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Standardisation of Design and Maintenance of DEWATS Plants in India

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Abstract:	Standardisation of Design and Maintenance of DEWATS Plants in India S.R.Sakthivel*, A.Seshadri**, Md.Azizurrahaman*, V.M.Chariar* * Centre for Rural Development and Technology, Indian Institute of Technology, Hauz Khas, New Delhi-110 016 ** The Vigyan Vijay Foundation, H-2/2-5, Mahavir Enclave, PalamDabri Road, New Delhi-110 045 Key words: DEWATS; Design; Maintenance Introduction Sewage disposal and treatment is a major concern in India and in most of the developing countries (Singh et al., 2011). In class I and II cities of India, a sewage treatment capacity of only 6,190 million litres per day (MLD) has been installed against the total sewage generation of 29,129 MLD (Nadeem et al., 2008). Therefore, promoting decentralised waste water treatment systems both at individual and institutional levels can offset this problem to a greater extent. Since 2000, The Vigyan Vijay Foundation (VVF), New Delhi has constructed over 14 DEWATS plants in the Northern India with the active collaboration of The Indian Institute of Technology Delhi. The foundation has also actively promoted the DEWATS concept through a number of capacity building programmes and advocacy initiatives in India. In 2009, the effort of VVF was recognised by BORDA - CDD and was selected as a member of the network for the promotion of DEWATS plants in India. This paper outlines the standard design procedure, economics and maintenance aspects based on the experience of VVF and IIT Delhi in promoting DEWATS plants in India. Materials and Methods Based on the experiences of promoting DEWATS plants (Table 1), simple standard design procedures have been developed which can be adopted while designing DEWATS plants. These steps have been found useful by fresh engineers trained on

DEWATS technology. Effectiveness of this design process has been validated based on performance of DEWATS plants constructed. Calculating the average cost per kilo-litres per day (KLD) of medium sized DEWATS plant can help in rapid estimation of the actual cost of a proposed plant. For this purpose, the actual of cost incurred for the construction of DEWATS plants at various locations were recalculated with the present cost of construction and converted to obtain an average cost per KLD. In addition, some innovative methods identified for easing maintenance routines and performance of DEWATS plants based on the experience are also presented.

Results and Discussion

*Standard Design: Although the components of DEWATS can be designed independently based on the expected inflow and other design parameters like HRT (Sasse, 2008), this becomes an elaborate procedure for an engineer who has just started to understand the concept of DEWATS. Therefore, simplifying the design procedures helps in designing DEWATS plants rapidly with ease. In the course of implementation of DEWATS plants, a rapid designing procedure was developed by VVF. This method involves arriving at the total capacity (volume) of DEWATS plant needed based on the daily sewage flow and HRT (Table 2). Finally, the estimated total capacity arrived at can be allocated to various components of a DEWATS plant. In general, for DEWATS plants implemented in most parts of India, assigning 30% of the total estimated capacity for anaerobic septic tank, baffled reactor, planted bed filter, which are important components of a DEWATS plant, was found to be adequate. The other secondary components like in the DEWATS plants such as settling tanks and storage/polishing tanks can be allocated the remaining volume of the estimated capacity or as desired.

*Economics: Based on the 5 selected DEWATS plants implemented by VVF, the average cost per KLD of DEWATS plants works out to Rs.66,000 per KLD. This estimated average cost per KLD is expected to hold good for medium sized DEWATS plants with capacities up to 100 KLD. However, the cost per KLD for small DEWATS plants implemented was found to be quite higher. The cost per KLD for a DEWATS plant worked out for individual house with 0.30 KLD was Rs.1,50,000/ per KLD. Sasse et al. (1996) in an analysis found that the cost per cubic meter capacity of DEWATS plant of small and large seized DEWATS plants was higher than medium sized plants. The increase in cost was attributed to the number of modules to be included for small capacity systems and also the sophisticated treatment required for large treatment plants.

*Maintenance Aspects: Maintenance of DEWATS plants pose a real challenge as it is labour intensive and expensive process. Routine maintenance aspect of DEWATS involves checking for proper flow, removal of grease, maintenance of water level and weeding of planted bed filter (CDD, 2010). Apart from these aspects, effective maintenance of filter media and planted bed filters can effectively enhance the performance of DEWATS plants. The filter media provided in baffled tank can be effectively maintained by providing filter media in small modules which can be removed with ease for maintenance and by providing dedicated suction pipes beneath the filter media for periodic removal of sludge without the physical removal of the filter media. Similarly, watering over the plants in planted bed for removal of dust particles accumulating on the leaves, especially in urban areas where heavy dust accumulation takes place, can results in enhancing the growth of plants resulting in improved performance of the DEWATS plants.

Summary

The experience of the VVF in India shows that DEWATS plants can be effectively promoted for the treatment of domestic wastewater both in large settlements and individual households. In addition, remediation of wasterwater flowing in urban drains using DEWATS plants for watering gardens and plantations in urban areas was found promising. The standard design elements proposed based on the experiences would be useful for rapid design of DEWATS plants by engineers with minimum training. Maintenance aspects suggested can be employed for effective maintenance of the DEWATS plants.

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Abstract

Standardisation of Design and Maintenance of DEWATS Plants in India

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Key words: DEWATS; Design; Maintenance

Introduction

Sewage disposal and treatment is a major concern in India and in most of the developing countries (Singh et al., 2011). In class I and II cities of India, a sewage treatment capacity of only 6,190 million litres per day (MLD) has been installed against the total sewage generation of 29,129 MLD (Nadeem et al., 2008). Therefore, promoting decentralised waste water treatment systems both at individual and institutional levels can offset this problem to a greater extent. Since 2000, The Vigyan Vijay Foundation (VVF), New Delhi has constructed over 14 DEWATS plants in the Northern India with the active collaboration of The Indian Institute of Technology Delhi. The foundation has also actively promoted the DEWATS concept through a number of capacity building programmes and advocacy initiatives in India. In 2009, the effort of VVF was recognised by BORDA – CDD and was selected as a member of the network for the promotion of DEWATS plants in India. This paper outlines the standard design procedure, economics and maintenance aspects based on the experience of VVF and IIT Delhi in promoting DEWATS plants in India.

Materials and Methods

Based on the experiences of promoting DEWATS plants (Table 1), simple standard design procedures have been developed which can be adopted while designing DEWATS plants. These steps have been found useful by fresh engineers trained on DEWATS technology. Effectiveness of this design process has been validated based on performance of DEWATS plants constructed. Calculating the average cost per kilo-litres per day (KLD) of medium sized DEWATS plant can help in rapid estimation of the actual cost of a proposed plant. For this purpose, the actual of cost incurred for the construction of DEWATS plants at various locations were recalculated with the present cost of construction and converted to obtain an average cost per KLD. In addition, some innovative methods identified for easing maintenance routines and performance of DEWATS plants based on the experience are also presented.

Table 1 - DEWATS Plants Constructed in Different Locations and their Performance

S.No	Location	Type of Influent	Plant Capacity (KLD)	Year	BOD		Efficiency of Plant (in % of reduction
					Inlet	Outlet	
1	Centre for Science and Environment, Delhi	Sewage	8	2002	300	20	93
2	Indian Institute of Technology Delhi	Drain Water	10	2002	200	20	90
3	Vasant Vihar Park, New Delhi	Drain Water	40	2002	350	30	91
4	Ashram, Utharakand	Sewage	30	2004	270	25	91
5	Scindia School, Gwalior	Sewage	15	2006	300	20	93

Results and Discussion

- **Standard Design:** Although the components of DEWATS can be designed independently based on the expected inflow and other design parameters like HRT (Sasse, 2008), this becomes an elaborate procedure for an engineer who has just started to understand the concept of DEWATS. Therefore, simplifying the design procedures helps in designing DEWATS plants rapidly with ease. In the course of implementation of DEWATS plants, a rapid designing procedure was developed by VVF. This method involves arriving at the total capacity (volume) of DEWATS plant needed based on the daily sewage flow and HRT (Table 2). Finally, the estimated total capacity arrived at can be allocated to various components of a DEWATS plant. In general, for DEWATS plants implemented in most parts of India, assigning 30% of the total estimated capacity for anaerobic septic tank, baffled reactor, planted bed filter, which are important components of a DEWATS plant, was found to be adequate. The other secondary components like in the DEWATS plants such as settling tanks and storage/polishing tanks can be allocated the remaining volume of the estimated capacity or as desired.

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Table 2 - Suggested Design Standards for DEWATS Plants in India

i) General Design Parameters		**iv) Secondary Treatment (Anaerobic Baffled Reactor)**	
HRT	8-10 days (25 days in cold regions)	Capacity (V_3)	30% of Total Capacity of Plant
Total Capacity of Plant (V)	Flow per day in KLDxHRT	Depth	3 m
Inlet, outlet and other pipes	1% slope between outlet and inlets. Minimum pipe size 100mm dia provided in staggered manner	Breadth (B)	Minimum 1.2m (for O&M)
Free Board	0.30m to 0.45m above the suggested depth	Length (L)	V_3/(DxB)
Manholes	Minimum 450mm wide/dia above each separated area of tanks	Baffles	4 no. (equally spaced)
Ideal Design Capacity of a Single Unit	Upto 25 KLD	Connection between baffles	PVC pipes positioned in baffles carry influent below the filter media
ii) Pre-treatment (Anaerobic Settling Tank)		Placement of Filter media	2m thick placed above the bottom level of tank
Capacity (V_1)	5% of Total Capacity of Plant	Filter media provided in Tanks	Stones 20-30 cm size and gravel (layers of 40mm and 20mm over it)
Depth (D)	1m	**v) Tertiary Treatment (Planted Bed Filter)**	
Breadth (B)	Minimum 1.2m (for O&M)	Capacity (V_4)	30% of Total Capacity of Plant
Length (L)	V_1/(DxB)	Depth	1.5 m
Baffles	1 no.(Volume of tanks - 50:50)	Filter media	Graded gravel (equal layers of 40 mm and 20mm thickness)
Opening between baffles	Bottom of the baffle	Plant Bed	Mud/Soil Balls of 20cm thick placed between the gravel layer
iii) Primary Treatment (Anaerobic Septic Tank)		Type of Plants	Canna Indiaca, Typa, Reeds - 300x300mm spacing
Capacity (V_2)	30% of Total Capacity of Plant	**vi) Final Treatment (Storage Tank or Polishing Pond)**	
Depth	3 m	Capacity (V_5)	5% of Total Capacity or as needed
Breadth (B)	Minimum 1.2m (for O&M)		
Length (L)	V_2/(DxB)	**Notes:** Design based on DEWATS Manual by BORDA and the Project experiences of The Vigyan Vijay Foundation	
Baffles	1 no. (Volume of tanks - 50:50)		
Opening between baffles	At middle of the baffle		

Summary

The experience of the VVF in India shows that DEWATS plants can be effectively promoted for the treatment of domestic wastewater both in large settlements and individual households. In addition, remediation of wasterwater flowing in urban drains using DEWATS plants for watering gardens and plantations in urban areas was found promising. The standard design elements proposed based on the experiences would be useful for rapid design of DEWATS plants by engineers with minimum training. Maintenance aspects suggested can be employed for effective maintenance of the DEWATS plants.

References

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