Biological Treatment of Textile Waste Water by Activated Sludge Process

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(Received 6th December, 2005, revised 19th September, 2006)

Summary: Biological treatment of textile wastewater in an activated sludge reactor reduces the pollutant up to National Environmental Quality Standards. The removal efficiency of the pollutants was studied before and after pretreatment with commercial lime and granular activated carbon. The contents of parameters BOD, COD, TDS and TSS were studied with respect to 10 days retention time. The reduction of BOD, COD TDS and TSS was 80, 78,48 and 79 % respectively in less than 6 days at neutral pH and 25 °C temperature.

Introduction

There are 442 organized textile units working in Pakistan, except a few all the units are discharging effluents without any treatment. As a result, the natural water bodies which were few years ago rich source of food and irrigation water, have now turned into wastewater drain.

Textile production involves a number of wet processes. Each process generates wastewater containing different types of pollutants. Finishing and drying processes generate volatile organic compound. Dyeing and printing processes produce wastewater-containing toxic organic compound such as phenols and also impart highly concentrated color and copper, chromium metals. Bleaching of fibers adds halogen, makes the wastewater alkaline [1]. Desizing step in textile process contributes 50 % increase of BOD load. Wool processing may release pathogenic germs. Sometimes pesticides are used for the preservation of natural fibers. These pesticides are discharged into wastewater during washing and scouring process [2]. Chemicals present in finishing wastewater are highly variable due to the broad range of finishers available, which generate pollutants of natural and synthetic polymers. The biodegradable organic compound can cause deficiency of dissolved oxygen in receiving water bodies and have a direct effect on aquatic life.

For the treatment of textile wastewater the activated sludge process is dominantly applied due to being efficient and cost effective [3]. The activated sludge is a suspended growth of different microbes in wastewater, which oxidize the organic matter in the presence of oxygen. The factors that may affect the process are light, temperature, pH, nutrients, and oxygen supply. The same study was conducted with the alum coagulation as pretreatment [4] considering the retention time and for combined municipal and industrial wastewater treatment of textile industry [5]. The main objectives of this study are to assess the effectiveness and efficiency of activated sludge reactor and to generate a systematic and reliable data that will help to design an indigenous textile wastewater treatment system.

Results and Discussion

Eight wastewater samples from a textile unit at Ferozepur road Lahore were collected and characterized. The statistical results are summarized in Table-1. All the major pollutant indicator exceeded the values provided in the National Environment Quality Standards (NEQS) thus imposed serious threat to the environment. The pH of effluents varied from 9.8 to 11 with mean value of 10.45 and standard deviation of 0.83. Temperature ranged from 33 to 40 °C. The minimum and maximum values for biochemical oxygen demand (BOD) is 542.0 and 675.0 mg/ l and for chemical oxygen demand (COD) is 396.0 and 1625.0 mg/ L respectively as shown in Table-1. The dissolved solids ranged from 3980.0 to 5030.0 mg/ L with an average value of 4446.0 mg/ l. The total suspended solids varied from 280.0 to 420.0 mg/ L with standard deviation of 43.0. The standard deviation for total dissolved solids appeared to be significantly high.

The effect of retention time on the reduction of BOD and COD, TDS, TSS contents was studied and result is given in Table-2 and 3. It is apparent that the removal percentage of BOD and COD increases with an increase in retention time. A six days retention time is highly significant in reduction (76 % BOD, 72 % COD parameter) [6]. The BOD

Table-1: Statistical analysis of data from textile waste water

Variable	No.of samples (n)	Min.	Max.	Range	Mean (Arthematic)	Std. Deviation
pH	8	9.8	11.0	1.2	10.45	0.83
Temp. (°C)	8	33.0	40.0	7.0	37.50	2.29
BOD	8	542.0	675.0	133.0	606.20	47.90
COD	8	1396.0	1625.0	229.0	1514.0	72.91
TDS	8	3980.0	5030.0	1050.00	4446.9	301.40
TSS	8	280.0	420.0	140.0	345.0	43.0

Table-2: Reduction of BOD and COD in laboratory scale activated sludge reactor

Retention time in Days	Biochemical Oxygen Demand (BOD) (mg/L)			Chemical Oxygen Demand (COD) (mg/L)		
	Influent	Effluent	Removal %	Influent	Effluent	Removal %
1	588.0	458.0	22.0	1528.0	1216.0	20.0
2	588.0	383.0	34.0	1528.0	1036.0	32.0
3	625.0	329.0	47.0	1530.0	853.0	44.0
4	625.0	248.0	60.0	1530.0	650.0	57.0
5	542.0	173.0	68.0	1396.0	501.0	64.0
6	542.0	130.0	76.0	1396.0	385.0	72.0
7	550.0	99.0	82.0	1430.0	298.0	79.0
8	550.0	72.0	86.0	1430.0	213.0	85.0
9	568.0	68.0	88.0	1465.0	170.0	88.0
10	568.0	67.0	88.2	1465.0	142.0	90.0

Table-3: Reduction TDS and TSS in laboratory scale activated sludge reactor

Retention time in (days)	Total Dissolved Solids (TDS) mg/L			Total Suspended Solids (TSS) mg/L		
	Influent	Effluent	Removal %	Influent	Effluent	Removal %
1	4250.0	4000.0	6.0	320.0	250.0	21.0
2	4250.0	3730.0	12.0	320.0	225.0	30.0
3	4550.0	3550.0	22.0	365.0	185.0	49.0
4	4550.0	2990.0	34.0	365.0	160.0	56.0
5	3980.0	2560.0	35.0	280.0	110.0	60.0
6	3980.0	2480.0	37.0	280.0	95.0	66.0
7	4260.0	2320.0	45.0	310.0	90.0	79.0
8	4260.0	2280.0	46.0	310.0	75.0	75.0
9	4285.0	2220.0	48.0	315.0	68.0	78.0
10	4285.0	2208.0	48.5	315.0	65.0	79.0

content was reduced to NEQS level after 8 days and removal efficiency was 86 %. After ten days retention time, the removal of COD was 90 %. Total dissolved solids and total suspended solids reduced to the standard value (NEQS) within 3 to 4 days retention time. [7]. Biological treatment of textile wastewater pretreated with activated carbon resulted in 50 % reduction in retention time and 27 % increase in the removal efficiency of biological process when compared with the results of biological treatment. The main reason to take longer time to treat the wastewater in biological sludge reactor may be due to inherent disability of microbes to break down the toxic compounds rapidly, so pretreatment is necessary [8]. The retention time when extended to 10 days, gave only a reduction of 12-18 % (small) of BOD and COD contents so six days are sufficient to reduce the pollutants up to NEQS level.

The commercial lime was used as coagulant for wastewater treatment, which reduces the pollution loads significantly but increased the pH and temperature of wastewater due to exothermic reaction of lime with water. It is inferred that if biological treatment is employed in conjunction with activated carbon adsorption method, the target will be achieved in short period of time.

Experimental

Sampling

Composite sampling of textile wastewater was done during the period from September to December 2002. Sampling frequency was one sample per 15 days, characterized in terms of pollution indicators including, biological oxygen demand (BOD), chemical oxygen demand by COD reactor, total

dissolved solids (TDS), total suspended solids (TSS) and pH. The analysis of samples was conducted according to the standard methods [9]

Chemicals

Different chemicals used during this study. such as Urea (Merck), Sodium Chloride (BDH), Lime (laboratory scale), Sugar (commercial) and fertilizers.

Apparatus

All the chemicals and glass ware used of Analytical / Laboratory grade. Electrical Balance (Shamadzu, Japan), Incubator (Sanyo), Dissolved Oxygen Meter (Hanna, Portugal) pH meter (Crision 2001), COD reactor (Bioscience. Inc, USA) and Turbidity meter (Hanna, Portugal), Activated Sludge reactor (local made). Which was comprise of five components as following.

Feeding Tank

30 liters capacity plastic drum with an outlet fixed at 3 cm above its bottom to stop the flow of solid to the aeration tank. There is a plastic tube to ensure proper and regular supply of untreated settled wastewater from feeding tank to aeration tank.

Pinching Cock

It regulates the flow of settled wastewater into an aeration tank, and is installed on the plastic tube

Air Pump

This pump provides sufficient supply of oxygen not only to meet biological oxygen requirements but also to keep suspended solids and activated sludge in suspension. It also helps to make contact between microbes and organic matter which is necessary for efficient treatment of waste water

Aeration Tank

It is simple locally fabricated plastic tank of dimension 20 cm x 15 cm x 29 cm. Working depth of aeration unit was maintained 17.5 cm. The working volume was 6.5 liter. The diffuser was placed at a depth of 2.5- 5.0 cm above the bottom of tank.

Final Clarifier

The final clarifier is separated from aeration tank by a glass plate, which acts as a weir to discharge flows to the final clarifier. The size of clarifier is 15 cm x 10 cm x 29 cm.

Method

The Effluent samples were pre- treated by using adsorption and coagulation processes. The laboratory grade lime was used for chemical treatment and granular activated carbon was used for physical treatment. The lime is inorganic

Coagulant in which Ca^{2+} has an electric charge and acts as neutralizer for charged colloidal particles to form aggregates [7,10]. After pretreatment, the composite 5-liter waste water samples was added in a laboratory scale activated sludge reactor.

The activated sludge was cultured from domestic sewage water with the addition of nutrients, fertilizers and sugar, which enhanced the sludge production. One liter of this sludge was mixed with sample water in the reactor and run in a continuous mode. The retention time varied from 1 to 10 days, the treated sample was collected daily and characterized for the pollution parameters.

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