Water Reuse in China
- Regulation, Technology and Application

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Outline

• Overview of Water Reuse in China
• National Criteria and Standards of Reclaimed Water
• Wastewater Reclamation Technology
• Challenges for Risk Management of Reclaimed Water
• Technological Needs for Water Reuse
Overview of Water Reuse in China
Water Environmental Problems in China

水污染
Water Pollution

水量不足
Water Shortage
Water Shortage in China

- Limited water resource
  - Per-capital 2,200 m3/yr, i.e., 1/4 of world average

- Unbalanced distribution of water resource
  - Geographical distribution: More at south, less at north; annual rainfall <400mm/yr area: 45%
  - Seasonal distribution: Rainfall at arid and semi-arid region concentrates on July, August, and September (50% of the total volume)
Water Shortage in Beijing

- Very limited water resource in Beijing

![Graph showing water resource and per-capital usage over years.]
Available Water Shortages
One of the limits of economic and social development in China

Wastewater Reclamation & Reuse
Essential approach for conserving and extending available water supplies
In China, reclaimed water is an important water resource in big cities, including Beijing and Tianjin.

- Number of reclaimed water plants: 343 (2010)
- Capacity of reclaimed water production: 19.67 million m$^3$/d,
- Amount of reclaimed water used in 2010: 2.83 billion m$^3$/yr (8% of amount of total domestic wastewater)
In Beijing, reclaimed water amount used was about 21% of total water consumption in 2012.
Wastewater Reclamation and Reuse in Beijing

- Reclaimed water supply of Beijing Drainage Group Co. Ltd. in 2011 (nearly 20% of total water supply)

![Pie chart showing water usage categories and their percentages]

- **Urban use** (sprinkling and cleansing, etc) 40 million m$^3$/yr (5.6%)
- **Surface water recharge** (landscape river/lake, etc) 230 million m$^3$/yr (32.4%)
- **Industry** (cooling water, etc) 140 million m$^3$/yr (19.7%)
- **Agricultural irrigation** 300 million m$^3$/yr (42.3%)
Wastewater Reclamation and Reuse in Beijing

- Reclaimed water supply site
- Vehicle cleaning
- Landscaping lake
- Recreational Water
Wastewater Reclamation and Reuse in Beijing

Sprinkling and cleansing for road

Green belt irrigation

Cooling for power plant

Fire extinguishing
National Criteria and Standards of Reclaimed Water
Technical Policy

- 《Technical policy for municipal wastewater reclamation and reuse》 (2006)

  - Guideline for the criteria and standards of municipal wastewater reclamation and reuse
  - To lead the development of technologies and devices of wastewater treatment
  - Technical basis of urban landscape construction, water environment and wastewater management
Goal of Recycling Rate

<table>
<thead>
<tr>
<th>City of water shortage</th>
<th>Recycling rate(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2010</td>
</tr>
<tr>
<td>Northern areas</td>
<td>10~15</td>
</tr>
<tr>
<td>Southern coastal areas</td>
<td>5~10</td>
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</tbody>
</table>

Technical Policy

- "Technical policy for municipal wastewater reclamation and reuse" (2006)
Municipal Wastewater

- 《Code for design of wastewater reclamation and reuse》
- 《Code of design for building reclaimed water system》

Industrial Wastewater

- 2003: 《Code for design of industrial recirculating cooling water treatment》
- 2008: 《Code for design of wastewater treatment and reuse of chemical industry》
- 2011: 《Technical specifications for wastewater treatment and reuse of iron and steel industry (draft)》
Water Quality Standards

- Standards for the reuse of urban recycling water
  - 2002
    - 《Classified standard》
    - 《Water quality standard for urban miscellaneous water consumption》
    - 《Water quality standard for scenic environment use》
  - 2005
    - 《Water quality standard for industrial uses》
    - 《Water quality standard for groundwater recharge》
  - 2007
    - 《Water quality standard for farmland irrigation water》
  - 2010
    - 《Water quality standard for green space irrigation》
Wastewater Reclamation Technology
The number of domestic wastewater treatment plants constructed each year (2010)

Total 2740 (the end of 2010)
Domestic wastewater treatment plants

Capacity distribution of domestic wastewater treatment plants

- Average: 4.57
- Median: 2.50
- Most frequent value: 2
- N=2740

Capacity of sewage treatment plant in China (ten thousand m$^3$/d)
Treatment process of domestic wastewater

Number-based percentage of different processes (2010)

AS: activated sludge, BFB: biological fluidized bed, CO: contact oxidation, CW: constructed wetland, OD: oxidation ditch
Treatment process of domestic wastewater

Capacity-based percentage of different processes (2010)

- OD: 22.4%
- A/A/O: 22.9%
- A/O: 10.6%
- AS: 13.5%
- BIOLAK: 1.9%
- BAF: 3.1%
- BFB: 3.1%
- CO: 0.8%
- CW: 0.3%
- AB: 0.3%
- Other: 7.7%
- UNITANK: 0.8%
- SBR: 5.9%
- CAST: 2.6%
- CASS: 3.9%
- MBR: 0.2%
Treatment process of domestic wastewater

Capacity distribution of different processes (2010)

- OD
- A/A/O
- AS
- A/O
- CASS
- SBR
- BAF
- CAST
- CW
- BIOLAK
- CO
- UNITANK
- BFB
- MBR
- AB

Treatment capacity \( (m^3/d) \)

$n=10$
$n=23$
$n=12$
$n=14$
$n=17$
$n=273$
$n=445$
$n=835$
$n=82$
$n=186$
$n=188$
$n=224$
$n=71$
$n=44$
$n=118$
$n=94$
$n=10$
$n=224$
$n=445$
$n=188$
Advanced treatment processes used

- Coagulation
- Sedimentation
- Filtration
- Disinfection
- Reclaimed water
- Secondary effluent
  - Pre-treatment
  - MF/UF
  - RO
  - Disinfection
  - Reclaimed water
- Biofiltration
- Ozonation
- Disinfection
- Reclaimed water

Advanced treatment process of domestic wastewater

- Sand filtration (rapid filter, V-filter)
- Comet-fiberous filtration (D-filter)
- Cloth-media disk filtration
- Membrane filtration (MF、UF)
Advanced treatment process of domestic wastewater

Advanced treatment process applied in 17 WWTPs of Beijing, Tianjin, Xian and Kunming City, China

![Bar chart showing treatment process amounts of WWTPs]

- BF + MF: Bio-filtration + Micro-filtration
- BF + RF: Bio-filtration + Rapid filtration
- AC + UF: Activated carbon + Ultrafiltration
- MBR + RO: Membrane bioreactor + Reverse osmosis
- CS + F: Coagulation sedimentation + Filtration

BF: bio-filtration; MF: micro-filtration; RF: rapid filtration; AC: activated carbon; UF: ultrafiltration; MBR: membrane bioreactor; RO: reverse osmosis; CS: coagulation sedimentation; F: filtration
Technological Needs for Water Reuse
再生水水质安全问题 Reclaimed water safety

✓ (病原) 微生物去除 Effective and safety disinfection
✓ 溶解性有机物控制 Control of DOMs
✓ 微量污染物去除 Micro-pollutants removal
✓ 氮磷高标准去除 Advanced nutrient removal
✓ 脱盐/浓缩液处理 Desalination/brine treatment
✓ 嗅味、色度 Odor, colour

• 污水再生处理工艺（多级过滤、脱盐、高级氧化、安全消毒）
Advanced reclamation process (Multi-filtration, desalination, advanced oxidation, safe disinfection technology)
• 再生处理工艺运行与水质保障技术/Process operating and water quality management technology
污水再生利用课题
Issues on Wastewater Reclamation and Reuse

- 工业废水和生活污水混合处理系统的水质安全保障
  Reclaimed water safety management for the combined treatment process of industrial and municipal wastewaters

- 再生水输送与储存过程中的水质保障
  Water quality management in pipe line and storage system of reclaimed water

- 再生水水质监控，再生处理系统自动控制与运行监管体系
  Water quality monitoring, automatic control system of advanced treatment process
再生水长期利用风险/累积风险
Long term/ accumulative risks

- 灌溉利用：污染物的积累（土壤和地下水污染）
  Agricultural and green irrigation (soil and groundwater pollution)
- 景观/环境利用：有毒有害污染物积累
  Accumulation of POPs, metals and harmful genes
- 工业利用（冷却水）：微生物生长、腐蚀
  Industrial uses: control of biofilm growth and corrosion
- 再生水管网系统：微生物生长、腐蚀
  Pipe line: control of biofilm growth and corrosion
Thank You for your attention!

Reclaimed Water in China: http://www.reclaimedwater.net