Treatment of distillery effluents

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Jacopo De Steffani (Lead Engineering & Projects)

In collaboration with
Mark Silvius
Ethanol Industry Specialist @ Paques
1 Introduction to Paques
Global leadership in biological wastewater & gas treatment

A FAMILY own business founded in 1960, 20% shares owned by S. Klatten

a worldwide presence through a network of regional offices and partners

think global, act local
Paques India inauguration of new factory in Sri City, Chennai, October 2016

Paques’ new factory was opened on South East coast (close to Chennai) to serve India and Asia Pacific
Paques Environmental Technology India (PETI) Pvt. Ltd., a wholly-owned subsidiary of the Netherlands-based industrial waste water management company Paques, opened its manufacturing base in Sri City. Marking the start of commercial production, Ambassador of the Netherlands in India A.H.M. Stoelinga, accompanied by Paques Holding CEO Stephan Bocken, founder and major shareholder of Paques Dr. Jos Paques, PETI managing director Sudeep Sangameswaran, and Sri City founder and managing director Ravindra Sannareddy, inaugurated the plant here on Tuesday.

Mr. Stoelinga said: “In recent years, the value of mutual trade has risen enormously and there are nearly 115 Dutch companies that have their presence in India. Besides, Netherlands too attracts most of the out-bound foreign direct investments from India.”

The plant, with a 2,500 sq metres area, was commissioned with an initial investment of Rs.30 crore, across a plot of two acres. It will manufacture core components for reactors that treat waste water and gas, and will supply its products to customers across South East Asia, Japan, Vietnam, besides India and the SAARC countries.

The plant will manufacture core components for reactors that treat waste water and gas.”
World class production facility
Paques’ uses natural biotechnology to treat waste.

- References in anaerobic digestion: 1000+
- References in ammonium removal: 50+
- References in gas desulfurization: 250+
- New Bioplastic production: 250+
Paques has repeatedly introduced technological innovations and converted them into high quality industrial applications. We have invented practically everything that we sell.
Product Range

revitalising resources

ETANOL

PHOSPAQ™

PHOSPAQ™

PHOSPAQ™

PHOSPAQ™

PHOSPAQ™

PHOSPAQ™

PHOSPAQ™
Paques provides the total package

Pre-treatment

Aerobic treatment

revitalising resources
Paques expertise with ethanol effluents
Paques has 94 anaerobic references and more than 30 years experience with ethanol effluents.
Paques’ first ethanol experiences were UASB’s treating cane vinasse in Brazil.
Paques’ first condensate references in the Ethanol Industry

1992
BIOPAQ® UASB, Netherlands

1996
BIOPAQ® IC, Japan
The experience of Paques in the Ethanol Industry ranges from small liquor distilleries to the big bio-refineries.

Beverage alcohol from fruits
Production: 0.2~0.3 mln l/year
COD load: **2.5 ton/day**

Cellulosic fuel ethanol
Production: ~80 mln l/year
COD load: **250 ton/day**

1993

2012
Paques reference base includes many feedstocks including latest developments (cellulosic, ethanol from syngas)

- Starch crops
- Sugar crops
- Advanced biofuels
Paques has experience with different vinasses from sugar cane
Paques has experience with treatment of Tequila vinasse from agave
Paques has experience with stillage/condensates from grain distilleries
Paques has experience with stillage from cassava

2013
207 ton/day SCOD

2007
146 ton/day SCOD
Paques has experience with stillage/condensate from second generation ethanol.
Paques has many returning customers in the Ethanol Industry and has customer statements

Customer statement VP Brands International

VP Brands International is a leading Belgian producer of high-quality wines and high-alcohol beers. The company produces, processes, and distributes a wide range of products in the beverage sector. VP Brands International has a strong reputation for quality and innovation and is well-regarded in the industry.

The company has many returning customers in the Ethanol Industry and has received numerous positive statements.

Biopaq® for reliable energy production

The distillery that became a net energy producer by embracing anaerobic technology

The challenge
• Feedstock: high-purity ethanol
• Treatment: anaerobic digestion
• Benefits: energy recovery, water reuse

The solution
• The use of Biopaq® technology as a membrane bioreactor to increase the biogas production rate
• Improved energy recovery from biogas

The benefit
• Net energy producer

3 anaerobic reactors at 3 different production sites of one liquor producer
3 Ethanol (distillery) effluents
STILLAGE is the main wastewater stream from ethanol production

Feedstock
- Lignocellulose
- Starch
- Sugar

Pre-treatment
- Mechanical
- Thermal
- Chemical
- Enzymes

Pressing

Fermentation

1st Distillation

Rectification
- Spirit 96%

Co2

Spent Lees
- Lutter
- Flegmass
- White stillage

Stillage
- Vinasse
- Pot ale
- Spent wash
- Slobs

Fuel grade ethanol
>99% EtOH

Non process streams:
- wash water /CIP
- Blow downs (boiler/ cooling)
- Sewage
- Brines / RO reject
- Other processes/ neighbors

OPTIONAL ROUTES
- Cattle feed production (DDGS)
- Irrigation and fertilizer
- Evaporation => condensate
- Wastewater treatment plant
- Digester
- Outfall to sea
- Partly Recycled to processes (backset)
- Composting
When stillage is evaporated condensate is main waste stream

Abbreviations

- DWG: distillers wet grains
- CDS: condensed distillers solubles
- DWGS: distillers wet grains and solubles
- DDGS: distillers dried grains and solubles
Examples of other wastewater streams send to treatment plant

- brines
- Feedstock Wash water
- Wash Water (CIP)
- sewage
- Blow downs
- Seal water
- Bottom drains fermentors
- Fusel oil
- other
- Spent lees
Composition of ethanol effluents depend on many factors like applied feed stock and fermentation and distillation operation.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Unit</th>
<th>Agave</th>
<th>Cane juice</th>
<th>Cane molasses</th>
<th>Corn/grains</th>
<th>Cassava</th>
<th>Condensate</th>
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<tbody>
<tr>
<td>TCOD</td>
<td>(g/l)</td>
<td>30~50</td>
<td>19~22</td>
<td>53~160</td>
<td>50~110</td>
<td>55~95</td>
<td>3 ~ 4</td>
</tr>
<tr>
<td>SCOD</td>
<td>(g/l)</td>
<td>24~35</td>
<td>14~20</td>
<td>-</td>
<td>20~75</td>
<td>26~50</td>
<td>3 ~ 4</td>
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<tr>
<td>TSS</td>
<td>(g/l)</td>
<td>2~18</td>
<td>1~4</td>
<td>2~14</td>
<td>15~50</td>
<td>25~40</td>
<td>&lt; 0.2</td>
</tr>
<tr>
<td>TN</td>
<td>(mg/l)</td>
<td>200~500</td>
<td>~200</td>
<td>330~2500</td>
<td>2000~5000</td>
<td>650~1100</td>
<td>low</td>
</tr>
<tr>
<td>TP</td>
<td>(mg/l)</td>
<td>100~450</td>
<td>-</td>
<td>60~2000</td>
<td>500~1300</td>
<td>200~250</td>
<td>low</td>
</tr>
<tr>
<td>SO₄</td>
<td>(mg/l)</td>
<td>700~1400</td>
<td>600~1300</td>
<td>3000~16,000</td>
<td>200~2700</td>
<td>100~300</td>
<td>low</td>
</tr>
<tr>
<td>Cond.</td>
<td>(mS/cm)</td>
<td>4~5</td>
<td>5~8</td>
<td>15~30</td>
<td>4~8</td>
<td>4~9</td>
<td>low</td>
</tr>
<tr>
<td>FOG</td>
<td>(mg/l)</td>
<td>~350</td>
<td>-</td>
<td>-</td>
<td>~4000</td>
<td>20~2300</td>
<td>absent</td>
</tr>
</tbody>
</table>
4 Treatment of ethanol effluents

revitalising resources

[Image of sugarcane field]
Different type of ethanol effluents and different customer needs require different solutions

Streams & Feedstock
- Stillage or condensate
- Other streams to be treated
- Feedstock affects:
  - pre-treatment
  - biodegradability COD

Client drivers
- Wastewater project (to meet discharge limits)
- Energy Project (Biogas generation)
- Or combination

wastewater composition
- COD
- TSS
- SO₄
- Nitrogen
- Phosphorus
- other

Destination final effluent
- Discharge, reuse or land application
- Extensive tertiary treatment might be required (e.g. color removal)
General flow scheme

- Pre-treatment
  - Buffering
  - Cooling
  - SS removal

- Anaerobic treatment
  - BIOPAQ®

- P-removal
  - PHOSPAQ

- N-removal
  - ANAMMOX®
  - Act. sludge
  - SBR
  - MBR

- Aerobic treatment

- Tertiary treatment
  - Membrane filtration
  - Sand filtration
  - Fenton
  - Activated carbon
  - Ozonation

- Discharge/reuse

- H₂S removal
  - Biogas

- Project (stillage)
  - specific additions

- Basic treatment
Why Anaerobic treatment?

COD → CH₄ + CO₂ + BIOMASS

- Less sludge production
- Production of reusable methane (green energy) and reduction of carbon foot print
- Production of valuable granular biomass
- Less power consumption
- Smaller reactor volume
Condensate case study 1

Country, year: China, 2014
Feedstock: corn
Streams treated: condensates, spent lees, cleaning water and sewage
BIOPAQ® reactor: 4895 m³
Condensate case study 2

**Country, year:** Netherlands, 1992  
**Feedstock:** sugar beet molasses  
**Streams treated:** condensates  
**BIOPAQ® reactor:** 145 m³
Condensate case study 3

Country, year: India, 2018
Feedstock: sugar cane molasses
Streams treated: condensates, spent lees
BIOPAQ® reactor: 387 m³

**Performance IC reactor + Aerobic**

<table>
<thead>
<tr>
<th>Date</th>
<th>COD Influent [mg/L]</th>
<th>COD Aerobic Effluent [mg/L]</th>
<th>Efficiency Aerobic [%]</th>
</tr>
</thead>
<tbody>
<tr>
<td>4-5</td>
<td>0</td>
<td>0</td>
<td>100%</td>
</tr>
<tr>
<td>5-6</td>
<td>0</td>
<td>0</td>
<td>100%</td>
</tr>
<tr>
<td>6-7</td>
<td>0</td>
<td>0</td>
<td>100%</td>
</tr>
<tr>
<td>7-8</td>
<td>0</td>
<td>0</td>
<td>100%</td>
</tr>
<tr>
<td>8-9</td>
<td>0</td>
<td>0</td>
<td>100%</td>
</tr>
<tr>
<td>9-10</td>
<td>0</td>
<td>0</td>
<td>100%</td>
</tr>
<tr>
<td>10-11</td>
<td>0</td>
<td>0</td>
<td>100%</td>
</tr>
</tbody>
</table>

**Influent**

TCOD (mg/l) | 2005

**Effluent**

Biopaq: 211
Aerobic: 43
Condensate case study 3

- **Caustic** (NaOH)
- **Lime** (Ca(OH)₂)
- **Micro nutrients** (BIOPAQ Micromix)
- **Nutrients (N&P)**: Urea + (NH₄)₂HPO₄

**Wastewater**
- Condensate

**Buffer/PA Tank**
- 355 m³

**Recycle tank**
- 180 m³

**BIOPAQ® IC**
- Ø5.0 x 20
- 392 m³

**Aerobic reactor**
- 2100 m³

**Secondary clarifier**

**Heating/cooling**

**Sludge tank**

**Gas buffer m³**

**Flare**

**Effluent IC**

**UF/RO**

**Recycle tank**
- 180 m³

- Air

- Flocculant (PAM)

- Dewatered sludge to disposal

**Decanter**

**Final effluent**
- To distillery (reuse)

**Final effluent**
- To distillery (reuse)

**Caustic (NaOH)**

**Lime** (Ca(OH)₂)

**Micro nutrients** (BIOPAQ Micromix)

**Nutrients (N&P)**: Urea + (NH₄)₂HPO₄

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Condensate case study 3

Onsite start up team from Paques and good cooperation with customer ensures smooth start up

Aerobic treatment

BIOPAQ®IC reactor

Clarifier

Membrane unit
The BIOPAQ® ICX technology is the latest (2015) development in the BIOPAQ® family

- The BIOPAQ® ICX is well suited for distillery applications
- The BIOPAQ® ICX is flexible towards tank design and therefore the most cost effective tank size and tank material can be chosen.
- The BIOPAQ® ICX has an excellent biocatalyst retention system.
- The BIOPAQ® ICX internals can upgrade low performing anaerobic reactors (e.g. EGSB’s).
- The BIOPAQ® ICX has a high filling degree of biomass which results in a relative small reactor (low CaPeX)
- The BIOPAQ® ICX has a relative low caustic consumption (OpEx)
Generating biogas from ethanol effluents is gaining more interest worldwide and is subsidized in some regions (e.g. UK).

The application of stillage on crop fields is more and more restricted.

In regions with high natural gas prices and/or subsidies some grain distilleries shift from DDGS production to biogas production.

Due to recycling of spent wash and shift towards continuous fermentation Indian spent wash has become more concentrated and more challenging to treat.

Introduction of new type of ethanol effluents due to new technologies (e.g. cellulosic ethanol, ethanol from syngas).

In India new build molasses distilleries must have zero liquid discharge.
Your contacts for Paques India

**Suchit Dekivadia**
Head Sales & Marketing
📞 +91 9840552002
✉️ d.suchit@paques.in

**Abhishek Tripathi**
Manager Sales
📞 +91 9717178836
✉️ a.tripathi@paques.in

**Chandrasekar Karthikeyan**
Manager Sales
📞 +91 9677153335
✉️ k.chandrasekar@paques.in
THANK YOU

www.paques.nl