The FILTRON:
Cherylynn Schilling
Southern Illinois University
REU-2007

University of Colorado - Dept. of Civil, Environmental, and Architectural Engineering
Mentors: Prof. Angela R. Bielefeldt, Prof. Scott Summers, Kate Kowalski, Ben Bishop

A Pressing Issue

- Diseases related to inadequate water and sanitation cause an estimated 80% of all sickness in the developing world
- Many factors contribute to this scarcity of clean water including the existence of dry-climate regions, the impacts of natural disasters, and the lack of proper education

Point-of-Use Devices

- Low-cost, efficient solution to the challenge of providing potable drinking water in low-income situations
- Refer to water treatment methods which treat water at the point of consumption rather than at the source

FILTRON: The Basics

- Combine local clay with a combustible element such as sawdust or milled rice husks, pressed into a bucket shape and fired in a kiln.
- Surface coated with or submerged in colloidal silver.
- Gravity-driven flow of water during treatment
- Inner volume of about 8.5 liters
- Placed in a five-gallon plastic or ceramic receptacle with lid and faucet

FILTRON: How does it work?

- Ability to convert raw water into clean drinking water is two-fold
- Pores are small enough to capture a significant portion of disease-producing micro-organisms
  - Most protozoans, some bacteria, little-to-no viruses (smaller than pore sizes)
- Silver serves as a means for bacterial inactivation
  - Currently unknown if effective on viruses

Past Research

- Pore size typically 0.6-3.0 microns
  - Latange, Danielle (Altheia Environmental)

- Pathogen removal in excess of 99%
  - http://www.pottersforpeace.org

Past Research

- Latange, Danielle (Altheia Environmental)

- Pathogen removal in excess of 99%
  - http://www.pottersforpeace.org
**Research Objectives**

- Evaluation of pore size by measuring removal efficiency of virus-sized microspheres
- Evaluation of the silver’s role in pathogen inactivation
  - Likely to be a function of both silver concentration and contact time

**Fluorescent Microspheres**

- Carboxylate-modified polystyrene from Molecular Probes
- Serve as surrogates for viruses and bacteria
- Range in size from 0.02 - 2.0 microns
- What kind of organisms are we talking about?
  - Rhinovirus, Influenza virus, Ebola virus, E.coli
  - Cryptosporidium parvum and Giardia lamblia

**Spheres Used in Experimentation**

<table>
<thead>
<tr>
<th>Size (um)</th>
<th>Color</th>
<th>Surrogate For:</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.02</td>
<td>Nile Red</td>
<td>Rhinovirus</td>
</tr>
<tr>
<td>0.1</td>
<td>Orange</td>
<td>Influenza virus</td>
</tr>
<tr>
<td>0.5</td>
<td>Yellow-Green</td>
<td>Aeromonas hydrophilia</td>
</tr>
<tr>
<td>1.0</td>
<td>Yellow-Green</td>
<td>E.coli</td>
</tr>
<tr>
<td>2.0</td>
<td>Yellow-Green</td>
<td>Encephalitozoon spores</td>
</tr>
</tbody>
</table>

**The Filters**

- 2 New filters without silver (1NS, 2NS)
- 2 New filters with silver (1New, 2New)
- 2 Used filters - 3 years in Nicaragua (1Used, 2Used)

**Microspheres: The Procedure**

- Dechlorinate tap water, add microspheres, and pour batch of water into each of 6 filters
- Collect water samples from inside filter and from effluent tap at multiple time points
- Measure depth of water in filter at each time point (use to calculate flow rate via geometry)
- Measure samples for: fluorescence (microsphere conc), turbidity, pH, water temperature
- Refill filter and repeat each test in triplicate

**Microspheres - The Results**

**Microsphere Calibration Curves**

- Nile Red (0.02um)
- Orange (0.1um)
- YG (0.5um)
- YG (1.0um)
- YG (2.0um)
**Microspheres: The Results**

**In-Filter and Effluent Concentrations**

0.1μm Orange in Filter 2NS

**Percent Removal Over Time**

(0.1μm Orange Pre-test)

**Percent Removal of YG (1.0μm) and Orange (0.1μm) Microspheres per Filter**

**E.coli: The Procedure**

- Grow E. coli sample in TSB broth for 2 days
- Measure turbidity of prepared stock solution and use linear equation to obtain concentration
- Determine amount of stock solution to be spiked
- Pour batch of water into test filter (2New), also fill one filter (1New) with unspiked water
- Collect samples from inside and effluent of filter at 2 and 4 hours
- Plate 3 replicates of multiple dilutions (3 or more) on agar using spiral plate and count 24 hrs later

**Summary of Results**
Future Research: Pathogen Removal

- Additional tests on pathogen removal
  - Re-coating “New” filters with silver
    - Also may re-coat “Used” filters

Questions?

Salamat! Asante! Dhanyavad! Gracias!

- Thanks to Professor Angela R. Bielefeldt, Professor Scott Summers, Kate Kowalski, and Ben Bishop!