Urban sanitation technology development and Reinvent The Toilet Challenge (RTTC) in China

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OUTLINE

Urban sanitation technology development

Reinvent The Toilet Challenge (RTTC) in China

Toilet revolution campaign in China
Part 1: The state of the art in the wastewater and toilet sections of China
Wastewater treatment capacity

Source: Ministry of Environmental protection of the republic of China, 2015
Percentages of wastewater treatment in China

Source: China Urban-Rural Construction Statistical Yearbook 2015
Gaobeidian WWTP in Beijing, Capacity: 1 million m³/d in 1999
Bailonggang WWTP in Shanghai
Capacity: 2 million m³/d in 2013, 3.5 million m³/d in Future
# Main technologies used in municipal WWTPs in China

<table>
<thead>
<tr>
<th>Biological Technologies</th>
<th>Number of WWTPs</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>A²/O</td>
<td>1167</td>
<td>26.31%</td>
</tr>
<tr>
<td>Oxidation ditches</td>
<td>1160</td>
<td>26.15%</td>
</tr>
<tr>
<td>CASS</td>
<td>391</td>
<td>8.81%</td>
</tr>
<tr>
<td>A/O</td>
<td>377</td>
<td>8.50%</td>
</tr>
<tr>
<td>SBR</td>
<td>297</td>
<td>6.70%</td>
</tr>
<tr>
<td>Two-stage biological processes</td>
<td>185</td>
<td>4.17%</td>
</tr>
<tr>
<td>CAST</td>
<td>163</td>
<td>3.67%</td>
</tr>
<tr>
<td>Activated sludge</td>
<td>162</td>
<td>3.65%</td>
</tr>
<tr>
<td>Biolak</td>
<td>110</td>
<td>2.48%</td>
</tr>
<tr>
<td>BAF</td>
<td>88</td>
<td>1.98%</td>
</tr>
<tr>
<td>MBR</td>
<td>24</td>
<td>0.54%</td>
</tr>
<tr>
<td>others</td>
<td>312</td>
<td>7.04%</td>
</tr>
</tbody>
</table>
Length of drainage pipelines in China (1978-2014)

Public toilets in China from 1979-2014

Public Toilets in China

Public toilet in urban area
Public Toilets in China

Public toilet in rural area
Household toilets

Household toilet in urban area
Primitive Pit Latrine in Rural Areas

Odor, mosquitoes, unsafe......

Household toilet in rural area
Household sanitary toilet coverage in rural areas

Source: China statistical yearbook on environment, 2012
## Water and sanitation in China, the year 1990 and 2015

<table>
<thead>
<tr>
<th></th>
<th>1990</th>
<th>2015</th>
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</thead>
<tbody>
<tr>
<td>Population(*1000)</td>
<td>1,165,429</td>
<td>1,401,587</td>
</tr>
<tr>
<td>Percentage urban population</td>
<td>26</td>
<td>56</td>
</tr>
<tr>
<td>Urban</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Improved</td>
<td>68</td>
<td>87</td>
</tr>
<tr>
<td>Shared</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>Other unimproved</td>
<td>24</td>
<td>7</td>
</tr>
<tr>
<td>Open defecation</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Rural</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Improved</td>
<td>40</td>
<td>64</td>
</tr>
<tr>
<td>Shared</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Other unimproved</td>
<td>49</td>
<td>31</td>
</tr>
<tr>
<td>Open defecation</td>
<td>9</td>
<td>2</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Improved</td>
<td>48</td>
<td>76</td>
</tr>
<tr>
<td>Shared</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>Other unimproved</td>
<td>42</td>
<td>18</td>
</tr>
<tr>
<td>Open defecation</td>
<td>7</td>
<td>1</td>
</tr>
</tbody>
</table>

Source: Progress on sanitation and drinking water, 2015 update and MDG assessment
Part 2: Reinvent the Toilet Challenge in China
WATER, SANITATION & HYGIENE: REINVENT THE TOILET CHALLENGE

FACT SHEET

SUMMARY AND ANALYSIS
The Water, Sanitation & Hygiene program of the Bill & Melinda Gates Foundation recently challenged 22 universities to submit proposals for how to invent a waterless, hygienic toilet that is safe and affordable for people in the developing world and doesn’t have to be connected to a sewer. Eight universities were awarded grants to “reinvent the toilet.”

The Water, Sanitation & Hygiene program initiated the Reinvent the Toilet Challenge to leverage advances in science and technology and create a new toilet that will transform

- Raise awareness about this research by publishing scientific papers in journals and articles in various media outlets

REINVENT THE TOILET CHALLENGE GRANTS
Upstream Innovation
1. A toilet that produces biological charcoal, minerals, and clean water

Professor M. Sohail of Loughborough University and his team propose to develop a toilet to transform feces into a highly energetic combustible through a process combining hydrothermal carbonization of fecal sludge followed by

Wastewater treatment development
(courtesy of BMGF, modified)
Reinventing the Toilet – Innovations can save billions of lives by turning human waste into...

- Pure Water
- Safe Fertilizer
- Electricity
- Heat
- Fuel
- Salt

NaCl

Bill & Melinda Gates Foundation
Centre for Sustainable Environmental Solutions
Evaluation Criterion

- Comfortable for user (no smell, no need to change position while using);
- Affordable (cost < $0.05/user/day, capital and service costs included);
- Aesthetically appealing;
- Suppressing smell and removing pathogens from waste streams;
- For single family or for a community facility;
- Achieving the above without needing connection to networked power, water, or sewers; and
- Recovering by-products of financial value (e.g. fuel products, clean water, fertilizer) if possible.
Reinvent the Toilet Challenge of Global Development Program by Bill & Melinda Gates Foundation

The vision of this program is of a re-invented toilet that would not need to be connected to a sewer, would not require water, and would be clean and odorless. It would remove pathogens from the environment. It would treat waste as a resource, creating usable energy, agricultural fertilizer, and potable water, all for just pennies per person/day.

RTTC (Rd1) 2011
RTTC (Rd2 & Rd3) 2012
RTTC China 2013
Reinvent the Toilet Challenge – China (RTTC China)

1st Round Launch Conference

2nd Round Launch Conference
OVERVIEW: The new toilets in RTTC-China
RTTC China-Round 1
Air flush toilet

(Beijing EnviroSystems Engineering and Technology Co., Ltd)

- No sewer, no grid
- Can be driven by solar energy
- Cleaning water < 0.1L in average

In the diagram:
- Air
- Urine
- Faces
- By solar or biogas
- Vacuum
- Clean water
- Fertilizer
Application of an innovative flat sheet FO membrane module for concentration of source separated urine

(Tsinghua University)

Based on a source-separation toilet system, the urine and feces are collected separately. The urine is concentrated by the FO membrane system and used as a high-efficient liquid fertilizer, the feces is digested to eliminate the pathogens.

A RO membrane system is used to recovery draw solution in and produce clean water for flush and greening.
Prototype testing
Toilet wastewater treatment and resource recovery system using FO as the key unit for household toilets with modified biochar pretreated (Tsinghua University)
Configuration and operation of the treatment process of toilet fecal water by high-performance ABR-MFC-MEC system

(Shanghai University of Technology)

Parasite eggs and pathogenic microorganisms in feces

- Remove 95%
- Remove 99%
- Further…

1-Aerobic baffled tank; 2-Baffled plate; 3-Microbial electrode; 4-Overflow hole; 5-Sedimentation tank; 6-Ceramic filter; 7-Clarification tank; 8-UV disinfection tank
Prototype testing
The Development of Thermochemical Facilities by Using Feces to Produce Biomass Oil

(Beijing University of chemical technology)
RTTC China-Round 2
Treatment of human waste through integrated HTL-gasification technologies

(China Agricultural University)
Treatment of human waste sewage by MAP crystallization-MDC coupled reactor and recovering valuable substance and energy

China university of Geosciences (Beijing)
A mechanical transmission type toilet without water flushing by using the source separation

(Hunan Hyso environment biological technology co., LTD)

The source solid-liquid separation technology has been applied to achieve self-cleaning without water; Feces are disposed by artificial dynamic without external energy device and feces will be made into organic fertilizers by biological fermentation, Urine purification and recycling can be realized after anaerobic rotten and micro algae processing.
Research & Development of Biodegradable Foaming Liquid Exclusively for Foam Toilets

(Yunnan Huiyun Yeguang Engineering Co. Ltd.)
Microbe reagent development for no-water or less-water flush toilet fecal sludge processing

(Dalian Jinzhou Jinshui Cleaning facilities Factory)

Bacillus cereus
Aeromonas
Pseudomonadaceae
Lactobacillus

New EM for fecal sludge stabilization
Part 3:
Toilet revolution campaign in China
There is a great need to have a toilet revolution, so that the residents in rural area could get access to sanitary toilet

-----16/07/2015

President Xi Jinpin
中国厕所革命研讨会
Seminar on Chinese Toilet Revolution
24 May 2016, Yiwu
The fifth space - new toilet in Beijing
The fifth space - new toilet in Beijing
THANK YOU!
Centre for Sustainable Environmental Sanitation

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