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Biodegradation of Tannery Effluent and Designing the Reactor for Clarifier and Activated Sludge Process

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ABSTRACT

The rapid industrialization has affected the Ecosystem to a very large extent due to the pollutants discharged from their operations. Among all the industrial effluents, the effluent from the tannery industry possesses a major problem. The effluent for the present study was procured from the company which is located in Erode. This project involves the treatment of tannery effluent. In the present study, the effluents were collected from the above industry and their biodegradation studies were carried out through the microbes present in the effluent itself at varying concentration and the degrading efficiency among the various organisms were also seen. Then based on the discharge of the effluent from the industry, the reactor for the primary sedimentation (clarifier) and Activated Sludge Process were designed. A simple model has been proposed to illustrate the relationship between the basic parameters, when compared with the experimental values.

KEYWORDS: Biodegradation, Tannery Effluent, Design, Reactor, Clarifier

1. INTRODUCTION TO BIODEGRADATION STUDY

Environmental pollution has become a global concern. The toxic pollutants include acids, alkalies, oils, fats, floating organic dissolved matter and colouring agents. There are various industries such as tannery, paper and pulp, sago, sugar, distillery etc which contribute to this pollution. The disposal of waste waters is of widespread national concern. Industrial activities generate a large number and variety of waste waters which are generally discharged into water streams. The nature of industrial wastes depends upon the industrial processes in which they originate. The problem of adequately handling industrial waste water is more complex and much more difficult than sewage.

Tanning is one of the major industries in our country. There are about 3000 major tanneries in India. Approximately 314 million kilograms of skin are processed annually. The tanneries discharge 3000 litres of waste water, 100 kg-1 of processed hides and the annual discharge of 9420 kilolitres. Tannery industry is reputed globally as a major industry, which contributes to water pollution, owing to the usage of mineral tanning agents. They discharge large volumes of effluents, because except one or two process in the tannery industry, all the processes are wet processes and generate huge quantities of liquid wastes. The effluents are far from the desired level for acceptance into two ways with a heavy load of pollutants like chromium, chlorides, sodium, dissolved solids, BOD, COD, Nitrogen and suspended solids.

Tannery effluents containing large amount of wastes especially tannins are toxic to plants, animals and soil as well as water microorganisms. In plants they cause stunting growth, chlorosis and reduction in yield. However, a few microorganisms degrade tannins and utilize their carbon source. Chaetomium globosum, Chaetomium cupreum, Fusarium solani, Aspergillus niger and Trichoderma viridae utilizes tannins as carbon source. Species of Rhizobium, Pseudomonas putida, Pseudomonas solanacearum grow luxuriantly when cultured in tannin medium. (Mahadevan and Sivaswamy, 1985).

The spent chrome liquor from tannery is one of the potential sources causing pollution. Chromium is known to be highly toxic to the aquatic organisms in the hexavalent state and somewhat less toxic in the trivalent form. Hexavalent chromium is carcinogenic, even with a little quantity, 10mg/L can cause nausea, vomiting, skin irritation and problems related to respiratory tract, can cause lung carcinoma due to chromium toxicity.

Problem of waste disposal can be greatly minimized if recovery of useful byproducts is made to the maximum extent possible. Numerous physical and chemical methods such as screening, flow equalization, primary sedimentation, chemical flocculation, aerobic activated sludge treatment, secondary sedimentation have been employed for the disposal of wastes.

The most reliable way seems to be the biological treatment in which microorganisms serves as an efficient detoxifiers of pollutants. It is cost effective and therefore highly suitable for reduction of pollutant load of an effluent as microorganisms are capable of oxidizing the organic and inorganic constituents.

In view of the above investigations, the present study is aimed to reduce pollution load of tannery effluents by using microorganisms particularly Bacillus species, Pseudomonas aeruginosa and Aspergillus niger.

2. INTRODUCTION TO DESIGNING OF CLARIFIER AND ASP

Mostly treatment plants use mechanically cleaned sedimentation tanks of standardized circular or rectangular design. The selection of the type of clarifier for a given application is governed by the size of the installation, by rules and regulations of local control authorities, by local site conditions and by the experience and judgement of the

engineer. Two or more tanks should be provided so that the process may remain in operation while one tank is out of service for maintenance and repair work. At large plants, the number of tanks is determined largely by size limitations. Typical design information and dimensions for the clarifier and Activated Sludge process are discussed in this chapter.

3. AIM AND OBJECTIVES OF THE STUDY

The vital objectives of the present project are to reduce the pollution from tannery industry, and to thoroughly assess and design a new treatment plant.

Following are the scope of present investigation

1. Sample collection from the tannery industry for the treatment process,
2. Analysis of samples for various physicochemical and biological characteristics,
3. Comparison between the efficiency of various microorganisms at different concentration in the degradation of tannery waste water,
4. Preliminary assessment of the possible treatment scheme(s),
5. Laboratory experimentation pertaining to the biodegradation study, and
6. Design of clarifier and Activated Sludge process to reduce the pollution from tannery industry.

4. TANNING PROCESS

In tanning industry, the animal skins and hides are treated to convert them to non-putrescible and tough leather. The processes involved in leather tanning industry are:

1. Beam House Processing
2. Tan-Yard Processing
    a) Vegetable Tanning
    b) Chrome Taning

4. MATERIALS AND METHODS

5.1 COLLECTION OF SAMPLES

The effluent was collected freshly from the company which is located in Erode and it was stored in a brown bottle. Prior to the collection, the sample water bottle was rinsed with sterile water. After collecting the sample, physical, chemical and bacteriological parameters were carried out from the sample, which was collected separately. The samples were taken to the laboratory as early as possible and it has to be protected from direct sunlight during transportation. The samples were stored in refrigerator.

5.2 ISOLATION AND IDENTIFICATION OF MICROORGANISMS:

Bacteria and fungi in the effluent were isolated using pour plate technique in Nutrient Agar and Sabouraud's Dextrose Agar and the isolated organisms were subjected to staining, motility and further identification.

- Gram Staining
- Lacto phenol cotton blue staining
- Motility Test
- Catalase Test
- Oxidase Test
- Indole Test
- Methyl Red Test
- Voges proskauer Test
- Citrate utilization Test
- Urease Test
- Carbohydrate Fermentation

5.3 ESTIMATION OF PHYSICO-CHEMICAL PARAMETERS

- Estimation of pH:
- Estimation of Dissolved Oxygen:
- Estimation of Biological Oxygen Demand:
- Estimation of Chemical Oxygen Demand:
- Estimation of Total Dissolved Solids:
- Estimation of Total Suspended Solids:
- Estimation of Total Hardness:
- Estimation of Chloride:
- Estimation of Alkalinity:
- Estimation of Chromium:

5.4 BIODEGRADATION STUDY

From the sample 80ml, 70ml, 60ml, 50ml of the effluent was filtered and sterilized in separate containers. To this 80ml effluent 20ml of the respective cultures was added and incubated. Likewise for the 70ml effluent, 30ml culture was added and incubated. For the 60ml effluent, 40ml culture was added and for the 50ml effluent, 50ml culture was added and incubated. At the same time blank was also inoculated with the same cultures and incubated. After 5days incubation, the physical and chemical parameters were estimated and tabulated.

5.5 DESIGN PARAMETERS

The following factors should be analyzed for the designing of the clarifier and Activated Sludge Process

5.5.1 For The Clarifier

- Weir flow rate
- MLSS Concentration
- Volumetric Organic Loading Rate
- Hydraulic Retention Time
- Aeration time
- Oxygen requirement:
    1. Based on BOD
    2. Based on Total Nitrogen

- Surface Area:
- Length of the tank
- Scour Velocity
- Detention Time

5.5.2 For The Activated Sludge Process

- Solid Retention Time (SRT)
- Total Sludge production / day
- Observed Yield
  Oxygen requirements
- Aeration Tank Volume

6. RESULTS

6.1 BIODEGRADATION STUDY

The biodegrading microorganisms like *Bacillus sps*, *Aspergillus niger* and *Pseudomonas aeruginosa* were identified and the biochemical characters of bacteria are mentioned in Table.1, and its cultural morphology is shown in Plate I, II and III.

TABLE.1 BIOCHEMICAL CHARACTERS OF THE ISOLATED BACTERIA

Name of the Bacteria	Morpholog y	Gram Staining	Motility	Catalase	Oxidase	Indole	MR	VP	Citrate	Urease	Glucose	Lactose	Maltose
Bacillus sps	Irregular, round, dull, opaque and grayish white colour colonies	+	-	+	+	-	+	-	-	-	A+	-	A+
Pseudomo nas aeruginosa	Bluish green colour colonies	-	+	+	+	-	-	-	+	+	A+	-	-

Physico-chemical parameters of the untreated effluent was estimated and mentioned in Table.2.

TABLE. 2 PHYSICO CHEMICAL CHARACTERISTICS OF UNTREATED EFFLUENT

pH	BOD	COD	TDS	TSS	Hardness	Chloride	Alkalinity	Chromium
12	252	512	6100	7966	380	36.92	454.5	6

All the values are expressed in mg/L except pH

Biodegrading ability of *Bacillus sps* at various concentrations like 20%, 30%, 40%, 50% was determined and presented in Table.3 and Plate VI.

TABLE.3 PHYSICO CHEMICAL CHARACTERISTICS OF TREATED EFFLUENT USING BACILLUS SPS

% of inoculums	pH	BOD	COD	TDS	TSS	Hardness	Chloride	Alkalinity	Chromium
20%	8.0	70	320	5896	7660	299	35.07	428.8	6
30%	8.5	62	304	5725	7654	240	32.66	390.5	5.6
40%	9.3	59	224	4832	7506	223	26.98	390	5.6
50%	10	54	160	4761	7418	160	25.7	358	4

All the values are expressed in mg/L except pH

Biodegrading ability of *Pseudomonas aeruginosa* at various concentrations like 20%, 30%, 40%, 50% was determined and presented in Table.4 and Plate IV.

TABLE.4 PHYSICO CHEMICAL CHARACTERISTICS OF TREATED EFFLUENT USING PSEUDOMONAS AERUGINOSA

% of inoculums	pH	BOD	COD	TDS	TSS	Hardness	Chloride	Alkalinity	Chromium
20%	9.0	66	288	5902	7470	280	35.50	450	5.9
30%	9.5	55	256	5868	6872	225	32.90	438.9	5.5
40%	9.8	53	240	5460	6617	205	31.09	402.7	5.6
50%	10	47	160	5090	5213	195	27.12	387.5	4.8

All the values are expressed in mg/L except pH

Biodegrading ability of *Aspergillus niger* at various concentrations like 20%, 30%, 40%, 50% was determined and presented in Table.5 and Plate V.

TABLE.5 PHYSICO CHEMICAL CHARACTERISTICS OF TREATED EFFLUENT USING ASPERGILLUS NIGER

pH	BOD	COD	TDS	TSS	Hardness	Chloride	Alkalinity	Chromium
9.0	58	448	5721	6294	270	34.08	428.1	5
9.5	51	460	5432	5827	241	28.40	403.2	4.6
9.7	49	400	4119	5604	187	27.26	379	4.2
10	45	304	4025	5419	170	25.28	348.9	3.8

All the values are expressed in mg/L except pH

Biodegradation study details were given in Figure1. to Figure.9

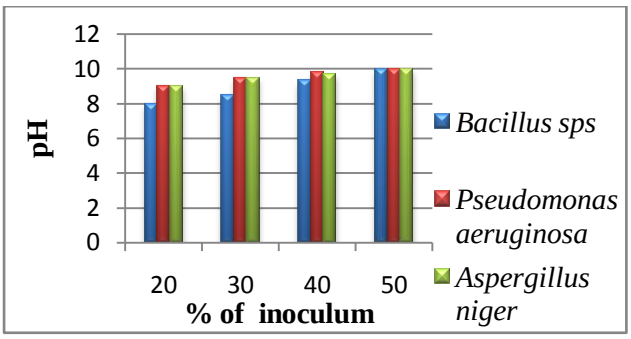

FIGURE.1 ANALYSIS OF PH AFTER DEGRADATION

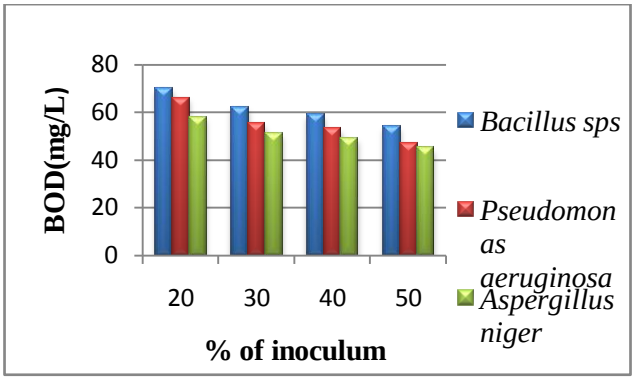

FIGURE.2 ANALYSIS OF BOD AFTER DEGRADATION

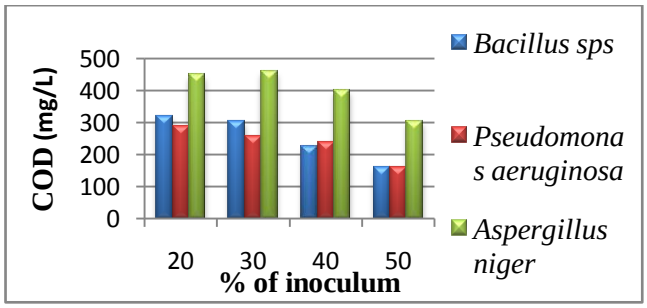

FIGURE.3 ANALYSIS OF COD AFTER DEGRADATION

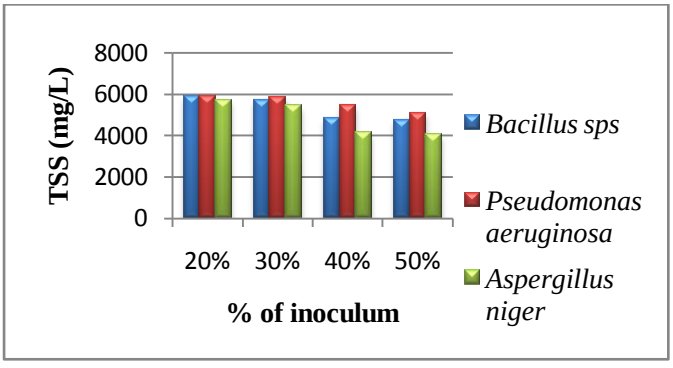

FIGURE.4 ANALYSIS OF TDS AFTER DEGRADATION

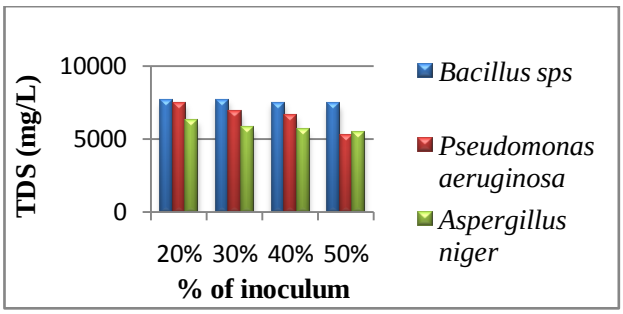

FIGURE.5 ANALYSIS OF TDS (MG/L) AFTER DEGRADATION

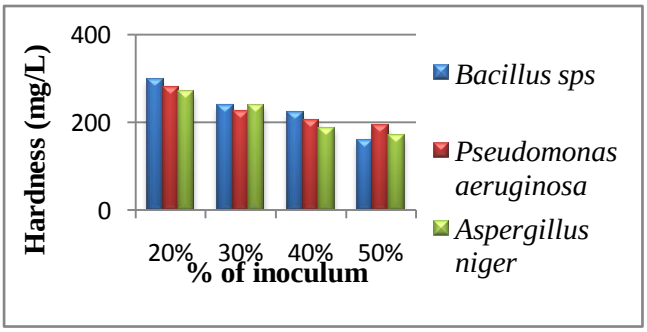

FIGURE.6 ANALYSIS OF HARDNESS AFTER DEGRADATION

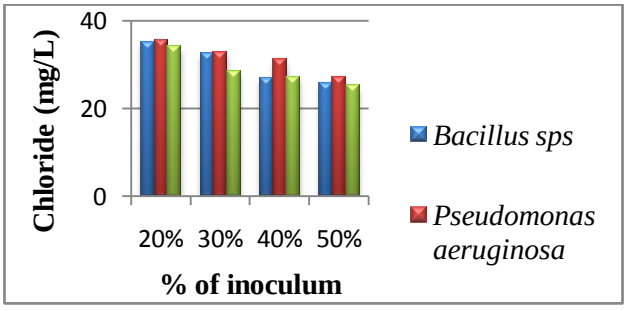

FIGURE.7 ANALYSIS OF CHLORIDE (MG/L) AFTER DEGRADATION

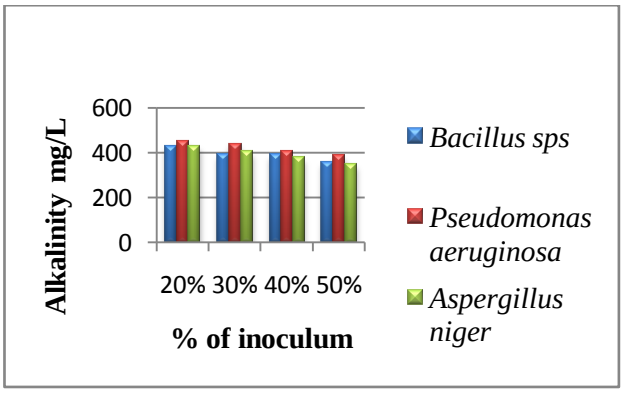

FIGURE.8 ANALYSIS OF ALKALINITY AFTER DEGRADATION

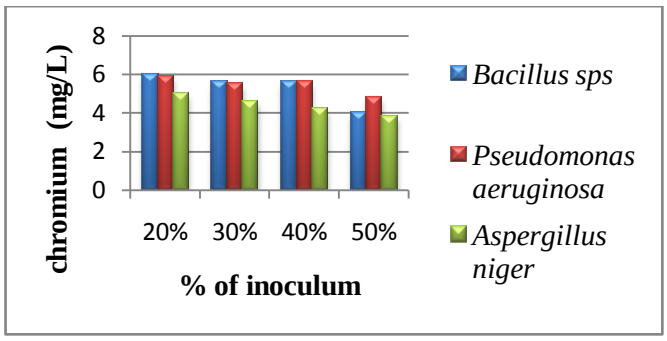

FIGURE.9 ANALYSIS OF CHROMIUM AFTER DEGRADATION

7. DESINING OF THE CLARIFIER AND ACTIVATED SLUDGE PROCESS

The various treatment units in different schemes were designed for a design flow of 10 Mld, in accordance with the CPHEEO Manual (1999) and/or other and appropriate criteria relevant for operation and design of appropriate units. The process design of Clarifier and activated sludge process (ASP) was done.

7.1 Design of Clarifier

The average flow rate of the industry is 10,000 m^3/d and the highest observed peak daily flow rate is 25,000 m3/d. The overflow rate for the clarifier is 40 $m^3/m^2.d$ at average flow and the side water depth of 4m. For this industry rectangular clarifier was designed based on the following criteria.

From the data, the following parameters were identified:

7.1.1 Surface area of the clarifier

$$A = \frac{Q}{OR} = \frac{10{,}000\ m^3/d}{40 m^3/m^2.d} = 250 m^2.$$

7.1.2 Length of the Tank

$$L = \frac{A}{W} = \frac{250 m^2}{6m} = 41.67m$$

7.1.3 Detention time and overflow rate at average flow

Tank volume = side water depth x length x width
= 4 x 42m x 6m
= 1008 m^2.

$$\text{Overflow rate} = \frac{Q}{A} = \frac{10000 m^3/d}{250 m^2}$$

= 40 $m^3/m^2.d$

$$\text{Detention time} = \frac{\text{Tank Volume}}{Q}$$

$$= \frac{(1008 m^3)\ (24\ h/d)}{10000 m^3/d} = 2.42h$$

7.1.4 Detention time and overflow rate at peak flow

a) $$\text{Overflow rate} = \frac{Q}{A} = \frac{25000 m^3/d}{250 m^2}$$

= 100 $m^3/m^2.d$

$$\text{Detention time} = \frac{\text{Tank}}{Q}$$

$$= \frac{(1008 m^3)\ (24\ h/d)}{25000 m^3/d} = 0.97h$$

7.1.5 Scour Velocity:

$$V_H = \frac{8k\ (s\text{-}1)\ gd}{f}$$

$$= \left[\frac{(8)\ (0.05)\ (0.25)\ (9.81)\ (100 \times 10^{-6})}{0.025}\right]^{1/2}$$

= 0.063 m/s.

7.1.6 Peak flow horizontal velocity:

$$V = \frac{Q}{Ax}$$

$$= \frac{25000\ m^3/d}{6m \times 4m} \times \frac{1}{(24\ h/d)\ (3600\ s/h)}$$

= 0.012 m/s.

7.2 Design of Activated Sludge Process

The average flow rate of the industry is 10,000 m^3/d and the highest observed peak daily flow rate is 25,000 m^3/d. The physic-chemical parameters of the untreated primary effluents analyzed are: bsCOD = 192g/m^3, nbVSS = 30g/m^3, and inert organics = 10 g/m^3. The aeration tank MLVSS = 2500g/m^3. For this industry, Activated Sludge Process for a 6-d SRT was designed based on the following criteria.

Kinetic coefficients for the designing are:

κ = 12.5 g COD/g VSS.d

Ks = 10 g COD/m3

Y = 0.40 g VSS/g COD used

*f*d = 0.15 g VSS/g VSS

kd = 0.10 g VSS/d VSS.d

Biomass VSS/TSS = 0.85

From the data, the following parameters were identified:

7.2.1 Effluent bsCOD concentration

$$\text{Effluent bsCOD concentration} = \frac{K_s\ [\ 1 + (kd)\ SRT]}{SRT\ (Yk - kd) - 1}$$

$$= \frac{(10\ g\ COD/m^3)\ [\ 1 + (0.10\ g\ VSS/g\ VSS.d)\ (6d)]}{(6d)\ [(0.40g\ VSS/g\ COD)\ (12.5\ g\ COD/g\ VSS.d) - (0.10\ g\ VSS/g\ VSS.d)] - 1}$$

$$= 0.56\ g\ bs\ COD/m^3.$$

7.2.2 Aeration Tank Volume

Aeration Tank Volume = $\tau(Q)$

The biomass concentration (X) = $\frac{Y(S_o\text{-}S)SRT}{[1 + (kd)SRT]\ \tau}$

$$= \frac{(0.40\ g\ VSS/g\ COD)[(192 - 0.56)g\ COD/m^3](6d)}{[(1 + 0.10\ g\ VSS/g\ VSS.d\ (6d)(\ \tau)]}$$

$$= 287.2\ g/m^3.d/\ \tau$$

$$X_T = \frac{Y(S_o\text{-}S)SRT}{[1 + (kd)SRT]\ \tau} + \frac{(fd)(kd)(X)SRT}{} + \frac{(X_{o.i})SRT}{\tau}$$

$$2500\ g\ VSS/m^3 = \frac{(0.40\ g\ VSS/g\ COD)[(192 - 0.56)g\ COD/m^3](6d)}{[(1 + 0.10\ g\ VSS/g\ VSS.d\ (6d)(\ \tau)]} + (0.15\ g\ VSS/g\ VSS)\ (0.10\ g\ VSS/g\ VSS.d)(X)(6d) + 30\ g\ VSS/m^3\ (6d)\ /\ \tau$$

$$2500 = \frac{287.2}{\tau} + 0.09(X) + \frac{180}{\tau}$$

$$= \frac{287.2 + 25.8 + 180}{\tau}$$

τ = 0.197d

Aeration Tank Volume = τ (Q)

= 0.197d (10000m^3) = 1970m^3.

7.2.3 Total Sludge Production

a) Total sludge production based on Kg of VSS/d

Total sludge production based on Kg of VSS/d = $\frac{X_T\ (V)}{SRT}$

$$= \frac{(2500\ g\ VSS/m^3)\ (197m^3)\ (1\ Kg/10^3\ g)}{6d}$$

= 82.1 kg VSS/d.

b) Total sludge production based on Kg of TSS/d

$$Px,TSS = \frac{QY(S_o\text{-}S)}{1 + (kd)SRT}\left\{\frac{1}{0.85}\right\} + \frac{(fd)(kd)YQ\ (S_o\ \text{-}S)SRT}{1 + (kd)SRT}\left\{\frac{1}{0.85}\right\}$$

$$+ QX_{o.i} + Q(TSS_o - VSS_o)$$

$$= \frac{(10000m^3/d)\ (0.40\ g\ VSS\ /g\ COD)\ [(192 - 0.56)\ gCOD/\ m^3]}{[1 + (0.10g\ VSS\ /\ g\ VSS.d)\ (6d)]\ (0.85)} + \frac{(0.15)(0.10)(10000m^3/d)(0.40)\ [(192 - 0.56)g\ COD/m^3]\ (6d)}{[1 + (0.10g\ VSS\ /\ g\ VSS.d)\ (6d)]\ (0.85)} + 10000m^3/d\ (30g/m^3) + 10000m^3/d\ (30g/m^3)$$

$$= (563 + 51 + 300 + 100)\ (10^3\ g/d) = 1014\ x\ 10^3\ g/d$$

= 1014 Kg /d.

7.2.4 Biomass Fraction

Biomass fraction = $\frac{\text{Biomass concentration (X)}}{\text{MLVSS } (X_T)}$

$$= \frac{(287.2\ g/m^3.d)\ (0.197)}{2500}$$

= 0.58

7.2.5 Observed Solids Yield

Y_{obs} = $\frac{\text{Solids wasted /d}}{\text{bs COD removed / d}}$

bsCOD removed / d = $Q(S_o - S)$

$$= (10000m^3/d[(192\text{-}0.56)\ gCOD/m^3]\ (1\ Kg/10^3\ g)$$

= 1914400 g COD/d

= 1914.4 Kg/d

Y_{obs} for VSS = 82.2 / 1914.4

= 0.043 g VSS/g bsCOD

Y_{obs} for TSS = 1014 / 1914.4

= 0.53 g TSS/g bsCOD

7.2.6 Oxygen Required

Oxygen Required (R_o) = $Q(S_o - S) - 1.42P_{X.bio}$

$P_{X.bio}$ = $P_{XT,VSS} - P_{nb\ VSS}$

= 82.2 Kg/d – (1000m3)(30g VSS/m3)(1 Kg/103 g)

= 522 Kg/d

Ro= (10000m^3/d)[(192 – 0.56) g COD/m3]((1 Kg/103 g) – 1.42(52.2 Kg VSS/d)

= 1177 Kg O_2/d.

8. DISCUSSION

Microbial analysis of tannery effluent was made and the dominating degrading organisms like Bacillus sps, Pseudumonas aerruginosa and Aspergillus niger was isolated.

Similar reports is presented in study on isolation and characterization of microflora present in the individual sectional waste water of a tannery. Despite the toxic nature the sectional

effluents exhibited microbial growth. Bacillus, Pseudomonas and micrococcus were the predominant species identified (Radha et al., 1995).

Tannery effluent used in the present study is highly alkaline and highly loaded with contaminant like BOD (252 mg/L), COD (512 mg/L), TSS (7966 mg/L), TDS (6100mg/L), Alkalinity (454.5 mg/L), Hardness (380 mg/L), Chlorides (36.92 mg/L) and Chromium (6 mg/L).

Bacillus sps was used at various concentrations to treat the effluent. Among that while at 50% inoculums was given there was a decrease in the value pH (10), BOD (54 mg/L), COD (160 mg/L), TDS (7418 mg/L), TSS (4761 mg/L), Alkalinity (358 mg/L), Hardness (160 mg/L), Chlorides (25.7 mg/L) and Chromium (4 mg/L).

Pseudomonas aeruginosa was used at various concentrations to treat the effluent. Among that while at 50% inoculums was given there was a decrease in the value pH (10), BOD (47 mg/L), COD (160 mg/L), TDS (5090 mg/L), TSS (5213 mg/L), Alkalinity (387.5 mg/L), Hardness (195 mg/L), Chlorides (27.12 mg/L) and Chromium (4.8 mg/L).

Aspergillus niger was used at various concentrations to treat the effluent. Among that while at 50% inoculums was given there was a decrease in the value pH (10), BOD (45 mg/L), COD (304 mg/L), TDS (5419 mg/L), TSS (4025mg/L), Alkalinity (348.9 mg/L), Hardness (170 mg/L), Chlorides (25.28 mg/L) and Chromium (3.8 mg/L). These three isolated organisms were used in the treatment of effluent. Since they are naturally present in the effluent, and which is a good environment for the organisms to survive. The physico-chemical parameters analyzed showed a gradual decreased values in microbially treated sample when compared to the untreated sample. It is clear from the results obtained that as the concentration of inoculums is increased the degradation of the effluent is also effective. Aerobic digesters are usually constructed as completely mixed reactors. The reactor may be fed continuously or intermittently with excess sludge. The objective of the digestion is to reduce the fraction of biodegradable organic material to such a level (in practice between 10 - 20% of the volatile solids) that the digested sludge can be disposed of without problems.

The reduction of pollution load of an effluent while using high concentration of inoculums is because of the biological respiration taking place as they oxidize organic and inorganic constituents found in the effluent (Sawyer, 1956).(Figure.10)

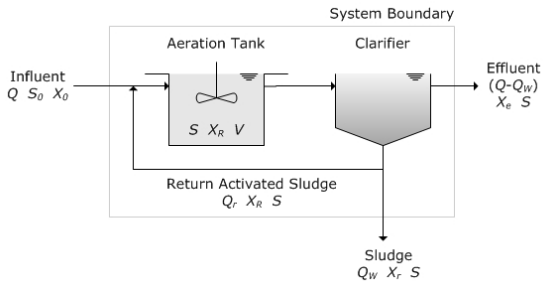

FIGURE.10 SCHEMATIC DIAGRAM

Where:

Q = flowrate of influent [m^3/d]

Q_W = waste sludge flowrate [m^3/d]

Q_r = flowrate in return line from clarifier [m^3/d]

V = volume of aeration tank [m^3]

S_0 = influent soluble substrate concentration (bsCOD) [BOD g/m^3] or [bsCOD g/m^3]

S = effluent soluble substrate concentration (bsCOD) [BOD g/m^3] or [bsCOD g/m^3]

X_0 = concentration of biomass in influent [g VSS/m^3]

X_R = concentration of biomass in return line from clarifier [g VSS/m^3]

X_r = concentration of biomass in sludge drain [g VSS/m^3]

X_e = concentration of biomass in effluent [g SS/m^3]

Even though there are numerous physical and chemical methods employed in the disposal of wastes the advantage in using bacterium is that they play a key role in the reduction of COD, BOD, total protein, total tannin and total phenol (Saravanana *et al.*, 1998).

For the efficiency of the treatment, various design parameters were analyzed because if the solids in the effluent were discrete particles of uniform size, uniform density, uniform specific gravity and uniform shape, the removal efficiency of these solids would be dependent on the surface area of the tank and the time of detention.

The selection of suitable loading rate depends on the type of suspension to be separated. The effect of the surface loading and detention time on suspended solids removal varies widely depending on the character of waste water, proportion of settable solids, concentration of solids and other factors.

In the designing of the clarifier, scour velocity is very important in order to avoid the resuspension (scouring) of settled particles, horizontal velocities through the tank should be kept sufficiently low.

From the designing values identified, the horizontal velocity value even at peak flow is substantially less than the scour velocity. Therefore, settled matter should not be resuspended. All the biological treatment reactor designs are based on the mass balance. Based on this biomass mass balance the organisms load can be inoculated for the efficient treatment.

9. SUMMARY

The tannery effluent was collected from the company which is located in Erode. The effluent was subjected to microbiological and physic-chemical analysis. The microbiological analysis reveals that the effluent contains both

bacteria and fungi. Among the microorganisms two bacteria Bacillus sps and Pseudomonas aeruginosa and one fungi Aspergillus niger were found predominantly and were selected for biodegradation study. These microorganisms were cultured in large quantities and inoculated into the sterile effluent at various concentrations (20%, 30%, 40%, 50%). After incubation the physico-chemical parameters were analyzed. It clearly indicates that for the treatment processes Aspergillus niger is effective in degrading the pollutant followed by Pseudomonas aeruginosa and Bacillus sps.

From the same industry, various parameters like surface area, length of the tank, scour velocity, weir flow rate were analyzed for the designing of the clarifier and Solids Retention Time, Observed Yield, Oxygen requirements and total sludge production / day were analyzed for the Activated Sludge Process. Based on these values the designing of the clarifier and Activated Sludge Process were done.

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