Anaerobic treatment of organic wastewater At ambient temperature

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Abstract— Water is one of the most valuable resources on Earth. Which becomes scarce globally. And due to discharging untreated wastes of high levels of inorganic pollutants in rivers and lakes that increase the impact loads on the ecosystems, so cleanliness of our lakes and rivers became one of the pressing goals for environmental protection. Biological treatment processes are widely used in the wastewater treatment industries. Anaerobic treatment is used for industrial or domestic purposes to converts the wastewater organic pollutants into small amount of sludge and large amount of biogas, it has the advantages of lower treatment costs with no secondary pollution, It is frequently used for medium to high strength wastewater, in our research we used chemical oxygen demand (COD) as a main parameter to indicate the ability of wastewater to be degraded by anaerobic treatment under ambient room temperature (approximately 35oC) by evaluating the start-up process and the operation performance during the experiment process we got closer to our COD target then Suddenly for unknown cause the COD started to increase again while methane gas still evolves.

Index Terms- methane, Anaerobic, Wastewater, Biogas, Organic waste, Sludge, Aerobic

1 Introduction

Water is one of the most valuable resources on Earth. Water and sanitation have a great effect on human health, food security and quality of life. Demands on water resources for household, commercial, industrial, and agricultural purposes are increasing greatly. Yet water is becoming scarce globally, with much indication that it will become even more scarce in the future. More than one third of the world's population roughly 2.4 billion people live in water stressed countries and by 2025 the number is expected to rise to two-thirds [1].

In some developing countries is commonly discharge untreated wastes in water bodies like rivers and lakes, which contain high levels of inorganic pollutants which can be easily biodegradable, which are impact loads on the ecosystems, either in Total Suspended Solids (TSS), Bio-chemical Oxygen Demand (BOD), or COD, may be in the tens of thousands mg/L [2].

Egypt's main source of freshwater is the Nile, which is subjected to unsustainably and shockingly high levels of industrial, agricultural and domestic wastewater pollution. Along the Nile valley between the Aswan High Dam and Cairo, there are 43 towns and approximately 2,500 villages, with a total population exceeding 20 million; all of them discharge their waste water and untreated sewage into the Nile [3]. Another problem is in the collection, treatment and disposal of effluents. This situation leads to serious public health problems. According to the Ministry of Water Resources and Irrigation, Egypt. Stated that Egypt has reached a state where the quantity of water available is imposing limits on its national economic development. As indication of scarcity in absolute terms, often the threshold value of 1000 m^3/capita/year, is used. Egypt has passed that threshold already in nineties. As a threshold of absolute scarcity 500 m^3/ca/yr is used, this will be evident with population predictions for 2025 which will bring Egypt down to 500m^3/ca/yr [4].

The cleanliness of our lakes, rivers is one of the pressing goals for environmental protection. The balance of nature depends therefore on the comprehensiveness of our approach to solve the problem of wastewater disposal. If water of high organic matter content or biochemical oxygen demand (BOD) value flows into a river, the bacteria in the river will oxidize the organic matter consuming oxygen from the water faster than it dissolves back in from the air. If this happens, fish will die from lack of oxygen, a consequence known as fish kill. A stream must have a minimum of about 2 mg/l of dissolved oxygen to maintain higher life forms. In addition to this life-sustaining aspect, oxygen is important because the end products of chemical and biochemical reactions in anaerobic systems often produce aesthetically displeasing colours, tastes and odours in water [5]

Wastewater treatment systems consist of physical, chemical and biological processes. The biological mechanism makes use

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of living organisms (generally bacteria) enhancing their functions in the natural ecosystems Biological treatment processes are widely used in the wastewater treatment industries. However, aerobic and anaerobic treatment processes can result in wastewater that is difficult to treat and handle.

Anaerobic digestion is a collection of processes by which microorganisms break down biodegradable material in the absence of oxygen. Anaerobic treatment is used for industrial or domestic purposes to convert the wastewater organic pollutants into small amount of sludge and large amount of biogas, a mixture of methane and carbon dioxide and low energy consumption [6]. In comparison to other biological methods of wastewater treatment, it has the advantages of lower treatment costs with no secondary pollution [7].

Anaerobic wastewater treatment is becoming an accepted technology for treating various types of wastewater. It is frequently used for medium to high strength wastewater (2,000 to 20,000 mg IL COD), but has had fewer applications to low strength wastewater 1,000 mg IL COD) especially in developed countries. In order to understand the applicability of anaerobic treatment for low strength wastewater, such as domestic wastewater, anaerobic wastewater treatment has the potential to reduce greenhouse gas emissions. A model was developed to estimate greenhouse gas production from domestic wastewater treatment and to compare the differences between aerobic and anaerobic methods. The greenhouse gas contributors of C02 and Ca. are included in the analysis, while N20 is neglected. Anaerobic wastewater treatment reduces carbon dioxide emissions through energy conservation but the dissolved methane in the anaerobic reactor effluent can offset this reduction when treating low strength wastewater. [8]

In general, aerobic systems are suitable for the treatment of low strength wastewater (biodegradable Chemical Oxygen Demand (COD) concentrations less than 1000 mg/L) while anaerobic systems are suitable for the treatment of high strength wastewaters (biodegradable COD concentrations over 4000 mg/L). According to Cakir and Stenstrom [9], while highly polluting industrial wastewaters are preferably treated in an anaerobic reactor due to the high level of COD.

There are many different measures of water quality, and the quality of the water often depends upon its use [10]. Dissolved oxygen is an essential parameter that is used to determine the water quality. Dissolved oxygen is important because it determines what happens in the water, whether the water is clean or not. Biochemical oxygen demand (BOD) and chemical oxygen demand (COD) are the main parameters used to indicate the ability of wastewater to be degraded.

(COD) is a measure of organic compounds & other oxidisable elements present in water? This is directly related to aesthetic quality of water. The minerals and impurities are normally present in very small concentrations are measured either as parts per million (ppm) (how many parts of impurities in a million parts of water) or milligrams per liter (mg/l). The terms are equivalent at low concentrations and are used interchangeably in the water and wastewater. [11].

In the paper [12], Sugar industry wastewater was treated in a UASB reactor seeded with no granular anaerobically digested sewage sludge. Under ambient room temperature between 29-37oC. The reactor was loaded up to 16 g COD/L. A maximum COD removal efficiency of 89.4% was achieved. The COD removal rate linearly increased with increase in organic loading rate (OLR) at ambient temperature.

Hence, The purpose of this study is to examine the biodegradability of organic components in wastewater by anaerobic treatment under ambient room temperature (approximately 35oC) by evaluating the start-up process and the operation performance.

2 EXPERIMENTAL PROCEDURE

2.1 Review Stage

- The anaerobic digester comprises two 5-litre upward-flow packed bed reactors with feed rate and temperature control facilities to allow steady.
- The reactors may be operated in series or parallel.
- A buffer vessel between the reactors permits discharge of excess flow from the first reactor when the second reactor is operated in series but at a lower flow rate.
- The flow rates to the vessels are set and controlled by calibrated pumps.
- The temperature of each reactor is controlled by an electric heating mat wrapped around the external wall.
- The gas off-take from each reactor is taken to a volumetrically calibrated collector vessel operating by water displacement.
- The collected gas can be exhausted from the vessel and the volume re-filled with water during a run without breaking the liquid seal.
- The equipment is mounted on a vacuum formed plastic base with an integral drain channel to cope with spillages and wash down.

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2.2 Materials required

Water: - 8L.
Sugar: 24 gm for 8L.
Sludge: - 500 kg for 8L.

2.3 Chemicals required

Potassium dichromate.
Sulphuric acid.
Sodium dihydrogen orthophosphate .1 hydrate ".

2.4 Apparatus required

Anaerobic digester.
Spectrophotometer.
COD digester.
COD vials with stand.

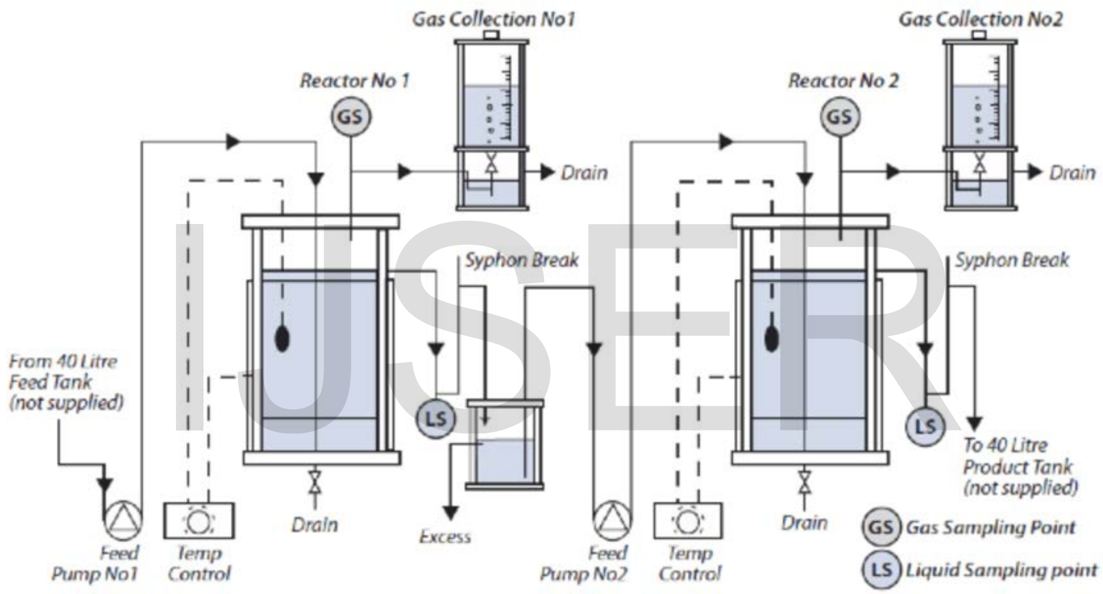

Figure 1 Shows the flow diagram of anaerobic digester [11]

Conical flask.
Graduated cylinder.
Pipettes.

2.5 Steps

- Bring large bath and put 500 Kg sludge + 24 gm sugar +8L water. Then stir them well.
- Divide the components into 2 reactors.
- Fill gas collector with water.
- Set temperature controller at 35 ^{o}C.
- Run the device.
- Take a sample from two reactors to measure chemical oxygen demand (COD).

COD: - is a test used to measure oxygen needed by organic matter in wastewater to oxidize chemically using high oxidizing agent.

Steps to measure COD: -

Firstly we need to make a blank to be my reference in measurement so we make the following steps: -

- Take 2 ml of distilled water in test tube.
- Add 2.5 ml sulphuric acid.
- Add 0.5 ml potassium dichromate.
- Tightly close the tube kept in COD digester at 150 ^{o}C for 2 hours.
- Then measure COD using sphectrophotometer.

After making blank we measure COD of samples by the following steps: -

- Take 5ml of sample from each reactor and put it in graduated cylinder (25 ml) and put on it 20 ml distilled water then shake it well. In order to dilute the sample.
- Take 2 ml of diluted sample in test tube.
- Add 2.5 ml sulphuric acid.
- Add 0.5 ml potassium dichromate.
- Tightly close the tube kept in COD digester at 150 ^{o}C for 2 hours.
- Then measure COD using sphectrophotometer.

3 RESULTS AND DISCUSSSION

We measured COD of sample daily so we had the following results: -

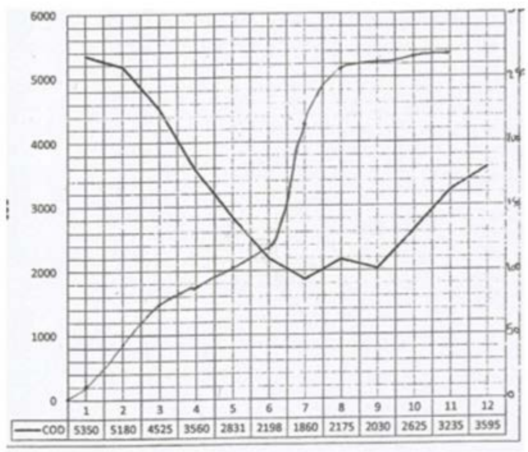

Figure 2 shows The COD vs number of days and how the water is treated

A variety factors affects the rate of digestion and biogas production.

The first factor is time so we took a sample every 24 hours to make COD to know if it increase or not and also we took reading of gas. The reactor was start with an initial COD of 5350. And the effect of time on methane gas generation from sugar industry and bio removal in pollution load (COD) is shown in Figure 2.

At 6th day we notice that COD was 1860 it got closer to our target. Our target that COD be 1000. Suddenly at Day (7) it increased to 2175. We didn't know why but we had some doubts that: -

1- the bacteria ate each other or another type of bacteria reproduced because lack of food.

2- The sugar binded up the water and thus made the water unavailable to the bacteria used.

3-The sludge used may contain pesticides so it will kill bacteria.

The second factor is temperature it is the most important.

Every type of bacteria has an optimum, minimum and maximum growth temperature. Temperatures below the optimum for the growth depress the rate of metabolism of bacteria cells. Above the optimal temperature, the growth rate decrease and thermal death may net decrease in the populations of viable bacterial cells with lowering of methane gas generation as well as COD. So we adjust temperature at 35 ^{o}C (ambient Temperature).

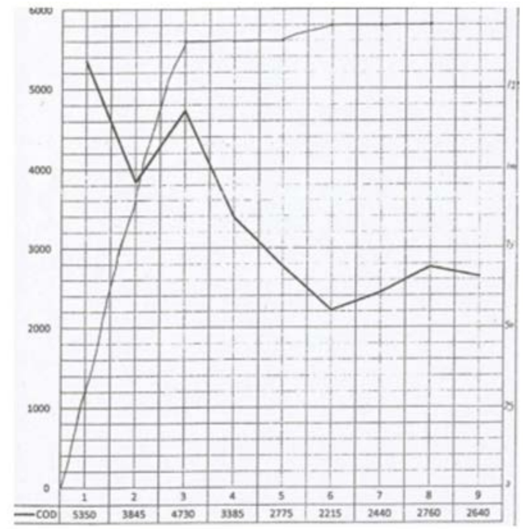

Figure 3 shows COD vs the number of days and how water is treated by adding nutrient.

To overcome the problem of bacteria we made another Experiment and put nutrient (sodium dihydrogen orthophosphate.1hydrate).

We made the same steps and same temperature and the reactor was start with the same COD 5350. We saw that in day (1) the COD decreased. Then at day (2) it increased again and so on. It increased and decreased . but the gas still evolved shown in Figure 3.

4. Conclusions

Generation of methane gas from sugar industry waste water in anaerobic digester using activated sewage sludge mixed bacteria is an effective biomethanation process. but we still don't know why COD increase and Decrease while the methane gas evolves.

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