WATER FILTERATION AND RECHARGING MODEL DEVELOPED BY USING DISPOSABLE WASTE WATER BOTTLES

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ABSTRACT: Soil plays an important role as a natural filter, which works as effective barrier to filter out the biochemical and biological properties of water passing through it. Moreover, it will work more effectively if the water passed through the designed filtration system. In this system the conventional filtering media with fineness modulus of 2.6 to 3.2 is placed over the Non Woven Geotextile Fabric (NWGF). The Geotextile fabric having mass per unit area varies typically between 100 gm/sqm to 1000 gm/sqm. A 2 mm thick Non Woven Polypropylene Geotextile (NWPG), having comparatively open and porous structure, would weigh around 180 g/sqm with cost of Rs/- 20/sq m.
This paper will focus on the experimental study and laboratory observations of designed and developed low cost filtration and recharging model. The motivational objective behind this experimental study is to develop the economical and efficient filtration system so that filtered water can be use for domestic and gardening purpose. This filtered water will be potable if it further passed through reverse osmosis process so that microbiological contamination can be avoided.
Keywords: Waste bottles, Non Woven Geotextile Fabric (NWGF), Filtration model, Economical and Efficient, Filtered water

1. INTRODUCTION

For every six water bottles we use, only one makes it to the recycling bin. The rest are sent to landfills. Or they end up as trash on the land and in rivers and other water bodies about 1,500,000 tons of plastic bottle waste per year. Plastic bottles take many hundreds of years to disintegrate and use a lot of fossil fuels and pollute the environment.
This research paper will be the solution towards the utilization of waste bottles. The interlocked waste bottles are arranged vertically in circular periphery of the metallic ring. About 135 liters of water can be stored and filtered. The water can be stored in the 27 vertical columns. Each vertical column comprises five interlocked bottles as shown in figure 3.

1.1 Objectives of Study

The India has 16 % of the global population and has 4 % of its fresh water resources. The estimates identify with the intention for surface and ground water availability is around 1869 Billion Cubic Meters (BCM) out of which 40 % is not available for use due to geological and topographical causes. The precipitated rain and snow contributes around 4000 billion cubic meters of fresh water most of which returns to the marine bodies through rivers. Total 92 % ground water extracted is used for agricultural activities whereas 5% utilized by industries and only 3% in domestic purpose. Further about 89% from surface water utilized by agricultural sector and 2% by industries the domestic activities consumes around 9% of total surface water.[1]
The upcoming water demand and recharging of available water sources will be at the prime importance of any developmental activity.

1.2 Need of study

The rapidly growing segments like industries, agriculture, supply chain etc and overall economical enrichment of society will increase the burden water demand. By the year 2050 India's demands for water will exceed all available sources of supply. At the same about 15 % of available aquifers are in crucial state and this percentage number will grow to 60 % in the coming 25 years unless there is alteration.[3] This study will be helpful to recharge the water sources by collecting the precipitation in the form of water.

1.3 India and Water Availability

Any country can be classify as 'water stressed' when water availability is less than 1700 cubic meter per head per annum while classified as 'water scarce' if it is less than 1000 cubic meter per head per annum. [4] In the India the availability of surface water in the year 1991 were 2309 cubic meters whereas in the year 2001 were 1902 cubic meters. [4] It has been expected to per head surface water availability is likely to be condensed to 1401 cubic meters and 1191 cubic meters by the years 2025 and year 2050 respectively. The per head water availability in the year 2010 was 1588 cubic meters against 5200 cubic meters of the year 1951 in the India.[4]

Table 1. Giving the facts about water availability in India

Sr. No.	Particulars	Ranges	Sr. No.	Particulars	Ranges
1	Area of the country as % of World Area	2.40%	6	Rank in water quality	122
2	Average annual rainfall	1160 mm and world average 1110 mm	7	Water as percentage of World Water	4%
3	Per head water availability in year 2010	1588 cubic meter	8	Rank in per head availability	132
4	Population as % of World Population	17.10%	9	Range of rainy days	5 to 150 days, Mostly during 15 days in 100 hrs
5	Range of rainfall distribution	150-11690 mm	10	Range of potential evapo-transpiration (PET)	1500-3500 mm

2. METHODOLOGY

2.1 Selection & Collection of Bottles

In order to reduce litter offered by the waste plastic bottles in the vicinity of the Parvati region of Pune city. We decide to select and to collect one liter of PET bottles from the hotels and restaurants within the study area. Around 100 numbers waste water bottles from 5 hotels are collected in one day of eight hours.

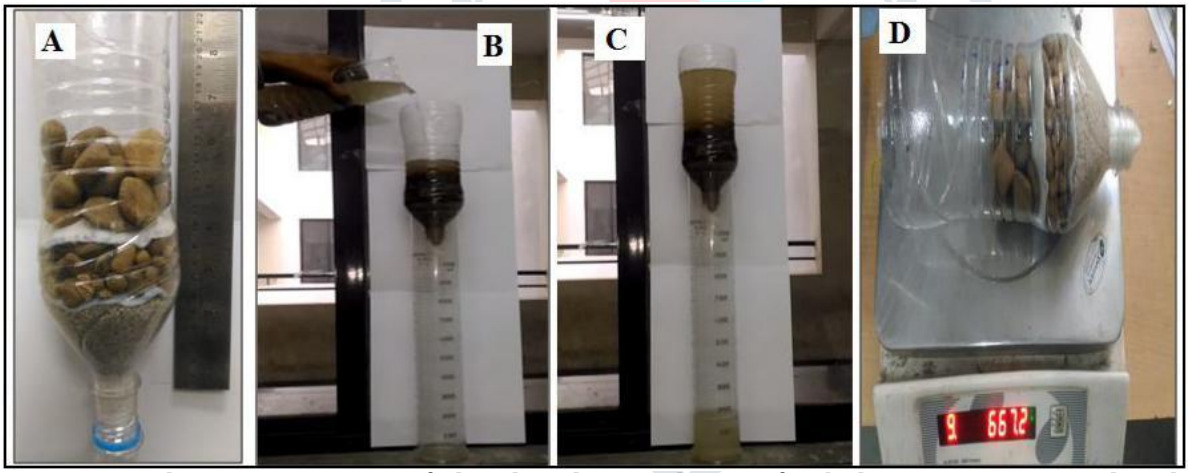

Fig. 1. Showing (A) Layers of placed media (B) Placing of turbid water over prepared media (C) Initial water quality before filtration and final quality collected in measuring jar after filtration (D) Weight of bottle and placed media with NWGF

2.2 Cleaning & Placing of media with NWGF

These collected bottles are cleaned with potable water and allow them to dry. By taking one dried bottle which was cutted from the bottom to place the granular media having fineness modulus of 2.6 to 3.2. The granular media having particle size varies from 3 mm to 10 mm. In the beginning at tapered mouth of the bottle the 82 mm Φ in conical manner is placed. The media of 3 mm (figure 2(A)) size is placed upto the depth of 45 mm. Once the 45 mm depth is covered with media another 82 mm Φ NWFG strip is placed at top of 3mm size media. The 35mm depth covered by the 5-8 mm (figure 2 (B&C)) size mixed media. Another strip of NWGF is placed above which 50mm thick coarse media of 10mm size (figure 2(D&E)) is placed. As shown in fig 01 total depth of filtering media is 150 mm including 20 mm depth of NWGF at tapered end of bottle and total weight of media is 667.2 gms as shown in figure 1(D)

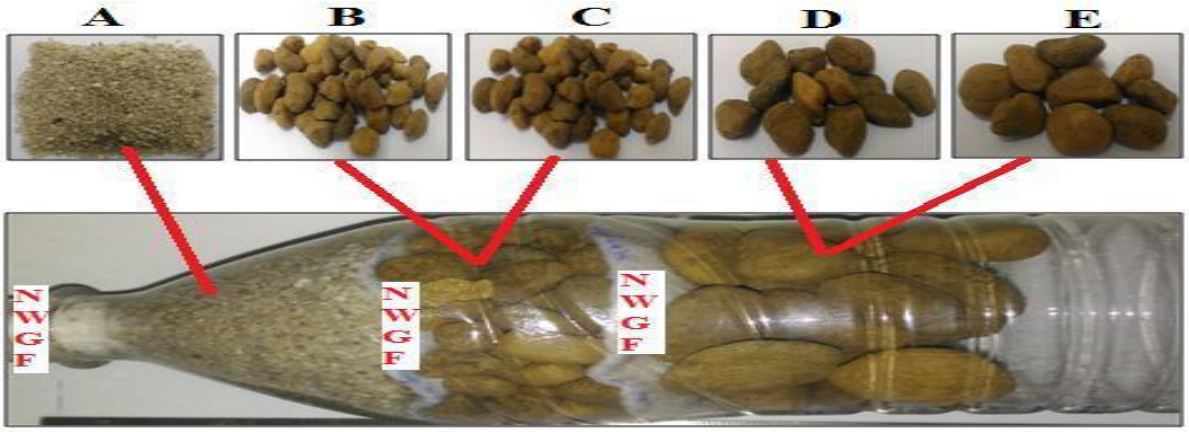

Fig. 2. Showing different media placed in bottle for filtration with Non Woven Geo-textile Fabric (NWGF)

2.3 Interlocking and column formation

As shown in fig 02 to prepare the vertical columns for storage and filtering of water, the interlocking of the water bottles are done by introducing the 24 mm Φ orifice at flat bottom portion of bottle, so that the outer edge of 28 mm Φ the tapered end will interlocked properly inside the bottom orifice.

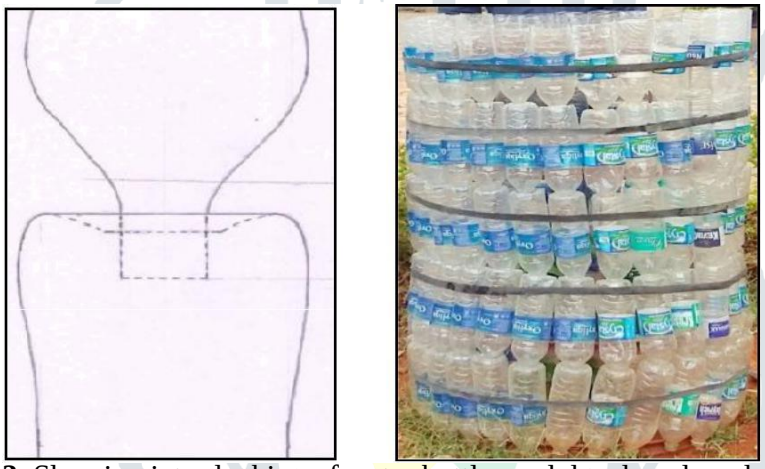

Fig. 3. Showing inter locking of water bottles and developed model

2.4 Description of used NWGF

Nonwoven geo-textiles are adaptable fabrics that are felt-like in appearance. The main functions for these products are filtration and separation. The most common nonwoven is a needle-punched product. In this study we used NBT 10/100 and its properties are as given in table 02[6]

Table 2. Properties used Non Woven Geo-textile Fabric

Sr. No.	Parameters of NWGF (NBT 10/100)	Value of NWGF	Unit	Conforming Standard
1	Weight	100	g/m^2	EN ISO 9864
2	Tensile Strength	6.5	kN/m	EN ISO 10319
3	Elongation	40	%	EN ISO 10319
4	Static Puncture (CBR)	1.05	kN	EN ISO 12236
5	Dynamic Perforation (Cone drop test)	--	mm	EN ISO 13433
6	Water permeability normal to the plane	110	$l/m^2/s$	EN ISO 11058
7	Opening Size	0.11	mm	EN ISO 12956
8	Thickness at 2 kPa	0.6	mm	EN ISO 9863

3. Results & Discussion

The four water samples were tested before and after it passed through the developed filtration mechanism. It was observed that the appearance initially was pale for water sample W1,W2,W3 and W4. There was no observation for the color and odor for collected samples. The turbidity in 7.2 NTU initially higher for water sample W1 before passing which reduced to 6.2 NTU after passing.

Table 3. Water parameters before passing through prepared media

Sr. No	Tested Parameters	Tested Samples			
		W1	W2	W3	W4
1	Appearance	Pale	Pale	Pale	Pale
2	Color	NA	NA	NA	NA
3	Odor	NA	NA	NA	NA
4	Turbidity- NTU	7.2	6.4	6.8	7.1
5	TDS- Total Dissolved solids	370	385	397	403
6	EC- Electrical Conductivity	400	422	453	487
7	pH	7.22	7.15	7.3	6.8

Table 4. Water parameters before after through prepared media

Sr. No.	Tested Parameters	Tested Samples			
		W1	W2	W3	W4
1	Appearance	Light Pale	Light Pale	Light Pale	Light Pale
2	Color	NA	NA	NA	NA
3	Odor	NA	NA	NA	NA
4	Turbidity- NTU	6.2	5.3	5.8	6.4
5	TDS- Total Dissolved solids	314	300	283	380
6	EC- Electrical Conductivity	293	340	362	407
7	pH	6.8	7.2	7.0	6.5

The total dissolved solids (TDS) for W4 was 403 ppm which came down to 380 ppm, the electrical conductivity for W4 was 487 S/m also higher due to higher TDS concentration for the same sample but it was observed that it was came down 407 S/m after passing at the TDS concentration of 380 ppm. As shown in Table no 03 and 04 all collected and tested water samples having pH ranging from 6.4 to 7.2 on pH scale.

4. CONCLUSION

The size and shape of model can be modified into any geometrical shape; number of bottles can be increased or decreased as per storage and filtration requirements. The filtration rate through one bottle column per hour is about 150 to 200 ml. The water quality can be enhanced by changing the filtration rate by modification in media layers and combination of geo-textiles fabric. The filtered water will be potable if it further passed through reverse osmosis process so that microbiological contamination can be avoided.

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