PROJECT FOR THE ELECTRICAL COGENERATION IN A DISTILLARY INDUSTRY: CAPEL CASE

Viña de Mar, November 2004

Presentation's Content

- Chilean Pisco industry.
- Laboratory experiments.
  - Wastewater anaerobic treatability
  - Irrigation experiments
- Full scale UASB implementation.
- La Chimba cogeneration Project
Popular alcoholic drink prepared by distillation of wine which is produced out of especial aromatic grapes (mainly Muscatel).

Its production involves several operations:

⇒ Maceration
⇒ Filtration
⇒ Flotation
⇒ Fermentation
⇒ Distillation
Washing operations (the most important in a volume basis).

Punctual discharges.

High content of organic matter (5-35 gCOD/L).

High content of suspended solids.

Generation of high concentration vinasses (40 gCOD/L).

**Anaerobic Wastewater Treatments**

Biogas production / kg CODr

300 L of methane

≈ 400-500 L of biogás

2600 kcal

3 kWh
### ANAEROBIC WASTEWATER TREATMENTS

**Vinasse: 38 gCOD/L**

- 17 m³ biogas / m³ vinasse
- 100 kWh / m³ vinasse

25 kgDQO / ton grape

- 11250 m³ biogas / ton grape
- 70 kWh / ton grape

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### ANAEROBIC WASTEWATER TREATMENTS

**Vinasse: 38 gCOD/L**

- 14 kg charcoal / m³ vinasse, or
- 21 kg wood / m³ vinasse, or
- 9.7 L oil / m³ vinasse

25 kgCOD / ton grape

- 9.5 kg charcoal / ton grape, or
- 14 kg wood / ton grape, or
- 6.4 L oil / ton grape
Two types of reactors were used: UASB and EGSB.

EGSB and UASB reactors were operated at superficial liquid velocities of 7 and 0.8 m/h respectively.

The reactors were fed by wine vinasses.

Laboratory reactors dimensions.

<table>
<thead>
<tr>
<th></th>
<th>UASB</th>
<th>EGSB</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volume (L)</td>
<td>4.5</td>
<td>4.7</td>
</tr>
<tr>
<td>Diameter (cm)</td>
<td>10</td>
<td>6</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>60</td>
<td>160</td>
</tr>
<tr>
<td>Height/diameter relation</td>
<td>6</td>
<td>27</td>
</tr>
</tbody>
</table>
### Laboratory Experiments

#### Anaerobic reactors operation

Vinasses characterization.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Units</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total COD</td>
<td>mg/L</td>
<td>37800</td>
</tr>
<tr>
<td>Soluble COD</td>
<td>mg/L</td>
<td>34400</td>
</tr>
<tr>
<td>BOD</td>
<td>mg/L</td>
<td>13500</td>
</tr>
<tr>
<td>Total solids</td>
<td>mg/L</td>
<td>25226</td>
</tr>
<tr>
<td>Volatile solids</td>
<td>mg/L</td>
<td>20588</td>
</tr>
<tr>
<td>Total suspended solids</td>
<td>mg/L</td>
<td>1526</td>
</tr>
<tr>
<td>Volatile suspended solids</td>
<td>mg/L</td>
<td>1495</td>
</tr>
<tr>
<td>Acidity</td>
<td>mg CaCO_3/L</td>
<td>1719</td>
</tr>
<tr>
<td>pH</td>
<td></td>
<td>3.0</td>
</tr>
</tbody>
</table>

Organic loading rate (gCOD/Ld) - 20, 20
COD removal rate (%) - 93, 89
Hydraulic retention time (d) - 1.8, 1.8
pH - 6.7-7.0, 6.7-7.0
Biogas production (ml/g removed COD) - 490, 490
Methane concentration in biogas (%) - 65, 65
Anaerobic reactors operation

- EGSB operation was unstable due to growth of excessive acidogenic microorganisms.
- Granules from UASB reactor showed better physical properties, offering a much stable operation.
- UASB technology was selected over EGSB reactor (less investment and operational costs).

Agricultural utilization of treated water

- Irrigation experiments were performed using lemon nursery plants
- Different levels of irrigation and fertilization were used.
- Height and diameter of stem were followed during a period of 4 months.
- Supplementary experiments were carried out using different levels of dilution of treated wastewater in order to evaluate the effect of its salt content.
Laboratory Experiments

Agricultural utilization of treated water

Parameter | Units | Results
--- | --- | ---
Nitrogen | % | 5.29
Phosphorus | % | 1.45
Potassium | % | 0.32
Calcium | % | 4.5
Magnesium | % | 0.42
Zinc | ppm | 293.8
Manganese | ppm | 182.5
Iron | ppm | 13031
Copper | ppm | 365
Boron | ppm | 8.16

Laboratory Experiments

Characterization of the anaerobic granular sludge
A 60 m³ UASB was built in Alto El Carmen (the smallest production plant).
The start up was performed between January and March 2001.
Treated water is being used to irrigate an eucalyptus and corn plantation.
Full Scale Application
UASB Reactor

(♦) Organic loading rate, (■) COD removal.
During the first weeks a high amount of sodium hydroxide was used for pH control (close to 2 g/L).

During this period some problems were detected on tree leaves, due to high content of sodium of treated water.

At organic loading rates over 6 kgCOD/m³d, the use of NaOH was considerably reduced (biogas production provides an important level of alkalinity).
• A 330 m³ UASB was built in La Chimba (Ovalle) with the Alto El Carmen developed technology.

• The start up was performed since October 2004.

• Generated Biogas will be used as energy source for the industry.
<table>
<thead>
<tr>
<th>Combustible</th>
<th>Unidad</th>
<th>Kcal/d/m³</th>
<th>m³/d</th>
<th>Vendimia</th>
<th>Post vendimia</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vicuña</td>
<td>petróleo</td>
<td>46.996</td>
<td>1.992</td>
<td>4.289</td>
<td>5.13</td>
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<tr>
<td>Valle del Limarí</td>
<td>petróleo</td>
<td>80.298</td>
<td>3.174</td>
<td>20.107</td>
<td>49.1</td>
</tr>
<tr>
<td>La Chimba</td>
<td>carbón bituminoso</td>
<td>208.378</td>
<td>6.879</td>
<td>43.339</td>
<td>767</td>
</tr>
<tr>
<td>Punitaqui</td>
<td>petróleo</td>
<td>107.916</td>
<td>3.597</td>
<td>33.094</td>
<td>767</td>
</tr>
</tbody>
</table>

*considerando 8 meses para plantas Capel Vicuña, Valle del Limarí y Punitaqui y 12 meses para La Chimba
**considerando proceso continuo, es decir, requerimientos de vapor 30 días/mes
***considerando proceso continuo, es decir, requerimientos de vapor 24 horas/día

UASB Reactor

- Biogás para utilización de vapor
- Biogás para generación de energía cogeneración
UASB Reactor

Planta La Chimba
Conclusions

- Anaerobic digestion is a suitable technology for treatment of wastewater generated during Chilean Pisco production.
- This industry offers an opportunity to exploit all advantages of anaerobic digestion by wastewater treatment.

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