

Need For Decentralized Wastewater Treatment in India

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Abstract: *In today's world, the global population has increased to such an extent that it is estimated to receive half the per capita water supply in future, simultaneously the current sources of water are exploited and degraded due to excess use of water and discharge of untreated wastewater. So treatment of wastewater at a decentralized level is necessary to address the above issues more efficiently.*

Keywords: *HPEC, PVC, BOD, TSS, COD, AMC, AUDA, RAH, TP Scheme, SP Ring road, NUSP, JNNURM, ULB, STP, NGO, AMRUT, INR*

1. Introduction

Water is a universal component, used up for various activities in residents, commercial and industrial areas as well as required for agricultural purposes. This water after being used up, flows out through sewage pipes as wastewater referred as sewage. Now in most frequent cases this sewage is discharged into water bodies without being treated. Now there are also cases of treatment of wastewater in presence of sewage treatment plants, either present centrally or at a decentralised level. According to (Bernstein, Freshwater and Human population: A Global Perspective), about 2.5% is fresh water, 0.5% is accessible surface water out of the total world water content. Having a global population of 6 billion, per capita water availability is declining in spite of an estimation that each year receives 9-14 cubic km of fresh water in the form of runoff. According to (WorldBank_Report, 2012) around 60.3% is agricultural land out of the total land area in India. Excessive population growth provided with increase in population density leads to increase in water demand. As an alternate source of water, waste water professionals have suggested that reuse of waste water as the other source and treated waste water to be used for various purposes as well as discharged into water bodies not affecting the aquatic life maintaining the water quality and also recharging local water bodies. Now there are certain issues regarding waste water management in India. According to (High_power_expert_committee, April 2011), 4861 out of total 5161 Indian towns don't have a partial sewerage network. Almost 50% of the households in many urban cities in India like Bangalore, Hyderabad, etc. do not have sewerage connections. Only 21% of the waste water generated is treated. Of the 79 sewage treatment plants under state ownership reviewed in 2007, 46 were operating under very poor condition. In many cities and towns in India, the full capacity utilisation of the existing sewage treatment plant is not done. There are also cases of proposal of new treatment plant, but the construction is pending due to lack of funds. Apart from these types of situation, where there is lack of funds, there have been cases where government constructs the sewage treatment plant and gives the operation and maintenance authority to private agencies. City like Mumbai has taken initiative towards proper sewerage system and has already constructed new sewerage treatment plants within a span of three years from 2006 to 2008. And then they have outsourced the operation and maintenance contract to private companies. So there has been lack of sewage network. The old network is in very poor condition and there is also occurrence of leakage. Due to absence of adequate number of sewage treatment plants, the sewage water is discharged without being treated. But under the current AMRUT mission, 81 Indian cities in Tamil Nadu, Madhya Pradesh, Jharkhand,

Odisha and Mizoram, are investing over 11000million INR for providing only sewerage connections to individual households. In National capital Delhi, 5.5million INR has been spend for setting up “toilet-to-tap” wastewater treatment plant at a decentralised level in Keshopur, to provide water of drinking quality. Further in Delhi, six more decentralised wastewater treatment are being under construction are six different areas with an estimated capital investment of 953.2million INR. Also in Devanahali town in Bangalore, a decentralised faecal sludge treatment plant has been setup.

2. Background

As per (Census, 2011) data, population of India has increased from 286.1 million (2001) to 1.221 billion (2011). Growth in population leads to increase in water demand for domestic as well as municipal activities. Simultaneously with more and more developments taking place, industrial water demand is also increasing. As a result of which, surface and subsurface water resources are being exploited to such an extent, leading to overexploitation of ground water. With an increase in global population by 80 million annually and the water demand is also increasing by 64000 billion litres. A (World_water, 2009) report revealed that by 2030 half of the population will be residing in water stress region. It is being reported that by 2050 the per capita supply of water will fall by half. Simultaneously due to lack of public awareness and infrastructure facilities, sewage is being discharged irregularly into water bodies resulting in degradation of surface water. So simultaneously two things are taking place-

1. Overexploitation of available water resources.
2. Degradation of the existing water bodies, the main sources of water.

Percentage of urban population to total population has increased to 27.8% (2001) as per census. The increase in urban population is a result of in migration of people from rural areas to urban core centres making it densely populated. This on one hand leads to increase in water demand, over exploitation of water, simultaneously increase in wastewater generation. Reuse of treated wastewater for landscape irrigation as well as non-potable indoor application can lead to significant saving of water, energy and money. Thus reducing the pressure on demand of high water quality. The rate of urbanisation of India is increasing. According to (HPEC, 2011) report, the number of metropolitan cities will increase to 87 (2031) from 50 (2011). 2031 year is predicted to have 255 million population in metropolitan cities and 343 million population in other cities than in 2011, where the record is 160 million population in metropolitan cities and 217 million population in other cities. According to the report (McKinsey_Global_Institute, April 2010), it is recorded that urbanisation rate of India will rise from 30% in 2008 to 40% in 2030, along with population increase from 1155million (2008) to 1470million (2030).

Wastewater reuse basically signifies waste water recycling. Environmental Protection Act, defines wastewater reuse as use of waste water or reclaimed water from one application for another application. This reuse of waste water is totally applicable for only beneficial purposes like landscaping irrigation, agricultural irrigation, aesthetic uses, ground water recharge, industrial uses, fire protection, etc. With the aim of providing universal sanitation, governments are taking initiatives to develop access to safe and hygienic sanitation facility at individual household level or community level to make cities defecation free, making sure that 100% availability of public sanitation facilities throughout the entire area. Therefore much preference is given for preparation of City sanitation plan.

3. Wastewater and Its Treatment

Wastewater is characterised into **Grey water** (coming out from bathing, washing clothes utensils and hand basins), **Brown water** (from toilets and kitchen) and **Yellow water** (from urinals).

As far as treatment of wastewater is concerned, there exists two approaches one is the **Centralised Wastewater treatment facility** (both Combined Sewer system and Separate sewage and storm water collection system) and the other, **Decentralised Wastewater treatment facility**. There are some advantages of the centralised system like it is beneficial from the point of construction of treatment infrastructure, cost and area requirement is less because of single unit, having a single specified location. But there are also disadvantages like with the growth of city, the capacity needs to be upgraded, expansion of the sewer network, thus increasing the maintenance of the sewer system. Simultaneously pumping is required at various locations and the failure of

the sewer system will stop the treatment of the wastewater of the entire town. Taking the case of Decentralised wastewater treatment, although there are disadvantages like man power for maintenance required is more because the number of units is more and also area for construction, but simultaneously there are also advantages like the efficiency of wastewater treatment is increased, so on failure of a single system, it will not hamper the treatment of the entire city, maintenance will decrease as the size of the pipes and depth of construction is less, hence less expensive.

4. Treatments

- **Septic Tank** - Operated and Maintained at household, community level, Septic tank is a watertight chamber, made of concrete, fibreglass, PVC or plastic, where black water from toilet, grey water from kitchen, washing and bathing and yellow water from urinal flows in for primary treatment. The design depends on the number of users, amount of water used per capita, desludging frequency, and retention time should be 48 hours. The effluent has 30-50% reduced BOD, 40-60% reduced TSS.
- **Anaerobic baffled reactor** - Operated and Maintained at household and community level, an anaerobic baffled reactor is an improved Septic Tank containing a series of baffles, under which the wastewater is forced to flow. The more contact time with the active biomass (sludge) results in improved treatment. 50% of the settleable solids are removed. As per design, the capacity ranges 2-200m³ per day, the retention time is considered 2-3 days. The effluent has COD reduced by 65-90%, BOD reduced by 70-95%.
- **Anaerobic Filter** - Operated and Maintained at household and community level, Anaerobic Filter is a biological reactor having a fixed bed with one or more filtration chambers in series. As wastewater flows through the filter, particles get trapped and organic matter is degraded by the active biomass that is attached to the surface of the filter material. Increase in contact between the organic matter and the active biomass, because of large surface being provided for the biomass increases degradation. As per design, the filter materials used must be gravel, crushed rocks, etc. of diameter ranging from 12-55mm, retention time is 1 day and the Effluent has its TSS reduced by 50-80%, BOD reduced by 50-80%, even up to 90%. This effluent can be used up for providing water to gardens, landscape irrigation, agricultural fields, fish ponds and water bodies.
- **Biogas Reactor** - Operated and maintained well at community level and in Industrial areas, a Biogas Reactor is an anaerobic treatment technology, that produces digested slurry that can be used up for soil amendment and biogas (mixture of Methane, Carbon dioxide and other trace gases which can be converted to heat, electricity or light) can be used up for energy. After sedimentation, and retention within the biogas reactor, the sludge gets transformed into biogas due to anaerobic digestion. This generated gas exerts pressure, rises up and gets collected, while the slurry gets displaced to expansion chamber. As per design, Hydraulic Retention Time is taken at least 2 months or more. For the community level use the temperature to be maintained should be between 30-40 degree C, capacity between 1000L-100,000L per day and should be emptied once in 6-10 months. The effluent coming out has 80-85% BOD removed and relatively high percentage of pathogen removal.
- **Waste stabilisation pond** - Operated and maintained at neighbourhood and city level, Waste stabilisation ponds are large, man-made water bodies where waste water is treated by natural occurring processes under the influence of solar light, wind, microorganisms and algae. There are three types of ponds-
 - (1) Anaerobic Pond- it is the primary stage, where the anaerobic bacteria converts organic carbon into methane. It is built having a depth of 2-5 Metre and the retention time considered to be 1-7 days, having reduction in BOD by 50-60%.
 - (2) Facultative Pond- here both anaerobic and aerobic process takes place. It is constructed at a depth of 1-2.5 Metre with a retention time of 15-30 days and BOD removed up to 75-80%.
 - (3) Aerobic (maturation) Pond- it is a very shallow pond ensuring penetration of sunlight up to full depth. It is designed for pathogen removal, and is constructed at a depth of 0.5-1.5 Metre, ensuring pathogen removal up to 90%.
- **Planted Gravel Filter** - Operated and maintained well at community and city level, it is the Root Zone technique Planted gravel filter having a simple permeable bed (constructed, filled with sand and gravel to support vegetation), that when loaded with sludge in layers (75-100mm), collects percolated leachate in the

drainage pipe and allows the sludge to dry by evaporation and there is a benefit of increased rate of transpiration and improved sludge treatment due to presence of plants. As per design layering of the bed is done- (a) 250 mm of coarse gravel (grain diameter of 20mm), (b) 250 mm of fine gravel (grain diameter of 5 mm), (c) 100-150 mm of sand, (d) Free space (1m) should be left above the top of the sand layer to account for about 3 to 5 years of accumulation. The sludge can be removed after 2 to 3 years.

- **Free water surface Constructed Wetlands** - Operated and maintained at community and city level, it is the system, where pathogens are destroyed as the wastewater gradually flows through the wetland, particles settle down and the utilization of the nutrients are totally done by the organisms and plants for their growth. As per design, the liner materials used, is an impermeable layer clay or geo textile covered with rocks, gravel and soil, Cattles, reeds and rushes are used as plantation and the depth of wastewater to be maintained above the ground level is 10-45 cm.

5. Uses of Treated Waste Water

Urban Reuse - Treated water from decentralised system can be used up to meet water demands for Landscape irrigation of school yards, public parks, highway medians and residential landscaping, during emergency for fire fighting, for flushing of toilets in residents.

Agricultural Reuse - Wastewater is pumped out and used up for irrigation purpose. This treated wastewater satisfies the quality of the water to be supplied to irrigation field.

Recreational Impoundments – The treated wastewater also abide by the quality of the water to be discharged in stagnant water bodies. Thus in this purpose the treated wastewater can be utilised for recharge of ponds, lakes, water bodies.

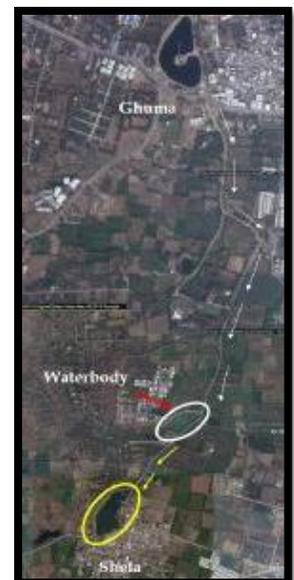
Environmental Reuse - Taking the case of constructed wetland in Kolkata, where the wastewater is discharged and this waste land is used up for fish cultivation generating employment and food for the local people and providing water for the cultivable land.

Industrial reuse - For industrial cooling purposes of machineries, treated waste water can be used.

6. Study Area- Two Villages Where the Approach Can Be Applied

Gujarat holds 44% urbanization rate with 25.2 urban populations and it is predicted that by 2030, 66% urbanization rate with 48million population. Focusing in Ahmedabad, according to (Census, 2011), population of Ahmedabad in 2011 is 5,570,585. Ahmedabad Municipal Corporation (AMC) has 190 square kilometres area under its jurisdiction whereas Ahmedabad Urban Development Authority (AUDA) has the jurisdiction of 150 villages that are located on the periphery of the city. There are 9 Municipalities located at the periphery of the city limit that comes under the jurisdiction of Ahmedabad Urban Development Authority (AUDA). The two selected villages (Ghuma, Shela) fall outside the AMC boundary, along the 2km wide RAH zone along the SP Ring road. After coming under the RAH zone, TP Schemes are going to be implemented in both Ghuma and Shela villages. As per TP Schemes, sewerage network is going to be laid down throughout the entire area forming a network that will meet the main sewer trunk, which is laid down by AMC along the SP Ring road.

In Ghuma village, where the population is 20,000 and household numbering to 6000, as per (AUDA, 2014), the city sewerage network is absent. At present the location being outside the boundary of AMC, sewerage connections are not been yet provided by any government bodies. As per primary survey, in the existing situation, it is found out that almost the entire population use Kharkua for disposal of waste water irrespective of being grey, black or yellow. Only 15-20% of the households drains their waste water coming out of kitchen into the local storm water drains. These kharkuas are actually soakpit having a depth of ranging 15-25 feet. The locals have been using this type of sanitation system since ages and has been practised since the time of their fore fathers. Now during maintenance municipality vehicle comes and pumps out the septage from inside and they charge about Rs. 250-300.



And in Shela village, where the population is 4276 and household number counting to 900, there is no sewerage connection in that village. According to primary survey, at present, the local gram panchayat has provided their own underground sewerage connection, which collects waste water other than that comes from urinal. These waste water flows through the drainage system and finally they get disposed of in the nearby water body locally known as Dhedhki Talav. Covering about 2km, around 55% households have the sewerage connections provided by the panchayat. The connection fees taken is around Rs. 500. For the urinal water, every household have their own kharkua, which is being practised there since the past. The kharkua being 15-25feet deep, has a period of around 15 years and more. Now in case of cleaning of any particular house's kharkua, septage cleaning vehicle from Bopal-Ghuma nagarpalika comes and pumps out the waste from within for which they charge around Rs. 600/hour.

In Ghuma and Shela, because of the soil type, the kharkua or the soak pit gets filled quickly. In many households it has been reported that because of the soil type being alluvial, the soap water coming as waste water after bathing, tends to form a layer on the walls of the 15-25 feet soak pit and this prevents the waste water from percolating into the soil and thus filling up the soak pit much before it could have been filled.

Now in the current scenario, the wastewater flows from Ghuma towards Shela village. Untreated wastewater from 15-20% households of Ghuma, combined with the treated wastewater coming from nearby ISCON apartments, flow towards Shela village and discharges in the water body, marked in Figure 1 Two Villages white circle, in the adjoining map. Previously it used to flow down more and discharge & Wastewater flow in the water body of the Shela village marked in yellow circle.

In the present situation, the wastewater during its flow from Ghuma to the water body (to be discharged) is being pumped out and used for irrigation purposes on the agricultural fields, present on the either sides of the path of flow.

7. Conclusions

1. The prevailing centralised wastewater treatment is preferred in place of Decentralised approach because there are Indian cities, irrespective of being small or metro cities, where even a single unit sewage treatment plant is absent. Decentralization approach should be taken into account during preparation of City sanitation plan and more focus needs to be given on this approach in National Urban Sanitation Policy, just like they aim for Greener cities. As mentioned in the report "Support for NUSP greener city approach", State Strategic Sanitation plan should focus on setting up guidelines, policies, regulations in the sewerage sector to detail out technical details and requirements of Decentralised approach. Upcoming smart city projects should emphasize more on this approach rather past JNNURM project which only have two related to decentralization of wastewater.
2. The cities are expanding, so the network needs to be expanded constructing new networks, connecting new houses and simultaneously the capacity of existing Sewage treatment plant needs to be increased. Instead of increasing the capacity of the existing STP and constructing new network lines, if the Decentralised approach is established it will increase efficiency of waste water treatment along with several advantages. But people are unaware of this approach and the many of the ULBs are not technically updated and skilful to promote its technology and implement it. In such situations Focus group discussions needs to be carried out to promote and make people aware of its technologies and benefits. A collaborative work among, the ULBs, NGOs, common people and other stake holders is necessary for its successful implementation.
3. There are also places, where due to absence of sewage treatment, untreated wastewater is discharged and the water bodies are contaminated affecting the aquatic life and quality of water resource. Implementation of this approach will increase the treatment efficiency at the local, neighbourhood level and will not affect the water bodies.
4. In case of the study area, taken as study area, the issues of the two selected villages in terms wastewater is mentioned. A combined system of Decentralised approach can be setup. Starting from Septic tank at individual housing unit, then to Anaerobic baffled reactor or Anaerobic filter set up at a community level and finally discharging into local water body that can be utilised as an Anaerobic Pond. A septic tank of capacity around 13 cubic metre requires an area of 5-6 square metre can be installed in every household. Then flowing out to either of Anaerobic baffled reactor or Anaerobic Filter having a capacity of 25000 litres

per day will require a maximum area of 12-13 square metre at the community level, supporting around 40-45 household, taking 5persons per households and total generation of 550 litres per day per household. And finally discharging in to the local water bodies having depth of around 2-5 metre, to be taken as Anaerobic pond will require approximate area of 25450 square metre which is quite less than the area covered the existing water bodies. If this approach is implemented, taking into view of the advantages and reuse of the treated wastewater, this system will be beneficial, long lasting, meet the water demands of many non-potable activities and the anaerobic pond can accommodate the wastewater discharge for the next 20-30years.

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10. Abbreviations

HPEC- High power expert committee

PVC- Polyvinyl chloride

BOD- Biological oxygen demand

COD- Chemical oxygen demand

TSS- Total suspended solids

AMC- Ahmedabad Municipal Corporation

AUDA- Ahmedabad Urban Development Authority

RAH- Residential Affordable Housing

TP Scheme- Town planning Scheme

S.P. Ring Road- Sardar Patel Ring Road

NUSP- National Urban Sanitation Policy

JNNURM- Jawaharlal Nehru National Urban Renewal Mission

ULB- Urban local body

STP- Sewage treatment plant

NGO- Non-governmental Organisation

AMRUT- Atal Mission for Rejuvenation and Urban Transformation

INR- Indian National Rupee