CHAPTER 5

SUMMARY AND CONCLUSION

In the present study, treatment of anaerobically digested distillery wastewater by integrated biological and chemical oxidation was investigated at the Centre for Environmental Studies, Anna University, Chennai, India. The observations and experimental results have been discussed in the light of the available literature. The major findings and conclusions drawn are summarized below:

The results of the study are:

- The anaerobically digested distillery wastewater is characterized by the presence of high chemical oxygen demand (COD) of 36,600 – 38,600 mg/L and contains BOD in the range of 8,000 – 9,200 mg/L and requires further treatment before its disposal into the environment.

- The performance of SBR at three different HRTs of 12 h, 24 h and 48 h was evaluated during the treatment of anaerobically digested distillery wastewater. At 12 h HRT, the COD removal efficiency was as low as 34%. Whereas, the COD removal of 54% and 56% was achieved at HRT of 24 h and 48 h, respectively. Similarly, the BOD removal efficiency was 58% at 12 h HRT. Whereas, HRTs of 24 h and 48 h showed a removal efficiency of 84% and 86%, respectively.
No significant difference in the COD and BOD removal efficiencies were observed at 24 h and 48 h HRT. Of all the three different HRTs examined, 24 h was to be optimum. Unlike BOD, the COD removal was comparatively less and this might be due to the presence of high molecular weight substances like polyphenols and melanoidins in the distillery wastewater that interfere in the removal of COD.

The reactor was operated at different organic loading rates of 1.8, 3.6, 5.4 and 9.0 kgCOD/m$^3$/d by varying the influent COD of 3600, 9000, 12000 and 17300 mg/L respectively and the reactor was operated at an optimized HRT of 24 h. The COD removal efficiency was greater than 74% at an OLR of 3.6 kgCOD/m$^3$/d, respectively. Whereas, the COD removal efficiency decreased from 74% to 67% for the organic loading rate of 5.4 kgCOD/m$^3$/d. Further increase in the OLR to 9 kgCOD/m$^3$/d results in further drop in the COD removal efficiency to 43%.

High organic loading greater than 3.6 kgCOD/m$^3$/d brought about a decrease in the biomass concentration (MLVSS: 3600 mg/L) and accumulation of inorganics in the reactor (high MLSS: 12000 mg/L) causing destabilization of the reactor and process failure and thereby significantly affects the reactor performance in terms of organic removal. The organic loading rate 3.6 kg COD/m$^3$/d was optimum and used in further study.

The anaerobically digested wastewater was diluted with domestic wastewater (1:4 v/v) and used as the influent in the aerobic Sequencing batch reactor. The average concentration
of COD and BOD in the influent wastewater were 10,000 mg/L and 1200 mg/L respectively. A significant amount of COD reduction (74%) was observed with 24 h HRT. Whereas the BOD reduction was relatively higher (96%) compared to the COD reduction.

- The BOD/COD ratio of the influent wastewater decreased to 0.009 after aerobic treatment with SBR. Therefore, SBR treatment system seems to utilise the full potential of the bacteria in the reduction of BOD and COD. The residual organics present in the treated effluent might be due to recalcitrants that contributes colour to the effluent.

- For the ozonation of anaerobically digested distillery wastewater, a maximum COD reduction of 40% and 44% was achieved for the ozone application rate of 0.2 g/h and 1 g/h at the end of 30 minutes of ozonation. Ozone application rate of 0.2 g/h provided colour removal values over 65% after 30 min of reaction and higher ozone application rate of 1g/h led to colour reduction of 78% in 30 min of ozonation.

- Low ozone dosage rate (0.2 g/h) shows significant removal of COD and colour and reduction in UV$_{254}$ absorbance. Higher ozone dosage (1 g/h) did not enhance the removal efficiency and ozone left the reactor without being consumed by the organic substrates. Therefore, low ozone dosage (0.2 g/h) and reaction time of 30 min are recommended to remove colour and COD from the anaerobically digested distillery wastewater.

- SBR treated effluent was subjected to ozonation in the bubble column reactor for the removal of COD and colour. The COD
removal efficiencies were 33% and 42% at ozone application rates of 0.2 g/h and 1 g/h, respectively at the end of 30 minutes of ozonation. For the ozone application rates of 0.2 g/h and 1 g/h a significant colour reduction of 87% and 89% was achieved.

- Based on the experiments conducted, the COD and BOD characteristics of the treated effluent at different treatment processes is given in Table 5.1.

- Based on the results obtained in the present investigation, three different options for the complete treatment of distillery wastewater treatment is proposed. The schematic of the proposed treatment scheme is depicted in the Figure 5.1.

  - Option 1 is the proposed scheme for the treatment of distillery wastewater combined with domestic water by aerobic SBR alone achieving a final BOD of 30 mg/L.

  - Option 2 is the proposed scheme for the treatment of distillery wastewater combined with domestic water with Pre-Ozonation followed by aerobic SBR achieving a final BOD of 30 mg/L.

  - Option 3 is the proposed scheme for the treatment of distillery wastewater combined with domestic water by aerobic SBR followed by Post-Ozonation achieving a final COD of 1600 mg/L and BOD of 30 mg/L.

- The activated sludge of the sequencing batch reactor was analysed for individual bacterial strains by 16S rRNA sequencing. Twenty two different bacterial strains were isolated from the SBR sludge.
Table 5.1 COD and BOD characteristics of the treated effluent

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Treatment process</th>
<th>Effluent COD (mg/L)</th>
<th>Effluent BOD (mg/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>SBR</td>
<td>2,700</td>
<td>30</td>
</tr>
<tr>
<td>2</td>
<td>Pre-Ozonation</td>
<td>5,900</td>
<td>900</td>
</tr>
<tr>
<td>3</td>
<td>Pre-Ozonation + SBR</td>
<td>2,700</td>
<td>30</td>
</tr>
<tr>
<td>4</td>
<td>SBR + Post-Ozonation</td>
<td>1,800</td>
<td>30</td>
</tr>
</tbody>
</table>

Figure 5.1 Wastewater generation and proposed treatment scheme for distillery wastewater management
Based on the present study, it may be concluded that the aerobic sequencing batch reactor has the potential to treat the anaerobically digested distillery wastewater combined with the domestic wastewater. The bacterial consortium used in this study has the full potential to tolerate the distillery wastewater and was able to treat the wastewater containing high COD. SBR along with ozonation is a potential alternative for the treatment of anaerobically digested distillery wastewater for organics and colour removal.