Performance Evaluation of Integrated Decentralized Wastewater Treatment System for an Engineering College

Guru Munavalli, Pratap Sonavane, Sagar Wandare, Nikhil Aswale and Kusum Biradar

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G. R. Munavalli[a], P.G.Sonavane[b], S. M. Wandare[c], N, M, Aswale[d], K. M. Biradar[e]
[a]Corresponding author, Professor, Department of Civil Engg., Walchand College of Engineering, Sangli, Maharashtra, India, guru.munavalli@walchandsangli.ac.in
[b]Professor, Department of Civil Engg., Walchand College of Engineering, Sangli, Maharashtra, India
[c]Junior research fellow, DST project, Department of Civil Engg., Walchand College of Engineering, Sangli, Maharashtra, India
[d]Project assistant, DST project, Department of Civil Engg., Walchand College of Engineering, Sangli, Maharashtra, India
[e]Project assistant, DST project, Department of Civil Engg., Walchand College of Engineering, Sangli, Maharashtra, India

Abstract: Decentralized treatment of domestic wastewater with the use of constructed wetland (CW) as physical and biological treatment is widely used and has proved to be a cost effective technology for treating domestic wastewater in recent past. Integrated Decentralized Wastewater Treatment System (IDWTS) was constructed in Walchand College of Engineering, Sangli (Maharashtra, India) in May 2018 for treatment of domestic wastewater generated from residences and hostels. IDWTS was assessed for its potential to remove COD during May to October, 2018. Anaerobic Baffled Reactor and Hybrid Baffled and Biorack Constructed wetland contributed 20% to 25% each for COD removal. Vertical Flow Constructed Wetland performed relatively better (30%). The overall COD removal was found to be 65% to 75%. IDWTS is a potential alternative to existing on-site treatment systems.

Keywords: Aeration**,** Decentralized Treatment, Dissolved Oxygen, Domestic Wastewater, Feeding System, Vertical Flow Constructed Wetland.

1. Introduction

Domestic wastewater is generally contributed by many sources in rural and urban areas. The wastewater generate from the sources such as public building, educational institutes, and commercial establishment is significant apart from residential sources. The wastewater load (volume and strength) can be reduced to some extent if the sources other than residential sources are segregated and provided with a separate treatment. In this context, the concept of

Decentralized Wastewater Treatment System (DWTS) can be implemented for treating wastewater from such isolated sources. The provision of DWTS will increase the potential for reuse and recycling at source of generation. The benefits derived are lesser load on municipal water supply as portion of non-potable water demand is met from reuse/recycled water. The possible non-potable purposes for which the reuse/recycled water can be used include gardening, flushing, cleaning, and washing. The groundwater recharge is also a potential option for disposing treated water from DWTS.

In Indian context, both aerobic, anaerobic and combination of these treatment systems are suitable options for DWTS. The primary level of treatment is generally anaerobic and followed by single/two stage aerobic/aerobic and anaerobic systems. Constructed wetland (CW) is invariably a part of most of DWTSs in India (Manual on Constructed Wetland as an alternative technology for Sewage Treatment in India, 2019). CW is a vegetated bed through which wastewater is passed either in horizontal or vertical mode. The natural mechanisms associated with wetland vegetation, support media and microbial assemblages dominate in treating wastewater. The use of CW in DWTS will lead to sustainable method of wastewater treatment for small communities and individual households (Gajewska et al., 2018). CWs have not gained much popularity in India majorly due to large area requirement and possibility of clogging of wetland beds due to high suspended solids in the wastewater, microbial biomass sedimentation through various processes, filtration and growth of microorganisms blocking pore volume (Manual on Constructed Wetland as an alternative technology for Sewage Treatment in India, 2019). Biorack constructed wetland on new concept are developed and modified (Valipour et al., 2009; Sathe and Munavalli, 2019) thereby overcoming the above mentioned limitations of CW. Vertical Flow Constructed Wetland (VFCW) is also an alternative to reduce area requirement and maintain aerobic conditions.

In the present study, DWTS [referred as Integrated Decentralized Wastewater Treatment System (IDWTS) in this study] constructed and operated in the campus of Walchand College of Engg., Sangli (WCE) is assessed for its performance to remove organic carbon over a period of six months.

2. Materials and Methods

2.1 Source of Wastewater

Municipal water supply with river as source and open wells located within (WCE) campus are the major supply used for potable and non-potable purposes respectively. The wastewater generated from residences, hostels, eating establishments, and canteens are the major sources generating wastewater. There are septic tanks provided at different locations and effluent from septic tank is collected and transported through sewers. Greywater and septic tank effluent are collected at two separate locations in the WCE campus. The total wastewater generated is 90 kLD. It is treated at two different locations and these are referred as IDWTS 1 and IDWTS 2.

2.2 Description of IDWTS 1

In the present work, IDWTS 1 is studied for its potential to treat 42 kLD wastewater. The system consists of screen, Anaerobic Baffled Reactor (ABR), Hybrid baffled and bioracks constructed wetland (HBBCW), and VFCW. The photographic view of IDWTS 1 is shown in Fig. 1. The primary treatment includes screen and ABR. HBBCW and VFCW constitute two-stage secondary treatment. Fine and coarse bar screens are provided to remove floating and coarser objects. ABR treats raw screened wastewater to reduce its organic strength anaerobically.

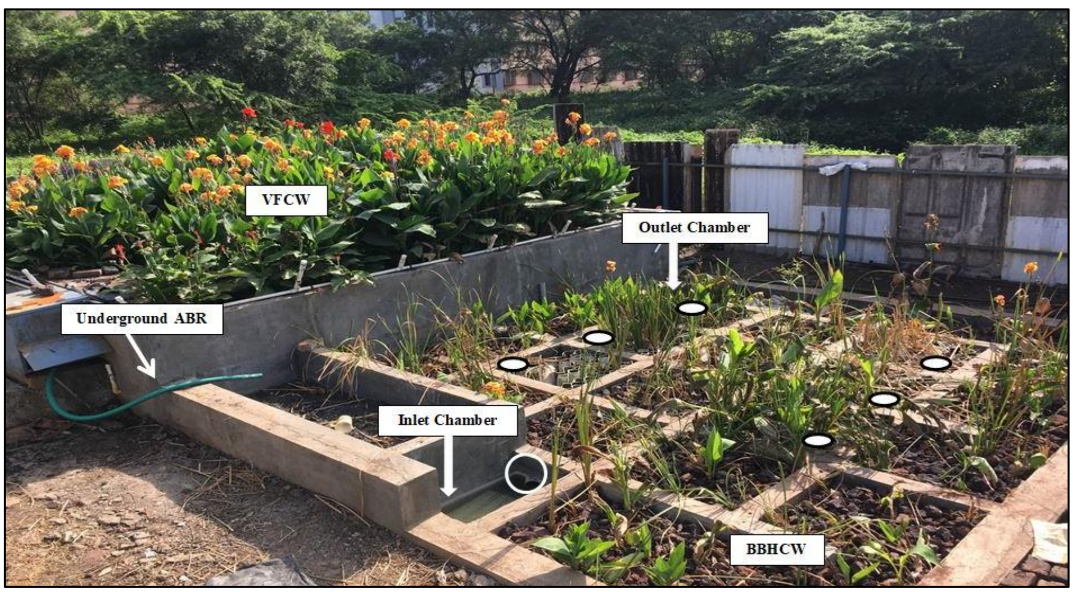


Fig. 1 Photographic view of IDWTS1 at WCE, Sangli.

It consists of six baffled compartments connected by down take pipes inducing upflow and down flow movement of wastewater. HBBCW is vegetated with *Canna Indica* and *Typha Angustifolia L*.in brick bat medium and bioracks. The bioracks were created with discarded drinking water bottles and AC sheets. ABR treated effluent undergoes further treatment in HBBCW and collected in a sump. Then it is pumped to VFCW for second stage secondary treatment. The pump operation is sensor based and feeding VFCW is auto-regulated. VFCW has bed of porous media made up of brickbat bed at bottom and mixed media of coarse aggregates and charcoal. It is vegetated with *Canna Indica*. The HBBCW effluent is applied uniformly on the surface of VFCW through the feeding system. The final effluent from IDWTS 1 is used for land application.

2.3 Sampling and Methods

The sampling locations used for assessment wastewater characteristics include, screened wastewater, ABR treated wastewater, HBBCW effluent and final effluent from VFCW. Grab sampling procedure was adopted and the samples were collected in clean 1 L bottle. The samples were collected daily in morning and afternoon hours. All the samples were analysed for pH and COD. APHA (2012)/IS 3025 was referred for methods of analysis. pH was measured by HACH multi-parameter meter and COD by closed reflux COD digester with titration with FAS.

3. Results and Discussion

IDWTS 1 was monitored during May, 2018 to October, 2018 and results are analyzed for its performance for COD removal. The total sample used for result analysis is 150. Fig. 2 shows variation in pH at every stage of treatment system. The results show that the range of pH is 7 to 8 with a variation of ±0.5. It is an indicative of existence of favourable conditions for bacterial growth. In particular, pH conditions in ABR are more conducive for anaerobic treatment. pH was maintained in this range without addition of any external pH adjuster like lime. There is no significant difference observed in morning and afternoon values of pH. The effluent from VFCW has pH within disposal standard specified by (Manual on Constructed Wetland as an alternative technology for Sewage Treatment in India, 2019.

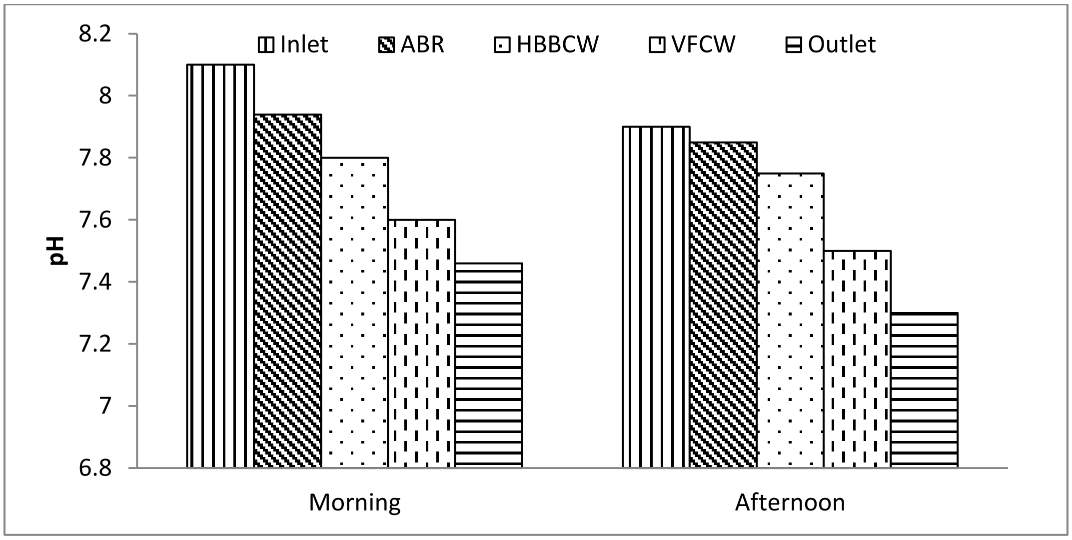
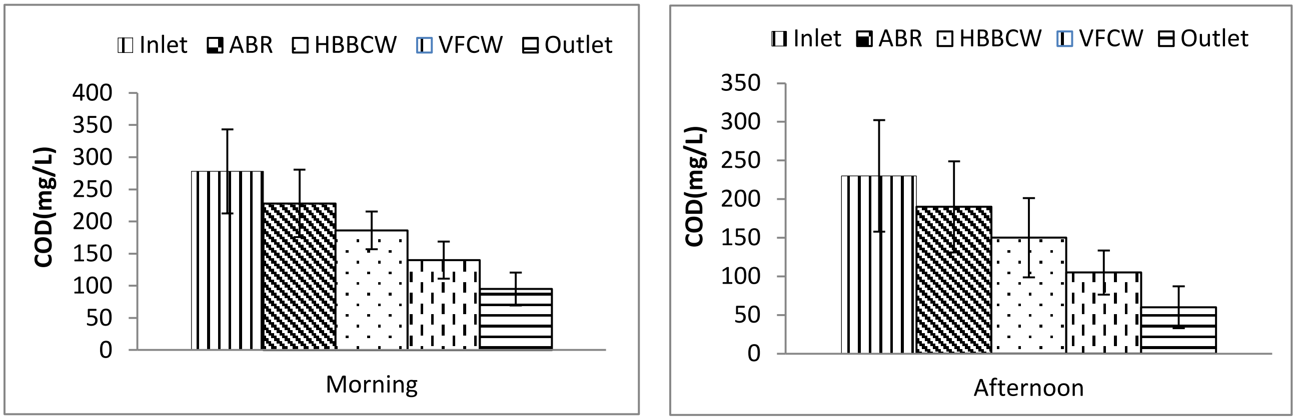


Fig. 2 pH variation in morning and afternoon

Fig. 3 shows COD variation and its removal at various stages of treatment system in morning and afternoon. The influent to IDWTS 1 is categorized to be low strength wastewater as COD is less than 500 mg/L. The influent COD are lesser in afternoon than in the morning. Normally peak flows are observed during morning hours and usage of sanitary facilities are more in the morning contributing to relatively high organic constituents. COD values decrease at each stage of treatment system. ABR and HBBCW contribute 20% each to COD removal. Anaerobic conditions prevail in these units. The efficiency of anaerobic systems is generally lower for low strength wastewater. HBBCW is supposed to be aerobic partially, however the system was in developing phase with vegetation growth in its initial stage and hence COD removal is relatively lower. Further the residence times in ABR and HBBCW are lesser. COD removal by VFCW is 25 to 30%. The vegetation growth in VFCW is better than in HBBCW and support bed is better aerated. Thus VFCW is more efficient as compared ABR and HBBCW due to better aerobic conditions. The overall removal for COD is to an extent of 65% to 75%. COD removal efficiency in afternoon is 10% higher than that in the morning. This is due to lower organic loading in afternoon than in the morning.

a) COD variation



b) COD removal

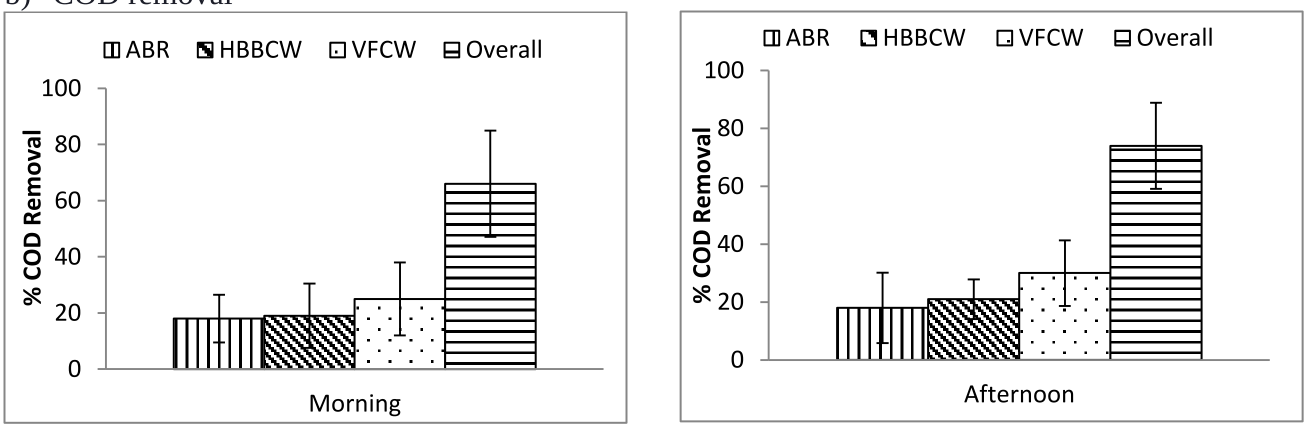
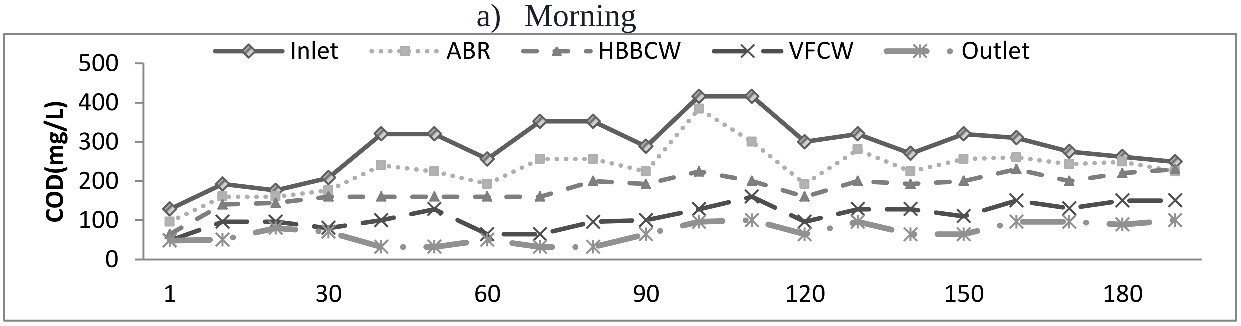


Fig. 3 : COD variation and removal at different treatment systems

a) Morning



b) Afternoon

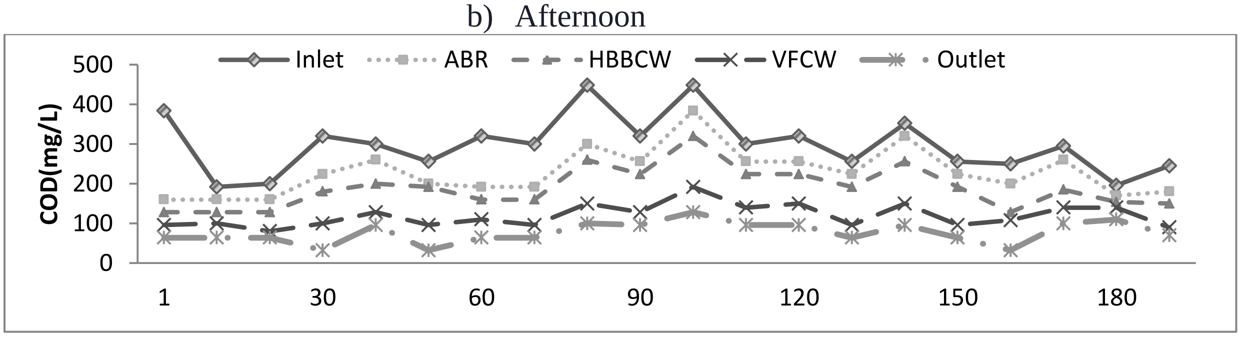


Fig.4 : COD variation throughout the study period in a) morning and b) afternoon

4. Conclusions

IDWTS 1 at WCE was monitored for a period of six months. The results obtained on COD removal and their further analysis is carried out. pH adjustment is not required for ABR as observed pH values are nearly neutral. ABR and HBBCW contribute 20% each for COD removal. VFCW is more effective than ABR and HBBCW systems. All the units of treatment system are relatively more consistent in their action. IDWTS1 is found to be an alternative option for treating domestic wastewater at isolated places with overall COD removal of 65% to 70%.

Acknowledgment

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5. References

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