Biosand Water Filter: A Boon

Deepali Jadhav[1], Dr. M. Husain[2], Prof.F.I.Chavan[3]

[1] *P. G. Student, Department of Civil Engineering, SSBT'S College of Engineering & Technology. Bambhori, Jalgaon.Maharashtra,India*

[2] *Professor & Head of Department of Civil Engineering, SSBT'S College of Engineering & Technology, Bambhori, Jalgaon, Maharashtra,India*

[3] *Professor, Department of Civil Engineering, SSBT'S College of Engineering & Technology, Bambhori, Jalgaon, Maharashtra,India*

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Abstract - ***The BSF technology has been patented in Canada, the United States and several other countries. BSF technology development was greatly accelerated by opportunities for its commercialization for humanitarian purposes. BSF technology is not only limited to household concrete filters but also plastic, stainless steel, and concrete BSF's ranging in capacity from 20 to 1,000,000 liters per hour are available. Household concrete BSF can be accessed & implemented everyone worldwide, without limitation, provided the personnel are appropriately trained. The Biosand Water Filter (BSF) is a technology which has been implemented in 70 countries worldwide to address water quality concerns. The BSF can remove 90 to 99% of waterborne pathogens .***

Key Words: *— Biosand filter (BSF)1, HWTS (household water treatment system)2, Schmutzdecke3, Moringa4.*

1. INTRODUCTION

Nearly one fifth or 1.1 billion people of the world population are without access to improved water supply. Figure 1 illustrates the global differences in improved drinking water use. Within one region, urban coverage is mostly higher than rural coverage, with the greatest differences between urban and rural water access in Africa and Oceania. In 1990, 77 % of the world population used improved drinking water. Global coverage in 2002 reached 83 %, putting the world on track to achieve the MDG target. Between 1990 and 2002, the region that made the greatest progress was South Asia, which increased coverage from 71 – 84 %. This jump was fuelled primarily by increased use of improved water sources in India, with a population of over 1 billion people. between 1990 and 2002, progress in sub-Saharan Africa was also impressive: coverage increased from 49 – 58 %. But this falls far short of the progress needed to achieve the MDG target to reduce by half the proportion of people without sustainable access to safe drinking water by 2015. Obstacles to accelerating the rate of progress in sub-Saharan Africa include conflict and political instability, high rates of population growth and low priority given to water and sanitation. Despite these obstacles, decentralising responsibility, ownership and providing a choice of service levels to communities, based on their ability and willingness to pay, are among the approaches shown to be effective in speeding up progress. [2]

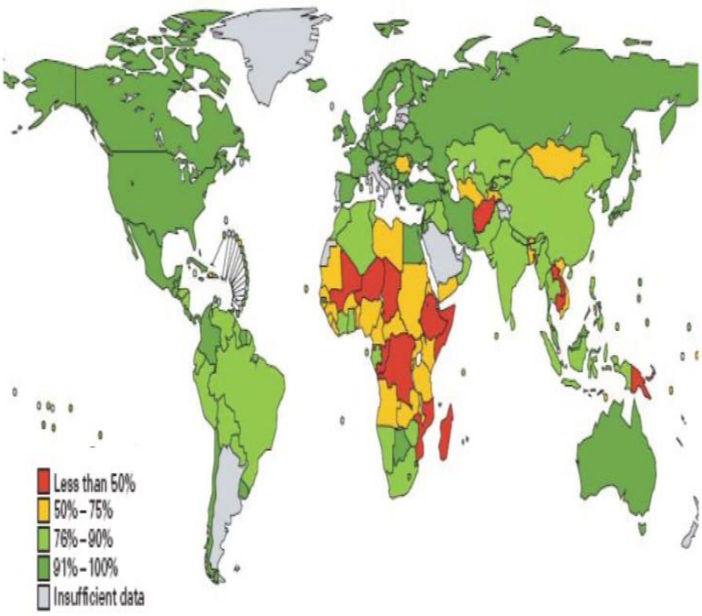

Fig -1. Percentage of population using improved drinking water sources in 2004.

2. THE OBJECTIVE OF HOUSEHOLD WATER TREATMENT

Currently, 1.1 billion people lack access to improved water sources (e.g. a household connection or a public standpipe). The Millennium Development Goal 7, Target 10, calls for reducing by half the proportion of people without sustainable access to safe drinking water by 2015. Reaching this target implies tackling both the quantity and quality dimensions to drinking water provision. However, studies suggest that depending on local conditions, a significant proportion of water from these sources may be contaminated. In the light of these findings, great efforts are required not only to extend services to the unserved but also to ensure these services are indeed supplying safe water. A recently published study estimated that improvements in drinking water quality through household water treatment lead to a reduction of diarrhoea episodes by 39%. Household-level interventions can make an immediate contribution to the safety component of this target and would significantly contribute to meeting the MDGs in situations where access to water supplies is secure but household water quality is not ensured. The availability of sufficient water is key to a consistent practice of hygiene behaviour. Therefore, the objective of HWTS is not to replace the installation of water supply infrastructure but to complement the effort in providing safe drinking water to the consumers and, therewith, contribute to reducing global diarrhoea. Focus of this module is on the treatment of water at household level. It addresses the systems and technologies used to improve the microbiological water quality, their operation, as well as their advantages and limitations. The question of safe storage of drinking water is also discussed. The aspects of water resource management and water supply are not discussed in detail in this Module. The availability of sufficient water is key to a consistent practice of hygiene behaviour. A HWTS must:

- Reduce the risk of disease transmission through drinking water by supplying safe water achieved through
  - protection of the source
  - treatment at the source
  - safe delivery
  - treatment at household level
  - safe storage to prevent recontamination
- Be affordable to all
- Be easy to operate and maintain
- Be culturally acceptable [2]

3. BIOSAND FILTRATION

The BSF is very similar to the slow sand filters but its use is on a much smaller house hold scale than slow sand filtration. Moreover, biosand filtration is still a relatively new technology that is being applied in the developing world prior to the implementation of the BSF, studies should be completed on the social, economic, and political factors of the developing country of interest.

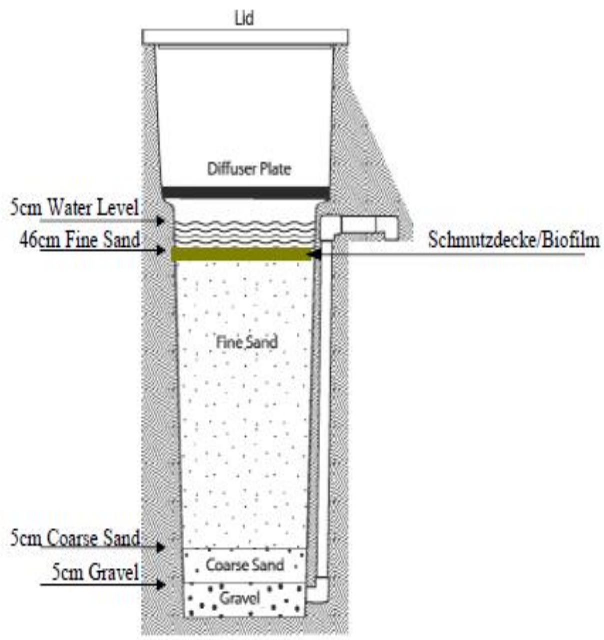

Fig -2: Illustration of a BSF unit

The function of the BSF begins with the raw water entering into the top of the filter where a diffuser plate is situated above the sand bed and dissipates the water at a regulated flow. So as to prevent the disturbance of the biofilm, the flow should be regulated. The water travels slowly through the sand bed of varying size and then collects at the base of the filter. The filtered water is driven out of the filter through PVC piping. In both BSF & slow sand filter, due to the decreasing pore size caused by the deposition of particles, the majority of the filtration and turbidity removal occurs at the top layer of the sand bed. The BSF removes the pathogens as the suspended solids pass through the sand in the filter, they will collide and adsorb onto the sand particles. The gradual formation of the biofilm happens as the bacteria and suspended solids begin to increase in the greatest density at the top layer of the sand, The biofilm layer is also known as the Schmutzdecke or dirt blanket. The Schmutzdecke consists of algae, bacteria, and zooplankton. It requires the water level to be 5cm above the biofilm in order to survive because the biofilm needs an aquatic environment and a constant influx of oxygen. The suffocation of the biofilm will happen if the water level above the biofilm rises above 5cm, the oxygen will not diffuse to the Schmutzdecke layer. Also if the water level is below 5cm then the flow of the water from the diffuser will lead to disturbance of the biofilm. It is therefore very important to maintain the water level at 5cm.

The biofilm system operates in multiple biological and physical mechanisms.
The biological mechanisms include:

1. Predation: bacteria and other pathogens are consumed by micro-organisms in the Schmutzdecke.
2. Scavenging: organisms such as aquatic worms that are found in the lower layers of the sand beds scavenge the detritus.
3. Natural death/inactivation: E Coli percentage decreases once they are introduced into the filter supernatant water.
4. Metabolic breakdown: this happens as the organic carbon is partially reduced.
The physical mechanisms include:
1. Straining: particles that are too large to pass through the media grain are captured.
2. Adsorption: organic removals through a physical process.

Some of the main benefits of the BSF include:
1) Intermittent flow is possible and without any decrease in performance can be used only during the times when treatment is required
2) Pre-treatment or any other treatment process can be used either before or after the BSF.
3) BSF has a faster flow rate whereas the traditional slow sand filtration rates are slow (0.6 m/h against 0.1m/hr).
4) Surface scraping, media disposal or replacement is not required and wastage of water is very less.
BSF comprises of a rectangular, concrete box, a metal or plastic diffuser plate, PVC piping, and specified layers of sand.

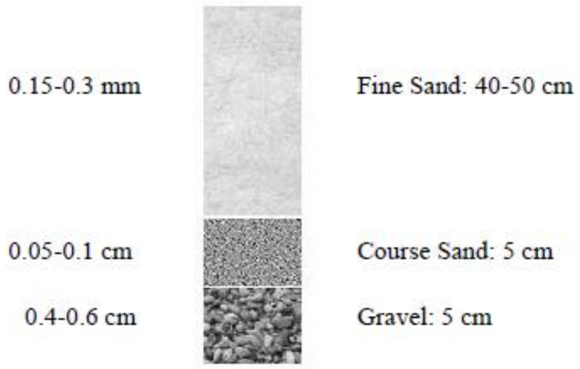

Fig -3: BSF media size (Basu, Cleary, 2003)

The BSF is versatile and the biological treatment of the raw water is quite successful, there are certain drawbacks of the BSF technology. The drawbacks are:
1. High turbidity during monsoon seasons, where the high amount of rain and runoff greatly increase the turbidity. Particle deposition happens and pore size decreases due to high turbidity. The flow rate of the BSF is reduced due to frequent clogging of the top layer of the sand.
2. The cost of the BSF is high in most developing countries.

To overcome the BSF's problems with respect to high turbidities clogging the BSF, following pre-treatment alternatives are suggested.

- Installation of roughing filters, where one or two rapid filters in series would be installed before the BSF. This will resolves the high turbidity problems.
- Moringa tree seeds as a coagulant: Past studies showed that the Moringa solution of 3-24 ml/L can lower the turbidity levels to 5 NTU. Low cost and efficiency of the powered Moringa coagulant makes it a highly recommended pre-treatment method in regions where Moringa trees are readily available.
- Use of a sari cloth: Many local people in India use this method as it is cheapest & readily available. Sari filter with pore size of 20μm can capture many of the suspended solids and bacteria. Because of its simplicity and high particle removal capabilities, the sari cloth filtration is one of the preferred pre-treatment methods. [3]

4. CONCLUSIONS

Prior to the implementation of the BSF, studies should be completed on the social, economic, and political factors of the developing country of interest. Along with studies on the socio-economic situation, education is crucial to the success of the BSF being properly operated by the local people. Only then could the BSF be a potentially sustainable and appropriate technology. It is essential for the implementation of large scale BSF project (i.e. over 100 BSF being implemented in a developing country) to form a highly interdisciplinary team in order to tackle the social, economical, health, and educational facets that the project will face.

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