CNanoz Nanotechnology Based - Water Purification System

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ABSTRACT

Carbon nano and alumina with ferric oxide nano materials are two key constituents used for water purification. Each serves a different purpose in the water purification process. CNanoz uses the two in conjunction and developed a hybrid filter. The carbon nano material is treated with dilute oxidizing acid to create functional groups attached to its surface. This treated carbon nano material removes virus, bacteria, microbes, heavy metals such as lead, cadmium, mercury, any traces of hydrocarbon and standard pesticides in water, which are not safe for drinking. The alumina and ferric nano materials absorb fluoride and arsenic. The source for our carbon nano material is attained by pyrolysis of coconut shell.and after initial purification is impregnated with nano silver Activated alumina is used for a wide range of adsorbent and catalyst applications. In various parts of the world , there is enough fluoride in the water to cause fluorosis resulting in detrimental effects on health including severe birth defects. The amount of fluoride and arsenic leached from the water being filtered depends on the contact time between the water and alumina/ferric filter media.

Keywords: hybrid, nanomaterial, fluorosis, arsenicosis

1 INTRODUCTION

Global drinking water statistics are disheartening. “More than 1.1 billion people lack access to safe water” (Source: World Bank Report: Sanitation & Water Supply). Drinking water contaminated with bacteria/viruses often results in waterborne disease. Approximately 1.6 million children die every year from diarrhea; in India alone. 1,250 children die each day from diarrhea related diseases. Waterborne diseases kill more people each year than all communicable diseases combined [1-2].

In addition to pathogens, many times there are equally dangerous toxins in water that are overlooked because most cannot be seen or tested. Exposure to these toxins, arsenic, fluoride, cadmium, lead etc., over an extended period, can promote harmful gene mutations that can affect the individual (cancer, neurological disorders, mental &physical disabilities) and these toxins may pass to progeny. As per a UN report, natural arsenic poisoning, developed through drinking water, affects 140 million people globally [3].

Today, a myriad of water treatment technologies exist. From inexpensive, low-tech and globally popular chlorine to expensive, high-tech niche technologies such as reverse osmosis, each having its advantages and disadvantages. Broadly speaking, the less expensive technologies deal with pathogens, but not chemicals or turbidity. Technologies that are more expensive may address a wider range of contaminants but are too expensive and especially consumed electricity to be widely deployed.

CNanoz has developed an innovative technology to filter water inexpensively. The system operates using force of gravity, hence removing the need for power source. The hybrid system is designed to be modular to handle up to 100,000 liters of water / day. The breakthrough is the proprietary composite nano filters that utilize carbon impregnated with nano silver, aluminum and ferric nanotechnology and are capable of removing turbidity, pathogens (bacteria, viruses & other microorganisms) and toxic chemicals (that cause cancer & birth defects). This system can be deployed independently or integrated into an existing system.

The developed process to produce hybrid nano material currently has 2 patents pending. Through controlled treatment with acid and alkali, all impurities are removed from the water. The nano material is functionalized with oxidizing acid treatment to attach sufficient carboxylic acid groups. Over- functionalization would render the carbon nano material water soluble, which is not suited for water purification while under-functionalization would not provide sufficient carboxylic groups to be conjugated with arsenic and fluoride removing catalysts. The extensive research CNanoz has done has helped to develop the optimal level of functionalization to remain water insoluble while providing sufficient carboxylic groups to conjugate with arsenic and fluoride removing catalysts. Studies done by CNanoz have shown that the carbon nano materials, which are in the form

of "nanospheres", trap bacteria, viruses, hydrocarbon waste and heavy metals (such as lead and cadmium). This integrated system is capable of removing pathogens as well as toxins. The nano filters can be customized according to the contaminant level of a site by attaching catalysts in appropriate proportions. The system operates using the force of gravity and therefore needs no power source. This integrated system with its customization capability, requiring no energy source to operate, makes it unique and progressive.

2 MANUFACTURING PROCESS OF VALUE ADDITION PRODUCTS

2.1 Carbon Nano Derivatized Material

Carbon sources such as those especially made from wood charcoal under controlled condition belong to the nano sized globules and are treated with nitric acid, which results in surface carboxylation. Any nitric oxide produced is scrubbed with NaOH to remove any traces of acid. In the next stage of the process, the carbon nano material is suitably impregnated with silver nitrate and heated in a muffle or rotary furnace for activation wherein metallic nano silver is deposited on the surface of the nano carbon and the nano composite is ready for use.

2.2 Alumina Nano Composite Material

Commercially available activated alumina (Al_2O_3) is used as the starting material in this process. It is treated with ferrous sulfate and ammonium hydroxide to precipitate ferrous hydroxide which was exposed in air to get its oxidation to ferric . This mixture is then heated in a muffle or rotary furnace and allowed to cool slowly, in the furnace, to room temperature. The resultant aluminum oxide coated with ferric oxide is now ready for use for the purpose of fluoride and arsenic removal in water.

3 TESTING DONE

CNanoz has extensively tested the system developed for the removal of pathogens, arsenic and fluoride in contaminated water using EPA (Environmental Protection Agency) standards for test purposes. In each study, 250 grams of composite/hybrid nano filter is used to test the bacteria, fluoride and arsenic removal capability. Using a computer model, the amount of nano filter that would be needed to remove fluoride and/or arsenic from 5000 liters of water per day for 90 days was extrapolated. For recycling purposes, CNanoz treats the spent nano material with 10% concentration caustic soda and is able to leach out fluoride and arsenic as safe sodium fluoride and sodium arsenate salts. The recycled product is able to perform at 60% capacity. Further studies are needed to increase the recycle product capacity to 80% or higher to make the system even more economical.

4 UNIQUE ASPECTS / KEY ADVANTAGES OF CNANOZ HYBRID FILTER

• Effectiveness – the technology and system design are the result of CNanoz'z own R&D. Carbon Nano Material (CNM) is utilized, leveraging the emerging science of nanotechnology, to filter water at two levels. The first is at the molecular level as nanotubes operate at the nano particle level (1 nano = $10e^{-9}$ meters). At this level, any microbe is stopped from passing through. The second is the ability to remove chemicals. The patent pending process functionalizes nanotubes so that they attract and hold specific chemicals. Trapped in the filter, toxins are effectively removed from the local environment. This filter is recycled so that the toxins do no reenter the environment.

• Cost – highly affordable. A hurdle for adoption of both water systems and nanotechnology is high cost. A proprietary manufacturing technique allows CNanoz to produce "1 gram of quality CNM for under $2". To put this number in perspective, "1 gram of quality CNM can be purchased from $5-$30 depending on quality." This cost advantage makes the target price for consumer's filtered water affordable for the developing world. This price is competitive to systems that do not remove chemicals.

• Ease of use – maintenance & operation. The system is designed to operate with limited inputs. It does not require electricity as it utilizes gravity and is modular, so that it can be scaled for local needs. Constructed using standardized food grade polyethylene; the system is hardy, resistant to rural conditions and affordable. Locals can maintain the system and ensure their own clean water supply. Local village resource can be employed to run and maintain the system.

• Customizable composite filter - can be customized to suit specific sites' contaminant levels. This increases the performance and life of the filter, which is key to making the system economical.

• Used filter material can be recycled and disposed in an environmentally friendly manner – toxins such as arsenic and fluoride can be converted to safe salts and either sold or disposed of safely

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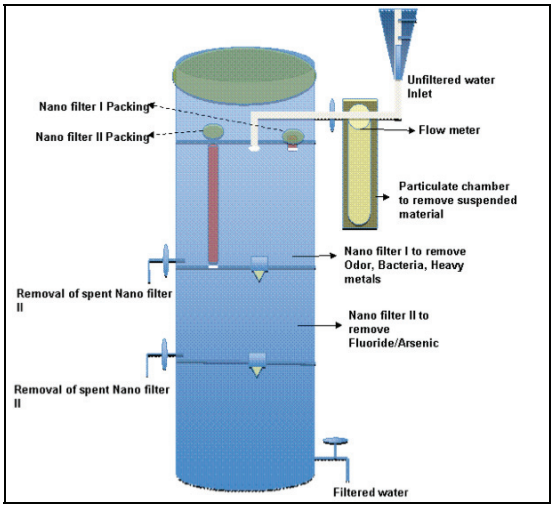

Figure 1: Schematic of water filtration system

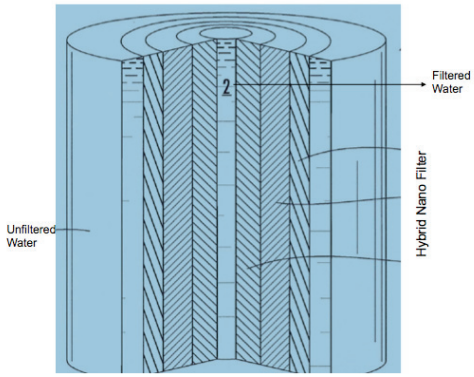

Figure 2: Cross section of Hybrid Nano Filter

5 FUTURE WORK

Studies need to be conducted in order to optimize the performance of the current system with different levels (parts per million) and combination of contaminants. A housing unit needs to be designed and engineered for the composite nano filters to provide maximum output per day to make it economical and cost efficient. Although techniques have been developed to remove the trapped toxins from the spent nano filters, further studies are required to optimize the life period of the recycled nano material. Use of recycled nano material is key to making the system economical as well to be deployed in a global marketplace. Finally, pilot studies need to be conducted to demonstrate and prove this technology, better understand the performance and use this data for optimization of the system on an ongoing basis.

6 PRODUCT LINE

CNanoz Inc. has developed the following two products. Each services specific needs of the consumer. The key focus of both these products is safety and well being of consumers. Both the product lines will have LCD indicators to indicate when the filter needs to be changed. This is key to ensure quality of filtered water is not degrading.

- Community Filtration Systems that can be configured to handle 5,000 liters per day to 20,000 liters per day.
- Tap filter system for individual residential use.

7 PATENTS

1. Title: Making And Using Composite Material Containing Nanospheres And Devices For Water Filtration And Devices Containing Such Composites - Application #: 13/181,855
2. Title: Water Filtration System Using Hybrid Nano Carbon, Silver, Iron And Aluminum Oxide - Application #: 13/791,058

8 REFERENCES

[1] Estimated with data from Diarrhea: Why Children are still dying and what can be done. UNICEF, WHO 2009.

[2] Estimated with data from WHO/UNICEF Joint Monitoring Programme (JMP) for Water Supply and Sanitation. (2012). Progress on Sanitation and Drinking – Water, 2012 Update.

[3] UN Water. (2008). Tackling a global crisis: International Year of Sanitation 2008