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# EVALUATION OF A TWO-STAGE TREATMENT OF DOMESTIC SEWAGE WITH ANAEROBIC-AEROBIC MICROBIAL FILM

*A. Mesdaghinia, Ph.D.**

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## ABSTRACT

The objective of this research was to study the feasibility of a two stage continuous system employing anaerobic-aerobic microbial film for domestic wastewater treatment and the effect of iron on the behavior of sulfate reducing bacteria in anaerobic metabolism.

A bench scale system with an anaerobic filter followed by an aerobic fixed unit and a final clarifier was studied in three different phases. The biological units used plastic media and were operated in up flow manner with hydraulic detention times of 6 hours, whereas the aerobic unit utilized diffused aeration. Raw domestic sewage was fed to the anaerobic unit, and the aerobic unit was fed with the anaerobic effluent.

Although, the anaerobic filter did not show a considerable organic removal with domestic sewage it was improved when glucose was added to the influent to increase

* School of Public Health, Tehran University of Medical Sciences, P.O.Box 6446-14155 Tehran- IRAN.

influent soluble COD. When glucose was added the anaerobic filter removed about 290 mg/l of influent soluble COD. The aerobic unit produced an excellent effluent with COD, $BOD_5$ and TSS concentrations of 37 mg/l, 9 mg/l and 10 mg/l respectively. Overall, the system removed 95 percent of influent COD, 97 percent of influent $BOD_5$ and 96 percent of influent TSS.

## INTRODUCTION

Adequate wastewater treatment is one of the major problems facing most of the developing countries and small communities in developed countries (3).

Package treatment plants used in small communities are generally extended aereation or contact stabilization activated sludge systems and both need close monitoring and attention. Unfortunately, developing countries are often unable to afford the necessary skilled operators. On the other hand trickling filters are easier to operate than activated sludge and less sensitive to shock loads but they do not produce the desired effluent quality.The fixed media activated sludge mixes the advantages of both activated sludge and trickling filters. Same as in aerobic processes the anaerobic filter optimizes the anaerobic treatment of organic wastes (2).

The main objectives of this research were:

1) To examine the use of the anaerobic filter in domestic sewage treatment.

2) To determine the feasibility of the proposed fixed media activated sludge for wastewater treatment.

## MATERIALS AND METHODS

A bench scale system with an anaerobic filter followed by an aerobic fixed media unit and a final clarifier were used in this study (Fig 1). The media were 5/8" flex rings from koch Engineering Company.

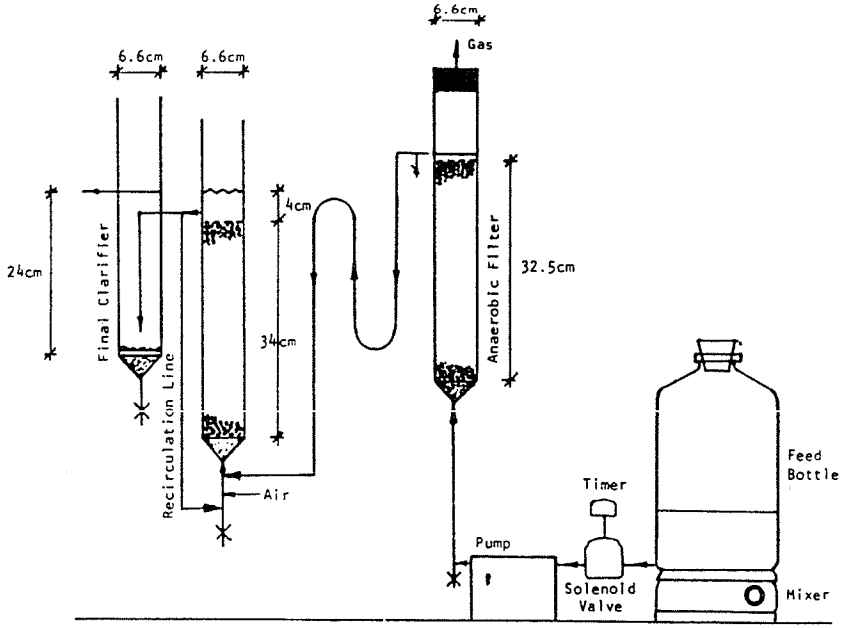


Fig.1: Schematic Diagram of two Stage System.

The sewage was pumped from feed bottle to the bottom of the anaerobic filter by a peristaltic pump which was operated on an intermittent basis by a timer arrangement. The pump was operated once every 10 minutes. The effluent from the anaerobic filter was fed to the bottom of fixed activated sludge unit and the aerobic effluent was settled in a final clarifier prior to collection for analysis. A return supernatant line recycled the aerobic effluent to the bottom of the FAS. Air was diffused to the aerobic unit through a glass "T" located at the bottom of the unit and through the recirculation and feed line. The study was done in three different phases. The hydraulic detention time of the anaerobic filter and the FAS unit were kept 6 hours during the study. The variable parameter was the organic content of the feed material. In first phase raw domestic sewage was used as influent where as in second phase glucose was added to the raw sewage to increase the soluble COD of the influent. In phase three, iron as $FeCl_2$ was added to the influent along with glucose to study the effect of iron on sulfate reducing bacteria activity. Table 1. shows the physical characteristics of two stage unit and Table 2. shows a summary of operational procedures.

Table 1. Physical characteristics of the two stage unit under study.

| Physical characteristics | Anaerobic unit | Aerobic unit |
|---|---|---|
| Inside diameter, Cm | 6.6 | 6.6 |
| Water depth, Cm | 33.5 | 38 |
| Effective depth, Cm | 32.5 | 34 |
| Effective zone volume | | |
| Without media, Cm | 1112 | 1163 |
| With media, Cm | 974 | 1028 |
| Porosity of media | 0.88 | 0.88 |

Table 2. Summary of operational procedures.

| Phase No. | Retention Time, hr | Substrate Fed | Operational period, day |
|---|---|---|---|
| 1 | 6 | raw sewage | 72 |
| 2 | 6 | raw sewage | |
| | | + glucose | 80 |
| 3 | 6 | raw sewage | |
| | | + glucose+ iron | 92 |

Samples were taken from influent and effluents from each unit and were analysed for suspended solids, $BOD_5$, COD... according to procedures given in Standard Methods (1).

## RESULTS AND DISCUSSION

As can be seen in Table 3, the anaerobic filter did not show a measurable soluble COD removal in phase 1. In phase 2 with increased soluble COD (by glucose addition to the influent) the anaerobic filter removed 194 mg/l of the soluble COD. In phase 3 iron as $FeCl_2$ was added to the influent along with glucose to overcome the problem of sulfate reducing bacteria. Apparently iron did not have any adverse effect on the microbes in the system and only precipitated the sulfides.

Table 3. Summary of system performance.

| Parameter mg/l | Anaerobic Filter | | | | | | Fixed Activated Sludge | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Phase 1 | | Phase 2 | | Phase 3 | | Phase 1 | | Phase 2 | | Phase 3 | |
| | In | Out | In | Out | In | Out | In | Out | In | Out | In | Out |
| Total COD | 382 | 322 | 858 | 564 | 840 | 527 | 322 | 35 | 564 | 37 | 527 | 36 |
| Soluble COD | 142 | 152 | 524 | 330 | 502 | 215 | 130 | 28 | 330 | 29 | 215 | 31 |
| TSS | 201 | 122 | 295 | 179 | 325 | 273 | 122 | 4.5 | 179 | 7.5 | 273 | 10 |
| VSS | 133 | 84 | 220 | 133 | 215 | 172 | 84 | 8.5 | 133 | 6.0 | 172 | 6.0 |
| Total $BOD_5$ | - | - | - | - | - | - | 120 | 5 | 261 | 9 | - | - |
| Total Alkalinity | - | - | - | - | - | - | 342 | 119 | 567 | 363 | 512 | 354 |

The results of the performance of the aerobic unit are also summarized in Table 3. A mean total COD reduction of 89 to 93 percent was gained with the FAS and the system produced an effluent with 35-37 mg/l total COD. The aerobic unit was very efficient in $BOD_5$ removal. As shown in the Table, effluent $BOD_5$ concentrations of 5 to 9 mg/l were achieved during the study. A consistently clear effluent was produced by the FAS as can be seen from suspended solids data. The effluent suspended solids were below 10 mg/l in all cases during this study and were independent of influent suspended solids in the range of normal conditions of domestic sewage.

## CONCLUSION

1. The anaerobic filter was not efficient in treating domestic wastewater. However, with increasing soluble COD it started improving.
2. An aerobic system should be used after the anaerobic filter to produce a high quality effluent for discharge back to the environment.
3. The addition of iron apparently did not have an adverse effect on the microbes in the filter and only precipitated the sulfides produced by reduction of sulfates in the anaerobic process.
4. The fixed activated sludge (FAS) employing diffused aeration showed an excellent performance in treating domestic wastewaters and produced a high quality and partially nitrified effluent.

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