Low Power Ultrafiltration

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Mission Statement: Providing low cost filtration systems capable of producing safe drinking water for community improvement.
Company Background

- Pumps of Oklahoma, Inc. is a wholesale supplier of industrial, municipal, agricultural and environmental pumps. They supply submersible and above ground pump equipment to the international community.

- Company has strong ethical standards and has close ties to the non-profit organization Water4.
Spring Requirements

- Problem
- Design
- Fabrication
  - Potting
- Testing
  - Bacteria
  - Flow
- Analysis
  - Economic feasibility
  - Backwashing schedule
  - Replacement schedule
- Results, Recommendations
783 million people lack access to safe drinking water.

Over two million deaths each year are attributed to diarrheal diseases caused by ingesting contaminated water.

90 percent of these deaths are children under the age of 5.
Improvements in sanitation and drinking-water could reduce the number of children who die each year by 2.2 million.

Suffering and death from diarrheal diseases is 100% preventable with access to safe drinking water.

A Simple Solution
Common Water Quality Contaminants

- Organic and Inorganic Salts
- Metals
- Dirt and Other Particles
- Infectious Species
  - Bacteria
  - Parasites
  - Viruses

The E-Coli Bacterium
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Competitors Response

- Ozone
- Chlorination
- Activated Carbon
- Reverse Osmosis
- Slow Sand Filtration (Biosand Filters)
- Water Distillation
Utilize polyvinylidene difluoride (PVDF) hollow fiber membranes.

Require very little or no power.

Provide water that is free of microorganisms and safe for human consumption.
Figure 1 - Sizes of potential contaminants that will need to be filtered from contaminated water. Ultrafiltration membranes will remove bacteria and visible particles but not viruses. Obtained from Nanotechnology in Drinking Water Filtration, a Literature Review
Ultrafiltration Module

- “Dead End” Filter
- Gravity Fed
  - Reduce power need
- Loop PVDF Tubes
  - Less Resin

Dirty Water
Initial try, holes in PVC cap to thread PVDF tubes.

Successful attempt, filled 90 bend with resin.
Test Results — Coliform Removal
## Test Results — Coliform Removal

<table>
<thead>
<tr>
<th>Inflow</th>
<th>Coliform</th>
<th>E. coli</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Large Cells</td>
<td>Small Cells</td>
</tr>
<tr>
<td>1</td>
<td>49</td>
<td>45</td>
</tr>
<tr>
<td>2</td>
<td>0</td>
<td>0</td>
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<tr>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>4</td>
<td>1</td>
<td>0</td>
</tr>
</tbody>
</table>
Tubing was used to connect the modules.

For backwash testing a second port was drilled for the large module. (Right)
Similar results for each module tested

Backwashed with small electric pump
  o Hand pump would work as well

Worst Case Scenario – 56.5 g/L suspended sediment
  o Mixed twice daily to simulate typical use

Last 1 week before reaching 0.075 gph
  o May follow decreasing exponential form
Testing Results — Backwashing
y = -0.0003x + 0.1314

R² = 0.7497
Flow Rate Reduction Over Time (Large Filter)

Flow Rate (gph)

Time (hr)

$y = 0.0021x + 1.2915$

$R^2 = 0.2504$
**Large Module Filter**

- Dimensions 2” X 12” PVC

**Material**
- Resin $10.66
- Pipe $0.68
- Fittings $4.66
- PVDF membranes $29.52
Total $45.52

Filters an average of 1.6 GPH

4 gallons per person per day

Supplies 9 people per filter

One Year Investment $5.06/person

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**Item** | **Quantity** | **Cost per Item** | **Total Cost**
---|---|---|---
100 gal. Stock Tanks | 2 | $118.16 | $236.32
1-1/4 X 1/2 Bushing | 12 | $1.06 | $12.72
1/2 X 1/4 Barb | 12 | $0.78 | $9.36
1/2 to 1/4 Bulkhead Fitting | 1 | $8.78 | $8.78
Total | | | $267.18
Filter Modules
- Reduce PVDF membrane packing density
- Mechanical agitation

Pretreatment
- Sediment/particulate filter (sand column)

Tertiary Treatment
- Virus Treatment
- UV or similar system
Acknowledgements

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  - Mr. Greenly
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Questions?

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References


World Health Organization, “Facts and Figures on Water Quality and Health,”


Slide 5 – Image From: https://water4.org/how-to-help/
Slide 6 – Image From: https://water4.org/contact-us/
Slide 7a – Image From: Technical Specifications Sheet