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Affordable Natural Water Purifier

Deepak Kandpal [1*], Priyank Kumar [2], Gaurav Chaturvedi [3]

[1] *Department of Civil Engineering, Government Polytechnic Dahod, 389151, Gujarat, India*

[2] *Applied Science & Humanities Department, Government Polytechnic Dahod, 389151, Gujarat, India*

[3] *Applied Mechanics Department, Government Polytechnic Dahod, 389151, Gujarat, India*

Abstract:- Humans in every part of the world consider rivers as most significant part of their life, sometimes they also worship it like a god but the same rivers are contaminated now a days and causing the water borne disease in our society specially the developing and the underdeveloped countries are facing this issue. Various programs are running to overcome the current scenario but the efforts are not reaching to the root level. Villagers who belongs to the poor background has the affordability issue as well. These people cannot afford the RO or UV type of water purifiers because of their higher cost & there dependability on the electricity as well. The issue of drinking water can also be solved with affordable "Natural water purifier" which will utilize the Natural material and will provide them a healthy water within their cost of living.

Keywords*: Natural water purifier, Activated Carbon, Affordable water purifier, Pot in Pot Cooling, MPN No., Turbidity, Bacteriological Test.*

1. Introduction

Waterborne diseases are a significant public health concern in India, primarily due to issues related to inadequate access to safe drinking water, poor sanitation infrastructure, population density, and varying environmental conditions. Here's a scenario of waterborne diseases in India. As per the report [1] of five-year plan 2007 to 2012 the following reasons were identified of water bound disease in India. There are about 2.17 lakh quality affected habitations in the country with more than half of the habitations affected with excess iron (1,18,088). This is followed by fluoride (31,306), salinity (23,495) nitrate (13,958) arsenic (5,029) in that order. There are about 25000 habitations affected with multiple problems. About 66 million populations is at risk due to excess fluoride in 200 districts of 17 states. Arsenic contamination is widespread in West Bengal and it is now seen in Bihar, eastern UP and Assam. The hand pump attached de-fluoridation and iron removal plants have failed due to in appropriate technology unsuited to community perceptions and their involvement. Desalination plants have also met a similar fate due to lapses at various levels starting with planning to post implementation maintenance.

1.1 **Lack of covered toilets** nearby imposes a severe hardship on women and girls. Also provision of clean drinking water without at the same time provision of sanitation and clean environment would be less effective in improving health. The two should be treated together as complementary needs.

1.2 **Sustainability of water availability** and supply, poor water quality, centralized vs. decentralized approaches and financing of operation and maintenance costs.

1.3 **Lack of Solid Waste Management (SWM)** Urban waste management by ULBs is already under stress because of paucity of resources and inadequacies of the system. In 2023 India has suppressed china in population & it is now world's highest populated country but Table I shows that all population is not covered with the water supply facility [1]. A study finds the prevalence of water borne disease among the elderly is more in the rural (22.5%) areas compared to the urban counterparts (12.2%) due to the use of unimproved water sources. [2]

Table I: Percentage of house hold covered with Sanitation facilities

Type of latrine	Number of households (million)	Percentage of households
WC connected to piped sewer system	25.8	33%
WC connected to septic tank	30.1	38%
Pit latrine with slab/ventilated improved pit	5.1	6%
Unimproved pit latrine	0.5	1%
Night soil disposed into open drain/removed by humans or animals	1.3	2%
Other system	1.4	2%
Public latrine	4.7	6%
Open defecation	10.0	13%
Total	78.9	100%

Kumar et.al 2022 [2] says that India suffers from a high burden of diarrhea and other water-borne diseases due to unsafe water, inadequate sanitation and poor hygiene practices among human population. With age the immune system becomes complex and antibody alone does not determine susceptibility to diseases which increases the chances of water borne disease among elderly population.

2. Parameters of Indian Standard IS-10500:2012

The Indian Standard IS 10500:2012 declares the drinking water quality standards in India [3]. These standards are essential to ensure the safety parameters of drinking water for human consumption. These parameters are crucial for ensuring the safety and quality of drinking water in India. Water treatment plants and facilities need to adhere to these standards to provide safe and clean drinking water to the public. It's important to note that water quality can vary from one location to another, so regular testing and monitoring are essential to ensure compliance with these standards. Below are the parameters outlined in IS 10500:2012 along with their respective permissible limits:

Table II IS-10500:2012 For Drinking Standards [11]

SN	PARAMETERS	STANDARD VALUE	PERMISSIBLE LIMIT
1	pH	6.5-8.5	NO relaxation
2	Turbidity (NTU)	1	5
3	Total Dissolved Solids (mg/l)	500	2000
4	Total Hardness (as $Caco_3$ in mg/l)	200	600
5	Sulphates	200	400
6	Magnesium	30	NO relaxation
7	Nitrate	45	NO relaxation
8	Chloride	250	1000
9	Residual Free chlorine	0.2	1
10	Calcium	75	200
11	Total alkalinity (as $Caco_3$ in mg/l)	200	600

Biological parameters are important factor that determine quality of drinking water. It is more important than physical and chemical parameters in term of direct effect on human health. Some important biological characteristics affecting quality of drinking water includes bacteria, protozoa, virus and algae. Disinfection using

various Oxidizing agents can be used to remove the pathogenic bacteria in the drinking water. Somani & Ingole 2011 explains that there are various chemicals like Halogens, Hydrogen peroxide, lime, ozone which can free, water from the pathogenic bacteria [4]. In our study we also used Azadirachta indica, commonly known as margosa or neem tablet to see the effect of this natural material over pathogenic bacteria.

2.1. Natural Material Available for water purification

2.1.1. **Sand** is used for water filtration dates back 2,000 years. The Greeks and Romans used sand to remove sediment from the water in their pools and bathhouses. It is noted that a sand filter of 37.5 cm depth can clean the suspended particles up to 84.3% and the depth of 50 cm can clean the suspended particles up to 87% [5].

2.1.2. **Oysters** naturally filter toxins when they feed. The water passing through the oysters is purified enough to drink. In some parts of the world, natural oyster reefs are still the preferred method for water filtration. One adult size oyster can filter 154 liters of water per day [6]

2.1.3. **Activated Carbon/ Charcoal** is a slow, but effective, water filter. The carbon in charcoal helps remove toxins. Charcoal filters out particles down to 1 micron, including nitrogen oxide, lead and sulfur oxide. If you use charcoal at home, make sure you buy hard charcoal and wash it thoroughly before purifying the water. Dirty or soft charcoal will dissolve into the water instead of purifying it. Activated carbon is currently widely used as an adsorbent material in both water treatment plants. Activated carbon is characterized as a carbonaceous material with a highly porous internal structure, which is usually derived from the pyrolysis and chemical treatment of sources including wood, coal, nutshells, bamboo and other organic materials [7].

2.1.4. **Coconut** filters water by absorbing it through layers of fiber. Coconut milk is second only to water in purity. Commercial water filters often use coconut carbon filters to remove toxins and particles. The coconut husks, whether used commercially or in a do-it-yourself filter system, trap most particles, toxins and parasites, including cryptosporidium and giardia study shows that copper-impregnated coconut husk carbon can be used as an adsorbent for the effective removal of "Arsenic" [As (III)] from aqueous solutions. [8]

2.1.5. **Coriander** found in some areas which is a "bio absorbent" plants that are much more readily available and cheap. Cilantro leaves do so well at removing pollutants – even toxic metals such as lead – that a bunch of the herbs can be used as a replacement filter for commercial purification systems. The substance which is a combination of dried coriander and dried Ecklonia maxima seaweed in a ratio of 1:1 was the most effective in removing general heavy metals from contaminated water. [9]

2.1.6. **Neem/Neem oil** The seed contains substances that act as a coagulant and thereby assist to settle out particles and pathogens from water. In India, lentils and seeds from the Tamarind tree and several other plants have also been proven as effective coagulants for waters with high turbidity [4]. At a constant mixing time of 5 min, a range of Neem oil doses from 2.13 to 17.1 g /lit was found to be effective at disinfecting the isolated culture of E. coli in pure laboratory grade water, the inactivation of E. coli exhibited no clear dependence on the Neem oil dose [10]

3. Methodology

Drinking water purification involves several steps to ensure that water is safe and free from contaminants. The specific methods and technologies used can vary depending on the source water quality and the treatment facility, but here are the general steps involved in drinking water purification. In our "Natural Purifier" we have just replaces the materials with the natural available materials. We collected a random sample of water of a pond near kali dam Dahod Gujarat and treated the water with our natural water purifier as follows.

Figure I: Showing the Structural Arrangement of Model

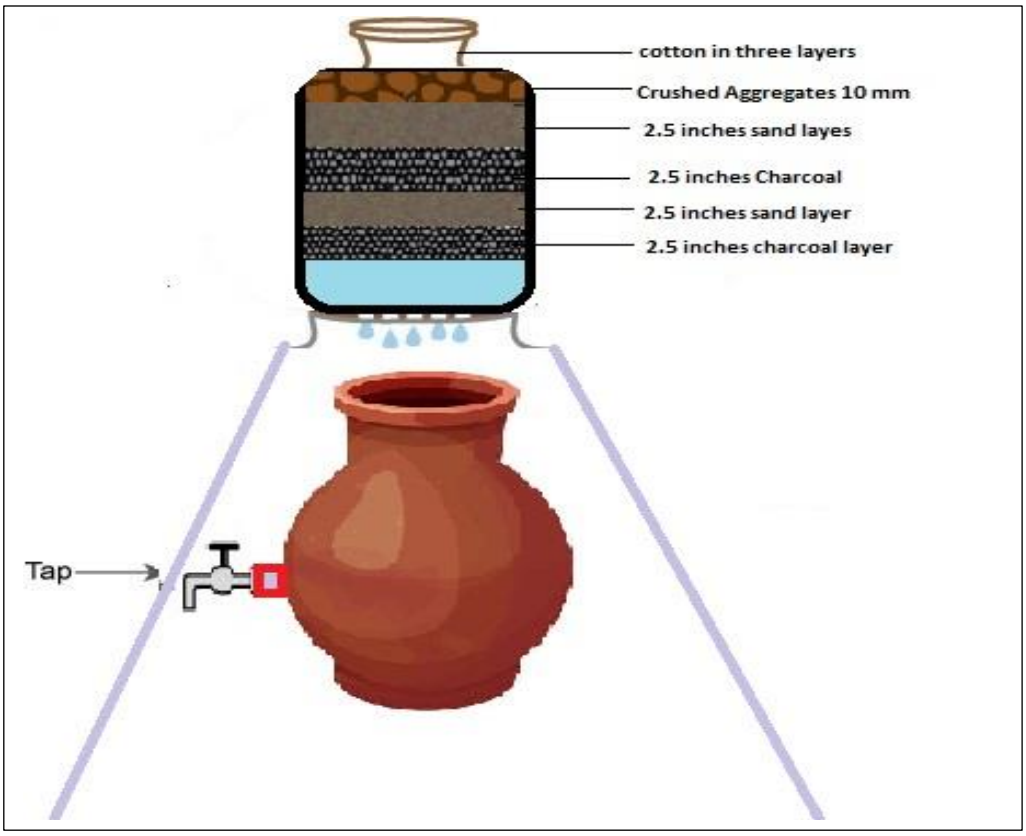

Figure II: Graphical image of the Model Structural

3.1. Screening- In screening we used 3 layer the cotton separated by the clean cotton cloth along with the crushed Aggregate of size 10mm. (approximate 2 inches) just blow it. which were quite effective and as per the certified water testing laboratory the turbidity level in the raw water was 41.7 NTU which was not fit as per the Indian standards of drinking [11] and after the treatment the turbidity lowered to 0.02 NTU. Although the neem tablet was very impactful disinfectant but it was imparting the higher turbidity to the water up to 17 NTU, a same study in 2009 suggests that neem may be used in the form of oil doses from 2.13 to 17.1 g /lit [10] for good results.

3.2. Filtration- The filtration aims to remove the micro suspended particle in the drinking water this also lowers the turbidity and mixed the water with the oxygen. In the present purifier we used 4 Alternative layers of

Charcoal & Sand (2.5 inches each) to filter the water. The size of sand particle may range from 4.75 mm and 0.075 mm. The charcoal powder worked as activated carbon. The activated carbon acts as a sponge and absorbs contaminants in water by absorbing them. The liquid's dissolved impurities move to the areas with the strongest attractive forces. So basically this layer was not only doing the Filtration of suspended particles but also helping in the Purification process of water.

3.3. Disinfection- The most-deadly impurities in the water are biological impurities that make the water extremely unsafe for use. Biological contaminants such as bacteria, protozoa, viruses, and parasites may lead to fatal waterborne diseases and health disorders. The minute organisms present in water lead to diseases such as typhoid fever, dysentery, and many other health problems.

We used Bleaching powder which is affordable as well as daily use material for the people with the dosage of 3mg/lit is more effective [12]

3.4. Biological Action- Water borne diseases spread mostly because of the bacteriological impurity in water. To remove the bacteria, present in the raw water sample we used the combined action of activated carbon with Bleaching power and activated carbon along with neem tablets. The biological test was conducted to examine the MPN No. (Most Probable number) which denotes the presence of coliform bacteria particularly E-coli in the water sample.

3.5. Pot in Pot Cooling- India lies near the equatorial position hence the average temperature in the summer season is 32–40 °C. according to the literature survey maximum temperatures in all the months have increased in India except a decreasing tendency in north central India in January [13] India lies near the equatorial position with extreme warm conditions in summer season. When we are talking about the affordability it also includes the expense in electricity and its maintenance. Almost each mechanism of cooling requires electricity in huge amount, hence looking for such requirement we used two concentric clay pots filled with wet sand placed at the bottom of the upward portion of present purifier as shown in the figure given below. This arrangement was quite significant and it has lowered the temperature of water up to 20°C since mainly the height of the pot, Radius of the significantly affect the cold zone temperature [14].

4. Cost of the Model

The approx. cost of our model of affordable natural water purifier was near about 1000 rupees although it was the cost of just a single working model in case of mass production this cost can be lowered to 500-600 INR (6 to7 USD) which is almost affordable for any house hold, daily wedge labor and the people living below the poverty line. A small startup or an NGO may provide such purifiers to improve the health of rural population. The operational cost of this experimental setup is also very less because of the nearby availability of the sand and charcoal.

5. Result & Discussion

The table III shows a highly turbid test result of raw water sample **DCW-1** along with the Basic range of pH value of nearby village pond. when the water is treated the results were within the drinking standards of IS 10500:2012 of sample **DCW-5** in table IV in each parameter. The powdered charcoal worked as an activated carbon and it reduces the bacteriological impurity as well. The water borne diseases are mostly because of the bacteriological impurities in water. The Table shows the

- Bacteriological test report of the raw water sample **DBW-1** which shows the result as the water is UNFIT due to the higher value of MPN No. at 37^0C which should be less than 2 when it is treated by the purifier setup the results of sample **DBW-2** was within the drinking range of Indian standards. The following points were observed during the purification process.
- Charcoal is helping in both ways in filtering the suspended particles as well as in the disinfection. So for a higher turbid of infectious water we can increase the number of charcoal layers.

- The neem tablet is imparting the bad taste even added in very small amount in water since the storage of our purifier is very small (5liters -10 liters). Although it is more effective than bleaching powder to remove E-coli bacteria from water.it may be useful for the purifier with large volumetric capacity.

Table III- Lab Result of the Raw water sample

TEST REPORT OF RAW WATER **Date of sampling- 14-03-2022** **Date of analysis- 15-03-2022** **Analysis Completion-16-04-2022**			
Main Source- Kali Dam		**Discipline- Chemical Testing**	**Group- Water**
Type of Sample- Raw water		**Date of issue**	**17-04-2022**
Village- Kaligam		**Habitat**	**Kaligam faliya**
Taluka- Dahod (District)		**District**	**Dahod**
Sample ID- DCW-1/03-22		**Sample type**	**Drinking Water**
Test report no.- 1/2022-23		**ULR NO- TC946322000000001F**	
s/SN	**PARAMETERS**	**UNIT**	**ANALYTICAL VAUE**
1	Colour	Hazen	5.70
2	Odour	As per IS:3025	Agreeable
3	Taste	As per IS:3025	Agreeable
4	Turbidity	NTU	17.7
5	pH at 25^0C	-	8.05
6	Conductivity at 25^0C	µS/cm	586
7	Total Dissolved Solids	mg/lit	232
8	Total Hardness (as$Caco_3$)	mg/lit	144
9	Calcium (as Ca^{+2})	mg/lit	34
10	Magnesium (as Ca^{+2})	mg/lit	14
11	Chloride	mg/lit	36
12	Sulphate	mg/lit	1.76
13	Nitrate	mg/lit	19.96
14	Fluoride	mg/lit	0.41
15	Total Alkalinity	mg/lit	148

Table IV- Lab Result of the Treated water sample

TEST REPORT OF TREATED WATER **Date of sampling- 14-03-2022** **Date of analysis- 15-03-2022** **Analysis Completion-16-04-2022**		
Main Source- Kali Dam	**Discipline- Chemical Testing**	**Group- Water**
Type of Sample- Raw water	**Date of issue**	**17-04-2022**
Village- Kaligam	**Habitat**	**Kaligam faliya**

Taluka- Dahod (District)		District	Dahod
Sample ID- DCW-5/03-22		Sample type	Drinking Water
Test report no.- 5/2022-23		ULR NO- TC946322000000005F	
s/SN	**PARAMETERS**	**UNIT**	**ANALYTICAL VAUE**
1	Colour	Hazen	0.01
2	Odour	As per IS:3025	Agreeable
3	Taste	As per IS:3025	Agreeable
4	Turbidity	NTU	0.02
5	pH at 25^0C	-	7.32
6	Conductivity at 25^0C	µS/cm	388
7	Total Dissolved Solids	mg/lit	218
8	Total Hardness (as$Caco_3$)	mg/lit	132
9	Calcium (as Ca^{+2})	mg/lit	30
10	Magnesium (as Ca^{+2})	mg/lit	13
11	Chloride	mg/lit	28
12	Sulphate	mg/lit	1.32
13	Nitrate	mg/lit	7.32
14	Fluoride	mg/lit	0.18
15	Total Alkalinity	mg/lit	740

Table V- Bacteriological Test of the Raw water sample

BACTERIOLOGICAL TEST REPORT OF RAW WATER

Date of sampling- 14-03-2022
Date of analysis- 14-03-2022

1	**DBW No.**	DBW-1
2	**Date of Collection**	14-03-2022
3	**Date of Arrival at Lab**	14-03-2022
4	**Source of Water Sample**	Reservoir of kalidam
5	**Village**	Kaligam
6	**Habitation**	Kaligam
7	**Taluka**	Dahod
8	**District**	Dahod
9	**APHA, AWWA, 9221-F Presence/Absence of Coliform Test at 37^0C**	PRESENCE
10	**APHA, AWWA, 9221-F Presence/Absence of E- Coli Test at 37^0C**	ABSENCE
11	**MPN of coliform per 100 ml of sample at 37^0C**	14

12	**MPN of fecal coliform per 100 ml of the sample at 44^0C**	<2
13	**OPTION FOR PORTABILITY**	UNFIT

Table VI- Bacteriological Test of the Treated water sample

BACTERIOLOGICAL TEST REPORT OF TREATED WATER **SAMPLE IS COLLECTED BY: SENDERS** **Date of sampling- 14-03-2022** **Date of analysis- 15-03-2022** **Analysis Completion-16-04-2022**		
1	**DBW No.**	DBW-2
2	**Date of Collection**	14-03-2022
3	**Date of Arrival at Lab**	14-03-2022
4	**Source of Water Sample**	Reservoir of kalidam
5	**Village**	Kaligam
6	**Habitation**	Kaligam
7	**Taluka**	Dahod
8	**District**	Dahod
9	**APHA, AWWA, 9221-F Presence/Absence of Coliform Test at 37^0C**	ABSENCE
10	**APHA, AWWA, 9221-F Presence/Absence of E- Coli Test at 37^0C**	ABSENCE
11	**MPN of coliform per 100 ml of sample at 37^0C**	<2
12	**MPN of fecal coliform per 100 ml of the sample at 44^0C**	<2
14	**OPTION FOR PORTABILITY**	FIT

6. Conclusion

Composite Water Management Index (CWMI) report 2018 of NITI Aayog [15] stated that in India near about two lakh people die every year due to inadequate access to safe water. In the same report of NITI Aayog it is estimated that about 600 million people may face water stress thus constituting about 40% of India's projected population by 2030. Hence it is very important to provide the safe drinkable water to the citizens of India. If we provide such Affordable water purifier to each and every household in India than the health index will surely improve. In current scenario India holds the highest population in the world & hence the health issues and the pandemic issues in India unwantedly affects the entire world. India’s infant mortality rate was recorded as32.5 per 1,000 live births in 2018. Hence such initiatives with the help of WHO & the government subsidies are advisable to improve the current situations in India.

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