Biological Treatment of Wastewater for Institutions using Activated Sludge Process

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Abstract— The wastewater generated from the canteen, mess, college hostel in were collected and analyzed. In the present study, an attempt has been made to evaluate the treatability of wastewaters using lab-scale activated sludge reactor under extended aeration. Studies on the efficiency of the activated sludge reactor were carried out by varying the solids retention time of 8,12 and 16days with various hydraulic retention time of 15,20,25 and 30h with an organic loading rate varying from 0.116 to 0.209 kg BOD/ m^3/day. The study revealed that the wastewater is amenable for treatment using ASP, with treatment efficiency as high as 91% and the bio-kinetics arrived at showed, better stability of the system and enhanced microbial activities at longer HRT and SRT. Also the design values suggest that the extended aeration system is the appropriate activated sludge treatment method for wastewater treatment.

Key words: Biological Treatment of Wastewater, Activated Sludge Process

I. INTRODUCTION

Domestic households, industrial and agricultural practices produce wastewater that can cause pollution of many lakes and rivers. Sewage is the term used for wastewater that often contains faeces, urine and laundry waste. There are billions of people on Earth, so treating sewage is a big priority. Sewage disposal is a major problem in developing countries as many people in these areas don't have access to sanitary conditions and clean water. Untreated sewage water in such areas can contaminate the environment and cause diseases such as diarrhoea. Sewage in developed countries is carried away from the home quickly and hygienically through sewage pipes. Sewage is treated in water treatment plants and the waste is often disposed into the sea. Sewage is mainly biodegradable and most of it is broken down in the environment. In developed countries, sewage often causes problems when people flush chemical and pharmaceutical substances down the toilet. When people are ill, sewage often carries harmful viruses and bacteria into the environment causing health problems.

II. OBJECTIVES OF THE STUDY

A treatability study on the combined sewage wastewater is proposed at a lab scale using Activated Sludge Process, with the following objectives:

- To study the feasibility of treatment of wastewater using activated sludge process.
- To determine bio-kinetic constants for the treatment of wastewater.
- To determine the optimum operational conditions for the treatment of wastewater.

III. TOLERANCE LIMITS

The combined wastewater has to meet the regulatory standards before disposal to surface water to avoid pollution. The regulatory standards are as detailed below in Table1

Contaminants	Unit	Weak	Medium	Strong
Total solids (TS)	mg/L	350	720	1 200
Total dissolved solids (TDS)	mg/L	250	500	850
Fixed	mg/L	145	300	525
Volatile	mg/L	105	200	325
Suspended solids	mg/L	100	220	350
Fixed	mg/L	20	55	75
Volatile	mg/L	80	165	275
Settleable solids	mg/L	5	10	20
BOD5, 20ºC	mg/L	110	220	400
TOC	mg/L	80 1	60	290
COD	mg/L	250	500	1000
Nitrogen (total as N)	mg/L	20	40	85
Organic	mg/L	8	15	35
Free ammonia	mg/L	12	25	50

Table 1: Tolerance limits for domestic waste water

A. *Process Description*

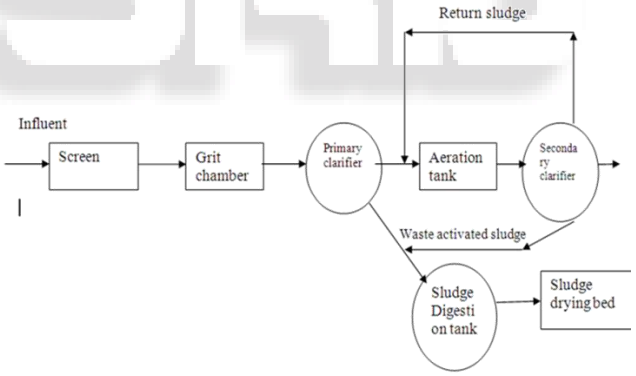

Fig. 1: Process Description

IV. MATERIALS AND METHODS

A. *Collection of Wastewater*

Samples of wastewater were collected from college discharging most contaminated wastewater. These samples were mixed to get a composite wastewater sample and were used in the analysis and treatment study.

B. *Characterisation of Composite Sample*

The individual and composite samples were analysed for various parameters such as pH, TSS, TDS, BOD_3, COD, and Chloride. The analysis was done as per the standard methods for the examination of water and wastewater (APHA 1998). The specific method of analysis adopted for each parameter is presented.

V. EXPERIMENTAL SETUP

The activated sludge laboratory model as shown in Figure 2 was made up of plexiglass consisted of two sections namely aeration and sedimentation with a volume of 7.5 L and 2.5 L respectively. A continuous supply of wastewater into the aeration section was maintained with a peristaltic pump. The extended aeration was carried out with the use of two diffuser stones and an air pump so as to maintain a dissolved oxygen concentration around 2-3 mg/L. The aeration was instrumental in terms of bacterial growth as well as maintaining homogeneity of the mixed liquor to confirm the complete mix flow of the reactor. The aeration section was separated from the sedimentation section with an adjustable baffle. The settled sludge was returned to the aeration section by passing it under the adjustable baffle. The photograph of the experimental setup is shown in Figure 3

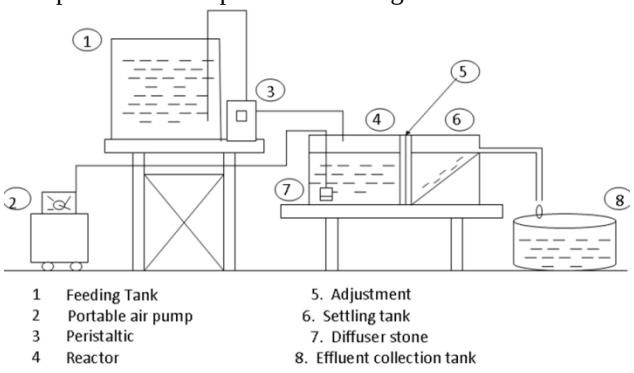

Fig. 2: The activated sludge laboratory model

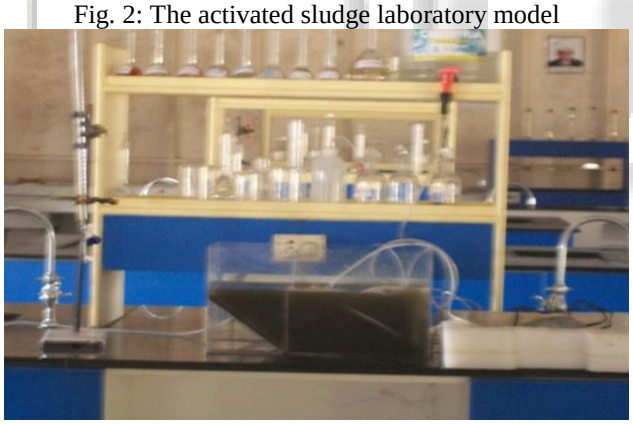

Fig. 3: The photograph of the experimental setup

VI. STARTUP AND BACTERIAL ACCLIMATIZATION

The Activated Sludge reactor was started using seed collected from local domestic sewage treatment plant. In the reactor sufficient MLSS was developed by adding continuously the fresh sewage, collected from the local treatment plant. The acclimatization of the bacterial culture to the composite wastewater was established by gradual addition of composite wastewater to the reactor starting with a composition of 10% composite wastewater and 90% domestic sewage. The addition of composite wastewater was increased by 10% daily. Gradually the reactor was fed with 100% composite wastewater and acclimatization was achieved. The design considerations for the treatability study of combined wastewater are given in Table 2

Sl.No.	Parameter	Range proposed
1.	Solids Retention Time	10-30 days
2.	F/M Ratio	0.1-0.2kgBOD/ kg MLSS/ day
3.	MLSS	3000-6000 mg/L
4.	Hydraulic Retention Time	15-30 h
5.	Oxygen supply	2-4 mg/L
6.	Ph	7-8.5 mg/L

Table 2: Design considerations for Activated Sludge Process
Source: IS 8413 (part II)-1982

VII. RESULTS AND DISCUSSIONS

A. *Characterization of the Collected Samples*

Parameters	Domestic sewage
pH	7.3-7.9
TS	710
TSS	210
TDS	500
BOD_3	204
COD	460
Chloride	50

Table 3 Characteristics of wastewater samples
Except pH all the values are in mg/L

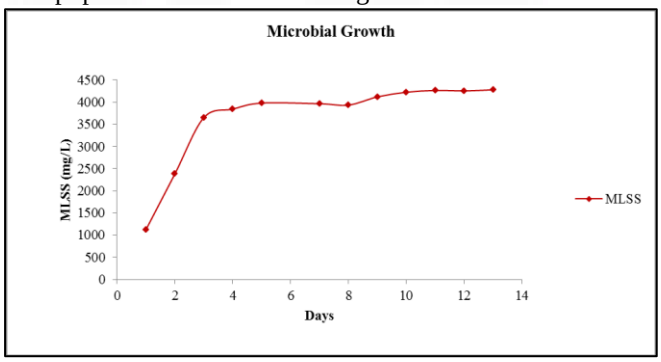

Fig. 4: Graph

Sl. No.	Hydraulic Retention Time 'd'	Flow (ml/min)	Organic Loading Rate (kgBOD/m^3/day)	Influent BOD (mg/L)	Effluent BOD (mg/L)	BOD removal (%)	MLSS (mg/L)	F/M Ratio (kg BOD/ kgMLSS/day)
1	0.63	8.33	0.230	145	84	42	3980	0.057
2	0.83	6.25	0.179	149	59	60.40	4005	0.044
3	1.04	5.00	0.148	154	40	74.02	4020	0.036
4	1.25	4.17	0.113	142	26	81.69	4015	0.028

Table: 4 Performance of ASP at SRT of 8 Days

VIII. CONCLUSION

The following conclusions have been made on the present study conducted on the treatment of sewage using ASP.

1) The sewage wastewater is amenable for treatment by Activated Sludge Process and a maximum treatment efficiency of 91% in terms of COD removal was achieved.

2) The optimum operating conditions for the treatment of composite wastewater were obtained as 8 days Solids Retention Time and 30 h Hydraulic Retention Time.
3) The organic loading rate at optimum operating condition was 1.61 kg COD/m^3/day.
4) The bio-kinetics obtained for the treatment of combined domestic and tannery wastewaters are as given below:
   Maximum substrate utilization rate (k) - 0.416 day^{-1}.
   Half saturation constant (K_s) - 122 mg/L.
   Yield coefficient (Y) - 0.539 mg of MLSS/mg of COD
   Endogenous decay coefficient (k_d) - 0.088 day^{-1}.
   Maximum specific growth rate (μ_m) - 0.224day^{-1}.
5) A maximum treatment efficiency of 91% was obtained for a lower F/M ratio of 0.08 kg BOD/kg MLSS.
6) A relatively higher half velocity substrate concentration and lower 'μm' value obtained provides better stability for the Activated Sludge Process.
7) The maximum rate of substrate utilization and half velocity- substrate concentration obtained in the present study are around the same than those obtained for combined tannery waste with cow dung because of higher initial substrate concentration.
8) The yield coefficient obtained in the present study was higher and decay coefficient was lower than the corresponding typical values for domestic wastewater due to longer SRT and HRT.
9) The present study will be a promising solution for the treatment of combined tannery and domestic wastewater in areas, inclusive of Melvisharam Municipality, where their disposal without treatment causes environmental degradation.

IX. Scope for Future Study

Pilot plant studies could be conducted to establish the treatment of combined wastewater using the Activated Sludge Process under field conditions and to obtain necessary data for full scale design.

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