IL RIUTILIZZO DELLE ACQUE DI SCARICO INDUSTRIALI E CIVILI: LE OPPORTUNITÀ’ E LE TECNOLOGIE PIU’ RECENTI

Giovedì 14 giugno 2012
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Via G. Valentini, 14
Membranes for reuse and drinking water treatment: advanced solutions and market overview

PURIFAST – Final Conference
June 14, 2012

Reuse of civil and industrial waste water: Recent opportunities and technologies

Dr.-Ing. Stefan Panglisch

IWW
WATER TECHNOLOGY MARKET EVOLUTION: DRIVERS

- The World is facing a crisis in the provision of water resources due to the following factors
  - Population explodes especially in Mega Cities and close to the coast
### THE BIG TEN IN 2011, SOURCE WORLD GAZETTEER

<table>
<thead>
<tr>
<th>Town</th>
<th>Country</th>
<th>Billion People</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tokyo</td>
<td>Japan</td>
<td>37,7</td>
<td>Coastal</td>
</tr>
<tr>
<td>Mexico City</td>
<td>Mexico</td>
<td>23,6</td>
<td>Inland</td>
</tr>
<tr>
<td>New York</td>
<td>USA</td>
<td>23,3</td>
<td>Coastal</td>
</tr>
<tr>
<td>Seoul</td>
<td>Korea</td>
<td>22,7</td>
<td>Coastal</td>
</tr>
<tr>
<td>Mumbai</td>
<td>India</td>
<td>21,9</td>
<td>Coastal</td>
</tr>
<tr>
<td>Sao Paulo</td>
<td>Brasil</td>
<td>20,8</td>
<td>Inland</td>
</tr>
<tr>
<td>Manila</td>
<td>The Phillippines</td>
<td>20,7</td>
<td>Coastal</td>
</tr>
<tr>
<td>Jakarta</td>
<td>Indonesia</td>
<td>19,2</td>
<td>Coastal</td>
</tr>
<tr>
<td>Delhi</td>
<td>India</td>
<td>18,9</td>
<td>Inland</td>
</tr>
<tr>
<td>Shanghai</td>
<td>China</td>
<td>18,6</td>
<td>Coastal</td>
</tr>
</tbody>
</table>
WATER TECHNOLOGY MARKET EVOLUTION: DRIVERS

The World is facing a crisis in the provision of water resources due to the following factors:

- Population explodes especially in Mega Cities and close to the coast
- Growing need to be water independent and to have reliable, independent water supply alternatives
- Rapid expansion causes harmful exploitation and pollution of water resources
- Climate change leading to changing weather patterns in populated areas
EMERGING PROBLEMS IN DRINKING WATER TREATMENT

- Raw water quality decreases
  - Persistent Pathogens
  - Salinity
  - Nutrients
  - Microcontaminants
    - EDC (Endocrine Disruptors)
    - Pharmaceuticals
    - POP (Persistant Organic Pollutants)
  - Nanocontaminants
- Dry seasons occurs more often and lasts longer
- Floods becomes stronger and more frequent
MEETING THE CHALLENGE WITH MEMBRANES

- Protection of Water Resources
  - Advanced Waste Water Treatment with Membrane Bioreactors and/or NF/RO
MEMBRANE BIOREACTOR (MBR): SUBMERGED
OPERATION OF SIDESTREAM- MBR
ADVANTAGES OF MEMBRANE BIOREACTOR (MBR)

- Effluent free of suspended solids
- Optimized biological treatment process
  - Reduced reactor volumes
  - Improved removal of biologically degradable organics (increased Sludge Retention Time)
  - Integration of biological treatment and tertiary filtration
- Replacement of clarifiers for solid/liquid separation (Submerged)
- MBR provides sufficient treatment for direct feed to RO for reuse in various applications (cooling tower make-up, boiler feed, ground water enrichment)
MBR MAJOR DRAWBACK ➔ ENERGY CONSUMPTION

- Process Air Blowers 35%
- Membrane Aeration Blowers (Cyclic Mode) 38%
- Recirculation Pumps 16%
- Mixers 4%
- Process Pumps 5%
- Other Equipment 2%
MARKET DEVELOPMENT (BCC RESEARCH REPORT)

- Market for wastewater treatment equipment is larger, but MBR market grows faster
- Global MBR market in 2011: US$ 838 million; is rising at a compound annual growth rate (CAGR) of 22.4 percent and is expected to reach US$ 3.44 billion by 2019.
MARKET EVOLUTION IN CHINA WITH RESPECT TO MBR
MBR – MARKET SHARE 2007

- GE Zenon: 35%
- Asahi Kasei: 8%
- Siemens Water: 11%
- Kubota: 9%
- United Envirotech: 5%
- Mitsubishi Rayon: 2%
- Koch: 2%
- Toray: 2%
- Others: 26%

Source: Frost & Sullivan
MEETING THE CHALLENGE WITH MEMBRANES

- Protection of Water Resources
  - Advanced Waste Water Treatment with Membrane Bioreactors and/or NF/RO

- New water resources
  - Desalination with RO and/or NF
MARKET FORECAST FOR DESALINATION

![Graph showing annual new contracted capacity (million m³/d) from 1990 to 2015. The graph compares historic data with a forecast. The source is GWI DesalData Desalination Markets 2010.](image)
TOP 15 DESALINATION MARKETS 2007-2016

Source: GWI DesalData Des
THERMAL VS. MEMBRANE

- 10 fold reduction in water cost over the last 20 years
- Much less energy demand
- Development and construction period is shorter

**Reasons**

**Annual new contracted capacity: thermal vs. membrane**

Source: DesalData/Desalination Markets 2010
TOTAL WATER COST FOR SEAWATER RO PROJECTS

Desalination Market Analysis 2003, Aqua Resources Int.
STEADY INCREASE OF DESALINATION CAPACITY
GLOBAL PLAYER: RO MEMBRANE SUPPLIER

Market Share 2011
Source: Nitto Denko

- Nitto Denko (Hydranautics): 30%
- Dow: 37%
- Toray: 14%
- Others: 13%
- Toyobo: 6%
MEETING THE CHALLENGE WITH MEMBRANES

- Protection of Water Resources
  - Advanced Waste Water Treatment with Membrane Bioreactors and/or NF/RO

- New water resources
  - Desalination with RO and/or NF
  - Waste Water Reuse (WWR) with RO and/or NF
THE FIVE MAIN DRIVERS OF WATER REUSE ARE:

- Increased demand for water
- Reduced availability of water supply
- Affordability
- Practicality of water reuse as a local solution
- Public policy

Main drawbacks
- Repressions on using reclaimed water for potable purposes
- Taking treated wastewater from where it is produced to where it is required is the main bottleneck in the industry.
MAIN MARKETS FOR REUSE

<table>
<thead>
<tr>
<th>Market</th>
<th>Capacity by 2015 (m³ / day)</th>
<th>Annual Increase</th>
<th>Expenditure (Billions)</th>
</tr>
</thead>
<tbody>
<tr>
<td>China</td>
<td>10,790</td>
<td>29 %</td>
<td>$ 3.615</td>
</tr>
<tr>
<td>Middle East</td>
<td>5,589</td>
<td>12 %</td>
<td>$ 7.053</td>
</tr>
<tr>
<td>USA</td>
<td>4,473</td>
<td>12 %</td>
<td>$ 5.636</td>
</tr>
<tr>
<td>Western Europe</td>
<td>3,895</td>
<td>10 %</td>
<td>$ 5.534</td>
</tr>
<tr>
<td>South Asia</td>
<td>3,750</td>
<td>14 %</td>
<td>$ 1.500</td>
</tr>
</tbody>
</table>

- Key markets such as China, the Middle East and North Africa
  - have limited wastewater infrastructure in terms of collection and treatment and thus strong potential for reuse.
  - They are expanding from a low base and are benefiting from very substantial investment in wastewater infrastructure.
- Significant investment in building new wastewater infrastructure dramatically increases the availability of wastewater for reuse.
REUSE VS. DESALINATION

- Currently: Installed capacity lower for reuse but distance becomes smaller
- Reuse, unlike desalination, benefits from increased environmental concerns over wastewater discharges.
- Water reuse is a solution for inland communities as well as for coastal ones, whereas seawater desalination only takes place in coastal regions.
- Red tide / algae bloom events complicate seawater RO pretreatment
- Specific costs for reuse are estimated to be lower than these of desalination projects (mainly because of energy costs)
MEETING THE CHALLENGE WITH MEMBRANES

- Protection of Water Resources
  - Advanced Waste Water Treatment with Membrane Bioreactors and/or NF/RO

- New water resources
  - Desalination with RO and/or NF
  - Waste Water Reuse (WWR) with RO and/or NF

- Superior Technology
  - Pretreatment for Desalination with UF/MF and/or NF
  - Treatment of surface waters with harmful pathogens with UF/MF
  - Treatment of surface waters with harmful micropollutants with NF
WHY MEMBRANES?

- Ongoing innovations in systems design and improvement in operation efficiency has resulted in a drastic reduction in both capital and operating cost in the past 5 years:
  - Energy recovery for high pressure systems
  - Specific membrane costs
- Other processes do not work with sufficient reliability
- Development and construction period for membrane plants is comparable short
- The market is also seeing greater acceptance in membrane technology as a result of membrane’s proven reliability and improved end-user’s confidence.
WHAT´S GOING ON?

- New membrane material shall cause lower salt passage, lower energy demand (increase in flux), lower fouling, higher chemical resistance and higher lifetime.
- New membrane module design shall cause higher packing density and less Capex.
- Membrane processes are being combined with conventional processes in synergy.
- Smart control systems to increase performance in terms of long term behavior and recovery.
- New processes are being developed
  - Forward Osmosis, Carbon nanotubes, Aquaporins.
- Established processes being optimized
  - Siemens new desalination system: Electrodialysis (ED) and Continuous Electrodeionization (CEDI).
- Huge demand for small, automated and modular plants.