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Anaerobic Treatability of Pharmaceutical Wastewaters

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This paper mainly focus on the anaerobic treatability of pharmaceutical wastewater. Wastes with high BOD:COD ratio are studied in a batch anaerobic digester, with acclimatized seed sludge. In the present study, an attempt has been made to evaluate the efficiency of batch type anaerobic reactor for pharmaceutical waste waters. Continous monitoring of parameters like BOD, COD, pH, Volatile fatty acids, alkalinity, sulphates were carried out to evaluate the performance of the reactor. The studies revealed that a maximum COD reduction of 73 % is obtained.

Key Words: Anaerobic treatment, Pharmaceutical wastes, COD, BOD.

INTRODUCTION

Industrial wastewater is a threat to the environment. Treatment of these wastewater streams (which contain high loads of BOD, COD, dissolved and suspended solids) aimed at complying with international standards is a difficult challenge to meet[1]. The greater environmental awareness in both the public and regulatory sphere in recent years has necessiated greater treatment of industrial effluent[2]. In recent years the development of newer[3], higher rate anaerobic process has shown a considerable potential for industrial wastewater treatment[4].

Anaerobic treatment is considered whenever a high strength waste (waste with high BOD) is encountered. Anaerobic treatment is cost effective in some situations[5,6]. Two basic processes are involved in the anaerobic digestion-liquefaction and gasification. The first group of microorganisms hydrolyzes and ferments the complex organic substances to simple end products which are primarily volatile organic acids and alcohols. This process is known as liquefaction. These microorganisims include both facultative and anaerobic types and are collectively known as 'acid fermenters'. The second group of bacteria convert the produced organic acids and alcohols to carbon dioxide and methane gas.This process is known as gasification. The microorganisms responsible for the process are strictly anaerobes and are known as 'methane formers'. Operation of anaerobic digesters is complicated by the delicate nature of the methane formers. These organisms are strict anaerobes and function within a narrow pH range of 6.5 to 8.5. These organisms are also sensitive to sudden changes in other environmental factors such as temperature, food supply, *etc.* Product gases from anaerobic digestion typically contain 65 to 70 % methane, 25 to 30 % CO_2 and trace amounts of other gases. Banerji *et al.*[7] reported that a significant portion of energy necessary to operate a wastewater treatment plant can be derived from the methane produced by anaerobic digesters.

EXPERIMENTAL

Secondary sludge was taken from the activated sludge process units and it was left over for 4 d for the anaerobic conditions to develop. This anerobic sludge was used for the present study. Acclimatization of the sludge was done for a period of 20 d. During this period daily 100 mL of wastewater was added to the sludge and 100 mL was withdrawn from the sludge. This process was carried out for 20 d. COD was analyzed for every 3 days and it was found that there was a considerable reduction in the COD levels indicating that the wastewater has been acclimatized to the sludge and that the anaerobic process was perfectly going on.

A batch reactor was set up by filling the reactor containing anaerobic sludge with the wastewater to be treated. A graduated bottle containing brine solution (gas collector) was attached to the digestor for the collection of gas. This was in turn connected to brine collector which collects the brine solution displaced by the gas collector. Strict anaerobic conditions were maintained. The temperature of the batch reactor was maintained at 35 to 37 ºC. During the process of anaerobic treatment the following parameters were analyzed for control purpose. The parameters, pH, alkalinity, COD and volatile fatty acids were analyzed daily and sulphate was done once in a week[8].

RESULTS AND DISCUSSION

Effect of temperature: The temperature has got a tremendous effect in the functioning of the digester. It has been established that 2 types of microorganisms mesophilic and thermophlic, are responsible for biodegradation at 2 diffferent temperature ranges. Once an operating temperature is fixed, any gross deviation from that temperature may result in an unsatisfactory performance of the reactor. Hence the temperature of the reactor was maintained at 35 to 37 ºC.

Effect of pH: With in the pH range of 6.5-8.5, the rate of methane fermentation is constant, outside this range the rate drops dramatically.

Effect of alkalinity: The alkalinity produced from the degradation of organic compounds in the anaerobic process helps control the pH by buffering the anaerobic system. As a general rule inhibition occurs at volatile acid concentrations in excess. The alkalinity concentration should be grater than 1.67 times the volatile fatty acids concentration.

Effect of sulphates: The presence of high levels of sulphates is undesirable for the best performance of anaerobic treatment, since it may result in the inhibition of the biological process[9].

TABLE-1
CHARACTERIZATION STUDIES

Parameter	Day 1	Day 2	Day 3	Day 4
pH	7.87	7.84	7.80	7.78
Alkalinity	805	736	603	580
VFA	1502	1028	1034	833
TDS	8390	8075	7740	6480
TDIS	2450	3390	2600	1540
TDVS	5940	4685	5140	4940
BOD	3900	3700	2600	1284
COD	7240	6560	6000	3200
Sulphate	1893	983	878	817

VFA = Volatile fatty acids, TDS = Total dissolved solids, TDIS = Total dissolved inorganic solids, TDVS = Total dissolved volatile solids, BOD = Biological oxygen demand, COD = Chemical oxygen demand.

TABLE-2
RESULTS AFTER ANAEROBIC TREATMENT

Days	pH	Alkalinity	VFA	COD
1	7.32	437	7557	7440
2	7.12	621	4460	5200
3	7.10	483	4137	3600
4	7.05	552	2704	3120
5	7.42	644	2664	3072
6	7.25	598	1848	2880
7	7.42	667	912	2752
8	7.08	644	816	2520
9	6.83	552	336	2224
10	6.77	506	323	2032

In the present investigation, an attempt has been made to study the characteristics of the effluent obtained from the pharmaceutical industry such as pH, colour, total dissolved solids, total dissolved volatile solids, total dissolved inorganic solids, Alkalinity, sulphates, biological oxygen demand, chemical oxygen demand to get the quality of the wastewater for physicochemical parameters have shown the values much higher than the permi-ssible limits. Therefore anaerobic treatment was adopted (for 10 d) to reduce the chemical oxygen demand of the effluent.

By anaerobic treatment chemical oxygen demand was reduced from 7440 to 2302 mg/L *i.e.* 73 %. The decrease in volatile fatty acid levels can be attributed to the increased methane production. The conversion of volatile fatty acids such as acetic acid into methane was responsible to the decrease in volatile fatty acid levels. The chemical oxygen demand reduction reached a constant state where no further reduction was seen indicating the completion of the anaerobic treatment. During the process of anaerobic treatment the alkalinity varies greatly.

Conclusion

Studies indicated that the wastewater selected for studies is amenable for anaerobic treatment. Anaerobic treatment systems being less expensive with respect to operating costs, wastewaters that are rich in biodegradable organics can be tested for anaerobic treatability and treated accordingly[10]. The fresh water provided by nature is not sufficeint. The people are forced to use the natural water for recycling. Every industry should have its own 'effluent treatment plant' (though cost effective)[11], as it plays an important role in purifying the wastewater by reducing dissolved solids, COD, BOD to large extent. Thus the water used in the industry should be treated and reused in the industry itself or for gardening etc. In order to avoid pollution of the surroundings and also to minimize the water usage.The gas produced during the anaerobic treatment can be utilised in the boilers as a substitute of coal.

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