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General Characteristic of Textile Industrial Wastewater by Anaerobic Digestion

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Abstract : *This work focuses on monitoring the generation of biogas by anaerobic digestion of solid and liquid textile wastewater under controlled conditions. A laboratory scale models of anaerobic digester of 8L capacity, with gas collecting bottles were setup to treat textile industry wastewater. The performance of the reactor in removing Chloride, Sulphate, Total Solids, Dissolved Solids and Suspended Solids were studied, with reference to different organic loading rates of 0.01, 0.02, 0.03 kg COD/m^3.d. The highest yield of Chloride, Sulphate, Total Solids, Dissolved Solids 82%, 96%, 89% and 98% respectively.*

Keywords: *Anaerobic Digestion, Chloride, Total Solids, Dissolved Solids, Suspended Solids, Organic Loading Rates, Sulphate, Textile Wastewater.*

1. INTRODUCTION

Water pollution is a serious problem in India as almost 70 percent of its surface water resources and a growing percentage of its groundwater reserves are contaminated by biological, toxic, organic, and inorganic pollutants. In many cases, these sources have been rendered unsafe for human consumption as well as for other activities, such as irrigation and industrial needs. This shows that degraded water quality can contribute to water scarcity as it limits its availability for both human use and for the ecosystem. In 1995, the Central Pollution Control Board (CPCB) identified severely polluted stretches on 18 major rivers in India. Not surprisingly, a majority of these stretches were found in and around large urban areas. The high incidence of severe contamination near urban areas indicates that the industrial and domestic sectors' contribution to water pollution is much higher than their relative importance implied in the Indian economy. The water quality monitoring results obtained by CPCB during 1995 to 2009 indicate that organic and bacterial contamination was critical in the water bodies. The main cause for such contamination is discharge of domestic and industrial wastewater in water bodies mostly in an untreated form from urban centers. [1]

Textile industries consume large volumes of water and chemicals during wet processing of textiles. Slashing, bleaching, mercerizing and dyeing are the major consumption activities as well as wastewater generation. The chemical reagents used during manufacture and processing are diverse in chemical composition ranging from inorganic compounds to polymers and organic products. The pollutant features of textile wastes differ widely among various organic substances such as dyes, starches and detergents in effluent undergo chemical and biological changes which consume dissolved oxygen from the receiving stream and destroy aquatic life. Such organics should be removed to prevent septic conditions and avoid rendering the water body unsuitable for municipal, industrial, agricultural and residential uses. Treatment of wastewater will definitely reduce the waste, prevent and make positive effects on its further uses. Biological treatment (aerobic and anaerobic type) is the most common and widespread technique used in textile wastewater treatment [Hunger 2003]. The biological treatment method include biosorption, use of enzymes, aerobic and anaerobic treatments [Nuran and Esposito 2000]. Only biotechnological solutions can be used for the reduction of COD. [2]

1.1 ANAEROBIC DIGESTION

If free dissolved oxygen is not available to the sewage, then anaerobic decomposition called putrefaction will occur. Anaerobic bacteria as well as facultative bacteria operating anaerobically will then flourish and convert the complex organic matter into simple organic compounds. The organic acids including alcohols produced are further converted into methane gas (CH_4), carbon dioxide gas (CO_2), etc., if methane forming bacteria are also especially present in the reactor. This conversion is represented by the equation: [3]

$$\text{Organic acids} \xrightarrow[\text{Anaerobic bacteria}]{\text{Methane forming}} CH_4\uparrow + CO_2\uparrow + \text{Heat (energy)}$$

<u>Anaerobic Digestion (stages):</u>

Biogas production through anaerobic digestion is a biochemical process involving microbial flora of bacteria adapted to oxygen free environment to convert complex biological and inorganic waste in sequential stages into methane, the major energy fuel.

<u>Hydrolysis:</u>

This is the first step, carried out by strict anaerobes such as bacterides, clostridia and facultative bacteria such as streptococci etc. This stage is very important because large organic molecules are simply absorbed and used by microorganisms as a substrate/food source.

Acidogenesis:

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, propanoic 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. [4]

Acetogenesis:

The products produced in the acidogenic phase are consumed as substrates for the other microorganisms, active in the acetogenic phase and thus convert the organic acids into hydrogen, acetate and carbon dioxide (gas).

Methanogenesis:

In the methanogenic phase, the production of methane and carbon dioxide from intermediate products is carried out by methanogenic bacteria under strict anaerobic conditions. Methanogenesis is a critical step in the entire anaerobic digestion process as it is the slowest biochemical reaction of the process. Figure 1.0 shows the whole anaerobic process. [4]

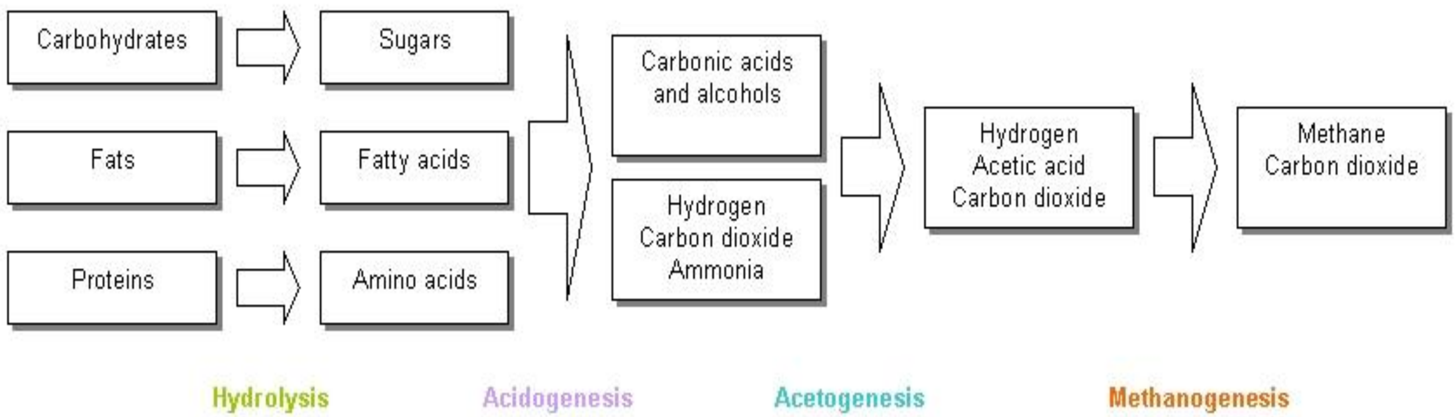

Fig 1: Stages of anaerobic digestion.

1.2 OBJECTIVES OF THE STUDY:

The main objective of this study is to remove chloride, sulphate and solids from textile industrial wastewater using anaerobic digestion process.

1. To determine the characteristics of textile industrial wastewater
2. To know the performance of the digester at ambient temperature.

2. LITERATURE REVIEW

As textile industry is one of the largest industries in the world and different fibers such as cotton, silk, wool, natural fibers as well as synthetic fibers are all pre-treated, processed, colored and after treated using large amounts of water and a variety of chemicals, there is a need to understand the chemistry of the textile effluents very well. Major pollutants in textile wastewaters are high suspended solids, chemical oxygen demand, heat, color, alkalinity and other soluble substances whose chemistry will be emphasized. Parallel to usage of huge amounts of water and chemicals, the textile dyeing and finishing industry is one of the major polluters among industrial sectors, in the scope of volume and the chemical composition of the discharged effluent. Dyeing, desizing and scouring are the major sources of water pollution in textile effluent. Specific problems pertaining to the textile industry include color removal from dye house effluent and toxic heavy metal compounds. [2]

Simmi Goel (2010) in present paper, continuous anaerobic treatment technology has been develpoed in anaerobic baffle reactor and some parameters HRT, OLR, pH and temperature were optimized. Active bacteria for degradation were added as digested sewage sludge. Highly coloured wastewater has successfully been treated in anaerobic baffle reactor. Textile industrial waste organic matter gave maximum biogas yield of 1.64±0.02 L/d, methane of 83%, and COD removal 71.5% at optimal parameters of OLR 0.5 kg/m^3.d, pH of 6.5-7.3 and at a temperature of 30-35^{0}C. [5]

M. Shohidullh Miah (2012) To minimize the cost effective treatment process a treatment process has been setup at Dalas Fashion Ltd and Liz Fashion Ltd, Gazipur, Dhaka. The treatment process consisted of a combined process (anaerobic and bio-filtration process) to remove the pollution through biological process. The anaerobic process followed by Up-flow

Anaerobic Sludge Blanket (UASB) process and Bio-filtration was maintained by polyurethane materials followed by down-flow process. The treatment processes are successfully operating without any chemical treatment process being thus more economic than the traditional chemical alternative. The raw textile wastewater is highly polluted with the characteristics of high alkaline in nature, pH=9-10, suspended biomass TSS= 1229-1500 mg/l, Chemical oxygen demand, COD = 1448-2000 mg/l, and biological oxygen demand, BOD= 550-800 mg/l. Significant reductions were achieved to remove TSS (98%) through bio-filtration process. In addition in the final effluent the removal efficiency were found COD (98%), BOD (94%). [6]

3. MATERIAL AND METHODOLOGY

3.1 FABRICATION AND EXPERIMENTAL SETUP:

The schematic diagram of experimental setup used for the present study is shown in figure 3.1. 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 bottle no.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. For the initial startup, cow dung slurry and septic waste will be used as seed sludge and mixed with wastewater and placed in the digester for acclimatization. From 5th day, regular wasting of digested sample and feeding of the fresh sample were continued until steady state conditions were reached. The steady was carried out for different organic loading rate of 0.01-0.03 kg COD/m^3.d at ambient temperature.

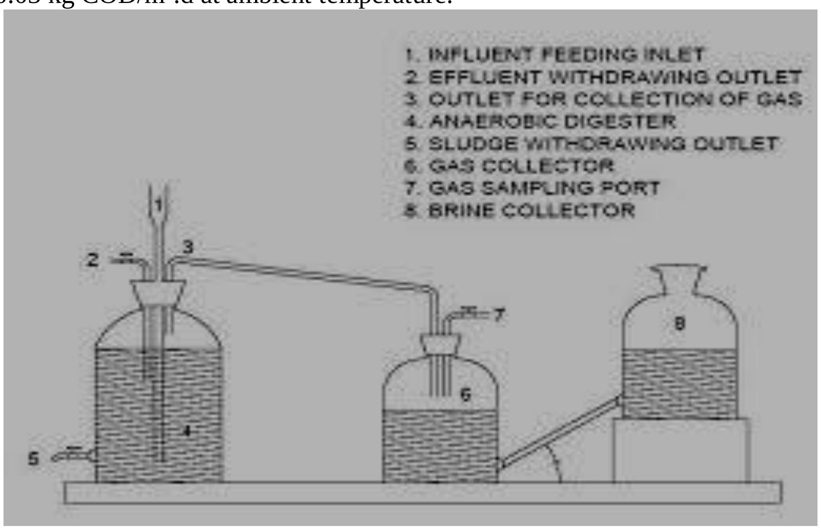

Fig 2: Experimental Setup of anaerobic reactor

3.2 Start up of Reactor:

During the start-up of the reactor, the reactor was loaded with 1.5 L of cow-dung slurry and septic waste & 6.5 L of textile wastewater with a BOD and COD concentration of 693 mg/L and 1040 mg/L respectively, this mixture gave a composite BOD and COD of 249 mg/L and 375 mg/L. By wasting 300mL of digested sludge, the reactor was loaded with fresh wastewater of volume 300mL with a COD concentration of 300 mg/L. The reactor pH was adjusted to 7.0 every day and the reactor was operated till stabilization achieved (30 days). During organic loading of 0.01-0.03 kg COD/m^3.d, 300ml of effluent sample was collected for analysis of various physico-chemical parameters such as pH, chloride, sulphate, total solids, dissolved solids and suspended solids, and the analysis were carried out as per the standard methods for the examination of water and wastewater (AWWA) 20th edition.

3.3 General Characteristics of Textile Wastewater:

The fresh wastewater samples were brought from “ETCO Denim Infrastructure, Vijayapur, Karnataka." to P.D.A Engg. College laboratory and preserved in deep freeze, to analyze the typical characteristics. The BOD_5 is 693mg/L, COD is 1040mg/L, pH is 9.4, chloride is 324 mg/L, nitrate is 11.6 mg/L, sulphate is 35mg/L, total solid is 3060, dissolved solids in wastewater is 1530 mg/L and suspended solid is 1530 mg/L. When wastewater 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. The characteristics of textile wastewater are as shown in the table.1.

Table 1. Characteristics of Textile Wastewater

Sl. No.	Characteristics	Results
1	Temperature, ^{0}C	32
2	Colour (by visualisation)	Indigo blue

3	pH	9.4
4	Total Solids, mg/L	3200
5	Dissolved Solids, mg/L	3000
6	Suspended Solids, mg/L	200
7	Sulphate, mg/L	35
8	Nitrate, mg/L	11.6
9	Phosphate, mg/L	20.8
10	Chloride, mg/L	324
11	BOD/COD	0.64
12	N:P	0.6:1

4. RESULTS AND DISCUSSION

The results of variation of chloride, sulphates, total solids, dissolved solids and suspended solids are shown in Figure 3, Figure 4 & Figure 5 for varying Organic Loading Rate.

The reactor was started with an OLR of 0.01 kg COD/m3.d and operated for a period of 26 days till it attains stabilization. During this period the pH is maintained from 7.02-7.01. The sulphate decreased from 46mg/L to 7mg/L, chlorides decreased from 317.4-83.48 mg/L, total solids decreases from 3060mg/L to 1476mg/L, dissolved solids reduced from 1530-755mg/L and suspended solids decreases from 1530mg/L to 721mg/L, as shown in figure 3.

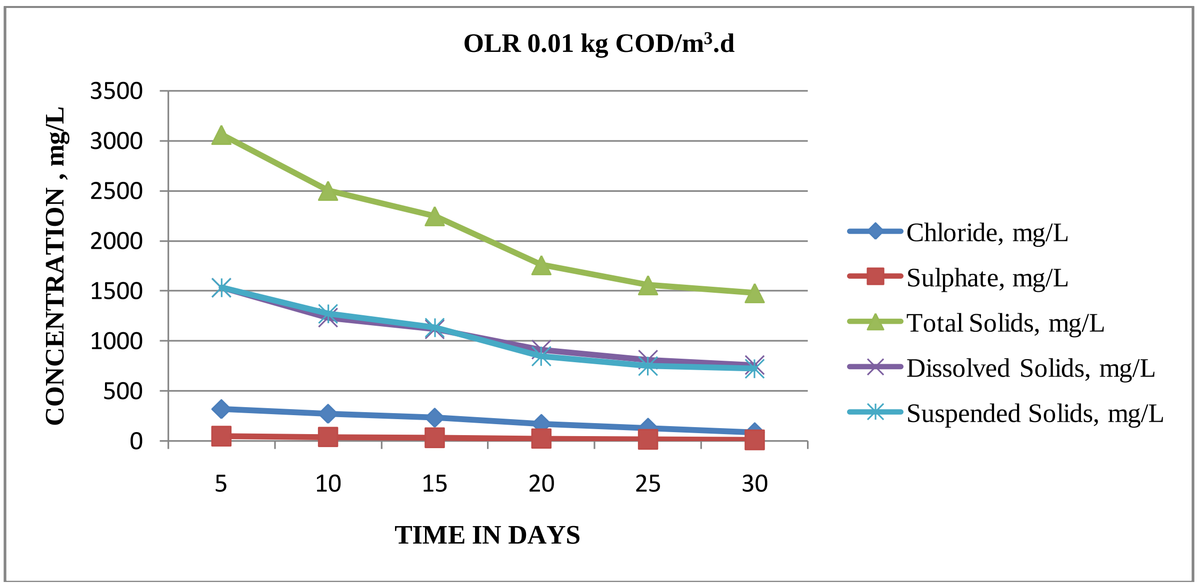

Fig 3: Graph of Chloride, Sulphate, Total Solids, Dissolved Solids and Suspended Solids

When the OLR was increased from 0.01 to 0.02 kg COD/m^3.d (36-61 days) & operated for a period of 26days till it attains stabilization. Throughout the study period the pH is maintained from 7.04-7.00, the sulphate decreased from 38.7mg/L to 2 mg/L, chloride decreased from 320.88mg/L to 59.38mg/L, total solids decreases from 3101mg/L to 343mg/L, dissolved solids reduced from 1593-63mg/L and suspended solids decreases from 1508mg/L to 280mg/L, as shown in figure 4.

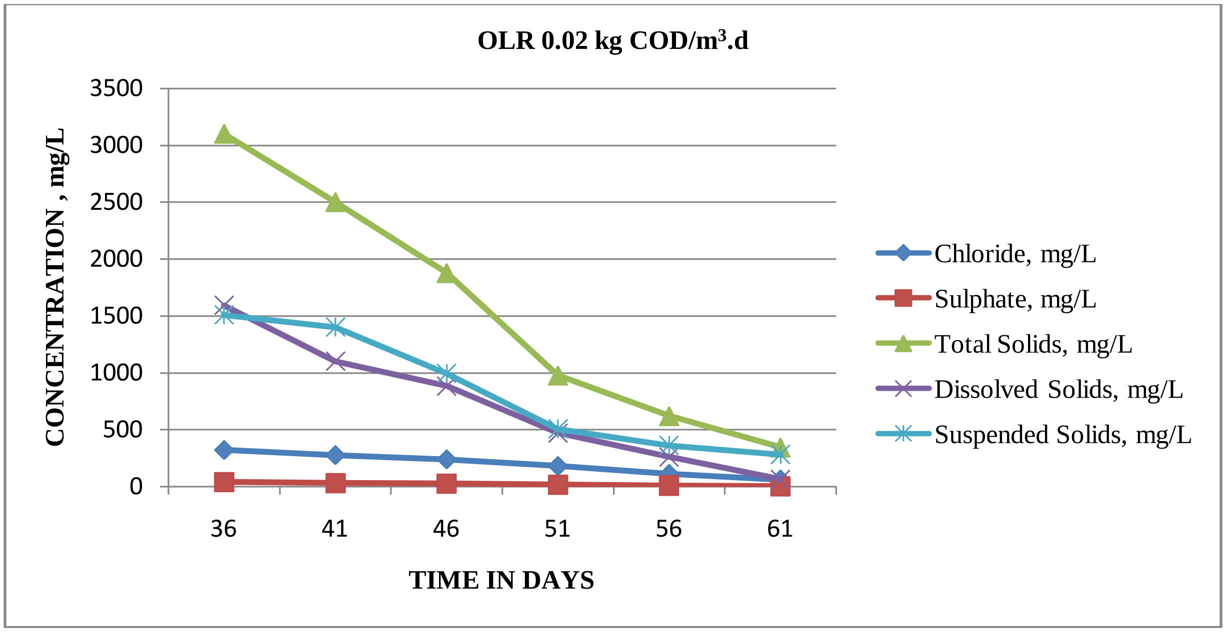

Fig 4: Graph of Chloride, Sulphate, Total Solids, Dissolved Solids and Suspended Solids

When the OLR was increased from 0.02 to 0.03 kg COD/m^3.d (67-91 days) & operated for a period of 25days till the reactor stabilizes. Throughout the study period the pH is maintained from 7.03-7.04, the sulphate decreased from 37.8mg/L to 6.6mg/L, chloride decreased from 317.74-78.11mg/L total solids decreases from 3000mg/L to 782mg/L, dissolved solids reduced from 1571-404mg/L, suspended solids reduces from 1429mg/L to 378mg/L, as shown in figure 5.

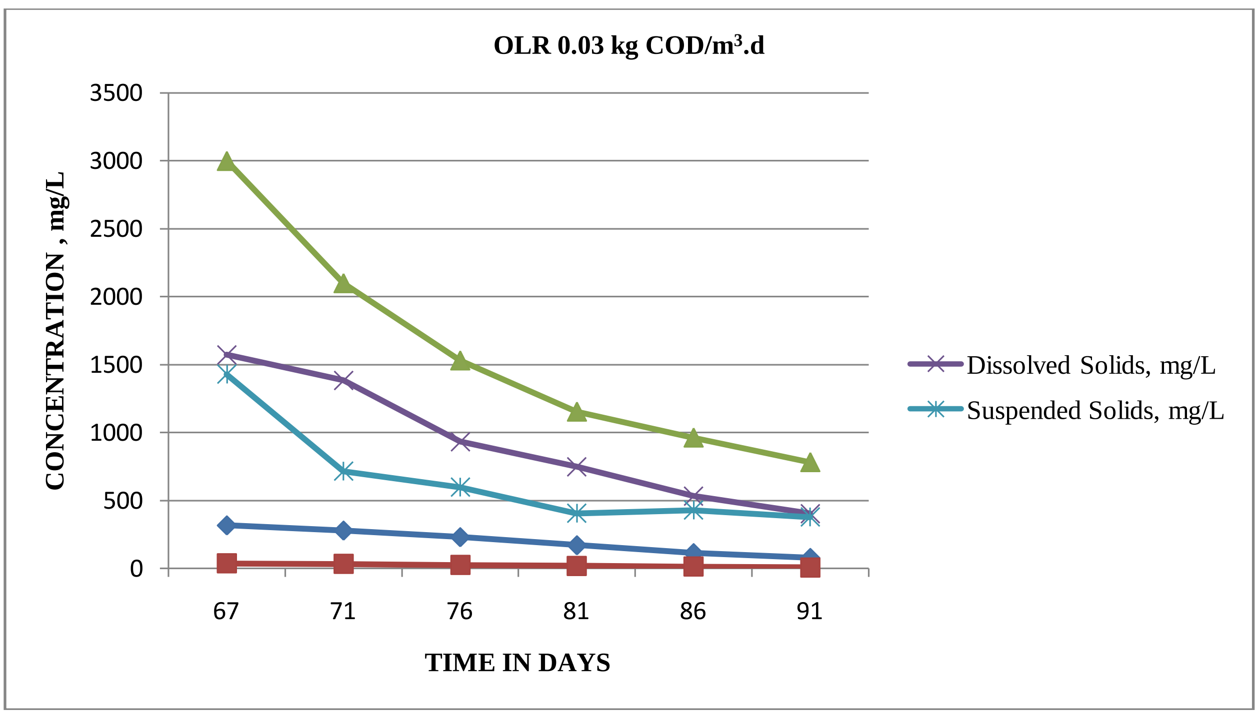

Fig 5: Graph of Chloride, Sulphate, Total Solids, Dissolved Solids and Suspended Solids

3. CONCLUSIONS

1. The sulphate removal for the loadings of 0.01, 0.02 and 0.03 kg COD/m^3.d are 85%, 96% and 86% respectively. The highest percent sulphate removal is obtained at an organic loading of 0.02 kg COD/m^3.d is 96%.

2. The removal of chloride at an organic loading rate of 0.01, 0.02 and 0.03 kg COD/m^3.d are 74%, 82% and 76% respectively. The highest percent removal of chloride is obtained at an organic loading of 0.02 kg COD/m^3.d is 82%.
3. The organic loadings of 0.01, 0.02 and 0.03 kg COD/m^3.d the total solids removal are 54%, 89% and 76% respectively. The highest total solid is obtained for loading rate of 0.02 kg COD/m^3.d is 89%.
4. The organic loadings of 0.01, 0.02 and 0.03 kg COD/m^3.d the dissolved solids removal are 75%, 98% and 87% respectively. The highest total solid is obtained for loading rate of 0.02 kg COD/m^3.d is 98%.
5. The temperature is maintained to ambient temperature throughout.

REFERENCES

1. M.N. Murty and Surender Kumar "Water Pollution in India, An Economic Appraisal", Infrastructure report 2011, pp. 285-287.
2. Dr Kiro Mojsov "Textile Effluent & Waste water" International Journal of Management, IT and Engineering, Volume 3, Issue 10 (2013), pp. 468, 471.
3. Santosh Kumar Garg "Sewage Disposal and Air Pollution Engineering" 23rd edition. (2010), pp. 180, 184-185, 517.
4. Kayode Feyisetan Adekunle*, Jude Awele Okolie, "A Review of Biochemical Process of Anaerobic Digestion", Advances in Bioscience and Biotechnology, 2015, pp. 205-209.
5. Simmi Goel, "Anaerobic Baffled Reactor for Treatment of Textile Dye Effluent", Journal of Scientific and Industrial Research, Vol. 69, April 2010, pp. 305-307.
6. M.Shohidullh Miah, "Cost-effective Treatment Technology on Textile Industrial Wastewater", Journal of Chemical Engineering, IEB Vol. ChE. 27, No. 1, June 2012, pp. 32-35.

