Removal of Chemical Oxygen Demand from Textile Wastewater by Anaerobic Digestion

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Abstract –This work focuses on monitoring the reduction of COD by Anaerobic Digestion of textile waste water under controlled laboratory conditions. The textile waste water is taken from one of spinning mills nearby city. A laboratory scale model of anaerobic digester of 10L capacity attached with a gas collector was setup to treat the textile waste water. C/N and C:N:P ratio are 16.34 & 218.8:8:1 respectively . BOD/COD ratio is 61.85 % this indicates the waste can be biologically treated. The performance of reactor in removing COD was studied with respect to different organic loading rates of 0.3,0.6,0.9 and 1.2 Kg COD/m^3·d.The higher % removal of COD was found in 0.9 Kg COD/m^3·d.

Keywords : Anaerobic Digestion, Textile Wastewater ,COD ,Organic Loading Rates.

I. INTRODUCTION

The textile industries are required to control their discharges and have effluent treatment plants for environment protection. To protect the environment from the harmful effect of the waste generated, the ministry of Environment, Government of India has set standards for the wastewater and other wastes which are discharged into the Environment after treatment. To ensure that the wastes meet the norms set by the Government, all the textile mills adopt various processes and technologies available in this regard. It is increasingly important in today's advanced way of life, to conserve the natural resources and the environment for the needs of the present and the future generations and economy. So in this regard Anaerobic Digestion(AD) may be one of the way to achieve the required standard economically.

1.1 ANAEROBIC DIGESTION

Anaerobic digestion is a natural biological process. The initials "AD" may refer to the process of anaerobic digestion, or the built systems of anaerobic digesters. Anaerobic digesters represent catabolic (destructive) processes that occur in the absence of free molecular oxygen (O2). The goals of anaerobic digesters are to biologically destroy a significant portion of the volatile solids in sludge and to minimize the putrescibility of sludge. The main products of anaerobic digesters are biogas and innocuous digested sludge solids. Biogas consists mostly of methane (CH4) and carbon dioxide (CO2).breakdown of organic matter is as shown in Fig 1

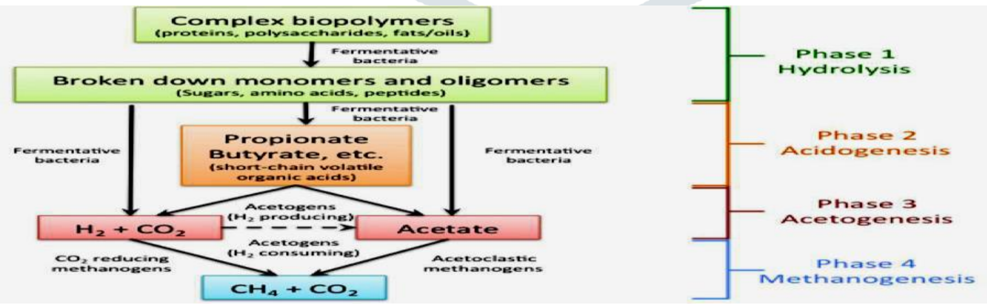

Fig.1 Breakdowns of organic matter in Anaerobic Digestion

A. STAGES OF ANAEROBIC DIGESTION

Biogas production through Anaerobic Digestion is a biochemical process involving microbial activities of bacteria adapted to oxygen free environment to convert complex biological and organic wastes in sequential stages (four) into methane, the major energy fuel as shown in fig 2.

STAGE 1: **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. Overall reactions are represented by the following equations:

$$C_6H_{10}O_4 \rightarrow C_6H_{12}O_6 + H_2O$$

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, propionic 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), propionic acid (CH_3CH_2COOH), butyric acid ($CH_3CH_2CH_2COOH$), and ethanol (C_2H_5OH).

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

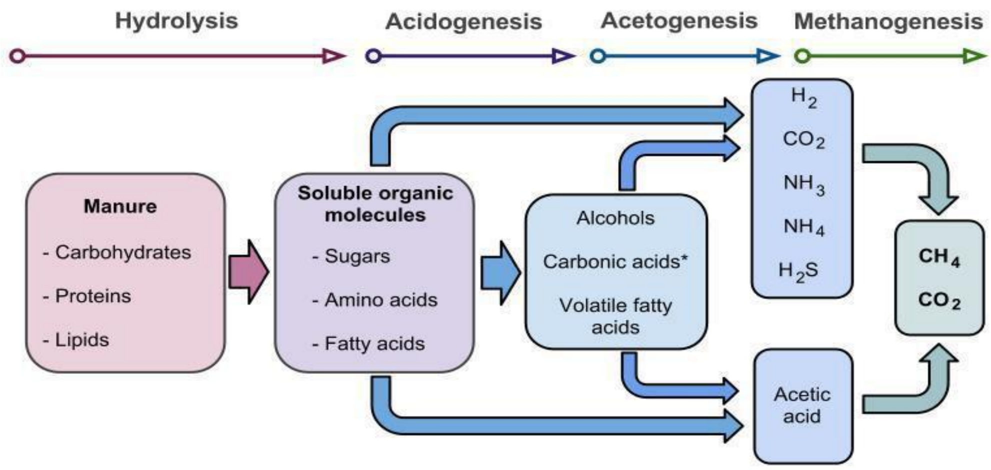

Fig 2.stages of Anaerobic Digestion

II. Materials and methodology

The Textile waste water sample was brought from nearby Textile industry. Grab Sampling of the sample was done and preservative was added to the sample and brought to the Environmental laboratory of civil engineering department, PDA college of Engineering, Kalaburagi, Karnataka state ,India. The Physico-chemical characteristics were tested as per methods prescribed by CPCB for the examination of water and wastewater (21st edition, 2012)

A. FABRICATION AND EXPERIMENTAL SETUP

The schematic diagram of experimental setup used for the present study is shown in figure 1.Aspirator Bottle no.1 of 10.0L capacity was used as digester with working volume of 10.L for the reactor. The digester will be connected with the second aspirator bottle of 5.0L capacity, which will contain the 0.1N NaOH solutions. The produced gas was collected in another container by water displacement method. The NaOH solution was displaced from second aspirator bottle and collected in the measuring cylinder and the amount of Biogas (Methane) produced was measured as shown in fig 3.

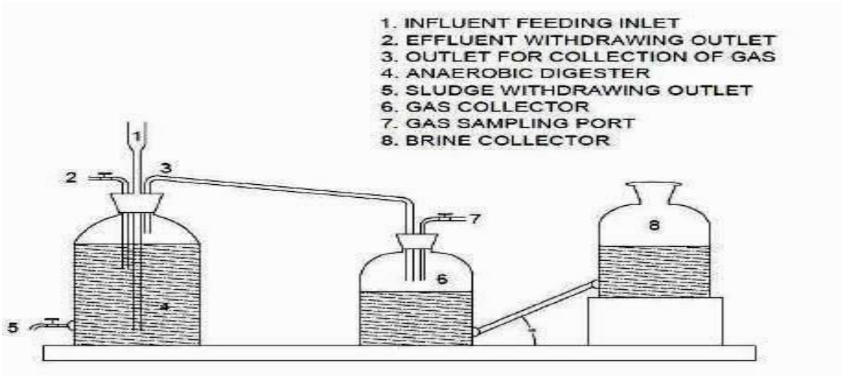

Fig 3: Experimental Setup of Anaerobic Digester

B. STARTUP OF REACTOR

1. For the initial start-up, cow dung slurry and septic tank waste were used as seed sludge and placed in the digester for acclimatization.
2. Reactor was fed with 2L filtered cow dung slurry (made by adding 40g of cow dung in 2L of tap water) and mixed with septic tank wastewater about 100ml/L and made up to 8L total working volume.
3. The digester was allowed for stabilization, after adding seed sludge for about 20 days.The raw textile wastewater characteristics were studied and are presented in table 1
4. Once the reactor gets stabilised ,initially it was loaded with 0.3 Kg.COD/m^3.d. and after stabilisation subsequently the reactor loading were increased with 0.6,0.9,1.2 Kg.COD/m^3.d organic loadings.

C.STUDY CHARACTERISTICS OF TEXTILE WASTE WATER

The study characteristics of Raw Textile waste water is presented in table 1

[1] **Table 1: Study Characteristics of Textile wastewater.**[2]

Parameter Results	Results
Colour	Dark greenish blue
pH	7.4
BOD_5 @ 20 ° C (mg/L)	720
COD (mg/L)	1200
Total Volatile solids(mg/L) (C)	1860
BOD/COD	61.85%
C/N	16.34
C:N:P	218.8:7.7:1

II. RESULTS AND DISCUSSION

The results of percentage of COD removal are shown in Figure 4,Figure 5,Figure 6, and Figure 7 for 0.3,0.6,0.9and 1.2 Kg.COD/m^3.d organic loading rates. Fig 7 shows COD removal with respect to time at each OLR

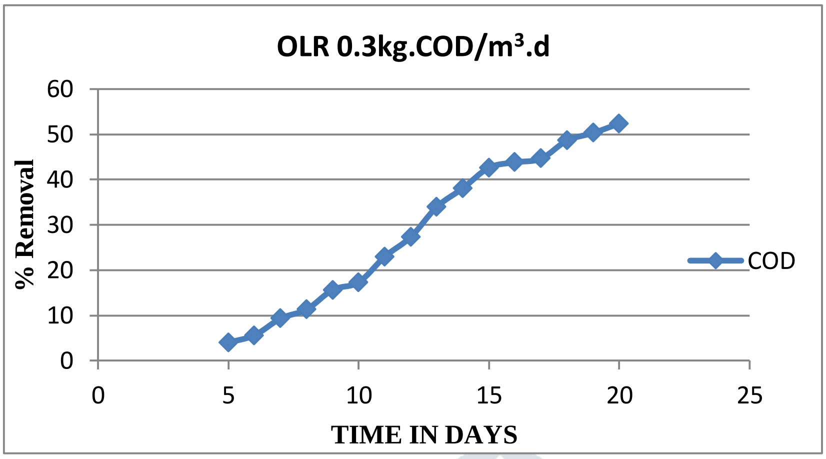

Figure 4: Percentage COD removal

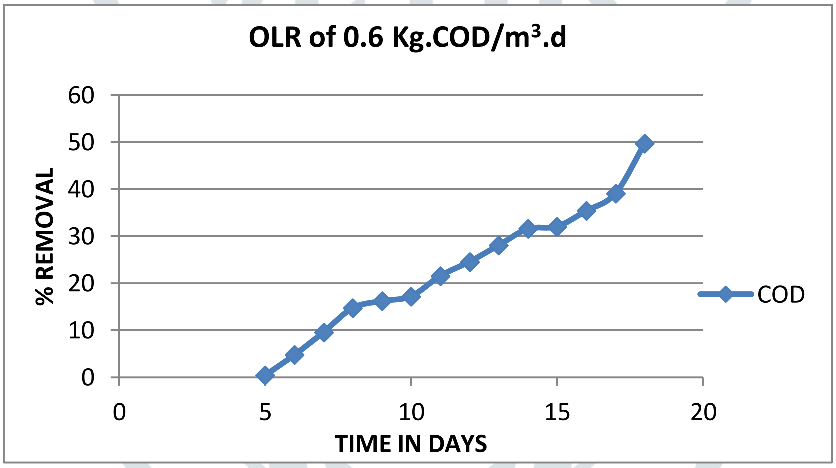

Figure 5: Percentage COD removal

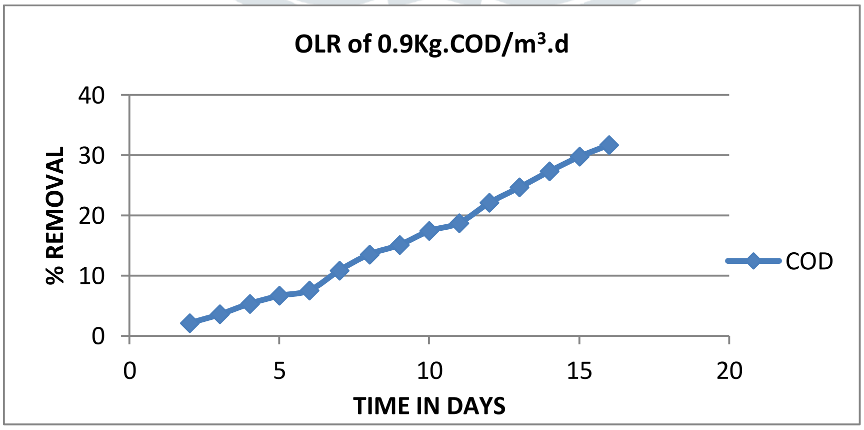

Figure 6: Graph of % COD removal

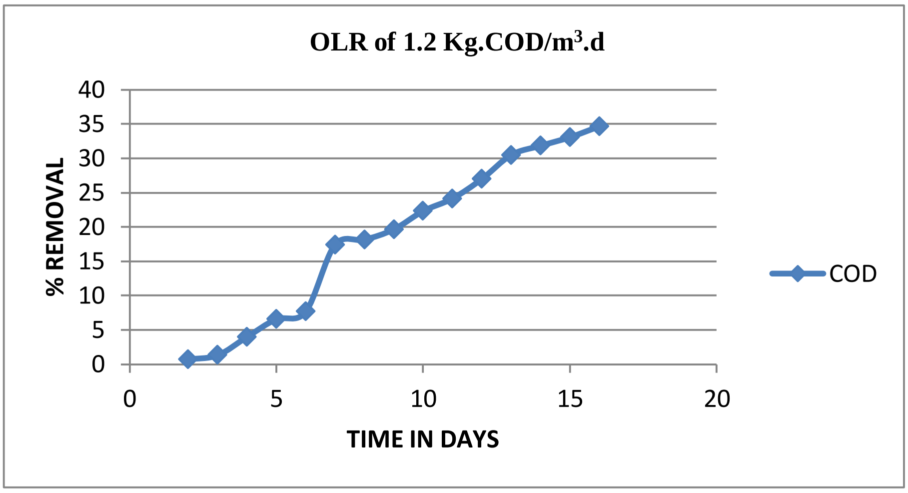

Figure 7: Graph of % COD removal

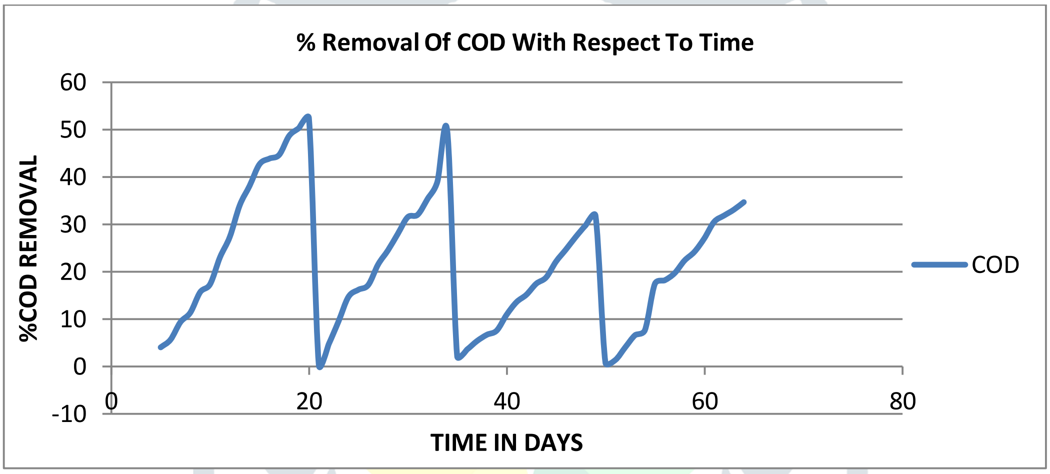

Figure 8: Graph of % COD removal with respect to time

The reactor with an OLR OF 0.3kg.COD/m^3.d from 5th experimental day onwards , study characteristics were analysed daily till 20th day .stabilization of wastewater took place on 15th day. COD for OLR of 0.3, 0.6, 0.9 and 1.2kg.COD/m^3.d were reduced to 48.43%, 34%, 45.31%,and 42.22% respectively.

IV Conclusion:

From the experimental results following conclusions were made:

1. As BOD/COD value is 0.6 the textile wastewater can be treated biologically.

2. The C/N and C:N:P ratio are 16.34 and 218.8:7.7:1 respectively which indicates that there is deficiency of Carbon content.

3. For OLR of 0.3, 0.6, 0.9 and 1.2kg.COD/m^3.d COD Was reduced to 48.43%, 34%, 45.31%,and 42.22% respectively.
4. The maximum % COD removal for textile wastewater is 45.31% for an OLR of 0.9kg.COD/m^3.d .hence this is taken as optimum organic loading rate.

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