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Low Cost Household Water Treatment Systems: A Review

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***Abstract*- Due to centralized water treatment system it is easy to get treated water in city. But it is difficult to get treated water in rural area. So this review paper contains detailed literature on low cost household water treatment methods. In this review paper various low cost household water treatment methods such as ceramic candle filter, silver impregnated pot filter, bio sand filter. Also various media used in this treatment methods such as activated carbon, resins etc. are used to treat water. This review paper compares efficiency of different household water treatment methods.**

Key words- Household water treatment methods, silver nano particle, resins, bio sand filter, activated carbon.

INTRODUCTION

Water is one of the world's most abundant resources, but less than 1% of the global supply of water is available and safe for human consumption. Where it is available, the cost of potable water is rising due to increasing energy costs, growing populations, and climatic or other environmental issues. The most important aspect in improving the health of the people is to provide communities with safe and clean water. A large percentage of these people are from the developing world, especially in the rural areas and low-income communities. In many developing countries, access to clean and safe water is a major problem. Poor water quality is a key cause of poor livelihood and poor health with 80% of all diseases in developing countries being water related.

The pollution and contamination of surface and ground water source has greatly impaired the quality of available water. The major impurities in surface water are turbidity, pathogens, and dissolved solids. More than 80 % of the Indian population live in rural areas, but only about 60 % of them have access to some form of potable water supply, with only about 20 % having piped water supply. It has not been feasible to cover all the villages with potable water supplies because of various constraints, such as scattered and inaccessible nature of village, non-availability of nearby water sources, non-availability of adequate funds to take up those projects which may serve only a few people, and non-availability of power for the required period, and hence may not become financially viable. [1]

LITERATURE REVIEW

Literature based on candle filter

1. Shreshta(2010) assessed effectiveness of ceramic candle filter for turbidity, suspended materials and pathogens removal from water. Removal takes place by physical process such as mechanical trapping and adsorption on the ceramic candles, which have micro-scale pores. Water is poured into the upper of two container and flows through a candle situated in the bottom. Usually the containers have a diameter of about 8 L and flow rate of 1-2 L per hour per candle. Removal efficiency of turbidity is 90-95%. It was seen that ceramic candle filter are easy to set up and operate, cheap and effective in removing bacteria and turbidity from water. Due to limited flow rate and storage capacity, filters are only suitable for small families, organisation or school classroom.

2. D. van Halem(2008) did the study on low-cost technology to treat water at the household level by using ceramic silver-impregnated pot filter (CSF). The CSF consists of a pot-shaped filter element that is placed in a plastic receptacle. Flow rate observed was 1-3 l/hr. Once the filter element has its shape it is fired in a kiln and the sawdust is combusted to leave porous material. The filter element is impregnated with a mixture of colloidal silver, for assumed disinfection purposes. It was observed that 95-98% pathogens were killed by using silver with ceramic pot filter.

Literature based on Bio sand filter

3. Jason Corey(2008) conducted study on performance evaluation of Bio Sand Filters, a method of Household Water Treatment. Field methods included microbial and turbidity water quality testing. The average filtration efficiency was found to be 98% for total coliforms, and 88% for turbidity. When water flows through the filter physical straining removes pathogens, iron, turbidity from drinking water. Biosand filter is proven technology which removes pathogens. And it is also somewhat effective for removal of E-coli Bio sand filter are suitable for the treatment of water at household-school or community level.

4. Qaisar Mahmood *et. al.*,(2011) studied a low cost household sand filter (HSF) to treat low quality drinking water in disaster-hit areas of northern Pakistan. Two villages were randomly selected for practical demonstration of a low cost drinking water treatment system in earthquake affected areas. The on-site performance of HSF was monitored during the operational period. The HSF was of dimensions of the inner diameter of the pipe was 15 cm; length of 90 cm; and wall thickness of 3.7 cm with 10 cm plain cement

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concrete at the bottom. It was stated that gravels with effective radii of about 15 mm were packed at the bottom to the depth of 5 cm followed by another packing of 5 cm depth by support gravels (6 mm). It was followed by 45 cm depth of sand with effective size (D10) which ranged from 0.19 to 0.22 mm in diameter and D60 whose size ranged from 0.66 to 0.90 mm. HSF operated for 10 days which shows results as 97% reduction in E. coli, total coliforms and 90-95% turbidity reduction was evidenced.

Literature based on activated carbon

5. Ratnoji and Singh(2014) did the analysis on activated carbon (AC) derived from coconut shell. These AC's were assembled at different depths independently as well as in combination. This work examined reduction and removal of iron, turbidity, biochemical oxygen demand (BOD) and chemical oxygen demand (COD) in river water by making different arrangements of CS-AC (Coconut Shell-Activated carbon) in the filtration unit. Also its comparison with sand filter, a conventional practice in water treatment plants in India was done to reduce these parameters. Finer grade activated carbon (AC-III) showed the maximum iron removal (95%). Turbidity was reduced to 1.7 NTU from 2.1 NTU.

6. Mwabi *et. al.*,(2011) assessed household water treatment systems by providing a solution to the production of safe drinking water by the low-income communities of Southern Africa. In this research comparison between four filters was done. Prior to use, all the buckets, sand, gravel and zeolites used for the construction of filter units were washed thoroughly using tap water and rinsed several times with distilled water and then placed in a laminar flow for sterilisation under UV light for 24 hours. Synthetic and environmental samples were used to evaluate the performance of each filter unit in removing or reducing the chemical and bacterial contaminants. The flow rate obtained for each filter unit during the study period were within the recommended limits. (171lit/hr, 167lit/hr, 6.4lit/hr, 3.5lit/hr for the BSF (Biosand Filter), BF (Bucket Filter), CCF (Ceramic Candle Filter) and SIPP (Silver-Impregnated Porous pot filter) etc. The highest removal performance of turbidity is 95% by CCF and 94% percentage removal of pathogenic bacteria by the BSF ranged between 98% and 100%.

CRITICAL ANALYSIS- DISCUSSION

The literature review showed that extensive research has been carried out to treat the drinking water economically. The studies include various materials used as media for treatment. The materials include colloidal silver, ceramic candle filter, activated carbon, sand used to prepare different water treatment units.

These water treatments are mainly for low income community and rural communities. It was mainly focused on removing turbidity, E-coli and some part of total dissolved solids.

Possible modifications for water treatment

Use of activated carbon along with ceramic candle filter

As activated carbon is use to remove organic dissolved solid which is some part of total dissolved solid. Also it is used to remove odour and taste. So combination of ceramic candle filter and activated carbon can be shown better efficiency in water treatment.

Use of blotting paper to prepare silver nano particle

Silver is used for disinfection purpose. Use of silver shows 95-98% removal of pathogens. To prepare silver nanoparticle, blotting paper is immersed in silver nitrate solution with sodium borohydride and sodium tricitrite with proper concentration

Use of resins for hardness removal

As ground water is extensively used for drinking purpose. But it has high amount of hardness. So provision of resins after sand filtration is required to reduce amount of hardness present in it. It can also regenerate after being used.

CONCLUSION

Household water treatment at low cost is needed for rural and low income community. The setup prepared from various materials can efficiently treat the water. Maintenance, low flow rate, these are the problems mainly related to household water treatment. Bio sand filters, ceramic candle with activated carbon filter, pot filter along with silver nanoparticle are the setups that economically treat water.

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