Proceedings of The National Conference
On Undergraduate Research (NCUR) 2016
University of North Carolina Asheville
Asheville, North Carolina
April 7-9, 2016

CLEARBLUE: The 3-D Printed Portable Water Filter

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Abstract

As stated by the World Health Organization, arsenic is the most common and dangerous metals found in drinking water worldwide. The issue arises frequently in developing countries where water is available but is not in drinkable condition. This project introduces a device, ClearBlue, that can not only filter out the two toxic metals and various types of bacteria, but is also portable and light weight- allowing it to be utilized at any time anywhere when filtered water is needed immediately. ClearBlue consists of a small sized filter that utilizes activated alumina technology and a bio-sand filter to kill and trap all arsenic metals, bacteria, and dirt. The exterior part of the filter was designed via designing software and was produced completely by a 3D printer, utilizing PVP plastic as the material- which is sturdy and well durable. The interior part, the actual filter itself, was put together with two sections. One section consisting of activated alumina- in which the water would absorb all arsenic metals. The second section is the bio- sand filter, which consists of finite sand and gravel that can trap 95% of all commonly found bacteria and dirt. Through further field testing, we will be able to confirm the success of this filter in purifying contaminated water into safe drinkable water.

Keywords: Water Treatment, 3-D Printing, Arsenic Removal

1. Introduction

A dependable access to clean and safe drinking water continues to be a rarity for many rural communities around the world. While they have access to rivers, lakes and wells, they do not possess a proper filtration system in order to kill off all contaminants that lay in these waters. From agricultural runoff and waterborne bacteria to arsenic metals- there is a need for an inexpensive filtration device that is capable of removing various types of contaminants. Furthermore, several communities in developing countries still receive water from the traditional well system- which many have difficulty accessing easily since it is shared by the entire community. This also calls for a solution that would allow access to clean water at any place during any time- for immediate hydration, rather than having to walk a great distance to a sharing well every time water is needed. Taking all of these issues into account- accessibility to water, cost and filtration- the ClearBlue filtration system was designed, developed and is currently being tested. The goal behind the ClearBlue product is to allow access to clean water at the instant that drinkable water is needed for all.

2. Methodology: Design Of The Product

The goal behind ClearBlue is to have a device that is small sized and light weight- allowing it to be easily utilized and carried to any place that is a water recourse. The cost of the product was also kept in mind throughout the designing stage, in order for it to be accessibly for a greater population including people in developing areas that cannot afford a filtration system otherwise. With all of these things in mind, the exterior of ClearBlue is produced 100% via 3-D printing. 3D printing allows one to independently design a product with their exact wants and is a very cost efficient solution compared to other means. By utilizing Computer Aided Design (CAD software, a design of the exterior was made.

Both ends of the product play a significant role in the receiving of water and drinking it directly. The bottom end contains 0.5 inch holes that upon suction will allow contaminated water will flow into. The middle section will hold the filter inside (not shown in the design) through which the water will go through for filtration, and finally, the top has a mouth piece which the person drinking the water fill use and through suction will be able to access the water. Through testing, it is concluded that ClearBlue is most efficient at an angle (anything less than 80 degrees) from the source of the water.

The material utilized for the exterior is PET plastic, polyethylene terephthalate, a popular thermoplastic polymer. PET plastic is formed via combining ethylene glycol and terepthalic acid. It has been used in various industries, from fibers in clothing to plastic containers utilizing for storing foods and numerous other objects. It is also very dependable due to its flexibility and durability in all types of climates (stays in form from -50F to 115F). Therefore, ensuring that the exterior will stay its shape in various environments throughout the world.

Below are pictures of the exterior filtration design and the beginning stages of the filter being printed:

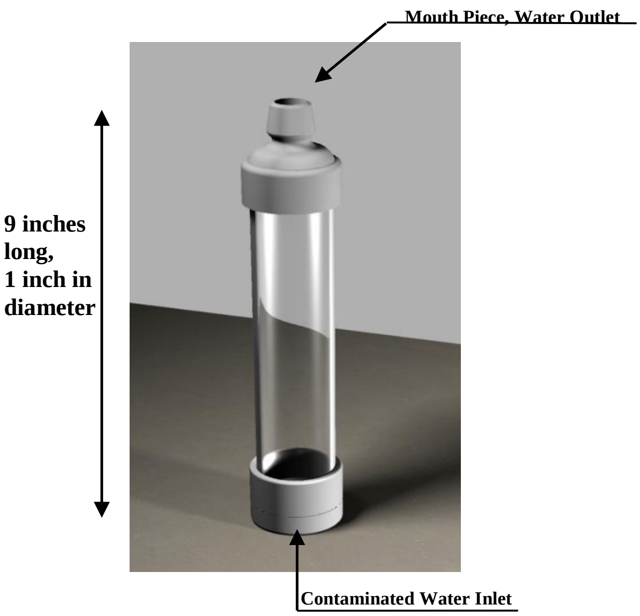

Image 1: Computer Design of Filter

Image 2: 3D Printing of Filter

3. Methodology: Interior Of Filter

The inside of the filter consists of two components: activated alumina technology and a traditional bio-sand filter. According to the World Health Organization, arsenic is one of the most common metals found worldwide, especially in countries such as India and China. A big part of this is due to agricultural run-off into rivers and lakes that are used as sources of water. Therefore, the filtration of arsenic is a key component which is kept in mind during the making of the interior filter. Activated Alumina, also known as Aluminum Oxide (Al_2O_3), is a filter media made by treating aluminum ore so that it becomes porous and highly adsorptive. Though removal capacity is low for As(III), activated alumina is strongly attracted to As(V) and is therefore a very efficient process in removing the metal. Just a small pile of the white spherical solids will allow for removal of arsenic from water. The second component to the filter, the bio-sand filter, is made up of cost efficient materials such as pea sized gravel and sand. These components are able to mechanically trap 98% of dirt, bacteria, and parasites from the water.

A picture design of how the bio-sand filter works traditionally is shown below (changes are made to fit the design of ClearBlue, such as the weight and ratio of the two materials).

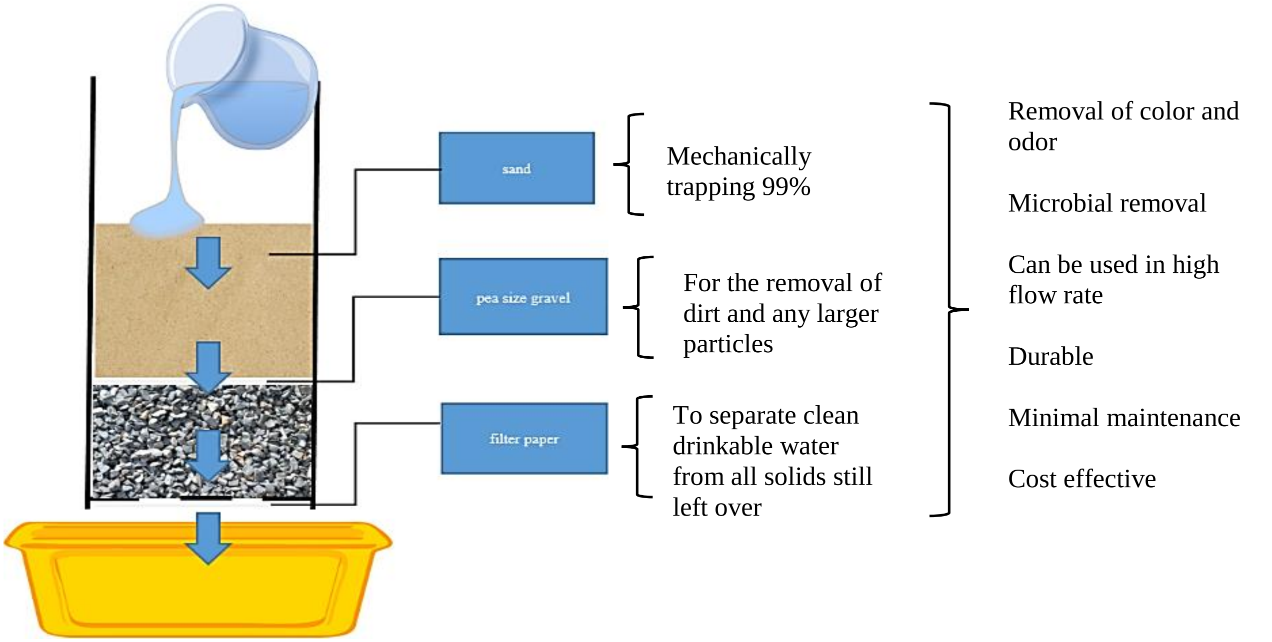

Image 3: Traditional Use of Bio-Sand Filter

The three materials utilized in the filter- activated alumina, sand and pea sized gravel- were all placed separately inside of the filter, divided by several sheets of filter paper to ensure they do not mix with one another during the flow in of the water.

4. Methodology: The "Twist-Off" Component

With the goal of keeping the ClearBlue filter as cost efficient as possible, yet working successfully, the twist-off cap component was added to the exterior of the filter. As shown in the picture below, the end of the filter will be able to be loosened and detached for the removal of the inside filter. Therefore, this would allow the person using the filter to only take out the interior filter and have it replaced with a new one after it has been used for a specific amount of time and is in need of renewal. The exterior part, the 3D printed component, will stay the same- making the filter itself more affordable and eco- friendly.

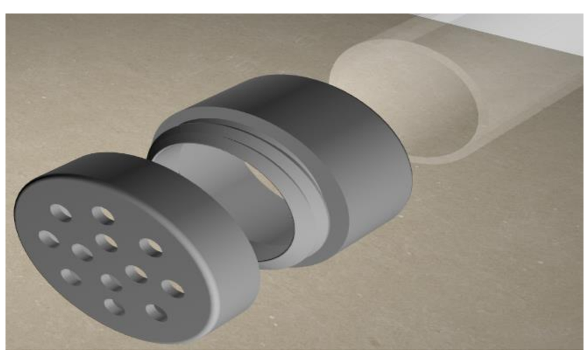

Image 4. Computer Design of Twist-Off Cap

5. Future Testings And Data Collection

With the exterior design and placement of the materials for the filtration designed and made, further work includes more field testing and analysis of contaminated water to conclude the success of the filtration system. Samples of contaminated water from streams and lakes in Southeast Texas have been collected and via liquid chromatography used in the chemistry department of Lamar University, a further analysis of what types of bacteria and other contaminants lay in the water will be concluded. Future goals also include having access to contaminated water in other regions of the world, such as villages in India and China that would allow a conclusion to be drawn on the success rate of the filtration device.

During field testing, many potential issues which can be faced and solved are being kept in mind, such as the amount of suction needed for the inflow of the water into the filter. Past testing has been done with no filter inside, and with just light suction to the mouth piece allowed for the water to enter in easily. However, in different environments such as a river where the water is moving a specific rate, things can be different. Therefore, detailed testing will be done in order to make sure all scenarios and surroundings are taking into account.

6. Conclusion

It has been concluded the design process, 3D printing, and making of a portable water filter with the utilization of activated alumina technology and a bio- sand filter for the purifying of contaminated water filled with arsenic metals, dirt and bacteria. Phase 1 of the project consisted of the design and 3D printing of the filter. The designing of the exterior filter was made with keeping in mind how one would be able to get access to water in rural communities and country side. With a mouth piece and twist-off cap produced specifically for the filter to be eco- friendly and cost effect, the ClearBlue water filter is an easy device that can be used by all. Phase 2, current and future work, consists of testing the various samples of contaminated water collected from the Southeast Texas streams and river. This work will be done in the MEAN lab, Materials Engineering and Nanosensor Laboratory, at Lamar University.

7. Acknowledgements

This work was supported by a Lamar University Office of Undergraduate Research (OUR) grant. The author also acknowledges the College of Engineering at Lamar University for their assistance in helping with the production of the filter.

8. References

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