Nimr Water Treatment Project Oman

Introduction
The Nimr water treatment plant (NWTP) project is located in the south of Muscat in Oman. The temperatures in the region can be as high as 60°C in the summer months, making it a harsh environment to work in. This water treatment project was co-executed by Bauer Environment and Petroleum Development Oman (PDO). The plant came online in late 2010 and has been treating water since 18th December 2010. The Nimr oilfield requires 250,000 m³/d of water to be managed to keep oil production going. Deep disposal wells were the main option but the Nimr WTP can address the issues of loss of revenue from oil left in produced water, stricter environmental regulations, high-energy costs and the carbon footprint associated with disposal wells.

Project overview
The Nimr WTP is designed to treat 45,000 m³/d, which is less than a fifth of the daily volume of produced water generated by the oilfield. It is a build-own-operate (BOO) project under a 20-year operation and maintenance contract. This is a unique model, for which BAUER designed and built the facility and is now operating it. BAUER has taken full liability for managing the water from the oil and gas producer. The composition of the produced water from the Nimr oilfield is brackish, with total dissolved solids (TDS) ranging between 7,000 mg/l and 8,000 mg/l. The oil in the water is higher than 400 mg/l in average.

The plant layout includes a pipeline, which enters the NWTP system and leads to an oil and water separator. The water is then distributed into a wetland facility where it is channeled through four wetland terraces by gravity feed. The overall area of the wetland is 2.3 million m². Finally, there are evaporation ponds used for salt recovery in order to reuse the salt for drilling operations in the oilfields of Oman. The figures below show the gravity flow reed bed.

Reducing the environmental footprint
The Nimr WTP project is reducing the environmental footprint. This project is able to recover as much as > 200 bbl/d of oil from the produced water. Since the start of the project, 30,000 barrels of oil have been recovered from the produced water stream. The concept of the plant was to have zero energy used for the water treatment, thus reducing the energy footprint by installing a gravity flow system plant design. Intermediate pumping is not required in the plant. To protect underground aquifers, the wetland area is lined with a mineral sealing layer rather than a HDPE liner, which is used typically. The climate and large surface area made using HDPE liners unfeasible. Local
materials were sourced to establish the sealing layer. For added value the project will also research how to reuse the biomass that the wetland will produce over time.

Compared to deep disposal wells, this reed bed approach has lower energy requirements and less carbon footprint. The table below shows the energy and carbon footprint associated with the two methods.

<table>
<thead>
<tr>
<th>Disposal options</th>
<th>Power required</th>
<th>Total power used in project</th>
<th>CO2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deep well disposal</td>
<td>Up to 5.5 kWh/m³</td>
<td>3,630,000 MWh</td>
<td>1,960,000 t</td>
</tr>
<tr>
<td>Reed bed</td>
<td>0.1 kWh/m³</td>
<td>66,000 MWh</td>
<td>35,700 t</td>
</tr>
</tbody>
</table>

Project success and outlook
The use of a mineral sealing layer rather than a HDPE liner has reduced the energy footprint during installation by 80%. The oil content in the produced water is reduced from 400 mg/l when entering the NWTP to less than 0.5 mg/l when leaving the wetland system. Despite the hot climate, the winter months provide temperatures, which are suitable for the growth of *Phragmites australis* plants. Petroleum Development Oman and BAUER are currently increasing the NWTP capacity to 95,000 m³/d.
Technical Design
Gravity flow reed bed…

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