International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 08 Issue: 09 | Sep 2021 www.irjet.net p-ISSN: 2395-0072

Portable Water Filter

Arshad Mulani[1], Chetan Masram[2], Rasika Bhitale[3], Harsh Pawar[4]

[1,2,3,4]*Department of Biotechnology Engineering, MGM College Of Engineering and Technology, Kamothe.*

Abstract – *Water sustains life and is connected to almost every life form on earth. Water is considered as the most important aspect for survival, but as of now, not only water but clean water is required to sustain life. Contaminated water is the root cause of many diseases, especially in a developing country like India. With the current economic distress and rapid growth in population at an alarming rate, the availability of freshwater resources remains the same, which calls for a portable, low cost and low maintenance water filter, that will end not only the physical scarcity but also the economic distress thereby, providing access to safe drinking water for everyone as it is a fundamental right. This project aims to provide safe drinking water with almost negligible impurities with no bulky machines and costly maintenance. Since the device includes no chemicals, it eliminates the chance of intolerance from person to person. It can also be used by victims of the flood where water is readily available but having clean drinking is a difficult task. This device can help improve the life expectancy of the underprivileged and the destitute who have less or no access to clean water. As we all know, India is the second most populated country globally, with a population that does not have access to unsoiled water. This filter will provide clean potable water free from bacteria, microorganisms, turbidity and chemical agents, which can also benefit 'travelers and people stuck in floods or other natural calamities.*

KeyWords: Water filter, Carbon Bed, Hollow fiber membrane, Portable filter, Activated charcoal.

1. INTRODUCTION

The most abundant natural resource of the earth is water which covers more than 70% of the earth's surface. However, merely 2.5 % of that total is in the form of freshwater. Many people worldwide are facing a water crisis, and the crisis will be severely fatal with time. Surface water and groundwater are the exclusive resources of drinking water. Water from each source of these sources contains various dissolved solids that contaminate it and make it impure. About 784 million people are deprived of safe drinking water and are subjected to its adverse effects. Poorly developed infrastructure, non-availability of electricity, poverty are some of the many problems that create hurdles in the management, filtration, storage, and supply of water. To accomplish the motive of providing safe water, the sediments from the water must be removed, and microbes must be killed. Our project aimed to create a water filter that won't be affected by prevailing the problems.

1.1Literature Survey

Hollow fiber membrane is an essential element when it comes to portable water filters available in the market. Undoubtedly hollow fiber membranes do an exceptional job when it comes to removing microbes and debris larger than 0.01 microns from water but the major drawback is that it can not eliminate harmful chemicals like chlorine, lead, arsenic. To tackle this particular problem, we have installed a bed of activated charcoal in the project which will not only remove chlorine, lead, arsenic but will also help in removal of detrimental odor, color, taste, and other organic and inorganic impurities based on the principle of adsorption. Not only activated carbon but we also have coconut carbon fiber which makes the water pass through two steps of adsorption process thereby removing almost every entity including halogens, herbicides and pesticides present in the water. It adsorbs any volatile organic compounds, e.g., formaldehyde, tetrachloroethylene, methylene chloride.

Another major element that makes this project even more effective is the use of copper mesh to integrate coconut carbon fibers. Copper is a cheap metal that is also easy to recycle, making it the greenest natural metal. Other than environmental benefits copper has a wide range of health benefits including fighting off cancer, reducing hypertension. All of the mentioned points make our project environment friendly, cost-effective and beneficial for the humankind.

1.2Proposed Project

With a growing population and dwindling drinking water supply, the continuous supply of safe drinking water is a significant issue the world faces. This problem will become a huge one in the near future. The main objective of the project is to provide access to every person to clean water irrespective of the place and source. The project aims to create a portable water filter that can purify water at a lost cost using components that are safe, efficient and inexpensive. The proposed system consists of a light-weighted and utilitarian water purifier equipped with coconut carbon fiber, copper mesh and hollow fiber filters combined meticulously to give the best possible results.

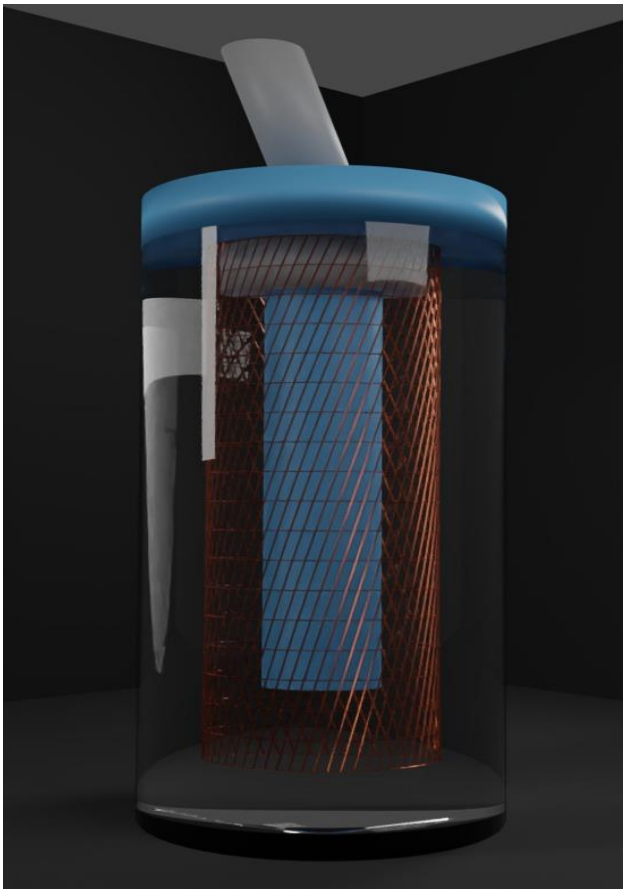


Figure 1- Diagrammatic representation of the device

2. METHODOLOGY

When water is collected by the user in the device, it passes through a series of processes before reaching out in the form of clean potable water. The process of filtration of water starts with the collection of water in the silicon bottle. Once stored in the bottle, the water to be treated first comes in contact with the coconut carbon fiber granules that are attached to the copper mesh. This is the primary step for the filtration to be carried out further. In this particular step, the water is incorporated with copper ions with the help of copper mesh used. Not only does the copper mesh help to integrate copper ions into the water, but is also used to provide mechanical support to the coconut carbon fiber granules. This ensures that the bacteria present in the water is killed as soon as it comes in contact with the copper mesh. The copper mesh provides the user with various health benefits as water with infused copper ions is scientifically proven to be anti-carcinogenic, anti-inflammatory and anti-bacterial in nature. The addition of cuprous ions is beneficial and favorable as it helps to improve digestion, prevent inflammation, produce red blood cells, and activate the immune system. At the same time, coconut carbon filter (CCF) is an excellent adsorption material that is used for the treatment of contaminated water. CCF granules are integrated on the copper mesh and are produced under specific conditions using hydrochloric acid as an activating agent. They are environment-friendly, cost-effective and are 50% more porous than coal; this helps in adsorbing humongous amounts of particulate matter and pollutants. Its adsorption properties also help in removing halogens, herbicides and pesticides present in water. It also helps increase the portability of water by adsorption of volatile organic compounds, improving the taste, pH and turbidity.

Figure 2- Coconut carbon fiber embedded on copper mesh

Following the primary step, the water proceeds to the hollow fiber membrane (HFM). A hollow fiber membrane (HFM) used in this device comprises numerous tubes of hollow fibers bundled together to create a filter network in a closed loop. Each hollow tube is accompanied by pores that open towards the inner side of the filter. The hollow fiber membrane, due to its numerous tubes of hollow fibers having micropores with a diameter of 0.2 microns which makes it practically impossible for any component with a size greater than 0.2 microns to pass through it. As water is pumped through the walls of these fibers, almost all microbiological entities are removed by the size exclusion method. This application of size exclusion not only removes almost every pathogen found in a water sample but can also remove sand, slit, clays, algae and natural, synthetic organic matter to reduce fouling potential. The hollow fiber membrane helps reduce most of the dissolved impurities that maybe in the form of chemical or physical entities from the soil. Unlike other filters, the HFM is cost-effective as it requires no electricity/batteries, does not remove important salts/minerals and generates no waste whatsoever.

The final step of filtration involves the passing of water through a bed of activated charcoal. The carbon bed is employed as the last filtration stage to eliminate various harmful compounds and filter water with its unique

adsorption properties. Carbon filters eliminate volatile organic compounds, extract free chlorine, and make water safe for drinking. Activated carbon can extract chlorine from the water and thus prevent the growth of pernicious bacteria. Since chlorine is removed from the water, the detrimental effects of acid reactions between chlorine and acids like humic acid that leads to the formation of carcinogens like tri-halo-methane are bygone. This step of filtration ensures that the total dissolved solids in the water are reduced maximally by adsorption. During this adsorption process, the carbon is not degraded. However, after prolonged use, the surface area of the carbon is completed occupied by adsorbed chlorine molecules and can no longer adsorb the free chlorine. Therefore, after a stipulated time, the carbon bed should be replaced with a new one to ensure continuous water filtration. The prime advantages of using activated carbon include superior quality filtration, removal of various gases, eliminating odor, and low operating cost.

3. RESULTS

In order to check the efficacy of the device, a water sample of around two liters was taken from a puddle. The water sample was then further contaminated using 150 grams of loose soil. The sample was then divided into two parts, namely sample A and sample B. Both samples come from the same origin and are further contaminated precisely the same. Sample A contained water that was contaminated and unfiltered. Sample B contained water that was passed through the water filter. Both the samples were further tested in terms of physical, chemical and microbiological entities in a private lab. The comparison of both samples in terms of various contaminants is shown below in pictorial representation.

Figure 3- Sample A

Figure 4- Sample B

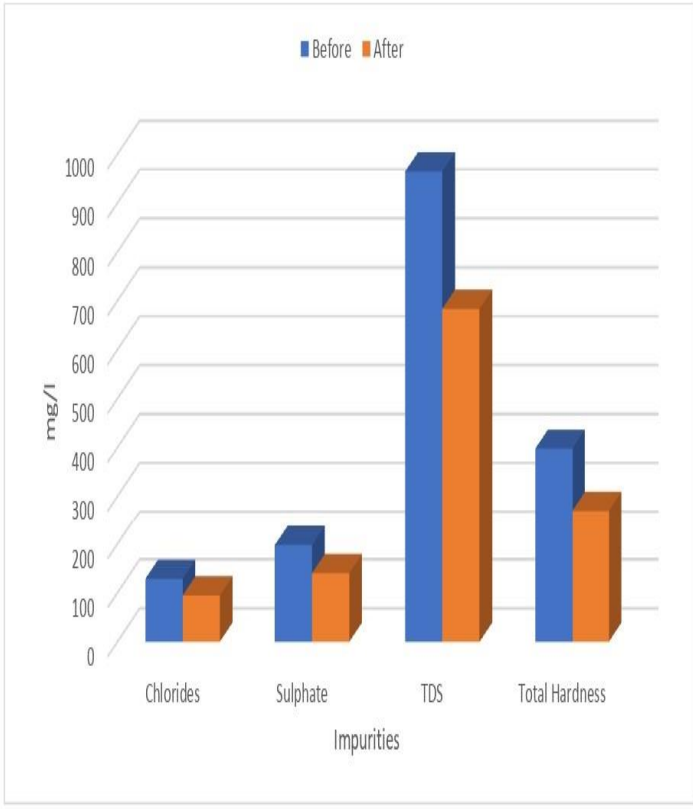
Sr. No.	Tests	Result before filteration Sample A	Result after filteration Sample B	Unit
1	Colour	ND<l.0	ND<l.0	Hazen
2	Taste	Disagreeable	Agreeable	-----
3	Odour	Disagreeable	Agreeable	-----
4	Turbidity	11.0	ND	NTU
5	TotalHardness	397.50	270.0	mg/l
6	Chlorides	128.55	94.27	mg/l
7	Calcium	70.14	32.06	mg/l
8	Fluoride	ND	ND	mg/l
9	Sulphate	197.52	139.91	mg/l
10	Silica	9.40	7.80	mg/l
11	Magnesium	54.1	46.2	mg/l
12	TDS	964.0	683.0	mg/l
13	Conductivity	1177.0	882.0	µs/cm
14	E.Coli	Absent<l	Absent<l	Cfu/lOOml
15	TotalColiform	>300	Absent<l	Cfu/lOOml
16	Colour	ND<l.0	ND<l.0	Hazen

1) ND- Not Detected

2) NTU- Nephelometric turbidity units

3) CFU-Colony forming unit

Figure 5- Difference in the values of entities



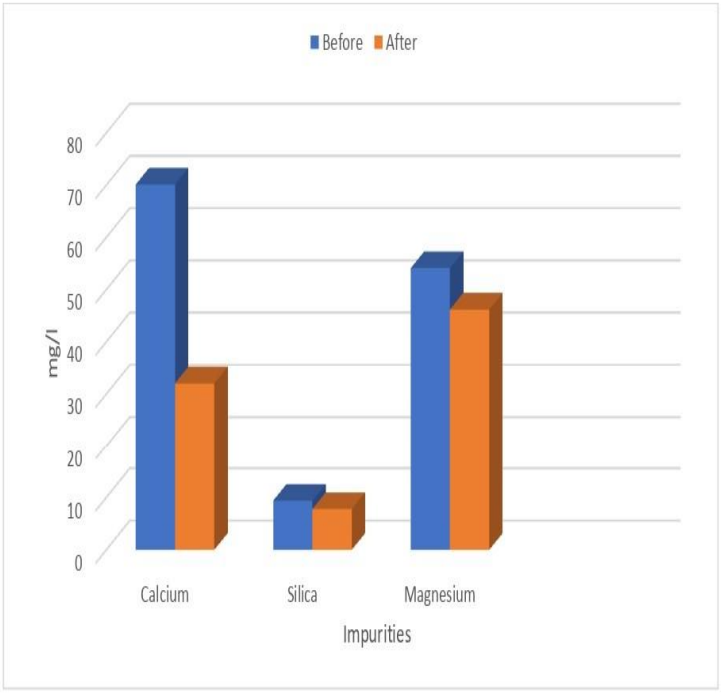
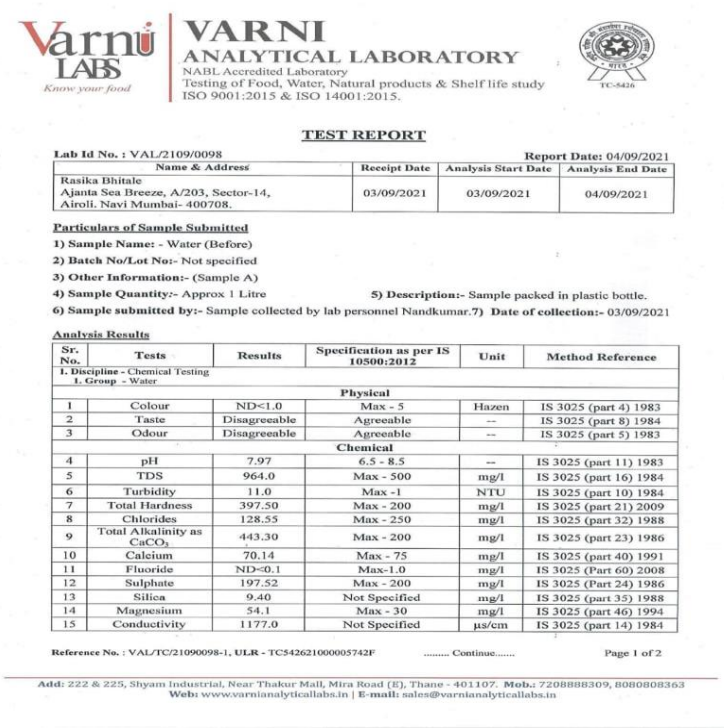


Figure 6- Graphical representation of various entities



VARNI ANALYTICAL LABORATORY
NABL Accredited Laboratory
Testing of Food, Water, Natural products & Shelf life study
ISO 9001:2015 & ISO 14001:2015.

TEST REPORT

Lab Id No. : VAL/2109/0098 **Report Date:** 04/09/2021

Name & Address	Receipt Date	Analysis Start Date	Analysis End Date
Rasika Bhitale Ajanta Sea Breeze, A/203, Sector-14, Airoli, Navi Mumbai- 400708.	03/09/2021	03/09/2021	04/09/2021

Particulars of Sample Submitted

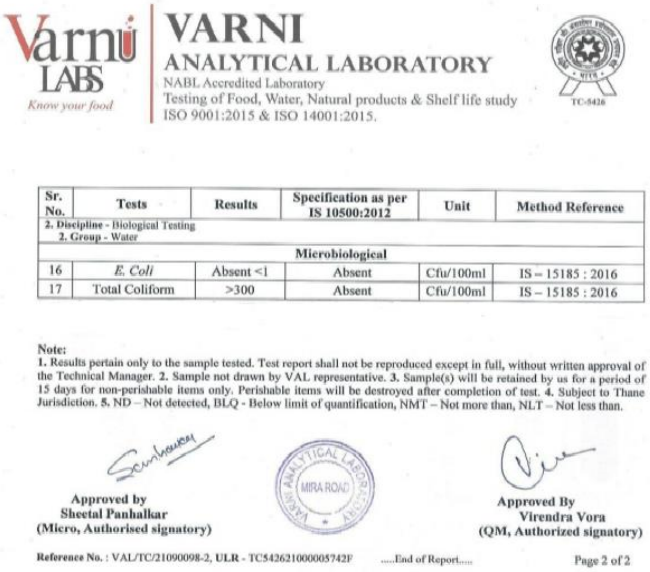
1) Sample Name: - Water (Before)
2) Batch No/Lot No:- Not specified
3) Other Information:- (Sample A)
4) Sample Quantity:- Approx 1 Litre **5) Description:-** Sample packed in plastic bottle.
6) Sample submitted by:- Sample collected by lab personnel Nandkumar.**7) Date of collection:-** 03/09/2021

Analysis Results

Sr. No.	Tests	Results	Specification as per IS 10500:2012	Unit	Method Reference
1. Discipline - Chemical Testing 1. Group - Water					
			Physical		
1	Colour	ND<1.0	Max - 5	Hazen	IS 3025 (part 4) 1983
2	Taste	Disagreeable	Agreeable	--	IS 3025 (part 8) 1984
3	Odour	Disagreeable	Agreeable	--	IS 3025 (part 5) 1983
			Chemical		
4	pH	7.97	6.5 - 8.5	--	IS 3025 (part 11) 1983
5	TDS	964.0	Max - 500	mg/l	IS 3025 (part 16) 1984
6	Turbidity	11.0	Max -1	NTU	IS 3025 (part 10) 1984
7	Total Hardness	397.50	Max - 200	mg/l	IS 3025 (part 21) 2009
8	Chlorides	128.55	Max - 250	mg/l	IS 3025 (part 32) 1988
9	Total Alkalinity as $CaCO_3$	443.30	Max - 200	mg/l	IS 3025 (part 23) 1986
10	Calcium	70.14	Max - 75	mg/l	IS 3025 (part 40) 1991
11	Fluoride	ND<0.1	Max-1.0	mg/l	IS 3025 (Part 60) 2008
12	Sulphate	197.52	Max - 200	mg/l	IS 3025 (part 24) 1986
13	Silica	9.40	Not Specified	mg/l	IS 3025 (part 35) 1988
14	Magnesium	54.1	Max - 30	mg/l	IS 3025 (part 46) 1994
15	Conductivity	1177.0	Not Specified	µs/cm	IS 3025 (part 14) 1984

Reference No. : VAL/TC/21090098-1, ULR - TC542621000005742F ..... Continue..... Page 1 of 2

Add: 222 & 225, Shyam Industrial, Near Thakur Mall, Mira Road (E), Thane - 401107. Mob.: 7208888309, 8080808363
Web: www.varnianalyticallabs.in | E-mail: sales@varnianalyticallabs.in



VARNI
ANALYTICAL LABORATORY
NABL Accredited Laboratory
Testing of Food, Water, Natural products & Shelf life study
ISO 9001:2015 & ISO 14001:2015.

Sr. No.	Tests	Results	Specification as per IS 10500:2012	Unit	Method Reference
2. Discipline - Biological Testing 2. Group - Water					
			Microbiological		
16	*E. Coli*	Absent <1	Absent	Cfu/100ml	IS – 15185 : 2016
17	Total Coliform	>300	Absent	Cfu/100ml	IS – 15185 : 2016

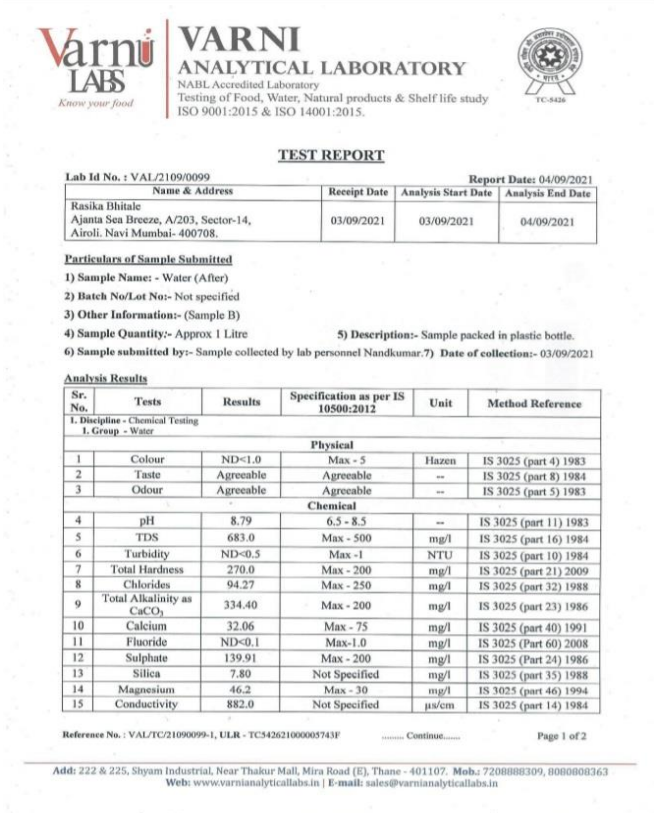
Note:
1. Results pertain only to the sample tested. Test report shall not be reproduced except in full, without written approval of the Technical Manager. 2. Sample not drawn by VAL representative. 3. Sample(s) will be retained by us for a period of 15 days for non-perishable items only. Perishable items will be destroyed after completion of test. 4. Subject to Thane Jurisdiction. 5. ND – Not detected, BLQ - Below limit of quantification, NMT – Not more than, NLT – Not less than.

Approved by
Sheetal Panhalkar
(Micro, Authorised signatory)

Approved By
Virendra Vora
(QM, Authorized signatory)

Reference No. : VAL/TC/21090098-2, ULR - TC542621000005742F .....End of Report..... Page 2 of 2

Figure 7- Lab results of sample A



VARNI
ANALYTICAL LABORATORY
NABL Accredited Laboratory
Testing of Food, Water, Natural products & Shelf life study
ISO 9001:2015 & ISO 14001:2015.

TEST REPORT

Lab Id No. : VAL/2109/0099 Report Date: 04/09/2021

Name & Address	Receipt Date	Analysis Start Date	Analysis End Date
Rasika Bhitale Ajanta Sea Breeze, A/203, Sector-14, Airoli. Navi Mumbai- 400708.	03/09/2021	03/09/2021	04/09/2021

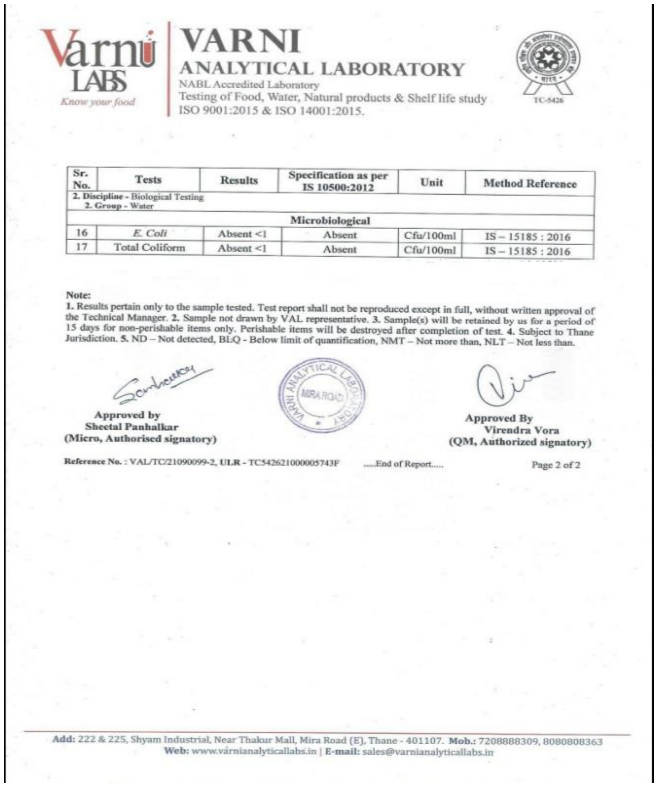
Particulars of Sample Submitted
1) Sample Name: - Water (After)
2) Batch No/Lot No:- Not specified
3) Other Information:- (Sample B)
4) Sample Quantity:- Approx 1 Litre 5) Description:- Sample packed in plastic bottle.
6) Sample submitted by:- Sample collected by lab personnel Nandkumar.7) Date of collection:- 03/09/2021

Analysis Results

Sr. No.	Tests	Results	Specification as per IS 10500:2012	Unit	Method Reference
1. Discipline - Chemical Testing 1. Group - Water					
			Physical		
1	Colour	ND<1.0	Max - 5	Hazen	IS 3025 (part 4) 1983
2	Taste	Agreeable	Agreeable	--	IS 3025 (part 8) 1984
3	Odour	Agreeable	Agreeable	--	IS 3025 (part 5) 1983
			Chemical		
4	pH	8.79	6.5 - 8.5	--	IS 3025 (part 11) 1983
5	TDS	683.0	Max - 500	mg/l	IS 3025 (part 16) 1984
6	Turbidity	ND<0.5	Max -1	NTU	IS 3025 (part 10) 1984
7	Total Hardness	270.0	Max - 200	mg/l	IS 3025 (part 21) 2009
8	Chlorides	94.27	Max - 250	mg/l	IS 3025 (part 32) 1988
9	Total Alkalinity as $CaCO_3$	334.40	Max - 200	mg/l	IS 3025 (part 23) 1986
10	Calcium	32.06	Max - 75	mg/l	IS 3025 (part 40) 1991
11	Fluoride	ND<0.1	Max-1.0	mg/l	IS 3025 (Part 60) 2008
12	Sulphate	139.91	Max - 200	mg/l	IS 3025 (Part 24) 1986
13	Silica	7.80	Not Specified	mg/l	IS 3025 (part 35) 1988
14	Magnesium	46.2	Max - 30	mg/l	IS 3025 (part 46) 1994
15	Conductivity	882.0	Not Specified	µs/cm	IS 3025 (part 14) 1984

Reference No. : VAL/TC/21090099-1, ULR - TC542621000005743F ..... Continue..... Page 1 of 2

Add: 222 & 225, Shyam Industrial, Near Thakur Mall, Mira Road (E), Thane - 401107. Mob.: 7208888309, 8080808363
Web: www.varnianalyticallabs.in | E-mail: sales@varnianalyticallabs.in



VARNI
ANALYTICAL LABORATORY
NABL Accredited Laboratory
Testing of Food, Water, Natural products & Shelf life study
ISO 9001:2015 & ISO 14001:2015.

Sr. No.	Tests	Results	Specification as per IS 10500:2012	Unit	Method Reference
2. Discipline - Biological Testing 2. Group - Water					
			Microbiological		
16	*E. Coli*	Absent <1	Absent	Cfu/100ml	IS – 15185 : 2016
17	Total Coliform	Absent <1	Absent	Cfu/100ml	IS – 15185 : 2016

Note:
1. Results pertain only to the sample tested. Test report shall not be reproduced except in full, without written approval of the Technical Manager. 2. Sample not drawn by VAL representative. 3. Sample(s) will be retained by us for a period of 15 days for non-perishable items only. Perishable items will be destroyed after completion of test. 4. Subject to Thane Jurisdiction. 5. ND – Not detected, BLQ - Below limit of quantification, NMT – Not more than, NLT – Not less than.

Approved by
Sheetal Panhalkar
(Micro, Authorised signatory)

Approved By
Virendra Vora
(QM, Authorized signatory)

Reference No. : VAL/TC/21090099-2, ULR - TC542621000005743F .....End of Report..... Page 2 of 2

Add: 222 & 225, Shyam Industrial, Near Thakur Mall, Mira Road (E), Thane - 401107. Mob.: 7208888309, 8080808363
Web: www.varnianalyticallabs.in | E-mail: sales@varnianalyticallabs.in

Figure 8-Lab results of sample B

4. CONCLUSIONS

The portable water filter created during the course of the project has evidently been successful in eliminating the harmful bactericidal entities present in the source water used for testing the filter. Water testing results show that the filter has remarkably reduced many different types of dissolved solid impurities along with some chemical entities implying that combining hollow fiber filters and coconut carbon fiber is valuable and efficient. The filter clearly demonstrates its use in purifying water on the go with its portable and easy to use design making it a smart choice for everyone deprived of clean drinking water irrespective of their financial background. Even with the use of all the components used in the filter, the user will experience an uninterrupted flow of water effortlessly in an instant.

ACKNOWLEDGEMENT

The authors also want to express sincere gratitude to honorable Head of Department Sandeep Singh for their constant support and encouragement.

REFERENCES

[1] https://www.waterprofessionals.com/learning-center/activated-carbon-filters/

[2] https://www.healthline.com/nutrition/copper-water-benefits#claimed-benefits

[3] https://envirosupply.net/blogs/news/use-of-coconut-shell-activated-charcoal-water-purification

[4] https://www.carbonblocktech.com/coconut-wood-coal-filters/

[5] https://xflow.pentair.com/en/spectrum/membra ne-technology-in-general/hollow-fiber-membranes

[6] https://www.bobvila.com/articles/best-portable-water-filter/