Haya Water

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Asset Management Division, Haya Water
OUTLINE

- Introduction to Haya Water
- Haya Water Strategy for Wastewater Connection, Treatment and Reuse of Treated Effluent
- Wastewater Treatment Processes
- Quality of Treated Effluent Produced
- Challenges and Opportunity for Safe Reuse of Treated Effluent
- Research and Development Activities with Haya Water
1. Haya Water

“GREENER AND HEALTHIER OMAN”
INTRODUCTION

- Haya was established in Dec 2002 by the Government of Oman to build and operate the Muscat Wastewater Project.

- Haya water is a name associated with life and greenery. Haya comes from the Arabic word ‘Hayat’ meaning life. Haya itself means water or fertility, or plants that grows after desert rains.

- The Company signed a concession agreement with the Government for 30 years ends by 2036.
INTRODUCTION

❖ Vision
   To enable Oman to become one of the top countries in the world by building & operating a world class Water Reuse system that connects at least 80% by year 2020.

❖ Mission
   Serving society by converting wastewater into environmental friendly products.

❖ Values
   “Always work as a team of professional people, treating each other and our customers with care and respect and conduct business with high degree of transparency and integrity”
HAYA WATER OBJECTIVES

- Planning a modern wastewater system to serve all the Governorate of Oman, excluding Dhofar Governorate.

- Operating, maintaining and managing the existing system and the wastewater network.

- Controlling and supervising new wastewater projects and the sewerage network.

- Supervising, operating, maintaining and managing of all wastewater components and the network of treated water distribution.
HAYA WATER SERVICES

- Sewage Treatment Plants (STPs)
- Pumping Stations
- Sewage Networks & House Connections
- Treated Effluent (TE) Networks & Supply
- Bio-Solids Composting
- Yellow Tanker Services
BENEFITS OF WASTEWATER PROJECT

- Protect groundwater sources and environment from pollution caused by Raw Sewage leakage.

- Overcoming the problem of Water Scarcity by providing alternative unconventional source of Treated Effluent.

- Contribute to making Oman Greener and Healthier through utilizing Treated Effluent for Irrigation and Landscaping.

- Transfer the Solid Waste after treatment to environmentally friendly organic fertilizer (KALA) for use in various agricultural operations.
2. Haya Strategy

- Wastewater Networks
- Treated Effluent
MASTER PLAN OF WASTEWATER NETWORKS

The Master Plan is built on future long-term planning by using scientific basis that used globally for planning purpose as following:

- Future population growth is predicted based on population statistics and forecasting the population growth rates.

- Water consumption per capita and therefore calculate the expenses over the duration of the project.

- Set estimated cost for the expected projects and a timetable for the implementation of each project.

- Develop long term plan for all projects according to priorities and distribution annual cost of each project.
WASTEWATER CONNECTION

### Descriptions

<table>
<thead>
<tr>
<th>Description</th>
<th>2020</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Governorate Domestic Properties</td>
<td>239,657</td>
</tr>
<tr>
<td>No. of Connected Domestic Properties</td>
<td>205,056</td>
</tr>
<tr>
<td>% Connected Domestic Properties</td>
<td>85.56%</td>
</tr>
</tbody>
</table>

### Diagram

- Residential Properties Connection to Sewer Networks in Muscat Governorate
- Yearly connection data from 2010 to 2025
- No. of Connected Governorate Domestic Properties
- Total Governorate Domestic Properties
- % Connected Governorate Domestic Properties
The Haya Water prepared a master plan for the reuse of treated water in Muscat Governorate in 2013 and was updated in 2016 to assess the current and future needs of the Treated Effluent, which aims to maximize the consumption of treated water up to 67% until year 2026. In addition to ensure the sufficient quantities of treated effluent to the needs of the Muscat Municipality and future needs of other customers.
TREATED EFFLUENT CONNECTION 2012-2015

Progress of TE Connection

<table>
<thead>
<tr>
<th>Year</th>
<th>Number of Connections</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012</td>
<td>37</td>
</tr>
<tr>
<td>2013</td>
<td>51</td>
</tr>
<tr>
<td>2014</td>
<td>72</td>
</tr>
<tr>
<td>2015</td>
<td>101</td>
</tr>
</tbody>
</table>

Total Flow (m³/day) | TE Production (m³/d) | TE Utilization (m³/d) | TE Utilization (%)
---|----------------------|-----------------------|-----------------------|
149,940 | 77,503 | 52%
Haya has been cooperated with Ministry of Agriculture and Fisheries to implement a pilot project for the reuse of Treated Water in productive agriculture processing and identified five farms in the village of Al Shakackhet Barka. It was agreed that Haya will supply treated water lines to the entrance of each of these farms and the Ministry of Agriculture provide modern irrigation systems and pay TE consumption cost. In addition, help the Farmers to select crops that should be cultivated.
Million Palm Project

There is coordination with the supervision team of Million Palm Project to explore the possibility of planting a part of the project with Treated Effluent based on studies prepared in this aspect. Haya supplied this project with about 800 cubic meter per day of TE from Ibri STP.
TREATED EFFLUENT CONNECTIONS

➢ **Golf Courses and Sport Stadiums**

Haya provide Treated Effluent with high quality (standard A) for all four golf courses in Muscat (The Wave, Muscat Hills, PDO Golf) instead of fresh water. In addition several of Sport Stadiums such us: Bowsher, A’Seeb and Al Rumais Stadiums.

➢ **Landscaping**

Also, there is coordination between the Muscat Municipality and Haya Water on utilizing the maximum amount of treated water to increase the green areas in Muscat.
TREATED EFFLUENT CONNECTIONS

- **Road Projects**

  Moreover, there is coordination between the Ministry of Transport and Communication and Haya Water on utilizing treated water for new road projects instead of fresh water.

- **Commercial & Industrial**

  Haya Water searching for new consumers to use the surplus of TE by coordination with the General Authority for the development of small and medium enterprises in the possibility of reuse of treated water such as for District Cooling System of Panorama Mall.
3. Wastewater Treatment Process

- Constituents of Wastewater
- Types of Wastewater Treatment
- Tertiary Treatment Technologies
CONSTITUENTS OF WASTEWATER

➢ Origin of Wastewater

Wastewater may be defined as water that is supplied to communities and utilized in several application then discharge the unwanted or unvalued, into sewer system.

➢ Wastewater Constituents

It mainly consists of water about 95% which is often added to carry waste down a drain. The other 5% composition of wastewater varies widely and could be classified into three groups are:

- Physical: Temperature, Color, Odor and Solid
- Chemical: pH, Anions (Nutrients), Cations (Heavy Metals)
- Biological: Viruses, Bacteria, Pathogens and it's Helminthes ova
## TYPICAL RAW WASTEWATER CHARACTERISTICS

<table>
<thead>
<tr>
<th>Raw Wastewater Parameter</th>
<th>Unit</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biochemical Oxygen Demand (BOD₅)</td>
<td>mg/L</td>
<td>350</td>
<td>400</td>
</tr>
<tr>
<td>Chemical Oxygen Demand (COD)</td>
<td>mg/L</td>
<td>600</td>
<td>900</td>
</tr>
<tr>
<td>Total Suspended Solids (TSS)</td>
<td>mg/L</td>
<td>350</td>
<td>500</td>
</tr>
<tr>
<td>Total Kjeldahl Nitrogen (TKN)</td>
<td>mg/L</td>
<td>50</td>
<td>70</td>
</tr>
<tr>
<td>Ammonia Nitrogen (NH₃-N)</td>
<td>mg/L</td>
<td>35</td>
<td>45</td>
</tr>
<tr>
<td>Total Phosphorus (TP)</td>
<td>mg/L</td>
<td>9</td>
<td>15</td>
</tr>
<tr>
<td>Oil &amp; Grease (O&amp;G)</td>
<td>mg/L</td>
<td>--</td>
<td>200</td>
</tr>
<tr>
<td>Total Alkalinity (as CaCO₃)</td>
<td>mg/L</td>
<td>100</td>
<td>200</td>
</tr>
<tr>
<td>Volatile Suspended Solids (VSS)</td>
<td>mg/L</td>
<td>280</td>
<td>400</td>
</tr>
<tr>
<td>VSS / TSS Ratio</td>
<td>%</td>
<td>75</td>
<td>85</td>
</tr>
<tr>
<td>pH</td>
<td>-</td>
<td>6</td>
<td>8.0</td>
</tr>
<tr>
<td>Temp</td>
<td>°C</td>
<td>20</td>
<td>35</td>
</tr>
</tbody>
</table>
WASTE WATER TREATMENT PLANT

- **Wastewater Treatment Plant**
  Mechanical process designed to remove wastewater constituents, thereby produce TE in compliance with regulation and permitting to be used safely for other purposes.

- **List of STPs in Muscat Governorate**

<table>
<thead>
<tr>
<th>STP Name</th>
<th>Capacity (m³/d)</th>
<th>Type of Treatment</th>
<th>CA &amp; MECA Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>A’ Seeb STP</td>
<td>60,000</td>
<td>SBR System + Ultra Filtration</td>
<td>Group 1 &amp; Standard A</td>
</tr>
<tr>
<td>New Al Ansab</td>
<td>57,000</td>
<td>MBR System</td>
<td>Group 1 &amp; Standard A</td>
</tr>
<tr>
<td>Darsait</td>
<td>21,000</td>
<td>Conventional (Clarifier + Sand Filter)</td>
<td>Group 2 &amp; Standard B</td>
</tr>
<tr>
<td>Old Al Ansab</td>
<td>20,000</td>
<td>Conventional (Clarifier + Sand Filter)</td>
<td>Group 2 &amp; Standard B</td>
</tr>
<tr>
<td>SAQ</td>
<td>7,500</td>
<td>MBR System</td>
<td>Group 1 &amp; Standard A</td>
</tr>
<tr>
<td>New Quriyat</td>
<td>1,000</td>
<td>MBR System</td>
<td>Group 1 &amp; Standard A</td>
</tr>
<tr>
<td>Al Amerat</td>
<td>650</td>
<td>Conventional (Clarifier + Sand Filter)</td>
<td>Group 2 &amp; Standard B</td>
</tr>
<tr>
<td>Bowsher</td>
<td>420</td>
<td>Conventional (Clarifier + Sand Filter)</td>
<td>Group 2 &amp; Standard B</td>
</tr>
<tr>
<td>HAG</td>
<td>200</td>
<td>MBR System</td>
<td>Group 1 &amp; Standard A</td>
</tr>
<tr>
<td>Jibroo</td>
<td>150</td>
<td>MBR System</td>
<td>Group 1 &amp; Standard A</td>
</tr>
<tr>
<td>Manuma</td>
<td>80</td>
<td>Conventional (Clarifier + Sand Filter)</td>
<td>Group 2 &amp; Standard B</td>
</tr>
</tbody>
</table>
TYPES OF WASTEWATER TREATMENT

➢ Primary Treatment
Mechanical Separation by a physical and/or chemical settlement of suspended solids, in which (BOD5) of the incoming wastewater is reduced by at least 20% before discharge and (TSS) is reduced by at least 50%.

➢ Secondary Treatment
Post-primary treatment of wastewater by a process generally involving biological treatment with a secondary settlement, resulting in (BOD5) removal of at least 70% and (COD) removal of at least 75%.

➢ Tertiary Treatment
Filtration system for further removal and polishing of TE. The treatment removal efficiency is at least 95% for BOD and 85% for COD, 80% for TN, and 99% for microbiological.
TYPES OF WASTEWATER TREATMENT
TERTIARY TREATMENT IMPLEMENTED IN HAYA WATER

➢ Conventional Activated Sludge
TERTIARY TREATMENT IMPLEMENTED IN HAYA WATER

- Membrane Bio-Reactor
TERTIARY TREATMENT IMPLEMENTED IN HAYA WATER

- Sequential Batch-Reactor + UF
4. Quality of Treated Effluent

- Regulation and Standard
- Studies in the Quality of Treated Effluent
## TREATED EFFLUENT COMPLIANCE

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Unit</th>
<th>Concession Agreement</th>
<th>** MD 145/93</th>
<th>*** MD 159/05</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>* Group 1</td>
<td>Group 2</td>
<td>Std. A</td>
<td>Std. B</td>
</tr>
<tr>
<td>Biochemical Oxygen Demand (BOD₃)</td>
<td>mg/L</td>
<td>&lt; 15</td>
<td>15</td>
<td>20</td>
</tr>
<tr>
<td>Chemical Oxygen Demand (COD)</td>
<td>mg/L</td>
<td>-</td>
<td>150</td>
<td>200</td>
</tr>
<tr>
<td>Total Suspended Solids (TSS)</td>
<td>mg/L</td>
<td>&lt; 15</td>
<td>15</td>
<td>30</td>
</tr>
<tr>
<td>Total Kjeldahl Nitrogen (TKN)</td>
<td>mg/L</td>
<td>-</td>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td>Ammonia Nitrogen (NH₃-N)</td>
<td>mg/L</td>
<td>-</td>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td>Total Nitrogen</td>
<td>mg/L</td>
<td>&lt; 15</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Nitrate (as NO₃)</td>
<td>mg/L</td>
<td>-</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>Total Phosphorus (TP)</td>
<td>mg/L</td>
<td>&lt; 30</td>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td>Oil &amp; Grease (O&amp;G)</td>
<td>mg/L</td>
<td>&lt; 5</td>
<td>0.5</td>
<td>0.5</td>
</tr>
<tr>
<td>pH</td>
<td></td>
<td>-</td>
<td>6 ~ 9</td>
<td>6 ~ 9</td>
</tr>
<tr>
<td>Fecal Coliform</td>
<td>MPN/100 mL</td>
<td>&lt; 200</td>
<td>200</td>
<td>1,000</td>
</tr>
<tr>
<td>Nematode Ova</td>
<td>Ova / L</td>
<td>&lt; 1</td>
<td>&lt; 1</td>
<td>&lt; 1</td>
</tr>
</tbody>
</table>

Note:
* STP Constructed After 1st Jan 2005  ** Wastewater Reuse & Discharge Limit  *** Marine Discharge Limit
Study of:
EVALUATION OF TERTIARY TREATMENT TECHNOLOGIES

Objective
The main objective of this study is to evaluate two wastewater treatment methods that are implemented at Al Ansab Sewage Treatment Plant which are Conventional Activated Sludge System (CAS) and Membrane Bioreactor Technology (MBR). The emphases of the research project are to characterize the strength of influent raw sewage, compare the quality of treated effluent to (MECA) Standard Specifications and calculate the removal performance.

Result
Both STPs produce very good quality of treated effluent since most parameters showed compliance with MECA standards. The removal efficiency achieved at CAS plant for TSS, TN and BOD are 97%, 60% and 98% respectively, while that accomplished at MBR plant are 98%, 85% and 98% respectively.
QUALITY OF TREATED EFFLUENT

Compliance of TSS in TE of SQ STP

- TSS (mg/L)
- Limit

Dates range from 10/18/2014 to 2/20/2016.
QUALITY OF TREATED EFFLUENT

Compliance of BOD in TE of SQ STP

- Blue line: BOD (mg/L)
- Orange line: Limit

Dates:
18/10/2014, 27/12/2014, 07/03/2015, 16/05/2015, 25/07/2015, 03/10/2015, 12/12/2015, 20/02/2016
QUALITY OF TREATED EFFLUENT

Compliance of NO3-N inTE of SQ STP

- NO3-N (mg/L)
- Limit

Dates:
- 10/18/2014
- 12/27/2014
- 3/7/2015
- 5/16/2015
- 7/25/2015
QUALITY OF TREATED EFFLUENT

Helminths Ova/L in the TE of SQ STP

- Blue line: VHO/L
- Orange line: Limit


Values range from 0 to 2.5
Objective
This study attempts to find best options for dealing with the treated effluent (TE) in more sustainable and beneficial ways. An exploratory and comparative study was performed in order to optimize Haya benefits from treated wastewater by considering different options for reusing and recycling of treated wastewater.

Result
The study concluded the possibility of the use of treated water in several areas; it was found that the priority of treated water usage as followings:
- Agricultural & Landscape,
- Urban Area,
- Industrial,
- Underground Injection.
5. Challenges and Opportunities for Safely Use of Treated Water
CHALLENGES

- One of the major challenges facing Haya Water with regards to process technology selection is to produce extremely high quality of Treated effluent, specifically compliance of Viable Helminth Ova parameter which the limit has been set as less than 1 Ova / Liter (< 1 Ova / Liter).

- There are very limited technology available for this level of liquid-solids separation for wastewater treatment services approved by Haya.

- In addition, technology required very High CAPEX & OPEX costs, in addition high level of skilled operator and O&M complexity compared to other treatment technologies (Dual Media Filters, Sand Filtration, etc.)
One of the main challenges facing Haya Water is finding customers to utilize the Treated Water that is produced in high quality and is compatible with the Ministry of Environment and Climate Affairs - Ministerial Decree No. (145/1993)

As well as, excess amount of Treated Effluent is discharged to Marine because there is no optimal consumption, where only 52% is consumed.
6. Research and Development
RESEARCH & DEVELOPMENT IN HAYA WATER

The R&D activities in Haya Water will be focused on proactive and improvement initiatives in technical aspects for the followings goals and purposes;

- To maintain Haya Water with up-to-date development of technology, technical standards and specifications in the industry, and in order to continuously improve the Haya Water Technical Standards (i.e. Design Manual, Standard Specifications, etc.).

- To optimise and enhance the performance of existing operating assets for an increased productivity, efficiency and product quality meeting the regulatory requirements / standards.

- To explore and sourcing alternative cost effective treatment solution, technology, higher efficient equipment’s, sustainable treatment method for development of Haya Water assets with aim for CAPEX and OPEX savings and better LCC.

- To assist and find solutions for O&M related technical problems and challenges.
### ON-GOING & FUTURE R&D INITIATIVES

#### SEWAGE TREATMENT PLANT

<table>
<thead>
<tr>
<th>S/N.</th>
<th>Potential Area of R&amp;D Initiatives</th>
<th>S/N.</th>
<th>Potential Area of R&amp;D Initiatives</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Explore alternative STP treatment technologies – example, eco-friendly technology, Reed Bed system.</td>
<td>5</td>
<td>Explore retrofitting technology for STP capacity upgrading and enhancement.</td>
</tr>
<tr>
<td>2.</td>
<td>Lower energy consumption aeration, pumping equipment (i.e. air blowers, diffusers, aeration devices, etc.).</td>
<td>6</td>
<td>Small STP and Packaged STP technology evaluation for outside Muscat STP projects</td>
</tr>
<tr>
<td>3.</td>
<td>Explore non-membrane STP technology and tertiary filtration system / technologies, alternative microfiltration system, double stage pressurised filter, cartridge filters, pathogen and VHO removal method, etc.</td>
<td>7</td>
<td>Alternative Odor Control System or treatment method.</td>
</tr>
<tr>
<td>4.</td>
<td>Alternative dewatering equipment’s for less chemical and power consumptions.</td>
<td>8</td>
<td>Bio-gas generation from anaerobic digester system.</td>
</tr>
</tbody>
</table>
THANK YOU