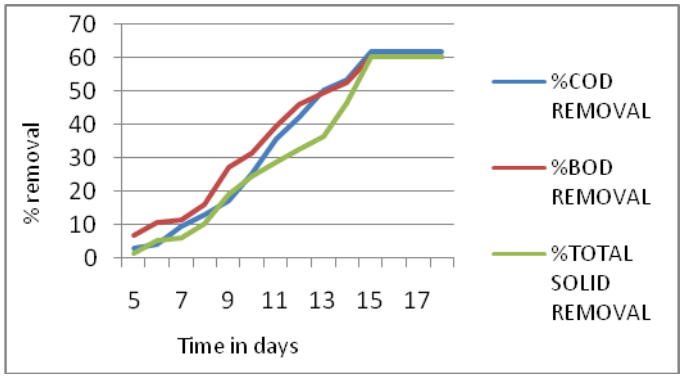

Chart -4: Variation of % COD, % BOD and Total solids for OLR=6.4 kg COD/m3.d

5. Conclusion

Leachate is biodegradable in nature as the value of BOD/COD ratio is 0.63.Slightly alkaline pH is maintained for all the loadings to improve the performance. The % removal efficiency of COD, BOD, TS is high at the OLR 6.4 Kg.COD/m3.d.For OLR of 6.4 Kg.COD/m^3.d the maximum removal efficiency of COD, BOD,TS obtained are 67.55%, 60.45% and 63.07% respectively hence for the Bench scale model this is selected as Optimum Organic Loading Rate

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