Using Reed Beds for Wastewater Treatment

Dr. Abdullah Abri
Scratching the Head ...

Total Global Oil Demand  =  MMm3 90  A Day 
One Third Through Arab States  =  MMm3 30  A Day

*if* ....

Every Oil Barrel bring along Water Barrels

<table>
<thead>
<tr>
<th>Oil barrels/day</th>
<th>Water production (MMm3)</th>
<th>Water production (MM Gallons/day)</th>
<th>Ave consumption per capita</th>
<th>Ave produced/total population</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>240</td>
<td>63,600</td>
<td>100</td>
<td>1223</td>
</tr>
<tr>
<td>5</td>
<td>150</td>
<td>39,750</td>
<td>100</td>
<td>764</td>
</tr>
<tr>
<td>2</td>
<td>60</td>
<td>15,900</td>
<td>100</td>
<td>305</td>
</tr>
</tbody>
</table>
Scratching the Head ...

Above and over …
  • Current water management practices (expensive)
  • Current water desalination practices (expensive)

Okay, what's the issue then …
  • Will
  • Skill
The Water Conundrum in Oil & Gas

In the GCC region, we suffer from **too little water** and **too much water** at the same time!
Too Little Water ..... 

.... A very large area of the GCC is arid desert
Too Much Water ..... 

.... In the GCC countries, for every barrel of oil produced, up to 10 barrels of water are extracted at the same time. And it gets worse with time!
Too Much Water – A Liability

Excess produced water is disposed of via deep water disposal (pumping the water very deep, below producing reservoirs), which is a very energy-intensive activity.
Produced Water Treatment Using Reed Beds
Nimr Reed Bed Facility Layout
Gravity Flow Reed Bed
Design Considerations

• Gravity flow of the produced water through the reed beds, (energy savings, reduction in carbon emission)

• Utilization of mineral sealing substrate layer, (80 % procurement cost reduction as against PE)

• Utilization of local material; i.e. Reeds Phragmites australis naturally found in Oman

• OIW 200ppm @ the start of the facility is reduced to a negligible level (<0.5ppm). Therefore reducing the hazardous component of the produced water
Nimr Reed Beds Performance

Oil Recovery
Few hundred barrels per day which is otherwise lost via DWD

Gravity Flow
System operates without intermediate pumping

Construction Measures
HDPE liner replaced with a mineral sealing

Biomass Production
CO₂ Fixture – Potential energy source

Potential Carbon Credits – Energy Balance
Future extensions to the treatment system may qualify under the Clean Development Mechanism (CDM) program of the UN to generate saleable CER’s (Certified Emission Reductions), commonly known as Carbon Credits.

3) Power Consumption

<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>~ 1,800,000 MWh</td>
<td>972,000 t CO₂</td>
</tr>
<tr>
<td>Technical Treatment Plant</td>
<td>0.8 kWh/m³</td>
<td>~ 255,000 MWh</td>
<td>137,700 t CO₂</td>
</tr>
<tr>
<td>Reed Bed</td>
<td>0.1 kWh/m³</td>
<td>~ 32,850 MWh</td>
<td>17,700 t CO₂</td>
</tr>
</tbody>
</table>

1 bcf/yr gas saving
300,000 tons/yr CO₂ emissions reduction
Project Extended Benefits

• Local job opportunities

• Develop biosaline agriculture (agriculture uses the biggest share of the GCC water whilst it makes a very small contribution to its GDP)

• New business opportunities for the country

• Greening the desert and creating new eco-systems in previously arid areas
Construction Phase – Initial Stage  2011
Construction Sequence

Planting of reed Plants
A Glimpse of Nature at its best at
NIMR REED BEDS (Oman)
Red-necked Phalarope

Phalaropus lobatus
Common Cuckoo

*Cuculus canorus*
Black-crowned Sparrow-Lark

Eremopterix nigriceps
Barn Swallow

Hirundo rustica
Yellow Wagtail

Motacilla flava
White Wagtail

*Motacilla alba*
Desert Whitethroat

*Sylvia minula*
Isabelline Shrike - ‘Turkestan Shrike’
Lanius (isabellinus) phoenicuroides
Western Marsh Harrier

*Circus aeruginosus*
Brown-necked Raven

*Corvus ruficollis*
Fish
More

What lies ahead!!