Characterization and Treatment of Industrial Effluent by Trickling Filter

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Received: 24/01/2016 | Revised: 27/01/2016 | Accepted: 04/02/2016

ABSTRACT

Biological wastewater treatment methods are classified as suspended growth and attached growth. Activated sludge process and trickling filters are examples of these types of methods. Removal of organic matter is main objective behind these treatment methods. In the present research wastewater from dye industries is treated by using trickling filter. The trickling bed was prepared by growing the microbial slim layer on the stone gravel filling. The dissolved oxygen, chemical oxygen demand and pH of the treated and untreated effluent was compared. In the present investigation about 75 percent of COD removal was obtained with 6 fold increase in dissolved oxygen.

Key words: Attached growth process, biological oxygen demand, dissolved oxygen, chemical oxygen demand.

INTRODUCTION

Industrial and industrial effluent contains organic matter, inorganic matter and pathogens. The metal ions and their derivatives are also present in wastewater. Various physical, chemical and biological methods can be used for wastewater treatment. The domestic effluent also needs treatment before disposal. The removal of organic matter is one of the main and important aspect of wastewater treatment. The physicochemical methods like adsorption are found to be very effective for removal of organic matter with COD removal ranging from 90 to 95 percent. \[5-8\] COD removal by various biological methods was also very effective. \[5-8\] Advanced methods such as membrane separation were also used by few investigators. \[9-11\] Advanced methods such as advanced oxidation, ozonation, U.V. treatment are important from regeneration point of view. \[12-15\] The cost and stringent norms for effluent are driving forces for research on cost effective treatment of wastewater. Trickling filters (TF) have simple operation and robust construction. The current research explores use of trickling filters for wastewater treatment.

EXPERIMENTAL SET UP AND METHODOLOGY

Trickling filter has been designed and fabricated at laboratory as shown in fig.1, with following details.

Material of construction: Mild steel
Volume of tank: 47 liter

Since the tank includes cylindrical as well as conical shapes the dimensions are as follows:

Dimensions for cylinder: Diameter of cylinder: 30 cm, Height of cylinder: 60 cm
Dimensions for cone: Diameter of cone: 30cm, Height of cone: 20cm.

Procedure for making Filter media:
Two buckets were used as container to produce the micro organism in it. For developing the micro organism, in one bucket waste water fruit waste was kept with stone granules and second bucket was used to prepare synthetic wastewater. Only the waste water and sludge was used. The bucket was kept undisturbed for near about 8 days in open atmosphere. Slowly micro organism started developing in it. This was used in trickling filter as a filter media. Granules and sand was also used in it of different diameter as making the layer of it.

Working of trickling filter
- The container was kept at height so that flow rate can be adjusted accordingly. The filter media was then transferred into trickling filter.
- Alternate layers of sand were created.
- Inlet Flow rate was maintained of 60ml per minute and it is kept fixed throughout the entire procedure.
- After every 30 minute sample (20 ml) was collected in beaker from bottom of trickling filter
- Total 5 sample were collected after every 30 minute.

Preparation of solution:
- Manganese sulphate solution: 48gms of MnSO$_4$.2H$_2$O was dissolved in water and volume was made up to mark in 100ml volumetric flask.
- Alkaline Potassium iodide solution: 125 gm. NaOH & 37.5 gm. at KI was dissolved in D.W. (H$_2$O) & diluted to mark in 250 ml volumetric flask.
- Standardization of sodium thiosulphate: about 0.6 – 0.7 gm of AR grade Na$_2$S$_2$O$_3$.5H$_2$O was dissolved in 100 ml distilled water, next 10ml of 0.025 N (K$_2$Cr$_2$O$_7$) & potassium dichromate and 10ml of conc. HCL acid are mixed in conical flask. Also mixture was added with 6ml of 10% KI and was kept in dark for 5 minutes to liberate I$_2$. The sides of the flask were washed with 10 ml water and shaken well. Then titrated with newly prepared thiosulphate solution till strew yellow colour was obtained then starch solution was added and titrated to a light green & product
- Starch solution: A small quantity of distilled water was also added to about 0.5mg of soluble starch (A.R.) taken in beaker. The mixture was stirred with a glass rod and heated to make transparent paste. This was added to 100ml of boiling distilled water with constant string & Cooled.
- BOD bottle was taken & 200 ml of water sample was added into it.
- 2 ml of manganese sulphate & 2 ml of alkali iodide solution was also added to the BOD bottle. The top of the pipette should below the Liquid level, while adding these agents.
- It was stoppered to exclude air bubble and mix by repeatedly inserting the bottle 2-3 times.
- If no O$_2$ is present the manganese ion reacts with hydroxide ion to form white ppt. of Mn(OH)$_2$. if O$_2$ is present Mn$^{++}$ is oxidized to Mn$^+$ and ppt. is brown coloured.
- After shaking and allowing sufficient time for all O$_2$ to react and settle, liquid within upper portion was seperated.
- 2ml of concentrated H$_2$SO$_4$ was added.
- The bottle was inverted & mixed by inverting until the suspension completely dissolved and yellow colour is uniform throughout the bottle.
- A volume of 20ml was taken to conical flask and titrated into conical flask with 0.025N sodium thiosulphate solution until yellow colour iodine turns to pale straw colour.
- Since it was impossible to accurately titrate the sample to colourless liquid 1-2 ml of starch was added.
- Continued titration was made to the 1st disappearance of the blue colour. D.O. and COD of effluent samples are shown in table 1 and 2.
RESULTS AND DISCUSSION

Table 1: Dissolved Oxygen Characterization

<table>
<thead>
<tr>
<th>Wastewater (ml)</th>
<th>K2Cr2O7 (ml)</th>
<th>Burette reading (ml)</th>
<th>DO (mg/lit)</th>
</tr>
</thead>
<tbody>
<tr>
<td>190</td>
<td>10</td>
<td>4.1</td>
<td>4.1</td>
</tr>
<tr>
<td>180</td>
<td>20</td>
<td>4.9</td>
<td>4.9</td>
</tr>
<tr>
<td>170</td>
<td>30</td>
<td>5.8</td>
<td>5.8</td>
</tr>
<tr>
<td>160</td>
<td>70</td>
<td>6.2</td>
<td>6.2</td>
</tr>
<tr>
<td>150</td>
<td>50</td>
<td>8.4</td>
<td>8.4</td>
</tr>
</tbody>
</table>

Table 2: COD Characterization

<table>
<thead>
<tr>
<th>Sludge (ml)</th>
<th>Effluent (ml)</th>
<th>CBR (ml)</th>
<th>COD (mg/lit)</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td>0</td>
<td>9.2</td>
<td>584</td>
</tr>
<tr>
<td>40</td>
<td>10</td>
<td>14.7</td>
<td>144</td>
</tr>
<tr>
<td>30</td>
<td>20</td>
<td>13.5</td>
<td>240</td>
</tr>
<tr>
<td>20</td>
<td>30</td>
<td>12.3</td>
<td>336</td>
</tr>
<tr>
<td>10</td>
<td>40</td>
<td>11.9</td>
<td>368</td>
</tr>
</tbody>
</table>

Table 3: COD, DO and pH of Treated Effluent

<table>
<thead>
<tr>
<th>Tests</th>
<th>Initial</th>
<th>Final</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ph</td>
<td>5</td>
<td>7</td>
</tr>
<tr>
<td>DO (mg/l)</td>
<td>1.32</td>
<td>8.4</td>
</tr>
<tr>
<td>COD (mg/l)</td>
<td>384</td>
<td>144</td>
</tr>
</tbody>
</table>

From table 3, percent COD removal=[(Initial COD - Final COD)/Initial COD]x100=[(584-144)/584]x100=75.34%

It can be observed from the above results that it was possible to remove 75.34 percent organic matter (measured as COD) from effluent sample. Also, the DO level of treated water increased from 1.32 mg/l to 8.4 mg/l.

CONCLUSION

Biological treatments with trickling filters are effective for removal of organic matter from the effluent. In the present investigation for 584 mg/l of chemical oxygen demand, about 75 percent of initial, was treated successfully. Trickling filters are robust and efficient. The main advantage of trickling filters is that they can handle shock loads. Also TFs produce less sludge and are easy to operate.

REFERENCES
