On-Site Sanitation for the Developing World: Challenges and Insights

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Understanding the Problem

Dhaka, Bangladesh
Population: 14.4 million

Ineffectively Treated

Source: SFD Promotion Initiative, Panesar, et.al., 2015
Project Background

Our Goal:
To enable universal access to sustainable sanitation services by supporting the development of radically new sanitation technologies and markets for new sanitation products and services.

- Hygienic and sustainable for the world’s poorest populations
- Operational cost of $0.05 per user, per day
- Does not require sewer, water, nor electricity
- No discharge of pollutants
RE-INVENT THE TOILET CHALLENGE

BILL & MELINDA GATES foundation
Not just toilets, but “FSM”

Success:
1. Exposure to pathogens is eliminated
2. Facilities are clean, safe, and aspirational
3. Everyone associated with each step of FSM makes money

Source: Bill & Melinda Gates Foundation
Caltech Team Approach – Electrolysis of Wastewater

Main reactions:

at the anode: chlorine generation
2Cl- ----> Cl2 + 2e-

at the cathode: hydrogen evolution and hydroxide formation
2H2O + 2e- ----> H2 + 2OH-

chemical reaction: chlorine and hydroxide ions react in the electrolyzer to form hypochlorite
Cl2 + 2OH- ----> Cl- + ClO- + H2O

overall mass balance: production of hypochlorite
NaCl + H2O = NaClO + H2
The Alpha Prototype
- Caltech conducts basic and applied research
- Kohler designs and manufactures test systems
- RTI conducts field testing of system performance
The Beta Prototype

Kohler Stewardship

Kohler Sustainability
First unit ready for field test site installation in India in September 2015.
Fabrication

Electrode set

Mechanical cabinet
Field Testing

• Worked with the Gates Foundation and the Indian government to identify acceptable test sites.

• Several test units are currently operating in Coimbatore.

• Purpose of testing is to identify technical issues and user acceptance.
Performance

• Good water quality
  • Clear
  • Colorless
  • Disinfected

• Steep learning curve associated with the project and technology.

• Water quality greatly impacts system performance

• Mechanical, electrical issues
Some Learnings

- Rapid dissolution of dissolved minerals
- Reduction of space between electrodes, and short circuits
- Accumulation of gelatinous precipitate on electrodes
Other Projects

Both systems:

• Treat and reuse water for flushing toilets.
• Are scalable.
• Render the waste stream harmless.

RTI International
Separates liquid from solid.
Burns solids for energy, and treats liquid for reuse.

Loughborough University
Treats waste with pressure and heat to separate liquid from solid and disinfect.
Summary

- Operating costs higher than expected, but could be offset with solar panels.
- Electrode technology is young and manufacturing costs are expected to come down over time.
- User acceptance of water for flushing toilets has been good.
- Testing will continue for several more months; and learning will continue.
Thank You!

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