Engineering World Health: BrightWater Filtration

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Abstract

Approximately 1.1 billion people across the world live without access to clean drinking water. *BrightWater* provides an efficient, cost effective, self-sustaining water purification solution to reduce casualties from contaminated water consumption. Here, we present a prototype that uses solar energy to purify the water, regulate the water flow and act as the power supply.

Background/Motivation

- According to WHO, 1.6 million deaths per year are due to contaminated water
- Dr. Shropshire emphasized the need for clean water when he and his team of health-care professionals volunteer for medical outreach trips to developing regions of the world
- Hillside Clinic in Punta Gorda, Belize operates without a water purification system
  - Water for sanitation directly from a well and import drinking water
  - Drinking water costs approximately $100 - $200 per month

Figure 1: Hillside Clinic

Figure 2: Water storage tanks on-top of the Hillside Clinic used for sanitation purposes.

Figure 3: Water jugs in which the drinking water is imported in.

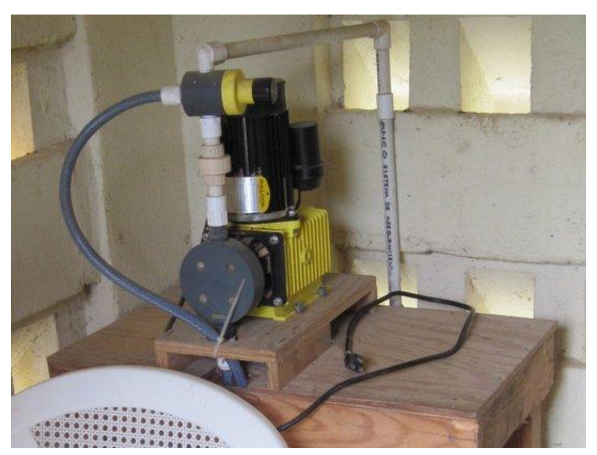

Figure 4: A new chlorinator found at a nearby village.

- Possibility to impact other developing regions such as Haiti or Africa

Design Criteria

- Purify water just as effectively as other water purification systems
- Must be made from materials found in the region of interest
- Transportable
- Low maintenance
- Cost effective
- Environmentally friendly

Figure 5: Transportation at the Hillside Clinic which can bring *BrightWater* to surrounding villages

Prototype

BrightWater Prototype

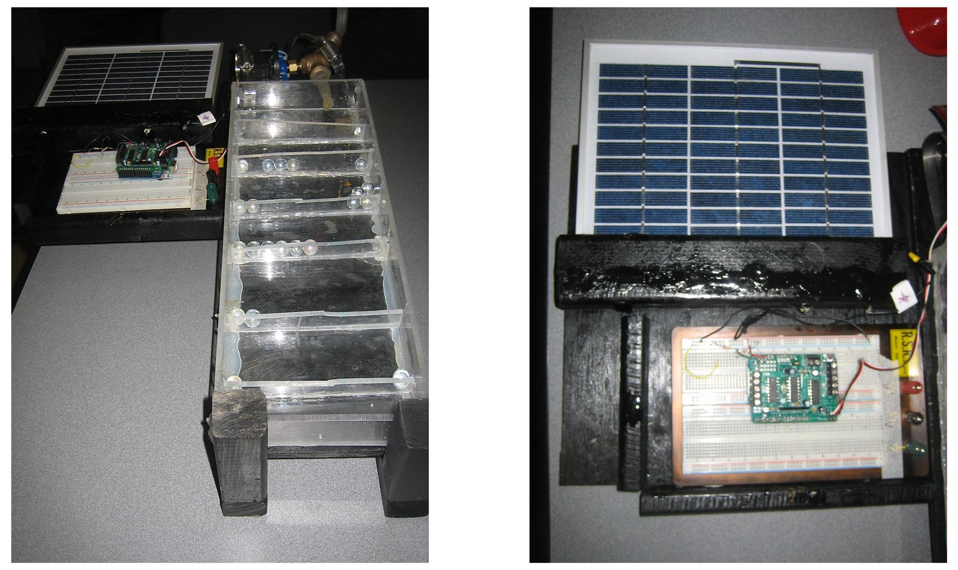

Figure 6: Full view of purification system (left). Close up of the solar panel and microcontroller (right)

Water Flow Control

- Photo-voltaic cells convert light into voltage.
- Microcontroller tells servo motor to open valve when the voltage rectified is sufficient enough to purify water
- Voltage from the solar panel is reduced by a 3rd by a voltage divider
  - The microcontroller handles 5Volt inputs

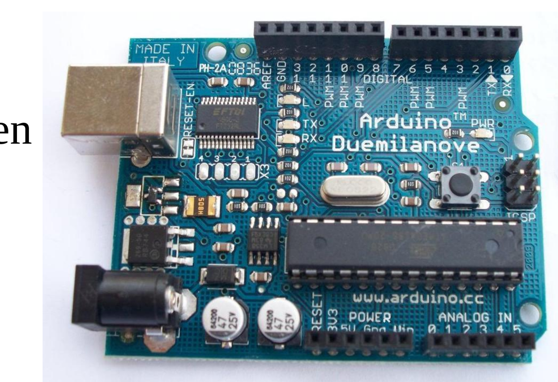

Figure 7: Arduino Omega is used in the *BrightWater* prototype

Main Compartment

- Made out of 9.525 mm thick Plexiglas
- Plexiglas ridges spaced approximately 10.16 cm apart
- Contains 6 mm diameter, 10 mm length borosilicate resin beads coated with titanium dioxide (TiO_2)
  - Smaller substrates for TiO_2 means higher surface-volume-ratio
- TiO_2 is a photo-catalyst
  - Organic material is degraded to CO_2 and H_2O
- Borosilicate resin beads are *uv* penetrable

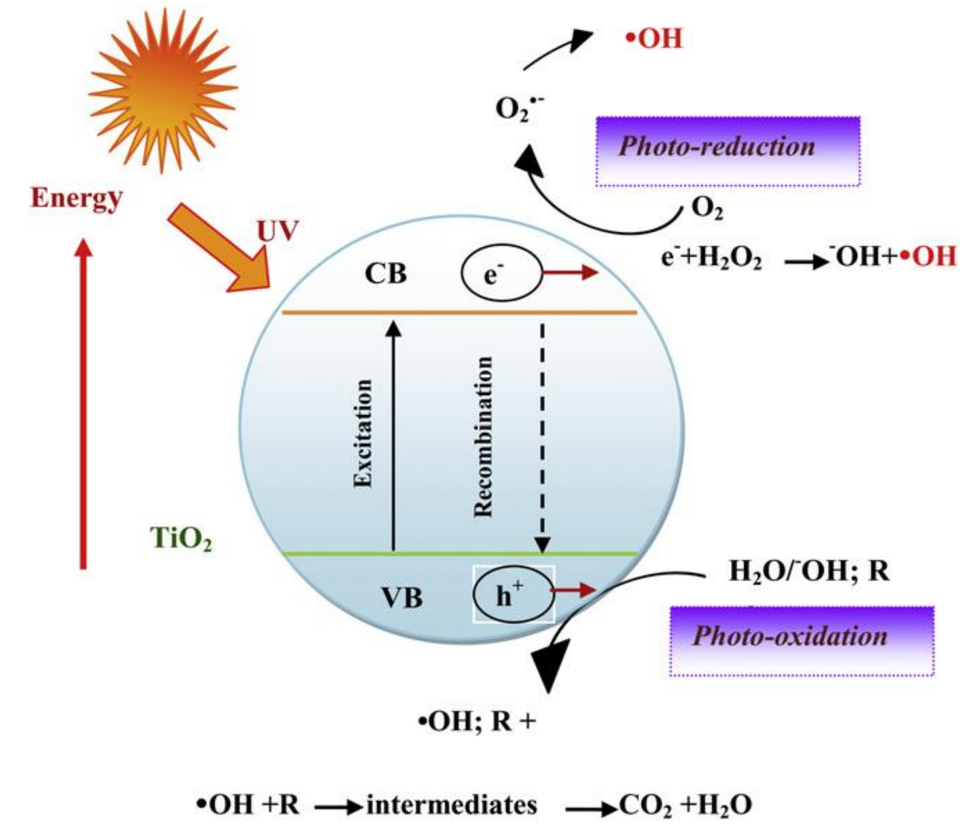

Figure 8: Schematic of TiO_2 catalytic activity wit *uv* radiation from the sun (Ahmed, 2010).

Finance

Material	Cost	Reference
5W Solar Panel	$47.58	BP Solar
91.44 cm x 121.92 cm Clear acrylic Plexi-glas sheet 9.525 mm thick	$30.85	Astronaut Plastics
3000, 6 mm diameter Borosilicate Glass Beads	$164.35	Fisher Scientific
Microcontroller and Server Motor	$3.00	Daycounter Engineering Services
500 grams of Titanium (IV) Oxide Anhydrous	$89.90	Fisher Scientific
Water Valve	$10.00	ACE Hardware
Transparent Tubing:	$2.00	ACE Hardware

Table 1: Unit cost of *BrightWater* prototype

- Total unit cost of the *BrightWater* prototype is $347.68
- Price of chlorination system range from $150-$1,000, maintenance $225/year
- Installation of reverse osmosis system is approximate $200, additional $100 every three years

Testing/Results

Procedure

- 1200mL sample fed through funnel
- Timed
- 50W *uv* B lamp, *uv* index of 2-5.
- 3 agar plates for each sample
- Dilute 1:100 ratio
- Record bacteria colonies 5 days after.

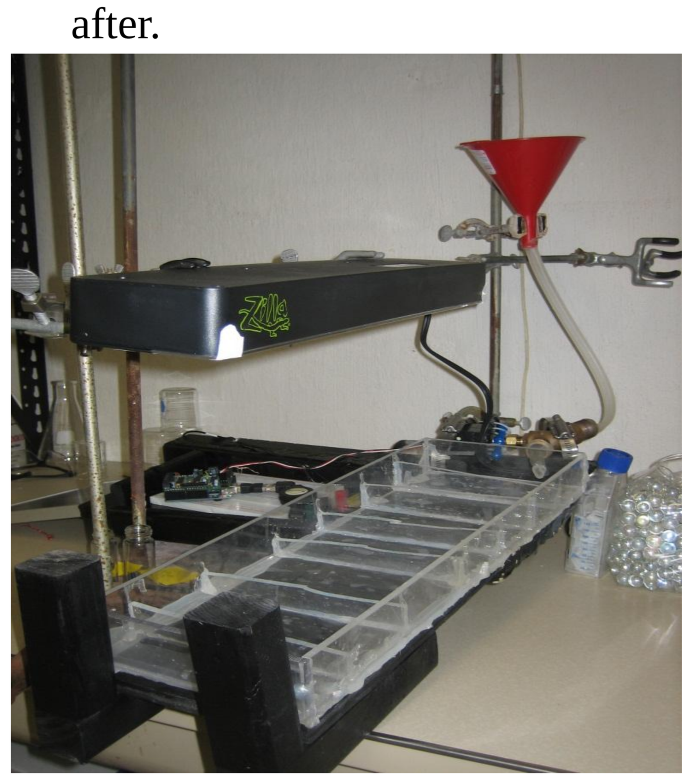

Figure 9: Experimental set up with *uv* source running parallel with Plexiglas box at a 6° angle

Bacterial Viability

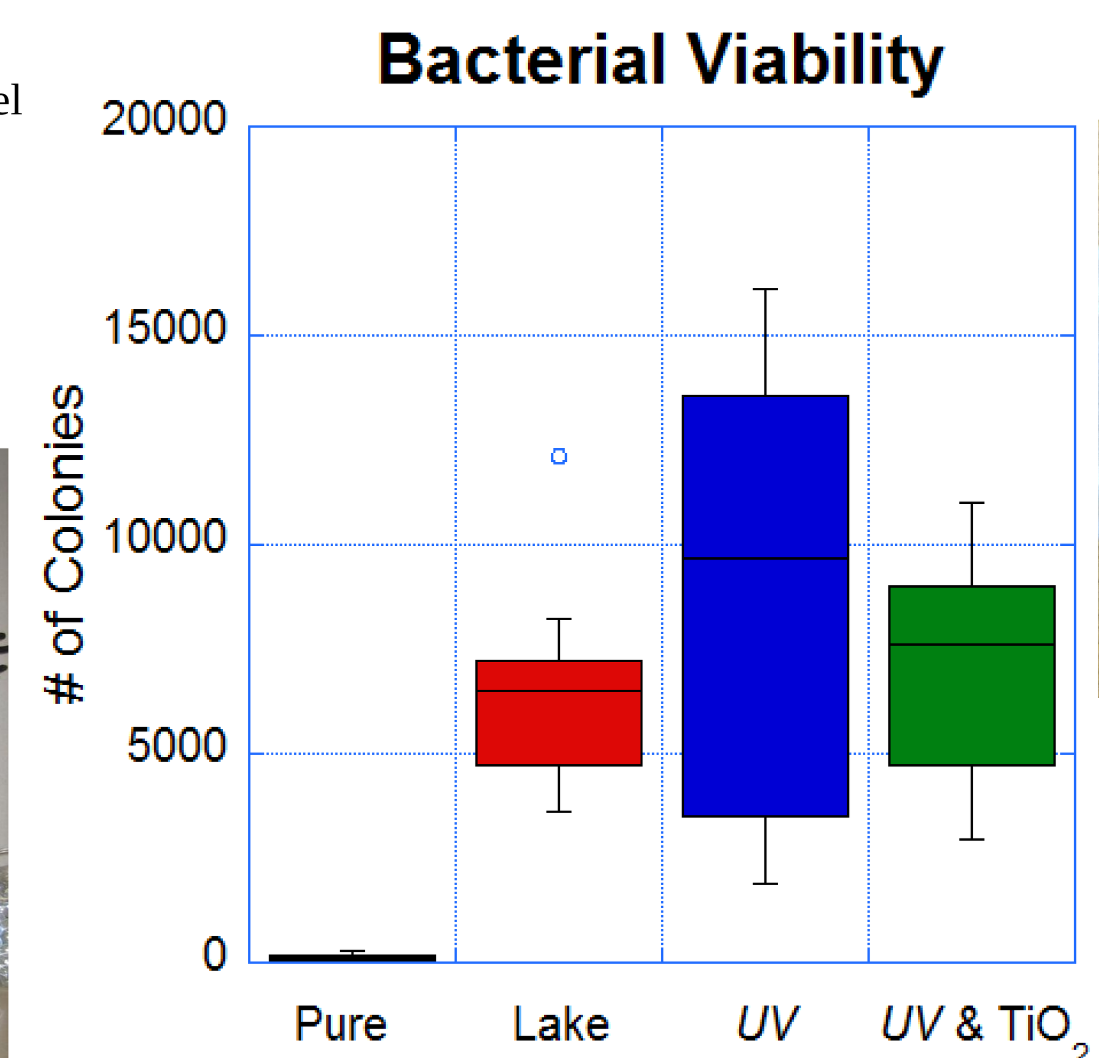

Figure 10: TiO2 + *uv* and *uv* effect on bacterial viability using *BrightWater* prototype.

Averages: Pure = 128, Lake = 5293, UV = 6125, UV & TiO_2 = 5289

Bacterial Regrowth

Figure 11 : TiO2 + *uv* (left) and *uv* (right) effect on bacterial regrowth using *BrightWater* prototype.

Results

- Appears to be less bacterial regrowth for TiO_2 + *uv* experiment
- More bacterial viability experiments needed
- Refine experimental procedure

Future Work

- Recharge car battery with solar panel.
  - Car battery will act as the power source for the motor and microcontroller
- Place water valve at the bottom so contaminated water will continue to interact with TiO_2
- Use a 12 volt water solenoid valve for more accurate turns/voltage.
- Insert custom made borosilicate glass cover over the top to seal main compartment
- Make the microcontroller and valve more dynamic with the amount of *uv* radiation available in the environment
- Research other substrates to coat with TiO_2
- Coordinate with the Belizean Ministry of Health Department to implement *BrightWater* filtration system

References

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