High rate anaerobic treatment for bakery yeast wastewater in Chile

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DSM Bakery Ingredients (DBI) operates a bakery yeast production plant in Santiago, Chile, producing bakery yeast for the national and international market. Beet molasses is used as raw material.

As a result wastewater equivalent to 150.000 – 200.000 pollution equivalents is produced. Treatment by the local sanitary company would result in high discharge fees, close to US$ 1.000.000, -- increasing in the years to follow.

In order to improve this situation, DBI decided to construct a wastewater treatment plant. To be able to discharge directly into a canal in the neighbourhood of the yeast plant, anaerobic treatment, to be followed by conventional aerobic treatment (SBR type), was selected. The contract for the design and supply of key equipment for the plant was awarded to Biothane Systems International from the Netherlands.

The anaerobic process applied is based on the Biobed® EGSB (Expanded Granular Sludge Bed) technology and is the first application in Chile.

It is by far the biggest industrial wastewater treatment plant in Chile with an investment close to US$ 5.000.000.

This poster highlights the start-up and the operation of the anaerobic part of the plant.

In order to design the wastewater treatment plant, DBI has executed a monitoring program to determine the volume and contaminant concentrations in the total factory effluent. In the following table the design parameters are summarised.

<table>
<thead>
<tr>
<th>Units</th>
<th>Design average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flow</td>
<td>m³/day</td>
</tr>
<tr>
<td>COD (excl. Betaine)</td>
<td>kg/day</td>
</tr>
<tr>
<td>COD (incl. Betaine)</td>
<td>kg/l</td>
</tr>
<tr>
<td>COD (incl. Betaine)</td>
<td>kg/l</td>
</tr>
<tr>
<td>BOD</td>
<td>kg/day</td>
</tr>
<tr>
<td>Suspended solids</td>
<td>kg/l</td>
</tr>
<tr>
<td>Total Kjeldahl Nitrogen</td>
<td>kg/l</td>
</tr>
<tr>
<td>P-PO4</td>
<td>kg/l</td>
</tr>
<tr>
<td>Sulphate</td>
<td>mg/l</td>
</tr>
</tbody>
</table>

The plant consist of a Buffertank (1750 m³) to receive and buffer the flow and load variations (because the yeast making process is a batch type process with high peaks only some hours a day). From this Buffertank the wastewater is pumped to the Conditioning tank
where the pH and temperature are adjusted; also nutrients (FeCl₃) can be added and anaerobic effluent is recirculated to this tank.

Next the conditioned wastewater is pumped to the anaerobic reactor (type EGSB, 1250 m³ wet volume) in which 60 - 65% of the load (as COD) is removed. The produced biogas (70% methane, 26% carbon dioxide, 4% H₂S) is treated in a scrubber to remove H₂S before it is transported to one of the yeast plant boilers, to produce steam. For final treatment the anaerobic effluent flows by gravity to two S.B.R.’s. (4000 m³ each), where the residual organics are further removed to fulfil the effluent parameter values (BOD < 35 ppm, TSS < 80 ppm, TKN < 50 ppm).

The surplus sludge produced in this aerobic stage amounts to approximately 1.500 kg dry matter daily, which is dewatered in a thickener/decanter unit.

A simplified flowscheme of the plant is presented in the following figure 1.

![Flow scheme of wastewater treatment plant](image)

**Figure 1. DBI Chile: Flowscheme wastewater treatment plant**

Originally the start up of the plant was planned to take at least two months, but because of a particular situation the local authorities demanded to fulfil all the parameters within three weeks. The original start up schedule needed to be changed to get the fastest way to have the anaerobic reactor (and aerobic system) working at full capacity.

A program of step increasing of the load to the anaerobic reactor was used. The performance was monitored carefully, keeping the load at its maximum at any time. Further to improve the situation steam was used to increase the process temperature till 36 ºC (the normal design temperature was 25-30ºC).

The Biobed® EGSB system was operating at full capacity within 15 days from start-up. From that moment till today the performance has been very stable (between 60 and 65% reduction in COD) despite the high load (up to 25 kg COD/ m³. day) and temperature variations along the year (from 25 ºC in winter till 35 ºC. in summer). See enclosed figure 2.
Only during the first two starting up weeks it was necessary to control de pH of the reactor (NaOH was dosed to the Conditioning tank). From that time the system had built up sufficient alkalinity making that pH adjustment was not necessary anymore. The performance of the plant is very stable and has demonstrated that it can easily cope with fluctuations. The system has also proved that it can manage higher load values with a very good performance.

The biogas production was estimated to be around 7000 m³/day, but due to high Betaine values (which is not measured in the COD analyses) in practice much higher values are found (up to 12000 m³/day). See figure 3.

Bakery yeast wastewater contains a relatively high amount of "inert" organics (colour) which can not be removed biologically.

For this reason the COD reduction rates are relatively low and the anaerobic effluent contains still high values (typical 4000 mg/l). See figure 4.
Even after aerobic treatment the final effluent still contains COD values in the range of 2000 ppm. The BOD reduction is much higher (over 99%) with final effluent BOD values less than 35 ppm.

![Graph showing TCOD influent and anaerobic effluent](image)

*Figure 4. DBI Chile: TCOD influent and anaerobic effluent*

After some months of operation the local team, in close communication with Biothane, made improvement in the original control philosophy of the plant. Normally the main control parameter for the anaerobic reactor is the VFA (volatile fatty acid) value of the anaerobic effluent. However, the result is that the biogas production fluctuates considerably with the fluctuating COD concentration (as a result of the batch type operation of a yeast plant) in the Buffer tank. Because the biogas is used in the boiler and fluctuations give problems in the boiler operation it was decided to look for a better control philosophy. The load to the anaerobic reactor (the influent feed pump) is now controlled and regulated by the biogas flow produced (in fact in such a way that the biogas flow is kept constant). So, the system itself is now controlling the load, only by measuring the biogas produced.