General Need: Rural Peruvian village needs a sustainable and inexpensive way to use local chlorine powder to disinfect water from pathogens.

Market: Need identified by Engineers Without Borders (EWB). Nearly 500 Villagers suffer from water borne illnesses in Compone, Peru. Implementable in most rural villages utilizing mountain springs.

Customer Requirements: Kill pathogens, electricity-free operation, infrequent refills of chlorine, semi-autonomous operation, neutral smell & taste of water, continuous water flow

Engineering Characteristics: Hopper capacity of at least 20 kg, dosing of 2 mg/L residual chlorine (4 mg/L total dosing), accuracy within 90%, flow rate capability of 0.3 – 3 liters/second, constructed from material that is non-corroding and non-oxidizing

Constraints: Residual chlorine < 2 mg/L, no electricity, adapt to a flow rate of 0.3 – 3 liters/second

**Objective**

**Concept Generation**

Paddle Wheel Clicker Auger

Paddle wheel is driven by water which drives an auger to deliver powder

Cup Volume Delivery

Water directed into a cup. Hopper releases discrete volumes of chlorine into cup. When water reaches a certain level, it will tip and empty into a catch basin

**Prototype and Testing**

**Test 1:** Relationship of fluid flow rate to paddle wheel RPM

**Test 2:** Ratio of paddle wheel RPM to auger RPM (Tested out at 2:1)

**Test 3:** Effective chlorine dosing

Analysis of Results:

Use (ANOVA) to compare prototype response to models

Calculating Flow Rate and Volume

<table>
<thead>
<tr>
<th>Vol</th>
<th>Time</th>
<th>Flow Rate (L/min)</th>
<th>Total Volume (L) @ 60 sec</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 L</td>
<td>1 s</td>
<td>0.30</td>
<td>18.18 L</td>
</tr>
<tr>
<td>10 L</td>
<td>11 s</td>
<td>0.99</td>
<td>54.30 L</td>
</tr>
</tbody>
</table>

**Paddle Wheel Clicker Gate**

Water drives paddle wheel. Rotation of paddle wheel rotates a “clicker” disc that periodically engages a gate to release powder

**Test Results and Future Work**

Summary:

- Problem identified by EWB regarding water sanitation
- Determined village requirements and engineering characteristics
- Generated plausible chlorine dosing concepts
- Selected and modeled most suitable system
- Tested to ensure system design accuracy

**Reflection:** Testing results clarified system constraints

**Future Work:**

- FEA: Transmission, Supports, Hopper, and Paddle Wheel
- Reliability Assessment: FMEA
- DFM, DFA
- Cost Analysis
- Suitable Design Changes
- Future implementation sites