Al Ansab MBR Sewage Treatment Plant - Step Towards Greener Muscat

M.S. Alhakawati, K. Al Badi, H. Al Jabri, Omar Al Wahaibi

Oman Wastewater Services Company
PO Box 1047, Al Khuwair, PC 133, Muscat, Oman
Oman Wastewater Services Company S.A.O.C

As Seeb STP (80,000 m³/d)

Al Ansab STP (85,000 m³/d)

Darsait STP (50,000 m³/d)

Proposed Al Amerat STP (10,000 m³/d)

Proposed Al Hajir STP (1,100 m³/d)

Proposed Quriyat STP (5,600 m³/d)

Total governorate/concession area = 3,900 km²

5 Provinces, 6 Catchments with 6 major STPs

LEGEND:
- MAJOR SEWAGE TREATMENT PLANT LOCATION
- SLUDGE PROCESSING PLANT LOCATION
- LARGE PUMP STATION LOCATION
- SMALL PUMP STATION LOCATION

NOTE:
24 PUMP STATIONS
6 MAIN STPs
2,600 km SEWERS
55 km RISING MAINS
285 km TE PIPELINE

Muscat Wastewater Scheme Project
Existing and New Greater Muscat TE Distribution Networks

Seeb STP
80,000 m³/day

Al Ansab STP
85,000 m³/day

Darsait STP
50,000 m³/day

Existing and New TE Distribution Networks

Existing TE distribution network

New TE distribution network
Oman Wastewater Services Company S.A.O.C

Preliminary Treatment

Biological Treatment

Existing Plant

Al Ansab STP
Oman Wastewater Services Company S.A.O.C
Existing Plant (design capacity = 12,000 m³/day), tankered sewage

New Plant (First Phase = 55,000 m³/day), network sewage
New Plant: Head Work (Preliminary Treatment)

- Influent Flow
- Pre-aeration Tanks
- Fine Screens
- Aerated Grit/Grease Removal Tanks
- Screenings/Grit Handling
- To Biological System
- Blower Room
- Electrical
- Sludge Holding Tanks
- Chemicals
- Dewatering
- New Plant: Head Work (Preliminary Treatment)
Total footprint of treatment tanks is 150m x 50m = 7,500 m²
200 flat sheet membrane panels in each deck

38 Double Deck Membrane Unit in each Membrane Tank

8 Membranes Tanks x 38 Double Deck Membrane Unit = 304 DDMU

304 DDMU X 400 Panels = 121,600 Flat Sheet Membrane Panels
## Design Criteria

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Units</th>
<th>MBR Influent Design Values</th>
<th>MBR Effluent set and expected values*</th>
<th>MBR supplier Effluent values guarantee*</th>
<th>Class A (agricultural irrigation permissible limits) (145/93)</th>
<th>Oman drinking water standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum Flow rate</td>
<td>m³/d</td>
<td>18,222</td>
<td>-</td>
<td>-</td>
<td>-</td>
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<tr>
<td>Average Flow rate</td>
<td>m³/d</td>
<td>55,246</td>
<td>-</td>
<td>-</td>
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<td>Max daily Flow rate</td>
<td>m³/d</td>
<td>76,821</td>
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<td>-</td>
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<td>-</td>
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<tr>
<td>Membrane type</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Flux rate</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>BOD</td>
<td>mg/l</td>
<td>312</td>
<td>5</td>
<td>10</td>
<td>15</td>
<td>Zero</td>
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<tr>
<td>TSS</td>
<td>mg/l</td>
<td>228</td>
<td>5</td>
<td>10</td>
<td>15</td>
<td>Zero</td>
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<tr>
<td>Total N as N</td>
<td>mg/l</td>
<td>50</td>
<td>8</td>
<td>9</td>
<td>21.3</td>
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<tr>
<td>NH₃ as N</td>
<td>mg/l</td>
<td>30</td>
<td>1</td>
<td>1</td>
<td>5</td>
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<td>Organic N as N</td>
<td>mg/l</td>
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<tr>
<td>NO₃ as N</td>
<td>mg/l</td>
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<td>7</td>
<td>8</td>
<td>11.3</td>
<td>11.3</td>
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<tr>
<td>Total P as P</td>
<td>mg/l</td>
<td>10</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
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<tr>
<td>pH</td>
<td></td>
<td>6 – 8</td>
<td>-</td>
<td>-</td>
<td>6 - 9</td>
<td>-</td>
</tr>
<tr>
<td>Effluent Temp (min)</td>
<td>°C</td>
<td>25</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
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<td>Effluent Temp (max)</td>
<td>°C</td>
<td>36</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
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<tr>
<td>Fats, Oils &amp; Grease</td>
<td>mg/l</td>
<td>&lt; 50</td>
<td>-</td>
<td>-</td>
<td>0.5</td>
<td>-</td>
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<tr>
<td>Total alkalinity (as CaCO₃)</td>
<td>mg/l</td>
<td>249</td>
<td>150</td>
<td>-</td>
<td>-</td>
<td>-</td>
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<tr>
<td>Faecal Coliforms</td>
<td>MPN/100 ml</td>
<td>&lt; 2.2</td>
<td>2.2</td>
<td>200</td>
<td>Zero</td>
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<tr>
<td>Viable Helminth Ova</td>
<td>Number /L</td>
<td>&lt; 1</td>
<td>&lt; 1</td>
<td>&lt; 1</td>
<td>&lt; 1</td>
<td>Zero</td>
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<tr>
<td>Turbidity</td>
<td>NTU</td>
<td>&lt; 0.5</td>
<td>-</td>
<td>-</td>
<td>-</td>
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</table>

* 95% of all effluent samples taken must comply and sampling may be as frequent as hourly.
Commissioning: Headwork

2 Pre-aeration Tanks; 2 Screens; 1 Grit Removal Tank

Flow = 10,000 m3/d
Commissioning: Secondary & Tertiary Treatment

1 Anoxic Reactor; 1 Aerobic Reactor; 2 Membrane Tanks
Influent tankered sewage
Influent tankered sewage
Equalization of influent tankered sewage
24-hour composite samples – influent tankered sewage

<table>
<thead>
<tr>
<th>Parameter</th>
<th>26 – 27 April 2007 (7 am – 6 am)</th>
<th>27 – 28 April 2007 (7 am – 6 am)</th>
<th>28 – 29 April 2007 (7 am – 6 am)</th>
<th>29 – 30 April 2007 (7 am – 6 am)</th>
<th>Average</th>
<th>Design value</th>
<th>% over design value</th>
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</thead>
<tbody>
<tr>
<td>BOD&lt;sub&gt;5&lt;/sub&gt;</td>
<td>381</td>
<td>478</td>
<td>347</td>
<td>363</td>
<td>392.25</td>
<td>312</td>
<td>25.7%</td>
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<tr>
<td>TSS</td>
<td>428</td>
<td>288</td>
<td>375</td>
<td>285</td>
<td>344</td>
<td>228</td>
<td>50.8%</td>
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<tr>
<td>pH</td>
<td>6.45</td>
<td>6.91</td>
<td>7.00</td>
<td>6.76</td>
<td>6.78</td>
<td>6 – 8</td>
<td>-</td>
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<tr>
<td>Ammonia Nitrogen</td>
<td>51.63</td>
<td>50.22</td>
<td>46.24</td>
<td>49.11</td>
<td>49.3</td>
<td>30</td>
<td>64.3%</td>
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<tr>
<td>Alkalinity</td>
<td>290</td>
<td>295</td>
<td>295</td>
<td>320</td>
<td>300</td>
<td>249</td>
<td>-</td>
</tr>
</tbody>
</table>

Simple calculation show that loading is 37% more than the design load

10,000 m<sup>3</sup>/day of tankered sewage is equivalent to 13,700 m<sup>3</sup>/day of normal domestic sewage (i.e. design values)
Biological treatment as on 25th December 2007.
Installation of piping work in membrane Tank 7
Installation of piping work in membrane Tank 8
Air & Permeate Header Piping outside membrane Tanks 5
Installation of Air Headers above biological aeration tanks
Installation of Air Centrifugal Blowers

Installation of PD Blowers
Operation Center (Handed over) as on 27th January 2008.
Conclusion
1. Muscat is planning for full reuse of the treated wastewater (irrigation, industry, crops production, aquifer recharge)
2. Al Ansab STP is the largest MBR wastewater treatment plant in the world up to date with a first phase capacity of 55,000 m$^3$/day and second phase capacity of 85,000 m$^3$/day.
3. The plant is the biggest wastewater treatment plant in Muscat and will provide Muscat with third of its requirement for landscape and beautification irrigation up to 2025.
4. The plant is tailored made to install Reverse Osmosis (RO) after the micro-filtration membranes. This will help in producing drinking water quality whenever it is required.

Recommendation to the Conference
1. Complete reuse of the treated wastewater in the GCC region.
2. Wastewater companies should adopt membranes technologies for the treatment (Micro & Ultra filtration) as they are the best technologies for water recycling.
Raw Sewage

De-ox Zone

Anoxic Reactor

Aerobic Reactor

Membrane Tank

Permeate

DO > 1.0 mg/L

DO > 2.0 mg/L

Recirculation Flow

3 – 5 Q
Biological Treatment

- **Aerobic Reactors**
  - Oxidation: \( \text{BOD} + O_2 \rightarrow CO_2 + H_2O \) [Aerobes]
  - Nitrification: \( \text{NH}_4^+ + O_2 \rightarrow \text{NO}_2^- + \text{NO}_3^- + H_2O \) [Aerobes]

- **Anoxic Reactors**
  - Denitrification: \( \text{NO}_3^- + O = \rightarrow \text{N}_2\uparrow + H_2O \) [Autotrophs]

- **Anaerobic Reactors**
  - Phosphorus Adsorption: \( \text{PO}_4 \rightarrow \text{O}_2\uparrow + \text{TSS} \) [Poly-P Organisms]
Figure 11. Equalized Influent Temperature
March 26 - 29, 2006

Degree Celsius

Sample Time

Raw Samples
6-hours EQ
Figure 10. Equalized Influent Alkalinity
March 26 - 29, 2006

Sample Time
CaCO3 mg/L

[Graph showing equalized influent alkalinity over the period March 26 - 29, 2006]
Figure 9. Equalized Influent TSS
March 26 - 29, 2006
Figure 7. Equalized Influent Ammonia
March 26 - 29, 2006

Time of Sample
NH3-N, mg/L

Raw Samples
6 Hours EQ