Bladder Well

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Abstract

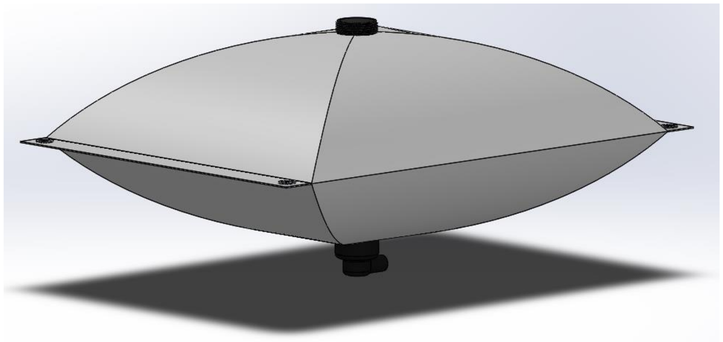
The growing scarcity of water around the world has placed a monumental strain on obtaining clean water for drinking and sanitation purposes. In LDCs, many use cumbersome means to collect water, and proper sanitation is often not an option; thus leading to disease and illness.

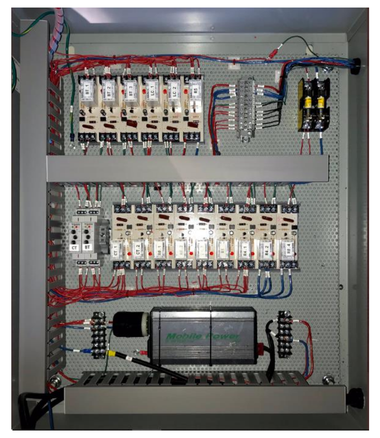
With a proper enclosure, the portable bladder well serves as a self-sufficient system for collecting and storing water underground until desired for distribution. Additionally, sensors and filtration devices ensure its cleanliness. Commercial implementation would revolutionize water storage and sanitization, along with solving a critical issue worldwide. Design of the preliminary bladder well allows for water collection and storage with a portable water bladder enclosed by a structure. Sanitation is automated through sensors to maintain the system and eliminate the human factor, while distribution of water is as accessible as opening a valve.

Introduction

Clean water and proper sanitation are essential for the survival and development of human beings. The limitations of current water collection and sanitation technologies create a clear and definite issue worldwide, especially in LDCs with arid climates that have extremely restricted access to these technologies.

Capturing and storing water in LDCs is still a primarily manual labor task, while sanitation is often not considered. The bladder well allows water to be easily collected through a funnel and stored below underground in a water bladder until desired. Made of polyvinyl chloride, the bladder is extremely flexible and portable. The inlet collects and stores water, while the outlet distributes water.

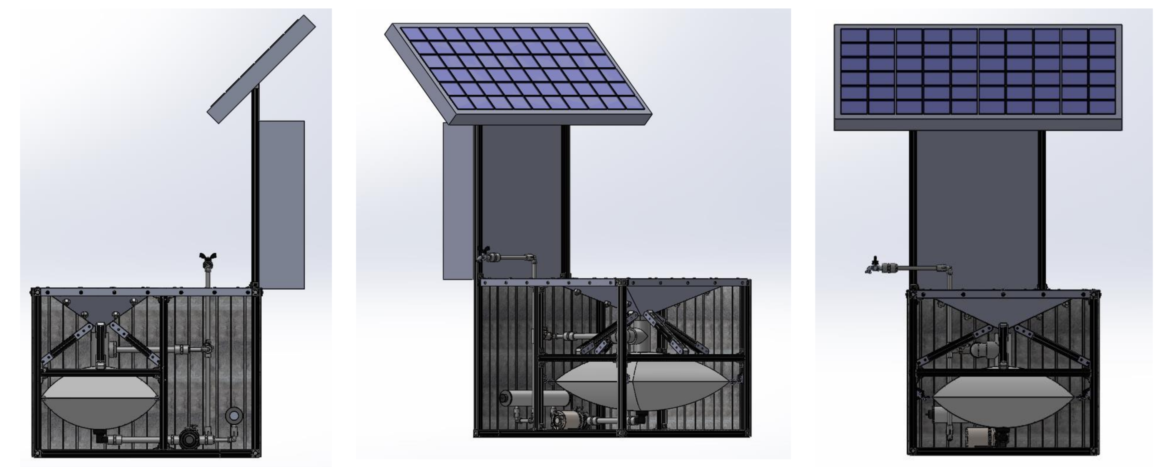




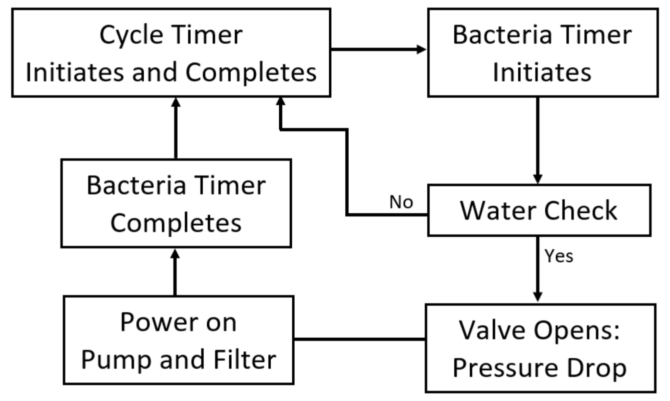
A controls system manages the distribution and cleanliness of the water within the bladder. To extract water, a pump is utilized and activated when called by the user. Sensors placed within the system sanitize the water through a UV light filter, in addition to monitoring the amount of water in the bladder.

Methods and Materials

Due to the flexibility of the bladder and being stored underground, casing is needed to protect it from tearing and puncturing. The casing features two sections: one for collection and storage through the funnel and bladder, and the other to section off electrical components for prevention of water damage. Corrugated steel sheets are secured to an assembled 6061 T-slotted aluminum framing. Also secured to the framing is a funnel machined from galvanized steel, supported by reinforcements. A sheet of galvanized steel is fastened to the framing to create the sections. Modeling the assembly was done through SolidWorks with forthcoming static structural simulations completed in ANSYS Workbench. Furthermore, Schedule 80 PVC piping moves water throughout the system.

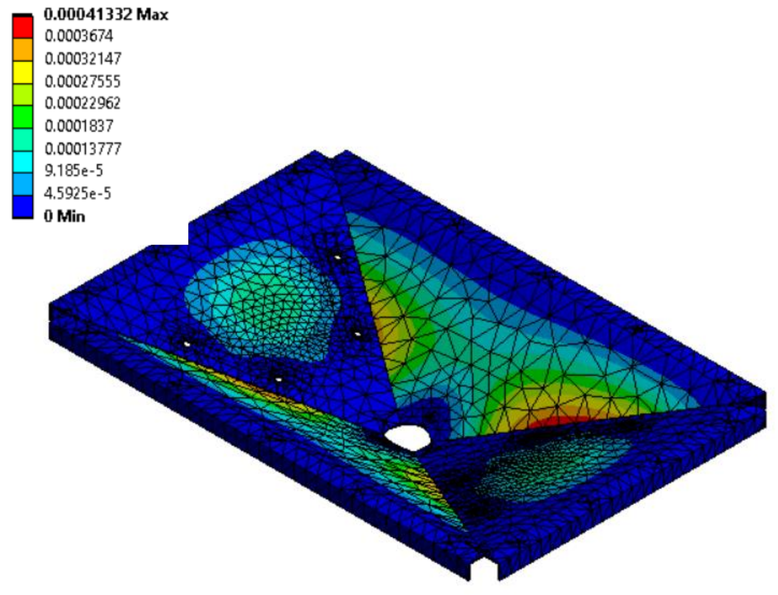


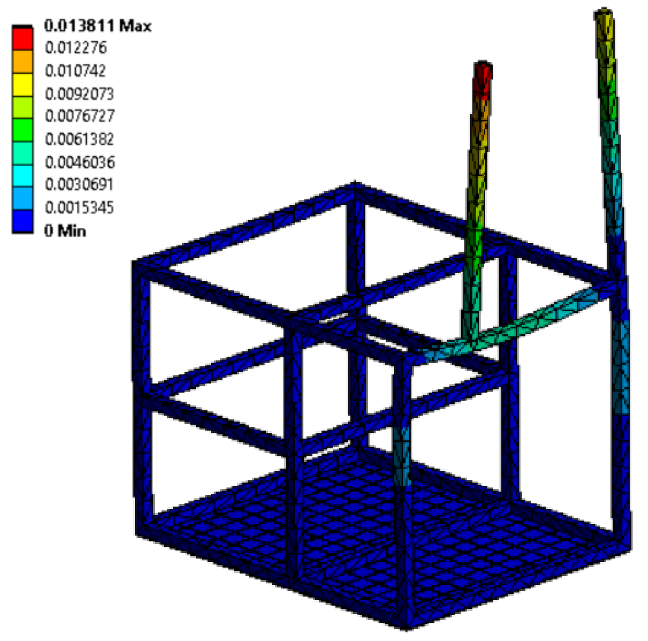
The controls for sanitizing system is comprised of single pole relays and single pole time delay relays. An Ultra-Violet light filter sanitizes the water, which loops back into the bladder using ladder logic.



Results

For results of finite element analysis, see Discussion section.





Discussion

The amount of pressure applied to the framing and funnel is due to the weight of the gravel, solar panel, and electrical panel. Both minimal deformation and equivalent stress are experienced on the device, with the pressure respectively applied to where it acts. See Results section for deformation. The table below contains results deformation and equivalent stress, well below the yield strengths of aluminum and steel.

Component	Deformation (in)	Equivalent Stress (psi)
Funnel	4.13E-04	301.93
Framing	1.38E-02	650.53

Further design refinement can be pursued to lower the cost of this device, which was designed on a 4:1 scale ratio with a total cost of $900. Refinement can specifically focus on the funnel reinforcement and framing, along with reducing the number of components in the overall system.

For future updating of the electrical system, it is ideal to keep all components according to Underwriters Laboratories (UL) standards. Due to inadequate resources, this was not accomplished.

This lays the foundation for future adaptation of portable underground water storage systems through the curation of the project by proceeding teams or commercial implementation. A commercialized design would utilize a larger-scale device so that the amount of water collected and sanitized can serve an entire community.

Conclusions

Water collection and sanitization desperately needs new, efficient, adaptive technology for not only LDCs, but also the world. Portable water bladders stored underground offers an economic, healthy, and automated solution to existing storing and sanitizing techniques.Structural devices, backed by sensors, filters, and prototyping experimentation allow for large-scale water collection and sanitization to occur.

Acknowledgements

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