With The Activated Sludge Technique, Treatment of Biological Waste Water

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Abstract A feasibility analysis of the activated sludge process for the treatment of synthetic wastewater was performed, and a straightforward design standard was created for use in the region. This was accomplished using a bench scale model that included an aeration tank and final clarifier. For 210 days, the model was run constantly.

Synthetic wastewater that had settled was used as the aeration tank's influent. To determine process efficiency for varied mixed liquor volatile suspended solids and hydraulic detention duration, the chemical oxygen demand of the influent and effluent was assessed.
The study's findings showed that operating the ASP at an MLVSS concentration of 3,000 mg/L while maintaining a 1-hour aeration period would yield an efficiency for COD of above 90%. The findings of this study may provide important information about how to effectively treat municipal and industrial waste water using the activated sludge technique.

Keywords: activated sludge; synthetic waste water; COD; MLVSS.

1 Introduction

All businesses, but chemical industries in particular, contaminate the environment by releasing solid, liquid, and gaseous waste products that are extremely toxic to aquatic life and humans. To lower the degree of pollution, the treatment of waste water will be looked into in this study. Typically, suspended solids and biological and chemical oxygen demands are used to gauge the level of pollution. Primary, secondary, and tertiary stages make up the treatment. Filtration is used to separate coarse materials in the initial stage.

Particularly dissolved organic contaminants are eliminated during treatment employing microbes in aerobic or anaerobic processes (biological). BOD should be 60 mg/L and SS should be 30 mg/L in the treated effluent. By filtering the secondary stage's treated effluent via sand, charcoal, and/or activated carbon in the third stage, the BOD and SS are further decreased to 20 and 10 mg/L, respectively (World Applied Sciences Journal, 2009).

In the sewage treatment procedure known as "activated sludge," air or oxygen is injected into the sewage liquor to create a biological floc that lowers the sewage's organic content. In all activated sludge facilities, excess mixed liquor is dumped into settling tanks once the sewage has received adequate treatment, and the supernatant is run off to receive more treatment before being discharged. Sludge, a portion of the settled material, is returned to the aeration system's head to replenish the tank with fresh sewage. Return activated sludge is the name given to this subset of the floc. Prior to disposal, the residual sludge—also known as waste activated sludge—undergoes additional treatment (Metcalf and Eddy, 2001).

1. ASP may be employed in a sewage treatment facility for one or more of the following functions:
2. One carbonaceous substance that oxidises is living stuff.
3. Nitrogenous substance is oxidised in biological materials mostly as ammonium and nitrogen.
4. 3 taking out phosphate
5. driving off entrained gases carbon dioxide, ammonia, nitrogen, etc.
6. generating a biological floc that is easy to settle

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7 generating a liquor low in dissolved or suspended material.

We cannot allow wastewater to be disposed of in a manner dangerous to human health and lesser life forms or damaging to the natural environment. Our planet has the remarkable ability to heal itself, but there is a limit to what it can do, and we must make it our goal to always stay within safe bounds. That limit is not always clear to scientists, and we must always take the safe approach to avoid it.

Basic wastewater treatment facilities reduce organic and suspended solids to limit pollution to the environment. Advancement in needs and technology have necessitated the evolving of treatment processes that remove dissolved matter and toxic substances. Currently, the advancement of scientific knowledge and moral awareness has led to a reduction of discharges through pollution prevention and recycling, with the noble goal of zero discharge of pollutants. Treatment technology includes physical, biological, and chemical methods. Residual substances removed or created by treatment processes must be dealt with and reused or disposed of in a safe way. The purified water is discharged to surface water or ground water. Residuals, called sludges or biosolids, may be reused by carefully controlled composting or land application. Sometimes they are incinerated.

2 Experimental setup

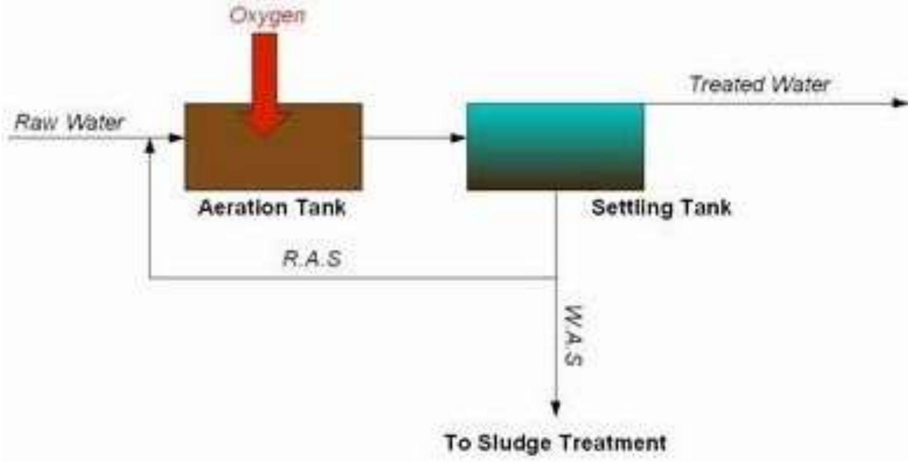
The general arrangement of an activated sludge process for removing carbonaceous pollution includes the following items:

1 aeration tank where air (or oxygen) is injected in the mixed liquor

2 settling tank (usually referred to as 'final clarifier' or 'secondary settling tank') to allow the biological flocs to settle, thus separating the biological sludge from the clear treated water.

This is illustrated in Figure 1.

Figure 1 Generalised arrangement of an activated sludge process (see online version for colours)



A laboratory scale bubble column reactor made up of glass having approximately 15 cm diameter and 1 m height with bottom sealed and top open with a provision of an overflow to hold atleast 10 L of waste water was used in this study. It consists of an aeration tank (bucket) of 15 L capacity. One aerator like that of fishpond with very fine bubbles and provision for uninterrupted power supply for aeration was used. The waste water fed as influent to the bubble column reactor was brought from Pentakali Dam, Dist: Buldana,10 km Chikhli – Mehakar Road.

Material and methods

Determination of COD and suspended solids were carried out by using $K_2Cr_2O_7$, ferrous ammonium sulphate, H_2SO_4. The COD was calibrated using exactly 1gm/L pure glucose solution (add 1gm glucose in distilled water and make up volume 1 litre). Here the data was collected and studied related to COD only.

Composition of synthetic wastewater

Following are the composition of synthetic wastewater for mg/L solution

- glucose: 1,000
- urea: 225
- magnesium sulfate: 100
- potassium phosphate: 1,000
- calcium chloride: 64
- ferric chloride: 0.5.

Chemical oxygen demand

Most of the organic matters are destroyed when boiled with a mixture of potassium dichromate and sulphuric acid producing carbon dioxide and water. A sample is refluxed with a known amount of potassium dichromate in sulphuric acid medium and the excess of dichromate is titrate against ferrous ammonium sulphate. The amount of dichromate consumed is proportional to the oxygen required to oxidise the oxidisable organic matter.

Procedure

Place 0.4g $HgSO_4$ in a reflux tube. Add 20 ml or an aliquot sample diluted to 20 ml with distilled water. Mix well, so that chlorides are converted into poorly ionised mercuric chloride. Add 10 ml standard $K_2Cr_2O_7$ solution and then add slowly 30 ml sulphuric acid which already containing silver sulphate. Mix well, if the colour turns green, take a fresh sample with smaller aliquot. Final concentration of concentrated $H2SO_4$ should always 18 N. Connect the tubes to condenser and reflux for 2 h at 150°C. Cool and wash down the condensers with 60 ml distilled water. Cool and titrate against standard ferrous ammonium sulphate using ferroin as indicator. Near the end point of the titration colour changes sharply from green blue to wine red. Reflux blank simultaneously with the sample under identical conditions.

$$\text{COD, mg / L} = \frac{(V_1 - V_2)*N*8{,}000}{V_0}$$

Total suspended solids

A well-mixed sample is filtered through a weighed standard glass-fibre filter and the residue retained on the filter is dried to a constant weight at 103°C to 105°C. The increase in weight of the filter represents the total suspended solids. If the suspended material clogs the filter and prolongs filtration, it may be necessary to increase the diameter of the filter or decrease the sample volume. To obtain an estimate of total suspended solids, calculate the difference between total dissolved solids and total solids.

$$\text{Total suspended solids mg / L} = \frac{(A - B)\times 1{,}000}{\text{Sample volume, ml}}$$

Sludge volume index

The sludge volume index (SVI) is the volume in millilitres occupied by 1 g of a suspension after 30 min settling. SVI typically is used to monitor settling characteristics of activated sludge and other biological suspensions. Although SVI is not supported theoretically, experience has shown it to be useful in routine process control.

SVI is an indication of the sludge settleability in the final clarifier. It is a useful test that indicates changes in the sludge settling characteristics and quality. SVI is the volume of settled sludge in millilitres occupied by 1 g of dry sludge solids after 30 min of settling in a 1,000 ml graduated cylinder or a settleometer.

A litre of mix liquor sample is collected at or near the outlet of the aeration tank, settled for 30 min in a 1 L graduated cylinder, and the volume occupied by the sludge is reported in ml. SVI is computed by dividing the result of the settling test in ml/L by the MLVSS concentration in mg/L in the aeration tank times 1,000.

$$\mathrm{SVI} = \frac{\text{Settled sludge volume (ml / L)} \times 1{,}000}{\text{Suspended solids (mg / L)}}$$

3 Results and discussion

The treatment efficiency of reactor in terms of COD removals was studied for concentrations of 1,200, 1,500, 2,100, 2,500, 3,000 mg/L at 0 of 60, 45, 30 and 15 min. It was noted that the process efficiency improved with increase in MLVSS concentration and 0. The removal efficiencies at different MLVSS and time are given in Table 2. Thus the results indicate that for optimal operation, ASP should be operated at MLVSS concentration of 3,000 mg/L and time value of 60 min.

The data in Table 2 are graphically represented in Figures 3 and 4, which reveal that a maximum COD removal efficiency of 94% was achieved at MLVSS concentration of 3,000 mg/L and 0 of 60 min.

Table l The reduction of COD of the 1 gpl solution as a function of time under batch condition

Sr. no.	*Dilution factor*	*Time (h)*	*COD (mg/L)*	*MLVSS (mg/L)*
1	4	0	1200	458
2	3	2	751	680
3	3	4	470	897
4	3	6	258	1060
5	3	8	94	1170

Table 2 COD determination of 1 gpl solution of SWW at different concentrations of MLVSS

Sr. no.	*Time (min.)*	*MLVSS (mg/L)*	*Influent COD (mg/L)*	*Effluent COD (mg/L)*	*COD removal efficiency (%)*	*SVI (ml/g)*
1	60	1,200	1,200	465	61.25	70
	45	1,200		610	49.16	67
	30	1,200		725	39.58	61
	15	1,200		840	30	57
2	60	1,500	1,200	340	71.66	67
	45	1,500		490	59.16	50
	30	1,500		620	48.33	48.32
	15	1,500		670	44.16	44
3	60	2,100	1,200	136.84	88.59	45
	45	2,100		186	84.5	43.2
	30	2,100		235	80.41	41.9
	15	2,100		385	67.91	34.54
4	60	2,500	1,200	112.30	90.64	48.9
	45	2,500		163	86.41	44
	30	2,500		226	82.5	32.3
	15	2,500		367	70.8	28.47
5	60	3,000	1,200	71	94	40
	45	3,000		110	90.8	31.8
	30	3,000		210	82.5	29.97
	15	3,000		350	70.8	28.1

Figure 2 Relationship among hydraulic detention time (h) and COD/MLVSS (mg/L) (see onlineversion for colours)

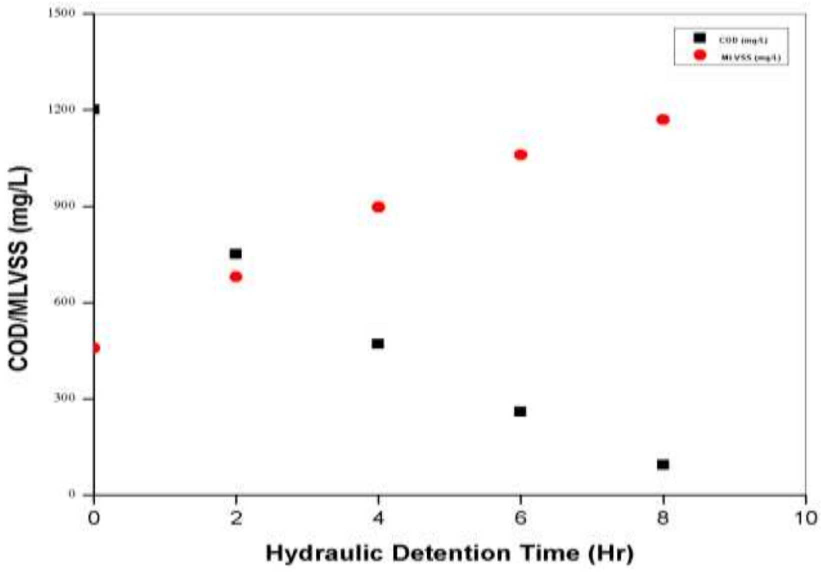


Figure 3 COD removal efficiency vs. time at various concentrations of MLVSS (see onlineversion for colours)

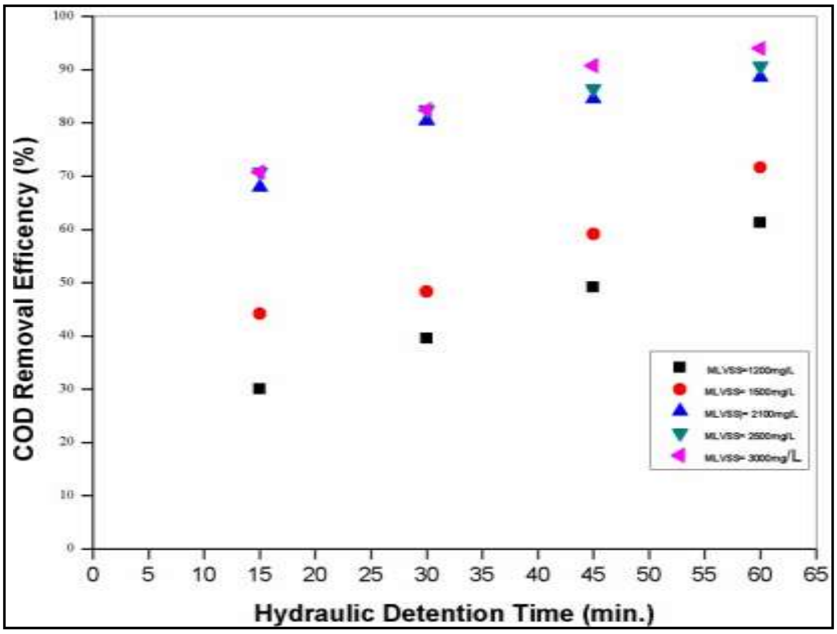
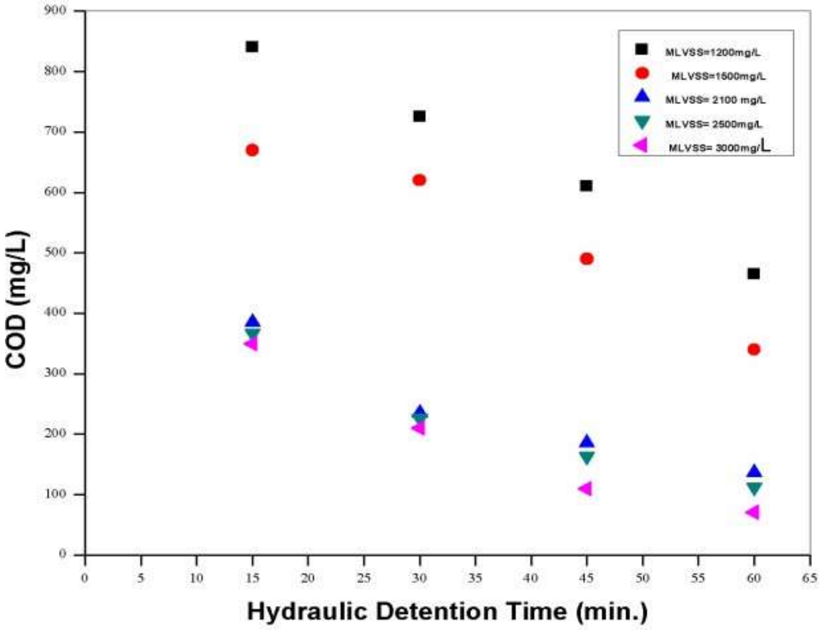


Figure 4 COD reduction vs. time at various concentrations of MLVSS (see online versionfor colours)



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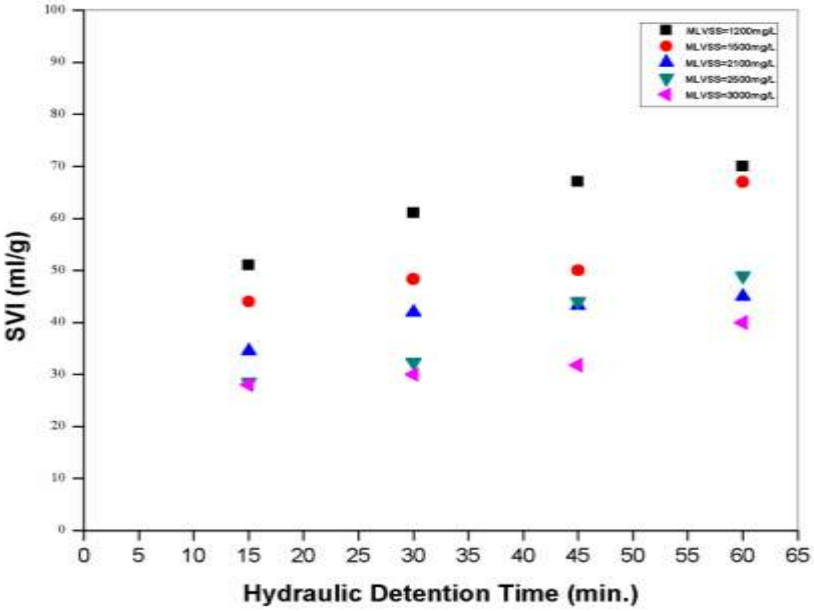
The data in Table 2 are graphically represented in Figures 3 and 4, which reveal that a maximum COD removal efficiency of 94% was achieved at MLVSS concentration of 3,000 mg/L and θ of 60 min.

The result shown in Table 2 indicates that the amount of COD reduction was variable throughout the experiment. The minimum reduction was about 30% when concentration of MLVSS was 1,200 mg/L and the maximum above 90% when concentration of MLVSS was 3,000 mg/L. The overall efficiency of the removals is indicated by

% reduction of COD in Figure 3. Also the effect of SVI reduction on time at various concentrations was studied as shown in Figure 5.

Figure 5 SVI reduction vs. time at various concentrations of MLVSS (see online versionfor colours)



The activated sludge methods of waste water treatment are the most economical and widely used for removing organic components from waste water. The pollution load was estimated by COD. A result obtained in this study has indicated that the percentage reduction of COD reached upto 94% in effluent, reduction from 1,200 mg/L to 3,000 mg/L.

4 Conclusions

ASP is a feasible treatment technology for biological wastewater treatment especially where limited space restricts the use of other biological methods. ASP for India may be operated with MLVSS concentration of 3,000 mg/L and θ value of 1 h in order to obtain optimal removal efficiencies with respect COD and SVI. However, for a biological wastewater treatment plant, bench scale studies to find out the optimal values of these parameters are needed prior to the design of biological unit. The effluent met COD at the above stated MLVSS concentration and θ value. However, COD limit for CPCB could be qualified. The study might be provided useful understanding for the treatment of different types of industrial waste water and COD reduction, which will meet to the standard discharge value of COD, set by Maharashtra pollution control board. Based upon this research, further work is proposed to study the nitrogen removal to estimate the permissible limit of BOD and COD in ASP. Additionally, effect of different MLVSS concentration and detention time on the efficiency of settling tank may be investigated.

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