CHAPTER-III
MATERIALS
AND
METHODOLOGY
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Materials and methodology framed to carry out the present research work to meet the objectives stated is discussed in this chapter. The discussions made include:

- Sources of Wastewater.
- Adsorbents Tried.
- Soil Samples Used.
- Parameters Monitored and Analyzed.
- Experimental Setup.

3.1 SOURCES OF WASTEWATER

As stated in objectives, high, medium and low strength wastewaters were used for experimentation to assess the treatment efficiency of SAT system in treating these wastewaters under varied experimental conditions.

High strength wastewater rich in BOD used for experimentation was collected from Davangere sugar company Ltd., Kukkuwada village of Davangere District. The medium strength wastewater viz-domestic sewage was collected from a drain flowing behind BIET poltechnic college. Low strength wastewater was collected from Blue Mountain Electroplating Industry situated nearby Davangere.

These wastewater sources selected, apart from of different strengths, were also found to be containing different metals of varying concentrations. Thus the wastewaters were of selective nature in terms of strength and metals concentration and thereby enhanced the scope of the study.

3.2 ADSORBENTS TRIED

In the present work, to evaluate the performance of SAT system in conjunction with adsorbents in treating wastewaters selected, three adsorbents namely Rice Husk, Groundnut shell and Saw Dust were used for experimentation. These adsorbents were
collected from nearby Rice mill, Oil mill and Saw mill respectively. The collected adsorbents were treated as per the procedure given in the literature and then used for experimentation.

3.2.1 Preparation of Adsorbents

Groundnut shell was treated as per the procedure given by Mohammad Ajmal, et al., (2006). Groundnut shell collected was dried at 103°C for 24 hrs before grinding. Then shell was pulverized and sieved to a geometric mean size of 0.424 mm. The adsorbent was then washed in distilled water to remove fine and adhered impurities, dried at 103°C for 24 hrs and then used for experimentation. Three other sizes of 1.641 mm, 0.89 mm and 0.288 mm were also prepared and used for experimentation.

The Rice Husk and Saw Dust were treated as per procedure given by Bilquees Ara Siddiqui et al., (1999). Each adsorbent was sieved through IS mesh No. 50-60 and washed several times with distilled water and then they were treated with 0.1 M aqueous solution of Disodium Hydrogen Phosphate for 24 hrs. Further, they were filtered and washed several times till no phosphate was released in washing. Again, they were dried at 40°C in an oven and used for experimentation.

3.3 SOIL SAMPLES USED

To assess the suitability of soils in treating wastewaters two soils belonging to two classes were used. Based on reconnaissance two different soil sample sites viz one being from industrial area Davangere adjacent to BMC Rice Mill and other being from agricultural land of Hanumapura village (near to industrial area), situated at about, 6 km from Davangere Railway station were identified and samples from these sites were collected as per standard procedure given in SP 36 Part (II). Based on the analysis of samples collected, soils samples were classified as Clayey Sand Soil and Silty Sand Soil.

3.3.1 Preparation of Soil Samples

It was planned to maintain the dry density of soil filled in the columns, same as that of field dry density of soil. Under such conditions the results obtained, inferences
drawn and thereby design parameters established can be used directly to design SAT system for in situ condition. Thus soil samples collected from the field were so filled into the columns such that dry density of soil filled in the column will be same as that of soil in the field.

To establish this condition, to begin with weight of the soil that can be filled in the column was calculated by multiplying volume of the column and field dry density of the soil. The weight of soil so calculated was multiplied by field water content of the soil which resulted in amount of water to be added. The calculated amount of water was added to weight of the soil determined and soil paste was prepared. The soil paste prepared was filled in four layers in a column. Each was compacted so that space occupied by the soil will be one fourth of the volume of the column. Whenever adsorbents was placed in the column in conjunction with soil, calculation were carried out excluding the depth of the adsorbent filled in the column.

3.4 PARAMETERS MONITORED AND ANALYZED

The soil samples collected, wastewater and adsorbents used for experimentation, samples collected from the column after treatment and soil samples and adsorbents at the end of termination of each cycle of study were analyzed for various parameters and are listed in the Table 3.1.

### Table 3.1: Parameters Monitored/Analyzed

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Sample analyzed</th>
<th>Parameters analyzed</th>
<th>Methods employed/instrument used</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Soil Sample</td>
<td>Silt, Clay and Sand content</td>
<td>Sieve analysis as per procedure given in SP 36 part (I) (1987)</td>
<td>Before experimentation</td>
</tr>
<tr>
<td>No.</td>
<td>Sample Type</td>
<td>Properties</td>
<td>Procedure Description</td>
<td>Before and after experimentation</td>
</tr>
<tr>
<td>-----</td>
<td>----------------------</td>
<td>-----------------------------------------------------------------------------</td>
<td>----------------------------------------------------------------------------------------</td>
<td>-----------------------------------</td>
</tr>
<tr>
<td>2</td>
<td>Soil sample</td>
<td>Geotechnical properties like: Field density, Specific gravity, Liquid limit, Plastic limit, Shear parameters, Permeability, Compaction test, Grain size distribution, pH, Electrical conductivity, Total solids, Total dissolved solids, Chemical oxygen demand, Biochemical oxygen demand, Heavy metals</td>
<td>As per procedure given in SP 36 part (I) (1987) and standard methods.</td>
<td>Experimentation</td>
</tr>
<tr>
<td>3</td>
<td>Soil sample</td>
<td>Metals namely: Zinc, Nickel and Chromium</td>
<td>As per standard methods (1998) used in AAS. Available at KSPCB at Davangere was utilized for analysis</td>
<td>Before and after experimentation**</td>
</tr>
<tr>
<td></td>
<td>Influent and Effluent</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 3.1: (Continued)

| Adsorbents** | Chemical oxygen demand, Chlorides, TKN, Phosphate, Potassium, Heavy metals like Chromium(VI), Nickel, Zinc | were analyzed using AAS, available at KSPCB Davangere. | 5 |

** Soil samples were collected from different depths of the column after experimentation and were mixed and used for analysis of metals. Whenever adsorbents were used in conjunction with soil, soil samples from different depths of column below and above the adsorbent were collected separately and were mixed separately and were used for metal analysis.

** Adsorbents were analyzed only for pH and metals content before and after experimentation. Remaining general characteristics of the adsorbents used are collected from literature.

### 3.5 EXPERIMENTAL SETUP

To evaluate the performance of SAT system in treating wastewaters of varying strength, with and without adsorbents, column studies were carried out.

In total six PVC pipes, out of which three numbers each of 6 inches diameter and 1.5 meters length and three numbers each of 6 inches diameter and 1.2 meters length were used as columns. In order to prevent the escape of soil the bottom of each...
column was plugged with 60 μm mesh inside. Further the reducer was fitted to the plug to enable the smooth collection of effluent. The columns were mounted on the stand.

Wastewater to be tested was fed into these columns by overhead tank. Flow from over head tank was so adjusted that the constant ponding depth of 30 cm was maintained above the soil mass in the column. However overflow pipe was also fitted to the columns to take care of ponding depth. The treated wastewater samples were collected from the bottom of the column and were analyzed for various parameters. The line diagram of the experimental setup is shown in fig. 3.1 and picturesque view of experimental setup are shown in plates 3.1, 3.2 and 3.3.

For each predetermined condition of experimentation, the soil and adsorbents were filled afresh in the column. For each feeding the column was allowed to saturate for first 20 min, effluent flow was discarded and then two effluent samples were collected for each 20 min duration successfully. Volume of effluent thus collected was measured and thereby rate of filtration was calculated.

The bird view of variables considered for series of experiments conducted in the present research work are shown in the Table 3.2.

Table 3.2: Bird View of Experimentation Variables

<table>
<thead>
<tr>
<th>SL.NO.</th>
<th>Variables</th>
<th>Particulars</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Soil types</td>
<td>Clayey Sand and Silty Sand</td>
</tr>
<tr>
<td>2</td>
<td>Soil depths</td>
<td>0.7 m and 1.0 m</td>
</tr>
<tr>
<td>3</td>
<td>Ponding depth</td>
<td>30 cm</td>
</tr>
<tr>
<td>4</td>
<td>Wastewaters</td>
<td>Low, Medium and High strength</td>
</tr>
<tr>
<td>5</td>
<td>Adsorbents</td>
<td>Groundnut shell, Saw dust and Rice husk.</td>
</tr>
<tr>
<td>6</td>
<td>Depth of adsorbents</td>
<td>10 cm</td>
</tr>
<tr>
<td>7</td>
<td>Positioning of adsorbent</td>
<td>25%, 50% and 75% from the bottom of column.</td>
</tr>
</tbody>
</table>

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fig 3.1 Soil Aquifer Treatment System-Experimental Setup
PLATE: 3.1 EXPERIMENTAL SETUP OF SOIL AQUIFER TREATMENT SYSTEM (SAT)
**Plate: 3.2 Wastewater Feeding Arrangement**

**Plate: 3.3 Wastewater Effluent Collection System**