Meeting refinery wastewater challenges - membrane based biological treatment and an asset sustainability program

Nauman Rashid
Marketing Director - Middle East & Africa
SUEZ Water Technologies & Solutions
Overview

- Delivering value to refineries, key solutions
- Refinery Water Balance
- Typical Refinery Wastewater Treatment
- Membrane Bio Reactor and wastewater treatment
- Uses of Recycled Water
- Supplemental supplies and mobile water
- BAPCO Refinery integrated water and wastewater
- Bashneft Refinery, Russia
- Digital Internet-of-Things: Asset Performance Management
- Conclusions and recommendations
Delivering Value to Refineries

Industry needs to curtail potable water and meet its water demand through reuse
Key Solutions to Wastewater Challenges

1. ROBUST WASTEWATER TREATMENT
   - Best in class technology for treatment solutions deployment

2. DEALING WITH CRUDE VARIABILITY
   - Enhancing oil recovery and minimizing treatment impacts

3. RECYCLE AND REUSE
   - Augmenting water recycling reducing source water needs

4. HEAVY METALS REMOVAL
   - Path to meeting strict discharge requirements (selenium & mercury)

5. SUPPLEMENTAL DEMAND & OPERATIONS
   - Options for planned or emergency needs and operating capabilities
65 to 90 gallons (245 – 340 litres) of water is used to process 1 barrel (160 litres) of crude

**Refinery Water Balance**

*If the process water used is not properly treated*
- the soluble minerals, suspended solids and inorganic contaminants
  *could affect the processing equipment by means of*
- corrosion and deposition
  *leading to problems in*
- heat transfer, water flow reduction, increased and higher waste treatment cost

**Pre-Treatment**
- City Water
- Well Water
- Surface Water
- Water in Crude Oil
- Sea Water
- Other (e.g. firewater)

**Refinery Water Use**
- Cooling Water
- Boilers
- Processes
- Recycle & Reuse
- Internal Recycle & Reuse
- Energy consumption
- To the Environment
  - Steam
  - Cooling Tower Evaporation
  - Cooling Tower Blowdown
  - Process Discharge
  - Boiler Blowdown
  - Recycle & Reuse

**WWTP**
- Effluent Discharge

**Storm Water**
- Ballast Water
Typical Refinery Wastewater Treatment

Water is critical to refinery health

Diagram:
- Pretreatment:
  - Slop Oil Recovery
  - Oil/Water Separator
  - Equalization Tank
  - Separator Bottoms
  - Hazardous Waste Solids Handling and Disposal
  - Non-Hazardous Waste Solids Handling and Disposal

- Primary:
  - Flotation Thickener
  - Skimmings & Bottoms
  - Waste Activated Sludge
  - Conventional Activated Sludge
  - Attached Growth or Hybrid
  - Membrane Bioreactor

- Secondary:
  - Ponds / Lagoons
  - Discharge
  - Tertiary Treatment
  - Reuse
Membrane Bio Reactor & wastewater treatment

Reinforced Membranes Critical to Reliability

- Hollow fiber configuration
- Billions of microscopic pores on the surface
- Pores are barrier to impurities but allow water molecules to pass
- Membrane layer integrated with support braid providing unmatched ruggedness

<table>
<thead>
<tr>
<th></th>
<th>Conventional</th>
<th>MBR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organics Removal (BOD)</td>
<td>&lt; 20 mg/L</td>
<td>&lt; 2 mg/L</td>
</tr>
<tr>
<td>Solids Removal (TSS)</td>
<td>&lt; 20 mg/L</td>
<td>&lt; 2 mg/L</td>
</tr>
<tr>
<td>Nutrient Reduction (TN)</td>
<td>&lt; 10 mg/L</td>
<td>&lt; 3 mg/L</td>
</tr>
<tr>
<td>Reuse Quality</td>
<td>😐</td>
<td>😊</td>
</tr>
<tr>
<td>Load Variations</td>
<td>😐</td>
<td>😊</td>
</tr>
<tr>
<td>Toxicity Impacts</td>
<td>😐</td>
<td>😊</td>
</tr>
<tr>
<td>Process Stability</td>
<td>😐</td>
<td>😊</td>
</tr>
<tr>
<td>Retrofit / Upgrades</td>
<td>😐</td>
<td>😊</td>
</tr>
<tr>
<td>Footprint</td>
<td>😐</td>
<td>😊</td>
</tr>
<tr>
<td>Ease of Operation</td>
<td>😊</td>
<td>😊</td>
</tr>
<tr>
<td>OPEX</td>
<td>😊</td>
<td>😐</td>
</tr>
</tbody>
</table>
Introduction

- Augmented organics removal - recalcitrant COD & toxic compounds
- Additional process stability
- Improved effluent quality for discharge or reuse
- Proven & robust solution
- Lowest cost of ownership
Uses of Recycled Water

- Process Water
  - Desalter makeup
  - HCU/HTU wash-waters
  - Coker quench water & cutting water
  - FCC wash-waters
  - Flare seal drum
- Boiler Feedwater Makeup
- Cooling Water Makeup
- Fire & Utility Water

Water Treatment to Align with Reuse Objectives
Supplemental supplies and mobile water

Short, medium and long term rental solutions

- Emergency
- Planned outages
- Incremental supplies
- Delayed Capex
- Build-Own-Operate Options

Offers a water availability solution literally on demand
BAPCO Refinery integrated water and wastewater

- BAPCO decided to upgrade its existing WWTP to comply with stricter discharge requirements using the best available technology: MBR
- The MBR system now takes care of Ammonia, Nitrate, Suspended Solids, Sulfides, Phenols, BOD, COD etc., present in the refinery effluent.
- BAPCO effluent from Refinery is unique with high salinity (i.e. TDS > 30,000 ppm and high temperature (> 45 °C).

The UF system has consistently met all effluent quality parameters, incl. TSS and turbidity.
Bashneft Refinery, Russia

**Customer challenges**

- Treat refinery wastewater, 84,000 m³/d average, 144,000 m³/d max day
- Meet stringent water quality requirements for river discharge (COD < 30 mg/L, phenols < 0.001 mg/L, heavy metal limits)
- Produce treated water for industrial reuse

**SUEZ solutions**

- ZeeWeed MBR with MACarrier + EDR (reuse) + IX (heavy metal removal for river discharge) + RO (EDR brine concentration)
- System performance allows water reuse & meets stringent discharge requirements
- Commercial operating date - 2016

---

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Raw Feedwater Quality</th>
<th>River Discharge Quality</th>
</tr>
</thead>
<tbody>
<tr>
<td>COD, mg/l</td>
<td>450</td>
<td>30</td>
</tr>
<tr>
<td>BOD&lt;sub&gt;5&lt;/sub&gt;, mg/l</td>
<td>135</td>
<td>3</td>
</tr>
<tr>
<td>Phenols, mg/l</td>
<td>7.0</td>
<td>0.001</td>
</tr>
<tr>
<td>NH₄-N, mg/l</td>
<td>40</td>
<td>0.5</td>
</tr>
<tr>
<td>TP, mg/l</td>
<td>0.2</td>
<td>0.13</td>
</tr>
<tr>
<td>TSS, mg/l</td>
<td>50</td>
<td>6.4</td>
</tr>
<tr>
<td>Oil, mg/l</td>
<td>25</td>
<td>0.05</td>
</tr>
</tbody>
</table>
Digital Internet-of-Things: Asset Performance Management

- Using InSight™ Remote Data Monitoring & Analytics
  - ensures assets – like boilers, cooling towers, reverse osmosis and ultrafiltration membranes and other key components operate at optimal levels
- Reduce Operational Risk ... by driving reliability and availability of equipment
- Minimize Total Cost of Ownership ... through optimized process operations
- Early detection is a key goal, detecting emerging problems, so that action can be taken now, before a failure is experienced in the future
Conclusions and recommendations

- The MBR system successfully passed all Performance Test conditions.
- The MBR system met all the treatment capacity requirements while keeping TMP values well below maximum limit of 8 psig.
- The performance 6 months after the completion of the Performance Test continued to be excellent.
- A water reuse target in refineries can help with the economics of their water bill and with suitable polishing technologies, applications towards cooling and boiler water needs can be met.
- A review of the water balance at each industrial site is recommended to fully understand the economic and operational setting to achieve full results.