Wastewater treatment and reuse in the oil & petrochem industry – a case study

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Wastewater Treatment and Reuse

In Oil & Petrochemical Industry

Otranto, June 2014
COMPANY PROFILE

DEGREMONT, THE WATER TREATMENT SPECIALISTS

4 areas of activities:
- Design & Build
- Operation & Services
- Equipment
- BOT / PPP

5 areas of expertise:
- Drinking water production plants
- Reverse osmosis desalination plants
- Urban wastewater treatment and reuse plants
- Biosolid treatment systems
- Industrial water production and wastewater treatment units plants
COMPANY PROFILE

For industrials:
- Energy
- Upstream oil and gas
- Refining and petrochemicals
- Chemicals
- Pharmaceutical, cosmetics, fine chemicals
- Metals and mining
- Food and beverage
- Microelectronics
- Healthcare providers

For local authorities:
- Drinking water
- Desalination
- Urban wastewater
- Sludge and biosolids

In over 70 countries, Degrémont offers solutions to local authorities and industries.
KEY DRIVERS
For Wastewater Reuse in the Industry

1. Local laws and regulations
   • Italy- Gela Refinery: contaminated groundwater treatment
   • Italy–Priolo Petrochemical site: contaminated groundwater treatment
   • China – Chendgu Sichuan Petrochemical site: wastewater treatment & reuse
   • USA – West Basin (CA):
   • Middle east countries (e.g. Qatar, Oman)

2. Difficult access to fresh water source
   • Italy- Taranto Refinery: wastewater treatment & reuse
   • Middle east countries

3. Difficult access to wastewater discharge point
   • Italy- Val D’Agri oil field

4. Corporate responsibility
   • Italy- Sannazzaro Refinery: wastewater treatment & reuse
## TYPICAL CONTAMINANTS
### Found in Refinery & Petrochem WWTP

<table>
<thead>
<tr>
<th>Water pollutant</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oil</td>
<td>Distillation units, hydrotreatment, visbreaker, catalytic cracking, hydrocracking, lube oil, spent caustic, ballast water, utilities (rain)</td>
</tr>
<tr>
<td>$\text{H}_2\text{S (RSH)}$</td>
<td>Distillation units, hydrotreatment, visbreaker, catalytic cracking, hydrocracking, lube oil, spent caustic</td>
</tr>
<tr>
<td>$\text{NH}_3 (\text{NH}_4^+)$</td>
<td>Distillation units, hydrotreatment, visbreaker, catalytic cracking, hydrocracking, lube oil, sanitary/domestic</td>
</tr>
<tr>
<td>Phenols</td>
<td>Distillation units, visbreaker, catalytic cracking, spent caustic, ballast water</td>
</tr>
<tr>
<td>Organic chemicals (BOD, COD, TOC)</td>
<td>Distillation units, hydrotreatment, visbreaker, catalytic cracking, hydrocracking, lube oil, spent caustic, ballast water, utilities (rain), sanitary/domestic</td>
</tr>
<tr>
<td>$\text{CN}^-$, (CNS$^-$)</td>
<td>Visbreaker, catalytic cracking, spent caustic, ballast water</td>
</tr>
<tr>
<td>TSS</td>
<td>Distillation units, visbreaker, catalytic cracking, spent caustic, ballast water, sanitary/domestic</td>
</tr>
</tbody>
</table>
Inlet Wastewater

- Deoiling
  - For free oil
  - >100 ppm

- Equalization
  - HRT 12 – 24 hr

- Dissolved Gas Flotation
  - For free oil
  - 10–100 ppm

- Sludge Dewatering

Pre-Denitrification
Nitrification

Clarifier

Sand filtration

Activated Carbon Filtration

Discharge
TYPICAL TREATMENT LINES
Wastewater Reuse For Refinery & Petrochem
TYPICAL TREATMENT LINES
RO Brine Treatment

COD Adsorption

COD 200 – 400 ppm

GAC Filters

Oxidation

Adsorption

Discharge COD < 160 ppm

COD 200 – 400 ppm

GAC Filters or Biofor®

Discharge COD < 100 ppm

RO Brine COD 200 – 400 ppm

Pre Ozonation

Biofor®

COD < 60 ppm

GAC Filters

Discharge COD < 100 ppm

COD Adsorption

GAC Filters or Biofor®

Oxidation

Adsorption

Discharge COD < 160 ppm

HMW molecules Break-up

Biofiltration

Strong Oxidation

COD Adsorption
Italy - Gela Refinery

Contaminated Groundwater Treatment & Reuse
Gela Refinery Contaminated Groundwater Treatment
Design data and performances of the plant

- Inlet contaminated groundwater – Design data:
  - Flow rate (design): 300 m3/h (7200 m3/day)
  - Ammonia: 300 ppm
  - Arsenic: 4300 ppb
  - BTEX: 4850 ppb
  - MTBE: 2220 ppb

- Pro-demi water production (Reverse Osmosis permeate):
  - Flow rate (design): 210 m3/h (5040 m3/day)
  - TDS: 80 mg/l

- Reverse Osmosis reject discharge to sea:
  - Flow rate (design): 90 m3/h (2130 m3/day)
  - As < 10 ppb
  - BTEX < 50 ppb
  - NH₄-N < 5 ppm
  - COD < 160 ppm
Gela Refinery Contaminated Groundwater Treatment Layout
Gela Refinery Contaminated Groundwater Treatment
Chemical oxidation and precipitation
Gela Refinery Contaminated Groundwater Treatment
Sand Filters, GFH Filters, GAC Filters
Gela Refinery Contaminated Groundwater Treatment
Nitrification basin
Gela Refinery Contaminated Groundwater Treatment
Ultrafiltration Membranes section
Gela Refinery Contaminated Groundwater Treatment
Reverse Osmosis section
Italy - Taranto Refinery

Waste Water Treatment & Reuse
Taranto Refinery Wastewater Reuse
Design data and performances of the plant

- Inlet treated wastewater – Design data:
  - Flow rate (design): 550 m³/h (13200 m³/day)
  - COD: 80 ppm
  - TDS: 20000 ppm
  - BTEX: 300 ppb
  - MTBE: 1200 ppb

- Pro-demi water production (Reverse Osmosis permeate):
  - Flow rate (design): 350 m³/h (8400 m³/day)
  - TDS: 10 mg/l

- Reverse Osmosis reject discharge to sea:
  - Flow rate (design): 200 m³/h (4800 m³/day)
  - COD < 160 ppm
  - BTEX < 50 ppb
  - MTBE < 500 ppb
Taranto Refinery Wastewater Reuse Layout
Taranto Refinery Wastewater Reuse
Reverse Osmosis First Pass
Taranto Refinery Wastewater Reuse
Reverse Osmosis Second Pass
Taranto Refinery Wastewater Reuse
Brine Treatment with GAC Filters
USA – West Basin (CA)

Wastewater treatment and recycling facility
West Basin Wastewater Treatment & Recycling
Design data and performances of the plant

• Inlet water: pretreated municipal wastewater:
  - Flowrate: 9000 m³/h (215000 m³/day)
  - TOC: 12 ppm
  - TDS 900 ppm
  - TSS 10 ppm

• Treated water production:
  - Pretreated Water (TSS removal) for Irrigation
  - Softened Water for groundwater injection
  - RO First Pass Permeate (TDS < 30 ppm) for LP Boilers
  - RO Second Pass Permeate (TDS < 2ppm) for HP Boilers

• Reverse Osmosis reject discharge to sea (no treatment required)
West Basin Wastewater Treatment & Recycling
Microfiltration
West Basin Wastewater Treatment & Recycling
Reverse Osmosis
West Basin Wastewater Treatment & Recycling
UV Disinfection
Thank you for your attention!