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Water conditioning system in rural and urban areas of India, current practices and future recommendation

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Abstract:

Water is the most vital resource & raw material of the 21st century. Thus a conditioning/ treatment of water as well as water reuse are becoming a subject of global & national significance. So, this paper presents a review of various water conditioning system in rural and urban areas of India. A study a various government policies in the field of water conditioning is also taken into consideration and their socio-economic impact on society. This paper also presents the merits & demerits of current water conditioning system in India and recommends a portable water conditioning system which is highly reliable & economical.

Keywords — **Wastewater,Sedimentation,Phase separation,Oxidation,Chemical oxidation,BOD.**

1. INTRODUCTION

With two third of the earth's surface covered by water and the human body consisting of 75% of it, is evidently clear that water is one of the prime element responsible for life on earth. But , with rapidly increasing population and decreasing water resources, wastewater is becoming a important resource. So, in this era of 'sustainable development' various technological innovations are required in the field of water conditioning.

At global level, only about 3% of water on our planet is fresh & of these just 10% can be exploited economically. It is estimated that 1.1 billion people lack access to clean drinking water and there is a water shortage in already 30 countries.

At national level, 21% of the communicable diseases are water related. Of these diseases, diarrhea alone is estimated to have killed over 5,35,000 Indians in 2004.

II. STATUS OF WATER CONDITIONING IN INDIA

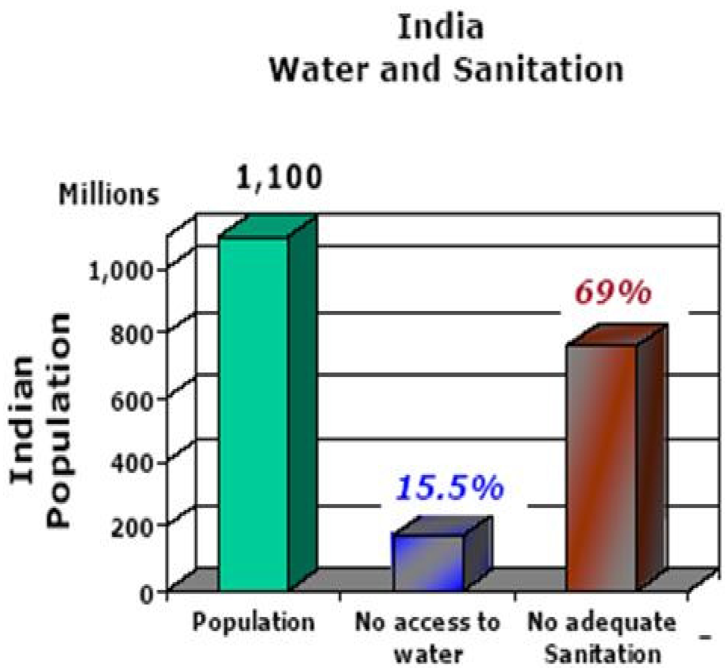
According to the NEERI's (National Environmental Engineering Research Institute) report only 24% of wastewater is conditioned in India and over 76% of wastewater remains untreated.

Total wastewater generated= 25305 MLD

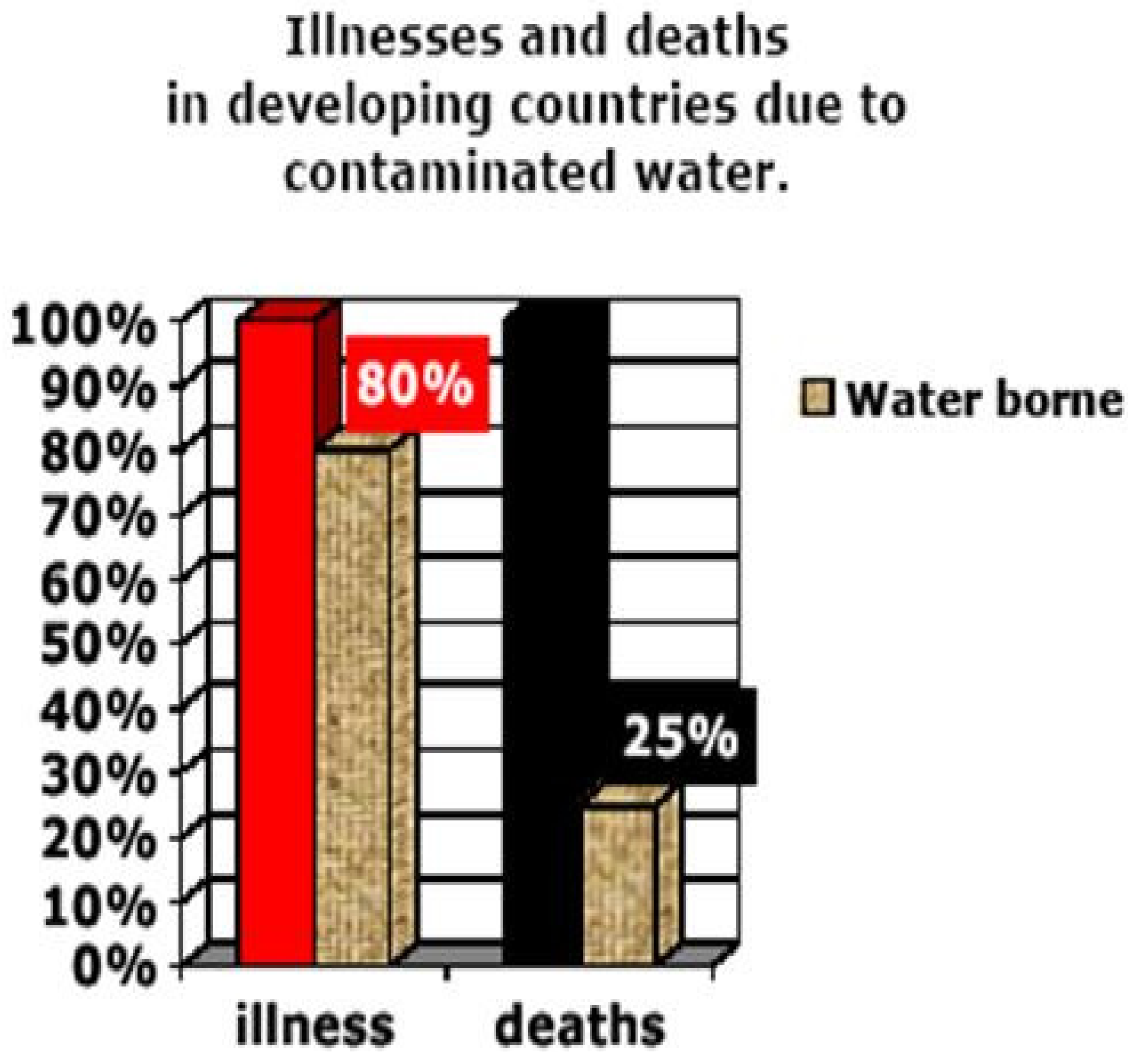
Total wastewater treated= 6015 MLD

Untreated wastewater discharged= 19290 MLD

It is estimated that over 15.5% of Indians don't have access to water and 69% of population don't have adequate saniation.



Among the developing countries it is estimated that over 80% of the population get ill due to water related communicable diseases.



2.1 Government schemes:

- National Mission for Clean Ganga. (NMCG)
- National Rural Drinking Water Programme. (NRDWP)
- National Urban Sanitation Policy.
- Area Development Plan (5 yr plans)
- “WATER App” of MDWS.

- JNNURAM
- SRA
- National Lake Conservation Plan
- National health policy- 2017 (safe water & sanitation by 2020)
- UN sustainable development goal 2030

3. WATER CONDITIONING SYSTEM IN RURAL AREAS

"DEWATS" i.e. "Decentralize Water Treatment System" is one of the most functional and relevant water conditioning system in rural India. Waste water is collected from individual source, treated and disposed/ reused near the source. Low cost, low maintenance are the main features of this system as compare to other systems.

Following are the modules wise explanation of DEWATS system:-

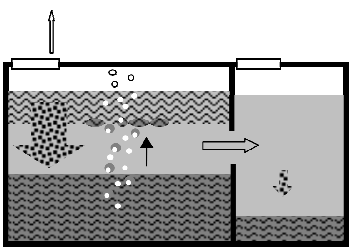


Fig. 1

In this module, two principle treatment takes place: mechanical treatment through sedimentation and floatation of solids, and biological decomposition through activity of anaerobic microorganism in the activated sludge. Fresh wastewater is biologically treated by getting in contact with the active sludge on the tank's bottom. Excessive sludge accumulation is avoided through sludge stabilisation by anaerobic digestion. The clarified layer flows through the outlet. The treatment efficiency of septic tank is in the range of 25-35% COD removal. Pathogens and nutrients are barely removed. Septic tank can be used for primary treatment, prior to secondary or even tertiary treatment.

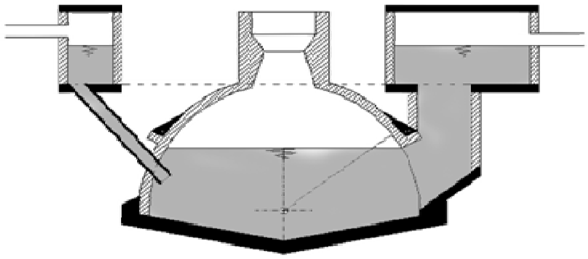


Fig. 2

Within a biogas digester, the new incoming influent is thoroughly mixed with the old substrate and the sludge. However, settle able solids settle at the bottom, where a sludge layer forms, which has to be removed periodically every 1-2 years. In most cases, the sludge is excavated by hydraulic pressure through special desludging pipes. Besides the mechanical removal of solids, anaerobic bacteria degrade organics and the sludge is digested anaerobically. Biogas production is therefore high, hence, utilisation of biogas is recommended, in which case, the plant must be gas-tight. Biogas is collected in an attached gas collection chamber (bigger plants) or under the digester's dome, which can be fixed or floating.

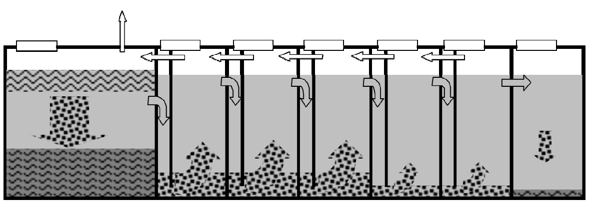
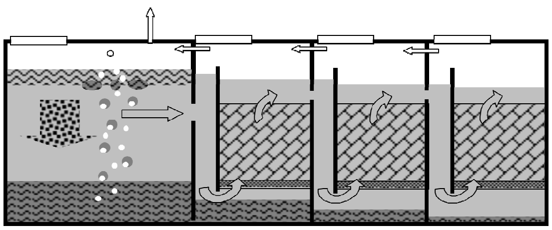


Fig. 3

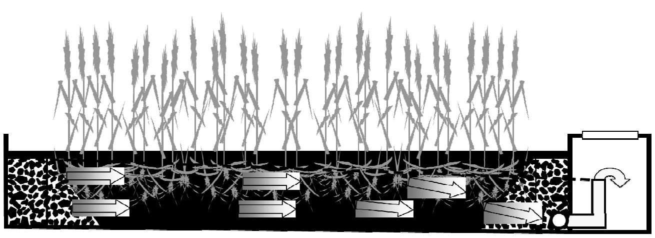
The ABR consists of a series of (at least 4) chamber, in which the wastewater flows upstream. Baffle walls or pipes direct the wastewater stream between the individual chambers from top to bottom. At the bottom of each chamber, active sludge is retained. During inflow into the chamber, wastewater is forced to pass through the activated sludge blanket whereby it is inoculated with the wastewater organism, which decompose the contained pollutants. In the first chamber, easily degradable substance are broken down while in the following chambers, decomposition of less decomposable substances take place. An equal distribution of fresh wastewater and a close contact between fresh influent and old active sludge are important process features, which is contrary to the principle of the imhoff tank. The wastewater flows upstream through each chamber with the effect that sludge particles settle against the upflow of the water. This provides the possibility of intensive contact between sludge and fresh incoming liquid. The wastewater flow between the chambers is facilitated by baffle walls or a parallel series of PVC –pipes which lead from the upper outlet of one chamber to the bottom of the following chamber; hence, the wastewater is directly exposed to the active sludge in the next chamber. The settled sludge must be removed periodically; however. Some sludge should always be left for continuous efficiency. In the first chamber, more sludge can be expected than in letter chambers, which determines the time of removal. The last chamber can have a filter in it's upper part to hold back eventual solid particles.

Fig. 4



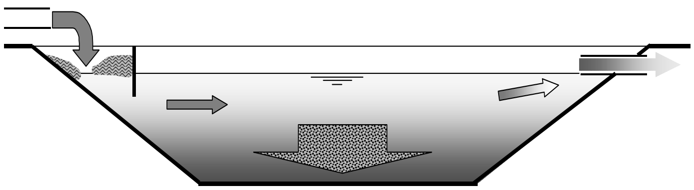
In anaerobic filter, intensive contact is facilitated between the wastewater and the bacterial biomass whereby organic matter is digested with short retention times. AF's are filled with special filter material, such as gravel, rocks, cinder, or plastic pieces. Appropriate materials have a relatively large surface area where the bacteria can fix itself. A rough surface provides a larger area. Most microorganisms are immobile, fixed on the surface of this filter material and the reactor walls; however, some bacteria are also in suspension. Anaerobic filters may be operated as down-flow or up-flow system. The up-flow system is normally preferred as the risk of washing out active bacteria is less. However, backwashing is easier with the down-flow system. An important design criterion is even distribution of wastewater across the filter area. The provision of adequate space of free water before the filter and the sae before the outet pipe supports equal distribution.

Fig. 5



In the planted gravel filter, the pre-treated wastewater flows horizontally, below surface, through the root zone of the plants. A distribution system in the inlet ensures equal distribution across the whole width, which is essential for an efficient treatment performance. The filter body is permanently soaked with water and operates partly aerobic in the top layer(free oxygen present), partly anoxic in the middle layer (no free oxygen but nitrate present) and partly anaerobic in the bottom layer. Oxygen reaches into the filter through gas exchange at the surface and through the roots of the plants. The filters are covered by suitable plantation i.e. plants which can grow on wastewater and whose roots go deep and spread wide. To an extent, the performance also depends on the species of plant chosen. The treatment process in horizontal ground filters is complex. It consists of the physical process of filtration, the intake of oxygen as well as the influence of plantation on the biological treatment process. Even if all influencing factor would be known, it is still their interaction which is difficult to predict. Generally, nutrients are removed in the filter through absorption by the plants roots. Pathogens are removed and eliminated through natural die-off, UV-exposition, adherence, and antibiotic released by the roots. BOD and COD are further reduced through biological aerobic and anaerobic composition in the respective layers.

Fig. 6

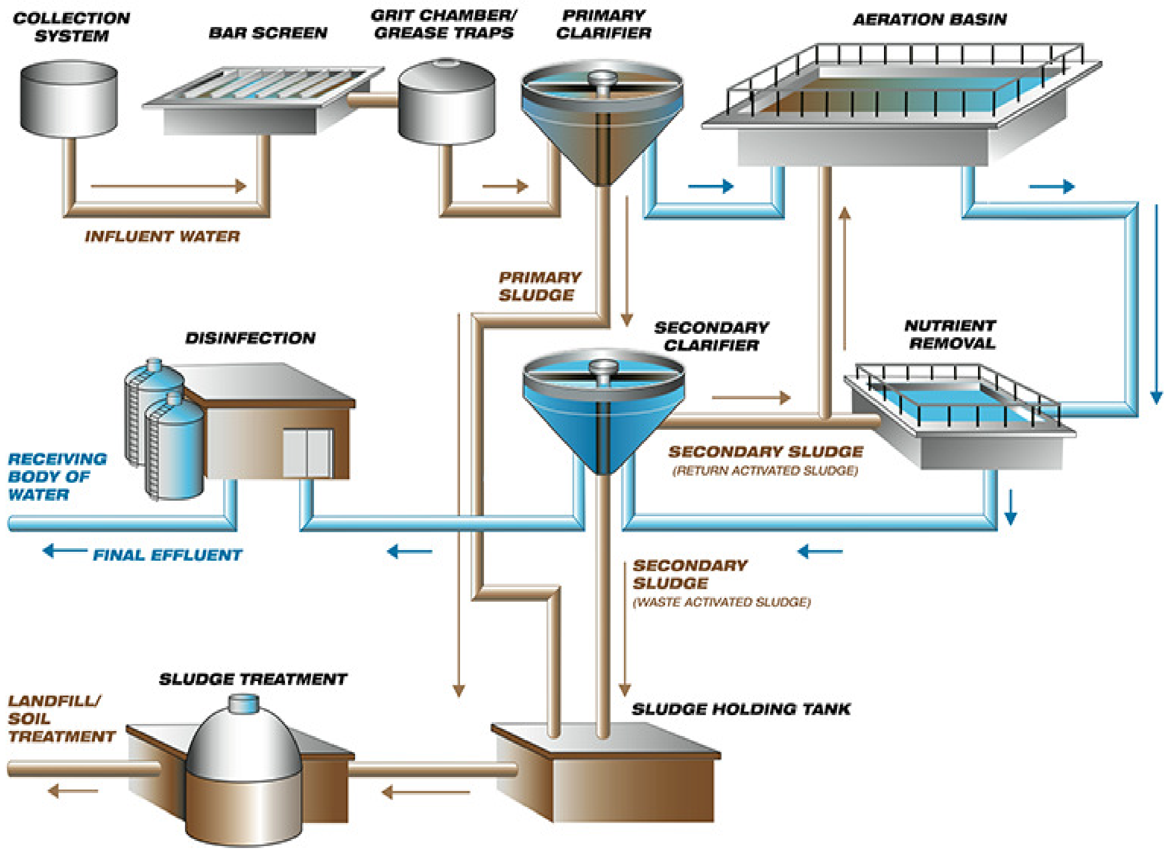


Maturation or polishing pond receive the effluent from aerobic ponds or other secondary treatment system and serve as storage structure until further use and primarily for final pathogen removal through UV-exposition. The process removes additional BOD, solids and faecal chloroforms plus some nutrients. Polishing ponds are designed to provide 1 to 3 days HRT and are normally operated at a depth of 1 metre.

4. WATER CONDITIONING SYSTEM IN URBAN AREAS

"Centralize" Water Treatment System is one of the most functional and relevant water conditioning system in urban India. Waste water collected from the whole community and conveyed to a single location. Pumping & control stations are the integral part of centralize system.

Following is a flow- chart of centralize system:-



Phase separation: It transfers impurities into a non-aqueous phase. Phase separation may occur at intermediate points in a treatment sequence to remove solids generated during oxidation or polishing. Grease and oil may be recovered for fuel or saponification. Solids often requires dewatering of sludge in a wastewater treatment plant. Disposal options for dried solids vary with the type and concentration of impurities removed from water.

Sedimentation: solids and non-polar liquids may be removed from wastewater by gravity when density difference are sufficient to overcome dispersion by turbulence. Gravity separation of solids is the primary treatment of sewage, where the unit process is called “primary settling tanks” . it is also widely used for the treatment of other wastewater. Solids that are heavier than water will accumulate at the bottom of quiescent settling basins. More complex clarifiers also have skimmers to simultaneously remove floating grease like soap scum and solids like feathers or wood chips. Containers like the API oil- water separator are specifically designed to separate non-polar liquids.

Oxidation: It reduces the biochemical oxygen demand of wastewater, and may reduce the toxicity of some impurities. Secondary treatment converts some impurities to carbon dioxide, water, and biosolids.

Chemical oxidation: It may remove some persistent organic pollutants and concentrations remaining after biochemical oxidation. Disinfection by chemical oxidation kills bacteria and microbial pathogens by adding ozone, chlorine or hypochlorite to wastewater.

5. MERITS & DEMERITS OF CENTRALIZE AND DECENTRALIZE WATER CONDITIONING SYSTEM

5.1 Centralize system

- Suitable for highly dence areas .

Ex. Urban areas :-

- Large capital investment.
- Regular maintenance required.
- It requires pump & piping material.
- Treated wastewater is reuse far away from generation point.

Demerit :-

- Land acquisition
- Financial condition of institution.

Decentralize system :-

- Suitable for less dence

  areas.

  Ex. Rural areas
- Low capital investment.
- Periodic maintenance required.
- Don’t requires pump & piping material.
- Treated wastewater is reuse at the generation point.

Demerits :-

- Land acquisition
- Financial condition of institution.

6. CONCLUSION & FUTURE RECOMMENDATION

Both, centralize and decentralize water conditioning system required adequate land for their functioning. But in this era of urbanisation where land is scared element, both the system are not reliable(difficult to implement). Land acquisition is also a major challenge for government to execute water conditioning system and other infrastructure projects.

So, there is a need of "portable" water conditioning system. In function, this water conditioning system is similar to DEWAT'S but don't have biogas generating module and only required two separate tanks for wastewater collection & treated water respectively and a pump to lift wastewater upto a first module.

The remaining five modules may be mounted over a portable tractor trolley in a two story manner which makes this arrangement efficient.

Advantages:-

- Light weight due to use of "FRP" material.
- Low cost due to mobile nature of system.(No need of land acquisition)
- Low maintenance as compare to current systems

Application-

- Housing colony
- Hospitals
- Residential societies in urban areas
- Educational institutes
- Public toilets
- IT parks & other commercial offices

Above all are the work engines of urbanisation and using this portable water conditioning system, the water conditioning scenario may get increase.

REFERENCE

1. Comparison on efficiency of various techniques in treatment of waste and sewage water – A comprehensive **review** , Review Article *Resource-Efficient Technologies, Volume 2, Issue 4, December 2016, Pages 175-184* P. Rajasulochana, V. Preethy

2. Decentralized Water Systems for Sustainable and Reliable Supply Original Research Article*Procedia Engineering, Volume 118, 2015, Pages 720-726* Kalyan R. Piratla, Suraj Goverdhanam

3. Decentralized wastewater treatment systems: Efficiency and its estimated impact against onsite natural water pollution status. A Romanian case study, Original Research Article *Process Safety and Environmental Protection, **In Press, Corrected Proof**, Available online 14 February 2017* Carmen Zaharia

4. Decentralized approaches to wastewater treatment and management: Applicability in developing countries Original Research Article *Journal of Environmental Management, Volume 90, Issue 1, January 2009, Pages 652-659* May A. Massoud, Akram Tarhini, Joumana A. Nasr

5. Decentralised schemes for integrated management of wastewater and domestic organic waste: the case of a small community, Original Research Articl *Journal of Environmental Management, **In Press, Corrected Proof**, Available online 21 December 2016* Lucía Lijó, Simos Malamis, Sara González-García, María Teresa Moreira, Francesco Fatone, Evina Katsou

Websites:

1. www.wikipedia.com

2. www.greenworldinvestor.com

3.www.mdws.gov.in

4.www.neeri.res.in

5.www.data.gov.in

6.www.mospi.gov.in

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