Accomplishing Zero Liquid Discharge in Petrochemical Facilities
Contents

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Introduction

Aquatech exists to meet the world’s need for Pure Water. We will provide **Technology Leadership**, and **Performance Excellence** to the markets we serve.

- Leading player in the global water industry
- 34 years of successful growth and performance
- Worldwide offices in Canada, China, India, Italy, UAE, KSA and USA
- Over 1000 Major Projects in > 60 Countries
- Focus - Industrial and Infrastructure Markets
  - Process / Pure Water
  - Wastewater Treatment and Recycle and Reuse
  - Desalination
  - Zero Liquid Discharge
- 4 Key Business Models
  - Capital Equipment / Systems
  - Design –Build Solutions
  - Technology Products and Components
  - Services : O&M / DB(O) / BOOT

Global Headquarters, Canonsburg, PA, USA

Manufacturing Facility
International Presence

Canada
USA
Mexico
Netherland
Italy
Oman
UAE
China
S. Korea
India
Singapore
Australia

ORGANIZATION
Worldwide Job Sites

Over 1000 Major Projects in > 60 Countries

Canada
USA
Mexico
Dominican
Aruba
Bermuda
Antigua
Argentina
Brazil
Chile
Panama
Peru
Venezuela
UK
Italy
Netherlands
Germany
Turkey
Algeria
Egypt
Ethiopia
Morocco
Jordan
Kuwait
Oman
Saudi Arabia
Syria
Sudan
UAE
Madagascar
China
India
Indonesia
Malaysia
Pakistan
Philippines
Singapore
Taiwan
Thailand
Vietnam
Japan
Korea
Australia

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In 1981 Aquatech was established specializing in pure water systems for the Steel Industry located in the metropolitan Pittsburgh area.

In the early 1990’s Aquatech developed a global presence.

The mid 1990’s saw Aquatech’s entry into the Zero Liquid Discharge and Wastewater recycle/reuse Markets.

In 1990, Aquatech began offering a more diversified product range including membrane systems and pre-treatment.

In the late 1990’s Aquatech acquired the Industrial Concentration and Desalination business units of Aqua-Chem, Inc. to strengthen their Desalination and Zero Liquid Discharge capabilities.

In 2000, Aquatech acquired the Industrial Concentration and Desalination business units of Aqua-Chem, Inc. to strengthen their Desalination and Zero Liquid Discharge capabilities.

In 2006, Aquatech becomes the EPC with ENEL Italy & Occidental Mukhaizna, Oman.

2009 & beyond, the management and shareholders of Aquatech commit to an accelerated growth strategy to become a Tier 1 Global Water Platform with >35% Recurring Revenue based Businesses including DBOOM, O&M and Products.

In 2009, Aquatech awarded one of the largest Thermal Desal MED based job for Petroleum Refinery in Oman, awarded to treat complex produced water for steam generation in Oman.

In 2012, Aquatech 1st ZLD in Egypt, completes 1st RR in GCC, awarded WWTP for Rabigh Ph II, Ethydco, Desal – FEWA, ZLD - Marcellus Shale.

In 2013, Aquatech 1st ZLD in Egypt, completes 1st RR in GCC, awarded WWTP for Rabigh Ph II, Ethydco, Desal – FEWA, ZLD - Marcellus Shale.

In 2014, was Aquatech awarded one of the largest Thermal Desal MED based job for Petroleum Refinery in Oman, awarded to treat complex produced water for steam generation in Oman.
Drivers for accomplishing ZLD

• Environment protection
• Meeting regulation requirement
• Economics
Source of Generation

Petrochemical Industry

- Crude Oil
- Naptha
- Aromatics
  - Xylene
  - Toluene
  - Benzene
- Pygas
- Olefins
  - Ethylene
  - Propylene
  - Butadiene
- Steam Cracking
- Ethane
- Propane
- Butanes
- Condensate
- Methane
- Synthesis Gas
- Methanol
- Amine
- Natural Gas
Various Generic Chemical Processes in a Petrochemical Plant

- Distillation
- Catalytic Cracking
- Catalytic Reforming
- Alkylation
- Hydrotreating
- Amination
- Condensation

- Esterification
- Halogenation
- Nitration
- Sulfonation
- Ammonolysis
- Isomerisation
- Pyrolysis
And Host of other Process
Sources of Generation

Direct Contact, Indirect Contact, Utilities -

- Water used for wash impurities from Organic Compound products or reactants
- Water used to cool quench
- Condensed Steam
- Water from Raw and product material storage tanks
- Water Used as carrier for catalysts and neutralizing agents
- Water as By Product
- Water used for Equipment Wash (Discharged from process equipment like Scrubbers, Decanters, Evaporators, Distillation Columns, mixing vessels, reactors
- Leakages from Pumps, Heat Exchangers, Condensers etc.
- As Blow Down from Boilers or Cooling Towers

- Accordingly the waste water streams generated contain contaminants, Organic Compounds etc.
- Some of them have Volatile Organic Compounds
## Analytical Quality of Effluent

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Feed Wastewater Quality Range</th>
<th>Treated Effluent Quality Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>5.0 – 9.0</td>
<td>7.0 – 8.0</td>
</tr>
<tr>
<td>Oil &amp; Grease, mg/l</td>
<td>100 – 300</td>
<td>ND</td>
</tr>
<tr>
<td>TSS, mg/l</td>
<td>100 – 1000</td>
<td>ND</td>
</tr>
<tr>
<td>Conductivity, µs/cm</td>
<td>100000 – 25000</td>
<td>&lt; 15</td>
</tr>
<tr>
<td>Total Hardness, mg/l CaCO3</td>
<td>50 – 100</td>
<td>ND</td>
</tr>
<tr>
<td>NH₃, mg/l</td>
<td>5 – 50</td>
<td>ND</td>
</tr>
<tr>
<td>Sulfide, mg/l</td>
<td>5 – 50</td>
<td>ND</td>
</tr>
<tr>
<td>Phenols, mg/l</td>
<td>5</td>
<td>ND ( &lt; 1 ppb)</td>
</tr>
<tr>
<td>Silica, mg/l</td>
<td>5 – 50</td>
<td>-</td>
</tr>
<tr>
<td>BOD₅, mg/l</td>
<td>30 – 200</td>
<td>ND</td>
</tr>
<tr>
<td>COD, mg/l</td>
<td>50 – 300</td>
<td>&lt; 10</td>
</tr>
<tr>
<td>BTEX compounds, mg/l</td>
<td>0.5 – 25</td>
<td>ND</td>
</tr>
</tbody>
</table>
CHALLENGES IN WASTEWATER TREATMENT OF PETROCHEMICAL EFFLUENT

- Removal of Oil & Grease
- Organics / Hydrocarbons present – Phenols, Glycols, VOC
- Hazardous air pollutants
- Removal of Heavy Metals
- Chemical Oxygen Demand (COD)
- Disposal of Spent caustic
- Solids Waste Management
Approach to Recycle & Reuse

Minimize Generation

Minimize Introduction

SEGREGATE & REUSE

RECYCLE

Recover Chemicals & Energy from W Water

Treat for Discharge

Safe Disposal

Recycle Reuse

HEIRARCHY
How to Achieve ZLD?

- **ZLD** is achieved by applying the **Thermal Evaporation Process**.

  **THERMAL EVAPORATION PROCESS**
  - Brine Concentrator
  - Crystallizer
  - Solid Recovery
Basic Design – Water Treatment System - PFD

Feed water – Nile river

Filtered Water Tanks
2 x 12000 M³

Process water to users

For distribution to users

Potable Water Tank

City Water

City / fire Water Tank
12,000 M³

Desalination
220 M³/hr

Desalinated Water Tank
4500 M³

Demineralization
190 M³/hr

Ethylene & Butadiene Plant
Polyethylene Plant
Butadiene Derivative Plant

Utilities

Cooling tower

12 cells
32,000 M³/hr

Reject water to drain
100 m³/hr

waste water to drain
15 m³/hr

Blow Down
1,000 m³/hr

Demin Water Tank
1000 M³

Steam

Boiler

Boiler Blowdown

To users
Case Study - Water Balance Diagram

- Boiler Blowdown: 2 A
- Cooling Tower Blowdown: 107 B
- Treated waste water and spent caustic from ETP: 80 C
- Filtered water: 785 D
- Backwash, LTDS regen waste: 136

E 1110 m3/h

EQUALIZATION TANK

Water for reuse

WTP - ZLD

ZERO Discharge

Solid as Salt
Process Wastewater WWTP

WWTP – Salient Features
MBBR – Disk Screen – Advanced Oxidation System
Sludge Dewatering – Centrifuge
Incinerator

WWTP using Bio Core

Bio Core - Moving Bed Bioreactor

Raw WW

CPI & DAF Pretreatment

Centrifuge

Clarifier

Disk Screen

Incinerator

Discharge To WTP

AOP

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WWTP utilizes the most Advanced Technologies

- FLOW RATE – 25 m³/h

- DAF – Dissolved Air Flotation – As pre-treatment

- BIOLOGICAL SYSTEM – BIOCORE™ – Moving Bio Bed Reactor – Fixed Film
  Utilizes the most advanced technology – Aqua Chip
  Aqua Chip has the highest s/a 3000 m²/m³
  Compact size of Bio reactor
  Most suitable for treating of difficult effluent

- DISK SCREENING – Advanced Filtration – Non stop operation
  - Consistent quality of treated waste water

- ADVANCED OXIDATION SYSTEM – Specifically designed to meet
  the stringent requirement of phenol levels as < 1 ppb

- INCINERATOR – Specifically designed to meet client’s requirement.
  It shall incinerate Oily and biological sludge
Evaporation - Package

Salient Features –

• Designed to treat Spent Caustic generated from during the process. It consisting of recalcitrant organics, volatile organics and inorganic salts.
• Flow Rate – 7.5 m³/h
• The evaporator utilizes Aquatech’s proven technology – FCC
WTP & ZLD utilizes the most advanced technologies

• HERO™ – High Efficiency Reverse Osmosis
  - Upto 95% recovery of permeate
  - Can withstand O&G up to 10 ppm & silica up to 2000 ppm
  - Cleaning frequency – once a year

• FEDI™ – Fractional Electro De Ionizer - Utilizes Advanced Technology
  - Advanced two stage process
  - Optimized power consumption
  - Environmental friendly
  - Free of scaling problems

• ZLD – Zero Liquid Discharge – Brine Concentrator & Crystallizer

1. Flow Rate – 1110 m3/h – Optimally designed for OPEX

2. There is zero waste water discharged from the complete system

3. Treated water produced in different stages of production meets all the requirement of utilities and process
ZLD – Process Schematic

Wastewater storage

Brine Concentrator

Crystallizer

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ZLD – Falling Film Evaporator
ZLD – Falling Film Evaporator
ZLD – Crystallizer
Conclusion

By applying the maximum water management and the ZLD concept water consumption was reduced from **2,660 m$^3$/hr** to **800 m$^3$/hr**, i.e. **saving almost 70 %** of the similar plant water consumption.
Ready for Questions?

Aquatech

Save Each Drop Of Water...