

Treatability Study of Tannery Effluent by Conventional Activated Sludge Process and Activated Sludge Process using Medium

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Abstract: The characteristics of tannery effluent vary considerably from tannery to tannery depending upon the size of the tannery, chemicals used for a specific process, amount of water used and type of final product produced by a tannery. The project is carried out with PVC spiral medium to observe the effect of Activated Sludge Process (ASP) on BOD and COD mainly. The experimental process involves the conventional Activated Sludge Process (ASP) that uses air (oxygen) and microorganisms to biologically oxidize organic pollutants producing a waste sludge containing the oxidized material. The study is conducted by following two methods: a) ASP without medium and b) ASP with medium (PVC Spirals). The tannery effluent measuring three litres and half litre of return sludge was filled in the aeration tank and was aerated in the aeration tank where air (or oxygen) is supplied for regular intervals of 4, 6, 8, hours respectively and allowed for settlement in a sedimentation tank for one hour. A settling tank (usually referred to as a “clarifier”) is used to allow the effluent sludge to settle. Part of this sludge is recycled to the aeration tank for initial growth of micro organisms in it. This part of sludge is known as return sludge. And the remaining sludge is removed for further treatment and ultimate disposal. Testing of different parameters like BOD, COD, Total Solids and Turbidity were carried out on the samples aerated with different aeration time, with and without medium and consequent results were found. In the presence of PVC Spiral medium, the concentrations of various parameters considered for study were found decreased when compared with the values of concentration found without using any medium. It is very clear that PVC Spiral medium contributes more to the surface area which is very essential for the growth of micro organisms for effective removal of pollutants from the effluent.

Key-Words: - Tannery effluent, Activated Sludge Process, PVC Spiral medium, BOD, COD, Total Solids, Turbidity.

1 Introduction

Industrial wastes are generated from various industrial processes, as a result the amount and toxicity of waste released from industrial activities varies with the industrial processes. Again, among all the industrial wastes tannery effluents are ranked as the highest pollutants (Shen, 1999) [1]. In developing countries, many industrial units are operating in a small and medium scale. These industrial units can generate a considerable pollution load by discharging untreated effluents directly into the environment. The effluent arising from tanneries is highly polluted and has to be treated before discharged into rivers. The environment is under increasing pressure from solid and liquid wastes emanating from the leather industry. There are inevitable by-products of the leather manufacturing process and cause significant pollution unless treated

in some way prior to discharge. In some instances, liquid waste is discharged into sewage systems (indirect discharge) where it undergoes full scale treatment before being returned to the environment via surface waters. In those cases, effluent treatment standards set by the authorities are governed by the scale of dilution with other effluents and domestic sewage, treatment plant capabilities, and problems related to plant and equipment management or maintenance. Under these conditions discharge limits are lower than those on discharge direct into surface waters. That notwithstanding, factors such as final sludge disposal and discharge limits for treated effluents that might be imposed on the sewage treatment authority also have to be taken into account. Where effluent is discharged direct into streams and rivers, it needs to be of higher quality as the

environment is sensitive and highly susceptible to damage. The greater the volume of the effluent compared to the volume of surface water, the higher the quality of the effluent demanded by the environment.

1.2. Objectives of the project

The objectives of the project are

- a) To design a lab-scale activated sludge process tank.
- b) To study the characteristics of the raw effluent.
- c) To compare the removal efficiency of parameters of the effluent after treatment by conventional activated sludge treatment method and by activated sludge treatment using PVC spirals as medium.

2 Methodology

2.1 Sampling

Tannery effluent sample was collected from “Rubena leather industries” located at Nagalakeni, Chrompet, Chennai. Generally, the activated sludge process is a treatment that comes under secondary treatment (Biological treatment), where the chemical oxygen demand (COD) and bio-chemical oxygen demand (BOD) levels in the effluent are minimized by the growth of micro organisms in it. The above mentioned sample was collected from the supernatant tank of the effluent treatment plant of the industry by grab sampling, where the sample was initially treated in reaction channel and then passed into primary clarifiers and then to the supernatant tank. So, the sample was collected from the supernatant tank, where the primary treatment was done and the secondary treatment yet to be done or can be said as between the primary and secondary treatment. S. Haydar, J. A. Aziz (2007) [2] have observed the feasibility of Activated Sludge Process (ASP) for the treatment of tannery effluent and to develop a simple design criteria under local conditions. A bench scale model comprising of an aeration tank and final clarifier was used for this purpose. The model was operated continuously for 267 days. The results of the study demonstrated that an efficiency of above 90% and 80% for BOD₅ and COD, respectively could be obtained if the ASP is operated at an MLVSS concentration of 3500 mg/L keeping an aeration time of 12 hours.

2.2 Characteristics of the raw tannery effluent

All the pollutant parameters were analyzed following the procedure as per the Standards Methods for the Examination of Water and Wastewater (APHA-AWWA-WPCF, 1998) [3] which is shown in table 1

Table 1 Characteristics of the raw tannery effluent

Sl no.	Parameter	Values of parameters
1	pH	6.51
2	TS	5800
3	TDS	5500
4	TSS	300
5	Alkalinity	1675 mg/l
6	Chlorides	2378.5 mg/l
7	Total Hardness	3500 mg/l
8	Turbidity	146 NTU
9	BOD	1200 mg/l
10	COD	1800 mg/l

2.3 Experimental setup

A lab scale model of activated sludge reactor shown in Fig 2 was prepared for the project in which there are two compartments namely, an aeration tank and a sedimentation tank.

The dimensions of the aeration tank are 0.2 x 0.15 x 0.2 meters in length, width and height respectively where the total volumetric capacity of the tank is 7.2 litres.

The dimensions of the sedimentation tank are 0.2 x 0.15 x 0.15 meters in length, width and height respectively where the bottom of the tank is provided with a slope of ratio 1:1. Thus, the total volumetric capacity of the sedimentation tank is 3.375 litres.

In this project we have treated the raw tannery effluent (which was collected after primary treatment) by providing continuous aeration in the aeration tank, for a specific time intervals varying a time period of 4 hours, 6 hours and 8 hours. The same process was repeated on the raw samples varying aeration time inclusive of PVC spiral medium shown in Fig 1. in the aeration tank filled up to half of the tank.

For each treatment, 3 litres of raw tannery effluent and 0.5 litre of return sludge was added, so, a total volume of 3.5 litres of raw effluent was treated in the aeration tank. After each treatment, the effluent was allowed to settle in the sedimentation tank which is provided in the reactor with a settling time of one hour.

From the above 3.5 litres which was allowed to settle in the sedimentation tank, 0.5 litre of the bottom settled sludge was collected and used as return sludge into the aeration tank. The remaining sludge was allowed for Ultimate disposal and the above floating water was collected and preserved (at a temperature below 5° C) for tests of different parameters such as BOD, COD, Total solids, Turbidity.

2.4 Medium -PVC spiral medium

Spiral, a revolutionary packing media of synthetic material, comprises of numerous winding or 'S' shaped portions continuous with each other extending in radial direction to provide maximum surface area for a given void ratio. This innovative product with uncountable pleats in the shape of spirals generates and contributes more to the surface area, up to 10 times more than conventional media. Spirals permit extremely high loading rates with high efficiency and provide significantly to the mass transfer performance.

Spirals, producing maximum surface, can be used in a variety of applications such as scrubbers, strippers or biological process. Systems can be designed to permit the liquid into a multiplicity of slow moving films dispersed through a volume of gas as in packed towers or break up gas into tiny bubbles that are passed through

volume of liquid as in submerged fluidized bed reactors. Spirals permit a large population of micro organisms to reside on its surface in the reaction tank to degrade the organic material from the liquid. This typically is a function of organic and hydraulic loading on the spirals to treat effluent of different characteristics.

The process of attached growth provides a greater efficiency, operational flexibility and versatility than any other aerobic biological treatment process.

Spirals combine activated sludge processes and trickling filter systems to achieve superior performance eliminating the need for recycle of sludge to the aeration tank maintaining biological activity to produce high quality treated water.



Fig.1 PVC Spiral medium

2.4.1 Characteristics of the Medium

- a) Size of each spiral = 55mm packing
- b) Surface Area of the spirals = 350 sq.m/cu.m
- c) Void Ratio of each spiral = 92%
- d) Packing Factor = 83 sft/cft
- e) Permissible temperature of the PVC spirals is upto 60°c
- f) Specific Gravity of the spirals is 1.05 to 1.10

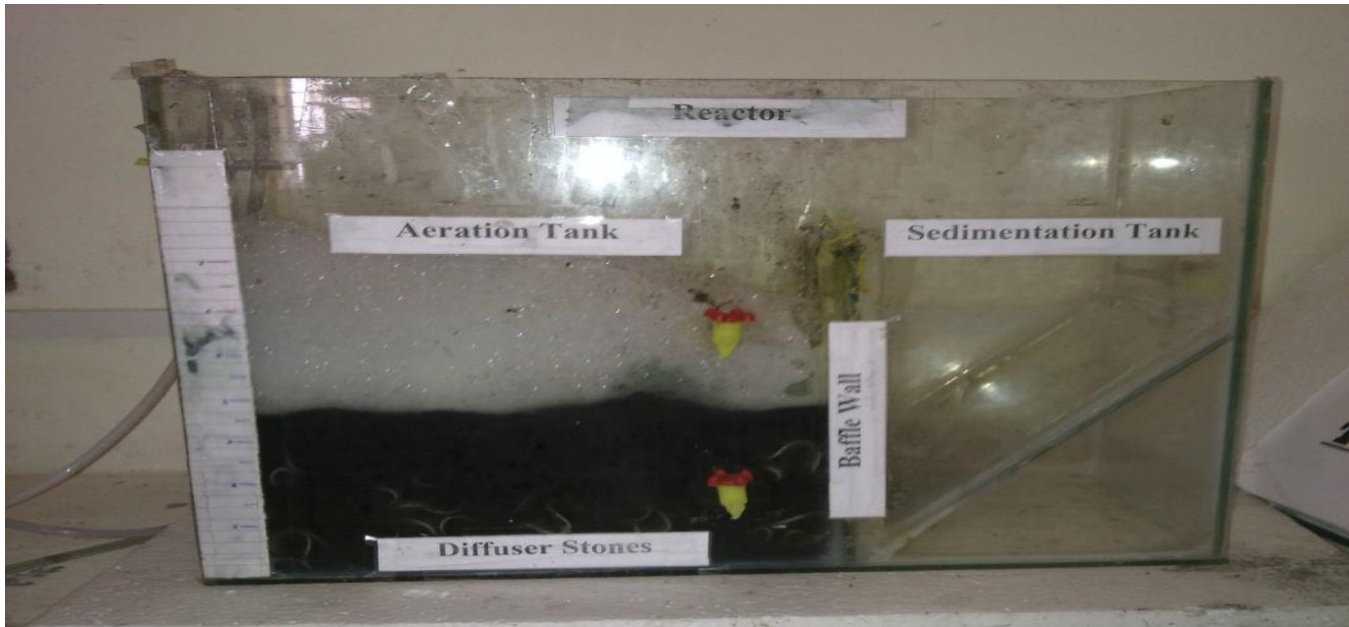


Fig.2 Lab scale model of ASP reactor with aeration in process

3 Results and Discussions

The tannery effluent was treated by conventional Activated sludge process without any medium and by using PVC Spirals as medium for different time intervals. The treatment of the raw tannery effluent is done by providing continuous aeration in the aeration tank, for a specific time intervals varying a time period of 4 hours, 6 hours and 8 hours. The same process was repeated on the raw samples varying aeration time inclusive of PVC spiral medium in the aeration tank filled up to half of the tank.

The following tables and graphs show the results obtained by the tests conducted on different samples aerated for different time intervals such as 4 hours, 6 hours and 8 hours.

3.1 Comparison of BOD of samples with different aeration time

The outcome of this experiment is shown in Fig.3 which shows the concentration of BOD varying with 4,6,8 hours respectively.

By increasing the aeration time from 4 hours to 8 hours, it was observed that the BOD levels decrease from 960 mg/l to 420 mg/l without medium.

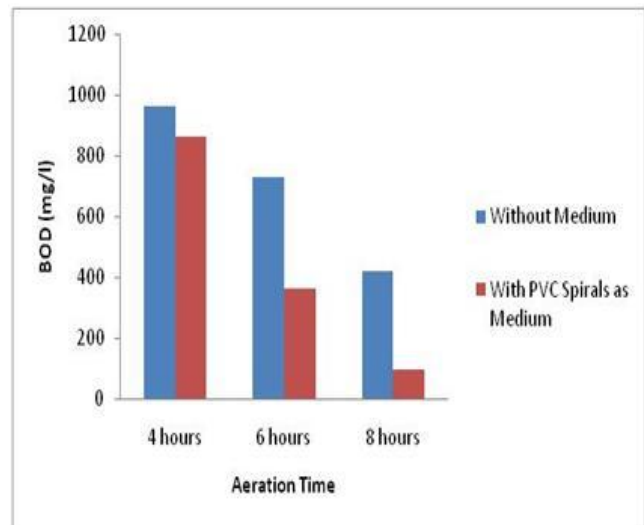


Fig.3 Effect of aeration time and PVC Spiral medium on removal of BOD

In case of with medium, it is seen that the BOD levels further decrease with the increase in the aeration time from 864 mg/l to 96 mg/l. Since there was an increase in the growth rate of micro organisms, it leads to the increase in the consumption rate which consequently led to the decrease of BOD levels respectively. It was observed that the efficiency of BOD removal was higher when PVC spirals were introduced as a medium into the conventional activated sludge process.

3.2 Comparison of COD of samples with different aeration time

From Fig.4, the concentration of COD varies with the aeration time 4, 6, 8 hours respectively.

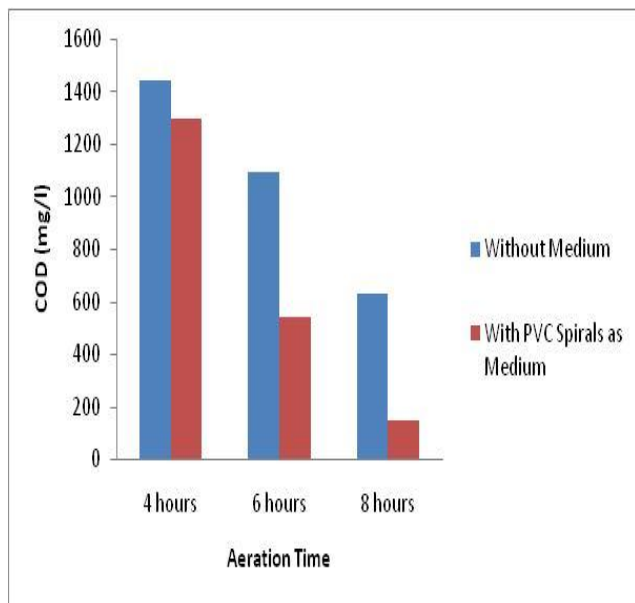


Fig.4 Effect of aeration time and PVC Spiral medium on removal of COD

By increasing the aeration time from 4 hours to 8 hours, it was observed that the COD content levels decreases from 1440 mg/l to 630 mg/l without medium.

In case of with medium, it is seen that the COD content levels further decreases with the increase in the aeration time from 1296 mg/l to 144 mg/l. Since there was an increase in the growth rate of micro organisms, it leads to the increase in the consumption rate which consequently led to the decrease of COD content levels respectively. It was observed that the efficiency of COD content removal was higher when PVC spirals were introduced as a medium into the conventional activated sludge process.

3.3 Comparison of Total Solids of samples with different aeration time

By increasing the aeration time from 4 hours to 8 hours, it was observed from Fig.5, that the concentration of Total Solids decreases from 5850 mg/l to 5100 mg/l without medium.

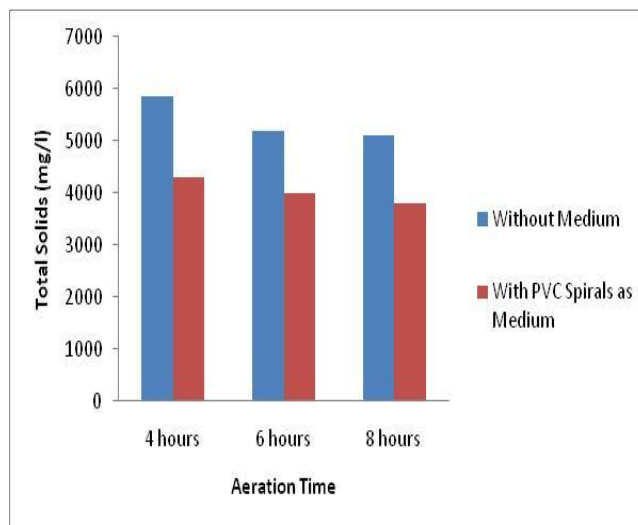


Fig.5 Effect of aeration time and PVC Spiral medium on removal of Total Solids

In case of with medium, it is seen that the Total Dissolved Solids content levels further decreases with the increase in the aeration time from 4300 mg/l to 3800 mg/l. Since there was an increase in the growth rate of micro organisms, it leads to the increase in the consumption rate which consequently led to the decrease of Total Solids content levels respectively. It was observed that the efficiency of Total Solids content removal was higher when PVC spirals were introduced as a medium into the conventional activated sludge process.

3.1 Comparison of Turbidity of samples with different aeration time

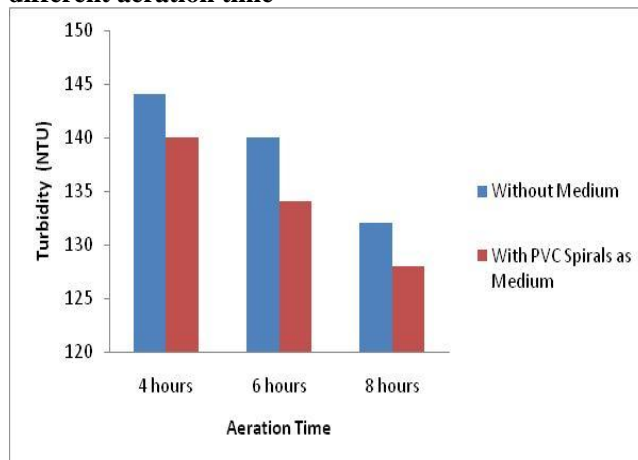


Fig.6 Effect of aeration time and PVC Spiral medium on removal of turbidity

By increasing the aeration time from 4 hours to 8 hours, it was observed that the Turbidity concentration decreases from 144 mg/l to 132 mg/l without medium which is shown in Fig.6 . In case of with medium, it is seen that the Turbidity content levels further decreases with the increase in the aeration time from 140 mg/l to 128 mg/l. Since there was an increase in the growth rate of micro organisms, it leads to the increase in the consumption rate which consequently led to the decrease of Turbidity content levels respectively. It was observed that the efficiency of Turbidity content removal was higher when PVC spirals were introduced as a medium into the conventional activated sludge process.

4 Conclusion

From this study, it was observed that Activated Sludge Process is the most efficient treatment method for tannery effluent. It is very clear that the concentration of BOD, COD, Total solids and Turbidity from tannery effluent has been found to be decreased by increasing the aeration time from four hours to eight hours. Further by introducing PVC spirals as medium, removal efficiency has been further increased.

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