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TEXTILE SLUDGE DEGRADATION USING WATER HYACINTH AND BIOGAS GENERATION

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ABSTRACT

Textile industry is growing on an enormous rate due to the capital demand of the product cotton, wool and synthetics. The waste water generated from different manufacturing processes in a point to treat because of its toxicity. The toxicity mainly comes from presence of heavy metals, chemicals and different compounds used in different manufacturing processes; among these heavy metals is of great concerns. The heavy such as Pb, Cd, Ni, Cu, As, Cr etc. are found in textile sludge. water hyacinth (Eichhornia crassipes) has received great attention because of its obstinacy and high productivity.

KEYWORDS: Heavy Metals, toxicity, textile sludge and water hyacinths.

INTRODUCTION

The textile industry has played an important role in growth of city. It houses a number of small and medium scale textile units, which are export oriented. textile common effluent treatment are involved activities like bleaching, dyeing, and printing and finishing of cotton, synthetic and blended fabrics. Performance of the digester largely depends on fluctuations in operating parameters. As discussed earlier the parameters are sensitive to small changes in environment and hence efforts are to closely monitor the parameters and take appropriate measures to maintain the stability of digester. The stability of the digester has to be maintained to achieve optimum gas production with maximum efficiency. The biogas or methane yield is measured by the amount of biogas or methane; the generation of blue colored flame indicates the production of methane. The overall Anaerobic Digestion process was controlled and the methane was generated efficiently with minimum cow dung and maximum CETP sludge. The Anaerobic Digestion process was carried out by controlling the parameters such as pH and Temperature etc. The biogas or methane yield is measured by the amount of biogas or methane; the generation of blue colored flame indicates the production of methane.

PROCESS INVOLVED AT CETP

Effluent is subjected to pre-aeration, physic-chemical treatment and solid separation, aerobic treatment as Activated Sludge Process to achieve the final COD of treated effluent less than 250 mg/l. The outlet effluent from tertiary treatment has TDS in the range 2500mg/l-3000mg/l, which is more than the desired MPCB norms <2100 mg/l. As the MPCB consent conditions, the desired outlet TDS (i.e <2100 mg/l) will be achieved by blending the treated sewage of less TDS. The required volume of treated sewage (9330m^3/d) for blending will be sourced from 29 MLD Sewage Treatment Plant of Ichalakaranji Municipal Council.

THE MAIN PROCESS STEPS OF ANAEROBIC DIGESTION

Hydrolysis

Hydrolysis is theoretically the first step of anaerobic digestion, during which the complex organic matter (polymers) is decomposed into smaller units (mono and oligomers). During hydrolysis, polymers like carbohydrates, lipids, nucleic acids and proteins are converted into glucose, glycerol, purines and pyridines. which is carried out by exoenzymes, produced by those microorganisms which decompose the undissolved particulate material

Acidogenesis

During acidogenesis, the products of hydrolysis are converted by acidogenic (fermentative) bacteria into methanogenic substrates. Simple sugars, amino acids and fatty acids are degraded into acetate, carbon dioxide and hydrogen (70%) as well as into volatile fatty acids (VFA) and alcohols (30%).

Acetogenesis

Products from acidogenesis, which cannot be directly converted to methane by methanogenic bacteria, are converted into methanogenic substrates during acetogenesis. VFA and alcohols are oxidised into methanogenic substrates like acetate, hydrogen and carbon dioxide. VFA, with carbon chains longer than two units and alcohols, with carbon chains longer than one unit, are oxidized into acetate and hydrogen. The production of hydrogen increases the hydrogen partial pressure

Methanogenesis

The production of methane and carbon dioxide from intermediate products is carried out by Methanogenic bacteria. 70% of the formed methane originates from acetate, while the remaining 30% is produced from conversion of hydrogen (H) and carbon dioxide (CO_2)Methanogenesis is severely influenced by operation conditions. Composition of feedstock, feeding rate, temperature, and pH are examples of factors influencing the methanogenesis process. Digester overloading, temperature changes or large entry of oxygen can result in termination of methane production

Operating Parameters of Anaerobic Digestion

The efficiency of anaerobic digestion is influenced by some critical parameters, thus it is crucial that appropriate conditions for anaerobic microorganisms are provided. The growth and activity of anaerobic microorganisms is significantly influenced by conditions such as exclusion of oxygen, constant temperature, and pH-value, nutrient supply, stirring intensity as well as presence and amount of inhibitors (e.g. Ammonia). The methane bacteria are fastidious anaerobes, so that the presence of oxygen into the digestion process must be strictly avoided

Temperature:

The anaerobic digestion process can take place at different temperatures, divided into three temperature ranges: psychrophilic (below 25^{o}C), mesospheric (25^{o}C–45^{o}C),and thermophilic (45^{o}C–70^{o}C). There is a direct relation between the process temperature and the HRT . The temperature stability is decisive for anaerobic digestion. In practice, the operation temperature is chosen with consideration to the feedstock used and the necessary process temperature is usually provided by floor or wall heating systems, inside the digester.

THE THERMOPHILIC PROCESS HAS FOLLOWING ADVANTAGES AND DISADVANTAGES

Effective destruction of pathogens. Higher grow rate of methanogenic bacteria at higher temperature. Reduced retention time, making the process faster and more efficient. Improved digestibility and availability of substrates. Better degradation of solid substrates and better substrate utilization. Better possibility for separating liquid and solid fractions.

The thermophilic process has also some disadvantages Larger degree of imbalance. Larger energy demand due to high temperature. Higher risk of ammonia inhibition.

pH - values and optimum intervals:

The pH-value is the measure of acidity/alkalinity of a solution (respectively of substrate mixture, in the case of anaerobic digestion) and is expressed in parts per million (ppm). The pH value of the anaerobic digestion substrate influences the growth of methanogenic microorganisms and affects the dissociation of some compounds of importance for the anaerobic digestion process (Ammonia, Sulphide, Organic Acids). Experience shows that methane formation takes place within a relatively narrow pH interval, from about 5.5 to 8.5, with an optimum interval 7.0 to 8.0 for most methanogens. Acidogenic microorganisms usually have lower value of optimum pH.

The optimum pH interval for mesophilic digestion is between 6.5 and 8.0 and the process is severely inhibited if the pH-value decreases below 6.0 or rises above 8.3. The solubility of carbon dioxide in water decreases at increasing temperature. The pH-value in thermophilic digesters is therefore higher than in mesophilic ones, as dissolved carbon dioxide forms carbo nic acid by reaction with water.

Ammonia:

Ammonia (NH_3) is an important compound, with a significant function for the anaerobic digestion process. NH_3 is an important nutrient, serving as a precursor to foodstuffs and fertilizers and is normally encountered as a gas, with the characteristic pungent smell. Proteins are the main source of Ammonia for the anaerobic digestion process. Its inhibitory effect, Ammonia concentration should be kept below 80mg/l.

Macro- and micronutrients (trace elements):

Micro elements (trace elements) like Iron, Nickel, Cobalt, Selenium, Molybdenum or Tungsten are equally important for the growth and survival of the anaerobic digestion microorganisms as the macronutrients carbon, nitrogen, phosphor, and sulphur. The optimal ratio of the macronutrients carbon, nitrogen, phosphor, and sulp hur (C:N:P:S) is considered 600:15:5:1. Insufficient provision of nutrients and trace elements, as well as too high digestibility of the substrate can cause inhibition and disturbances in the anaerobic digestion process

C: N ratio:

C:N ratio is most important in anaerobic Digestion. Carbon is main source of methane generation process and nitrogen as nutrient source, optimum C :N is 30:1 or 40:1, C:N ratio not excess than 40:1

Organic loading:

The construction and operation of a biogas plant is a combination of economical and technical considerations. Obtaining the maximum biogas yield, by complete digestion of the substrate, would require a long retention time of the substrate inside the digester and a correspondingly large digester size. In practice, the choice of system design (digester size and type) or of applicable retention time is always based on a compromise between getting the highest possible biogas yield and having justifiable plant economy.

Hydraulic Retention Time (HRT)

An important parameter for dimensioning the biogas digester is the hydraulic retention time (HRT). The HRT is the average time interval when the substrate is kept inside the digester tank. HRT is correlated to the digester volume and the volume of substrate fed per unit time.

ANALYTICAL METHODS

Treatments composition and measured parameters:

The experiment consisted in use the cow dung as a micro-organisms inoculation source and moisture corrector in the treatments composed by textile sludge. Treatments consisted the following proportions: 70% textile sludge +30% cow dung. The initial parameters such as pH, temperature were maintained.

Conducting the laboratory experiment:

The experiment was conducted at the Environmental science and technology laboratory. For heavy metal removal, plastic bottle used in that sludge were used with water hyacinth, which helps to minimize the heavy metal concentration. Bio stabilization systems were built in 8 liter M.S. digester, in which 3 kg cow dung were added. Also water added in ratio 1:1. The inoculum is then added with textile sludge in the ration 3:7 the total concentration was 8 kg filled in 21 liter gas holder capacitor.

After generation of gas the slurry added with textile sludge in the ratio of 3:7 and kept for the degradation. After 20 days the gas was generated which was tested by burner, a blue flame generated that states generation of methane.

Water hyacinth growth mechanism:

The CETP sludge taken weighing 5 kg which was put in plastic container, 1 liter water is added to make the slurry with proper interval of time. Water hyacinth was grown on provided media and kept for heavy metal removal. With proper observation 10 days the water hyacinth was completely grown and that was set up for 21 days to uptake heavy metals from the sludge.

Acidigestion (detection of heavy metal concentration):

1. Preparation of 0.05 N H_2SO_4 .
2. 10 gm sludge sample was taken and diluted with 50ml 0.05 N H_2SO_4 .
3. Diluted mixture was heated for 10 min with proper sterilization.
4. After sterilization the mixture was set to cool for 10 min.
5. The mixture was filtered by Whatman's filter paper.
6. Supernatant was separated from filtrate and kept for further tests.
7. Similarly the sludge after minimization of heavy metals by water hyacinth was tested by the process of acidigestion.

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UV Spectrophotometer:

The supernatant from both before minimization and after minimization was compared with blank. Readings were taken by putting the dry sludge sample against the blank. Similar procedure was done to carry out the readings in case of wet sludge or slurry.

To carry out the procedure the absorption limits of different heavy metals are needed so by this by putting the particular limit of absorbance of particular heavy metal the quantity of heavy metal present in the sludge can be known.

The biogas or methane yield is measured by the amount of biogas or methane; the generation of blue colored flame indicates the production of methane. The overall Anaerobic Digestion process was controlled and the methane was generated efficiently with minimum cow dung and maximum CETP sludge.

Figure 1: UV Spectrophotometer

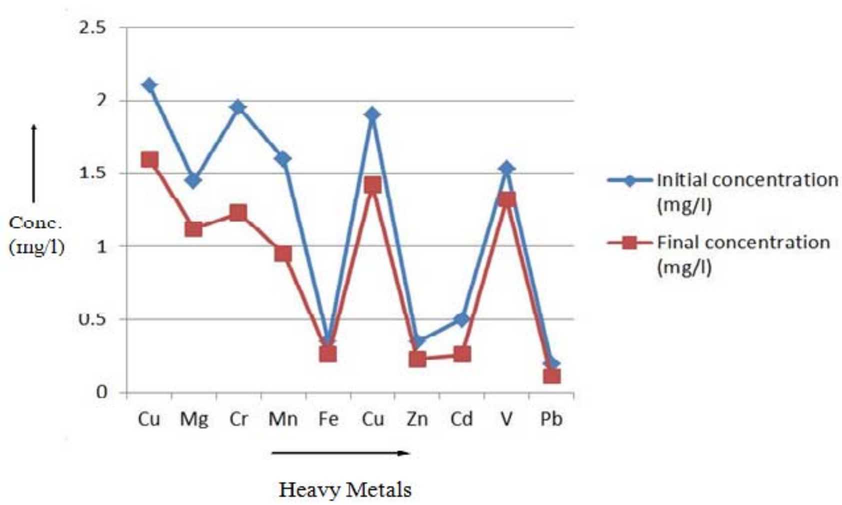
RESULT AND DISCUSSION

The experimental work of studying the performance evaluation of pilot scale biogas plant for industrial sludge was done The parameters of feed were predetermined and recorded daily. After feeding, the digester effluent was collected and analysis of various parameters was done soon after.

Table 1 : Concentration of Heavy metals found in CETP Sludge

Sr.. no	Heavy Metals	Wavelengths (nm)	Initial concentration (mg/l)	Final concentration (mg/l)
1	Cu	317.933	2.1	1.60
2	Mg	285.200	1.45	1.12
3	Cr	267.716	1.95	1.23
4	Mn	294.920	1.6	0.95
5	Fe	238.204	0.35	0.26
6	Cu	327.393	1.9	1.42
7	Zn	213.857	0.35	0.23
8	Cd	226.502	0.5	0.26
9	V	290.880	1.53	1.32
10	Pb	217.000	0.2	0.11

Graph 1: Conc (mg/l) vs Heavy Metals



The Digester pH was basic initially during hydrolysis process and again decreased to set the neutral condition. There is a slight increase in pH during the acidogenesis and acitogenesis process and again decreased to neutral conditions. It concludes there is variant pH from initial process to final, leading to gas generation. The digester temperature was initially 28^{O}Cit means there was formation of psychrophiles bacteria. Again the temperature was increased to 33^{O}C it implies that there was formation of mesophilic bacteria. The final process of methanogenesis signifies the formation of methanogens leading to temperature of 38^{O}C. Finally the temperature reduced to the initial stage of 27^{O}C.

Figure 2: Water Hyacinth

CONCLUSION

The heavy metals present in the CETP sludge was found reduced by some extent using the Water Hyacinth. It states that the Water Hyacinth is capable of minimizing the heavy metals present in sludge. The inoculums degradation took place on the ratio of 3:7 as Cow dung and CETP sludge. Performance of the digester largely depends on fluctuations in operating parameters. As discussed earlier the parameters are sensitive to small changes in environment and hence efforts are to closely monitor the parameters and take appropriate measures to maintain the stability of digester. The stability of the digester has to be maintained to achieve optimum gas production with maximum efficiency.

REFERENCES

[1] Islam M.M., Halim M.A., Safiullah. "*Heavy Metals (Pb, Cd, Zn, Cu, Cr, Fe and Mn) content in textile sludge" Gazipur, Bangladesh. Research Journal of Environment Science page no. 311-315, 2009.*

[2] Hardy David H., Jeena Myers, Catherine Stokes, "*Heavy Metals Occurrence and Uses" N.C Department of Agriculture and Consumer Services. 2008*

[3] Aremu A.S. [*Department of Civil Engineering, University of Ilorin, Ilorin, Kwara State, Nigeria, Transnational Journal of Science and Technology August 2012 editio n vol.2, No.7.*

[4] Bhattacharya Anjanabhaand Pawan Kumar, *Electric Journal of Environmental Agriculture and Food C hemistry.*

[5] Gupta Piyush, Roy Surendra, Amit B. Mahindrakar**,** *Resources and Environment 2012,2(5)page no. 202-215.*

[6] Zongping Wang, Miaomio Xue, Zizheng Liu, Huazhong *University of Science and Technology, China.*

[7] Aksakal, "*Removal of Heavy Metals from Industrial Sludge", Graduate School of Applied Science.*

[8] Ratna1, Padhi. B.S 2 1- *Department of Chemistry, Deen Dayal Upadhyaya College University of Delhi, International Journal Of Environmental Sciences, Volume 3, No 3, 2012.*