WASTEWATER IN THE FOOD INDUSTRY – COMBINING TECHNOLOGIES TO FACILITATE TREATMENT EFFICIENCY

Gunnar O. Sigge¹, Trevor J. Britz¹ & Neels Barnardt³
¹Department of Food Science, University of Stellenbosch, South Africa.
³Enviro Services, Somerset West, South Africa

Fruit canning and wine making are two major food processing industries generating large volumes of wastewater. Both these industries face the task of converting to cleaner production and waste minimisation production processes, in an attempt to maintain a profitable level of production while reducing water intake, and disposing of the large volumes of effluent in an environmentally friendly manner. Considerable interest has been shown in the application of anaerobic digestion to wastewaters from the food industry. The upflow anaerobic sludge blanket (UASB) bioreactor, especially, has been shown to be suitable since the nature and strength of the wastewaters often provide the ideal conditions for digester operation. Ozonation has also been proven to be a useful option in wastewater degradation, where it has been mainly used as a post-treatment. It has also been shown, however, that ozonation of food industry wastewaters could lead to the formation of organic solutes more susceptible to biological degradation.

The aim of this study was, firstly to investigate the feasibility of using ozonation as a pre- and post-treatment to existing UASB’s treating apricot canning and winery wastewaters and secondly to investigate the performance, over an extended period of time, of UASB reactors treating pre-ozonated peach canning and winery wastewaters.

METHODOLOGY

Trials were done to investigate the feasibility of using ozone as a pre- and post-treatment to anaerobic digestion of apricot canning and winery wastewaters. This involved ozonating the raw wastewaters, treating the wastewaters by UASB, post-ozonation of the UASB reactor effluent, pre-ozonation of the wastewaters before UASB treatment and pre- and post-ozonation to UASB treatment. Wastewaters were collected from a fruit cannery during the apricot season and had an average COD of 7 500 mg.L⁻¹ and a pH of ca. 5.0. Winery wastewater was obtained from a local winery and had an average COD of 3 700 mg.L⁻¹ and a pH of ca. 4.8.
An extended trial was also conducted to investigate the effects of pre-ozonation on the operating parameters of a laboratory-scale UASB reactor treating a pre-ozonated peach canning wastewater over an extended period. A fruit cannery wastewater with an average COD of 6 500 mg.L\(^{-1}\) and pH of \(\text{ca.} \ 6.0\), collected from a nearby fruit cannery during the peach canning season, was used. Post-ozonation of the UASB reactor effluent was also done.

Anaerobic digestion of the wastewaters was done in 2.3 L laboratory-scale UASB reactors operated at 35°C and hydraulic retention times of 24 h. The wastewaters were fed semi-continuously to the UASB reactors by means of peristaltic pumps controlled by electronic timers.

Ozonation of the wastewaters and UASB reactor effluents was done in a continuous mode, bubble/granular activated carbon (GAC) contacting system. This consisted of a glass bubbling column connected to a GAC column. Ozone was bubbled upwards through the glass column, while the effluent was re-circulated from the bubbling column through a GAC contacting column. An ozone generator producing 9.0 g.h\(^{-1}\) O\(_3\) at a flowrate of 4 L.min\(^{-1}\) was used for the ozonation trials.

**RESULTS AND DISCUSSION**

Significant colour reductions were achieved by the various treatment combinations, ranging from 37 and 47% for UASB treatment alone to 90 and 91% for UASB treatment with pre- and post-ozonation treatment. COD reductions for these trials ranged from 53 and 62% to 95 and 99% as can be seen in Figure 1. An UASB treatment of the cannery and winery wastewaters resulted in total COD reductions of 88 and 92%, respectively.

During the investigation into the effects of pre-ozonation on the efficiency of a UASB reactor treating a peach canning wastewater, it was found that pre-ozonation increased the COD removal efficiency of the UASB reactor. The UASB reactor had stabilised at a COD removal efficiency of only \(\text{ca.} \ 61%\) prior to pre-ozonated substrate being fed. This was significantly lower than expected. Within two weeks of being fed with pre-ozonated substrate, the COD removal efficiency had increased to 85% and this level was maintained until the end of the trial, 35 days later. Pre-ozonation followed by UASB treatment and a post-ozonation was successful in reducing the wastewater COD. The COD reductions at various stages of the treatment process are summarized in Table 1.
Figure 1. COD removal during the different treatment combinations for pre- and post-ozonation and UASB treatment.

CONCLUSION

The use of ozone as a pre- or post-treatment to anaerobic digestion was shown to be successful in that total COD and colour reduction was increased. It was also shown that the long-term use of pre-ozonated wastewater as UASB substrate did not inhibit the anaerobic digestion process and improved the total COD removal efficiency of the UASB reactor, while also increasing the methane production. Final COD values of the UASB reactor effluent after pre- and post-UASB ozonation, were well below the South African legal limit (75 mg.L\(^{-1}\)) for discharge of wastewaters to a water system.

Table 1. Average COD concentrations at different stages of pre- and post-UASB treatment.

<table>
<thead>
<tr>
<th>Treatment stage</th>
<th>COD (mg.L(^{-1}))</th>
<th>COD reduction (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Undiluted Peach Canning Wastewater</td>
<td>6 500</td>
<td></td>
</tr>
<tr>
<td>Pre-ozonated Peach Canning Wastewater</td>
<td>2925</td>
<td>55.0</td>
</tr>
<tr>
<td>After UASB treatment of pre-ozonated Peach Canning Wastewater</td>
<td>368</td>
<td>94.3</td>
</tr>
<tr>
<td>Post-ozonation</td>
<td>26</td>
<td>99.6</td>
</tr>
</tbody>
</table>