MPP SYSTEMS
Macro Porous Polymer Extraction Systems (MPPE)

Presentation of Cases:
HYDRO/SHELL, Ormen Lange, Norway
WOODSIDE Pluto, Australia
STATOIL Kollsnes, Norway
SHELL Floating LNG Prelude

VWS Oil & Gas is the global division of Veolia Water Solutions & Technologies dedicated to serving the Oil and Gas industry www.vwsmppsystems.com www.vwsoilandgas.com
## Offshore produced water

### Flow rates (m³/h)

<table>
<thead>
<tr>
<th></th>
<th>Gas produced water</th>
<th>Oil produced water</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>&lt; 1 – 150</td>
<td>100 – &gt; 1000</td>
</tr>
</tbody>
</table>

### Inlet (ppm)

<table>
<thead>
<tr>
<th>Component</th>
<th>Gas produced water</th>
<th>Oil produced water</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aliphatic HC (dispersed oil)</td>
<td>200 – 1400 (484*)</td>
<td>40 – 100 (15*)</td>
</tr>
<tr>
<td>Aromatics (BTEX)</td>
<td>300 – 2500 (482*)</td>
<td>30 – 70 (6*)</td>
</tr>
<tr>
<td>PAHs</td>
<td>1 – 80</td>
<td>0.5 – 2</td>
</tr>
<tr>
<td>TPH</td>
<td>700 – 4000</td>
<td>&gt; 200</td>
</tr>
</tbody>
</table>

### Typical goals

<table>
<thead>
<tr>
<th>Component</th>
<th>Gas produced water</th>
<th>Oil produced water</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disp. oil</td>
<td>&lt; 10 – 30</td>
<td>Disp. oil &lt; 10 – 30</td>
</tr>
<tr>
<td>BTEX</td>
<td>&lt; 10</td>
<td>?</td>
</tr>
<tr>
<td>PAHs</td>
<td>&lt; 0.1 – 0.01</td>
<td>?</td>
</tr>
<tr>
<td>TPH</td>
<td>&lt; 10 – 30</td>
<td>?</td>
</tr>
<tr>
<td>EIF</td>
<td>Zero Harmful</td>
<td>?</td>
</tr>
</tbody>
</table>

* Shell average offshore data Tekna 2012
MPPE for Statoil/Hydro-Shell ORMEN LANGE
Gas Produced Water Treatment

Ormen Lange Project
- World’s most challenging gasfield development project
- Makes Norway world’s largest exporter of natural gas
- Largest industrial project ever carried out in Norway
- 100 kilometer from the northwest coast of Norway

MPPE Unit removes the:
- Dispersed oil (aliphatics)
- Dissolved and dispersed aromatics (BTEX)
- Poly Aromatics (PAHs)

- Flow rate 70 m³/h
- > 99% removal of BTEX, PAHs, Aliphatics (oil)
- In operation since October 2007
MPPE for Statoil/Hydro-Shell ORMEN LANGE
Gas Produced Water Treatment
MPPE for Statoil/Hydro-Shell ORMEN LANGE
Gas Produced Water Treatment
MPPE for LNG Plant Woodside PLUTO - Australia
Gas/LNG produced water reuse for demin water

Pluto Woodside Project
- Pluto Project will increase the present Natural gas production with approximately 25%
- Veolia Oil & Gas supplied a total Wastewater Treatment Package consisting of:
  CPI, MPPE unit, Chiller, MBR, Oxidation/ozone, Activated Carbon & Demin unit.
The treated water is reused.
- Planned to be on stream in 2011

MPPE Unit removes the:
- Dispersed oil (aliphatics)
- Dissolved and dispersed aromatics (BTEX)
- Poly Aromatics (PAHs)

- Total MPPE Unit capacity 43 m3/hr
- 2 parallel column trains guarantee 100% redundancy extraction capability
MPPE for LNG Plant
Woodside PLUTO – Australia

Gas/LNG produced water reuse for demin water
MPPE for LNG Plant Woodside PLUTO - Australia
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Gas/LNG produced water reuse for demin water
MPPE for Statoil Kollsnes, Norway
Gas Produced Water Treatment

Kollsnes project
Produced water treatment of 5 gas fields. MPPE Mobile unit is running since 2005. Existing Biological WWTP failed when produced water from new field was added to the feed. Upstream treatment by MPPE Mobile unit removes toxic Aromatics and PAHs. The Biological WWTP recovered within 3 months. Mobile unit will be replaced by permanent unit indicated below.

MPPE Unit removes the:
• Dispersed oil (aliphatics)
• Dissolved and dispersed aromatics (BTEX)
• Poly Aromatics (PAHs)

• Total MPPE Unit capacity 20 m³/h
• Includes Steam Generator and RO unit
• > 99% removal of BTEX, PAHs, Aliphatics (oil)
• To be shipped in April 2011
MPPE for Statoil Kollsnes, Norway    Gas Produced Water Treatment
MPPE for Statoil Kollsnes, Norway  Gas Produced Water Treatment

MPP SYSTEMS  VWS OIL & GAS
MPPE for Statoil Kollsnes, Norway  Gas Produced Water Treatment
Boiler Feed Water Reverse Osmosis Unit (1)
MPPE for Statoil Kollsnes, Norway    Gas Produced Water Treatment
Boiler Feed Water Reverse Osmosis Unit (2)
MPPE for Statoil Kollsnes, Norway  Gas Produced Water Treatment

Top Deck Manifold

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MPPE for Statoil Kollsnes, Norway  Gas Produced Water Treatment

Buffer Tank

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MPPE for Statoil Kollsnes, Norway    Gas Produced Water Treatment

MPP SYSTEMS    VWS OIL & GAS
MPPE for Statoil Kollsnes, Norway  Gas Produced Water Treatment
Special pumps for transporting separated hydrocarbons (oil) as a product
MPPE for Statoil Kollsnes, Norway    Gas Produced Water Treatment
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MPP SYSTEMS    VWS OIL & GAS
MPPE for Statoil Kollsnes, Norway  Gas Produced Water Treatment
MPPE for Statoil Kollsnes, Norway    Gas Produced Water Treatment

Connections
MPPE for Statoil Kollsnes, Norway  Gas Produced Water Treatment

Shipment for Norway

MPP SYSTEMS  VWS OIL & GAS
Shell Prelude
Floating LNG

- Treatment + liquefaction
- 488m x 74m: largest floating structure
- Avoids: pipelines, coastal modifications, land use
- Lower environmental footprint
- Flexibility to relocate and reuse
- For “stranded” gas assets
MPPE
Shell Prelude
3D model
MPPE in hull
Shell Prelude
FLNG