Cause of Failure of Municipal Waste Water Treatment Plant in Narayanghad

Ramesh Khanal
Department of Civil Engineering
Nepal Engineering College, Nepal
rameshk@nec.edu.np

***Ramesh Khanal** has received his MSc in Industrial Management from Royal Institute of Technology, Sweden and BE in Mechanical Engineering from Pulchowk Campus. He is a full-time faculty of Nepal Engineering College since November, 2008. Now he is an Associate Professor of the college. Beside regular academic position, currently he is also involved in designing wastewater treatment projects.*

Abstract –

Constructed wetland (CW), combined with other physical treatment units, is considered as an environmentally friendly and sustainable option for waste water treatment of varying scale. The absence of mechanical system makes the CW a low maintenance system but not maintenance free. The maintenance free treatment plant concept was observed in municipal waste water treatment plant in Narayanghad, Nepal largely because of its poor maintenance. Due to the absence of maintenance for a long time, sludge from the primary treatment units started to flow to the wetlands which, in turn, caused the reed plant to wither. From different literatures it was found that high organic solid load was the prime cause for the clogging of the filter medium. Clogging triggered oxygen deficiency at the root of the plant and hindered its growth.

Keywords – Constructed wetlands, reed plant, waste water

I. Introduction

Constructed wetlands (CWs), similar to natural wetlands, are environment friendly and sustainable waste water treatment technology since they are designed considering natural environmental phenomenon [1]. Based on the water flow, CWs are divided into surface flow CWs in which water flows above the filter medium, and subsurface flow CWs in which water flows below the filter medium. Subsurface flow CWs are again divided into horizontal flow (HF) and vertical flow (VF) CWs. However, CWs are not complete systems by themselves. For the proper functioning of CWs, it is necessary to combine CWs with other physical treatment units so they are widely used as tertiary treatment units [2]. The application of CWs can range from single household to large scale municipal waste water treatment system [3].

In spite of easy maintenance due to the absence of mechanical systems, the consequences of insufficient maintenance practices of the CWs are seen in reality. Lack of sufficient maintenance may not be visible in the system initially but in the long run the performance of the system plummets due to continuous deterioration of its components [2]. Vymazal[4] also emphasizes the importance of

maintenance in CWs by separating operation problems into two categories: one due to poor maintenance and another due to improper design. He further argues that natural treatment systems are not a "build-and-forget" type of system.

A similar perception was evident in the municipal waste water treatment plant in Narayanghad, Nepal. Constructed wetland was first introduced in Nepal in 1997 with the construction of the water treatment system at Dhulikhel Hospital [5]. According to Shrestha [6], one of the challenges in the successful operation of the constructed wetlands in Nepal is the misconception of CWs as zero maintenance system.

So, this paper examines the maintenance issues and their consequences on the performance of the municipal waste water treatment plant in Narayanghad, Nepal. The paper also attempts to relate the maintenance issues and consequences to the existing literatures from different journals. In doing so, this paper does not, however, examine the design criteria, design parameters, and performance parameters of the existing treatment plant.

II. Study area

The study area is located on the bank of Narayani River. Three horizontal flow CWs were constructed on the bank of Narayani River that receive and treat waste water of about 12,000 population residing in the core market area of Narayanghat. The treatment plants are designated as C1, C2 and C3. Bharatpur Municipality is responsible for the operation and maintenance of each plant.

Fig. 1 Location of treatment plant (Source: Google Earth)

Out of the three units, problem first began to appear in treatment plant C3. The major complaint was that the reed plant (Phragmites Australis) started to wither and the growth of reed plant continued to decline. The plant C3 had been operating for the last 9 years and its performance, as informed, had been quite satisfactory until then.

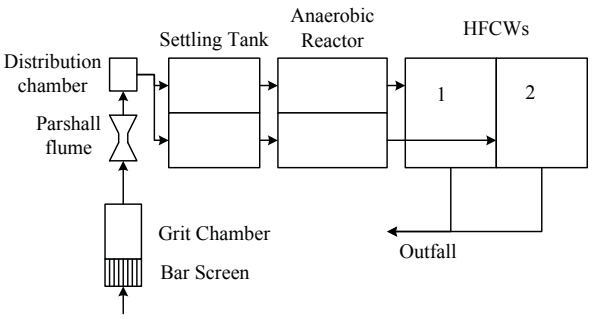

Fig. 2 Components of treatment plant

The major components of the treatment plant C3 are shown in the schematic diagram (Fig. 2).

III. Observations and Findings

In order to assess the problem, site visit was carried out; the responsible engineer and maintenance staff were interviewed; and drawings of the existing system were analyzed. Based on these, following observations were made on the following components:

A. Bar and screen

There were two screens-coarse and fine. As can be seen in Fig. 3, the finer screen is completely damaged and hence is not able to segregate floating particles and objects.

Fig. 3 Bar and screen

B. Grit chamber

Although it was constructed, the grit chamber was not in function. As shown in Fig. 4 the grit chamber was full of debris and the sewage from the bar and screen was made to pass to the Parshall Flume through a pipe. That resulted in the failure to remove inorganic waste from the sewage thereby allowing travel of inorganic matter to further treatment units.

Fig. 4 Grit chamber

C. Settling tank

As informed, no desludging process had been carried out on the site since the plant's operation. The collection of sludge in the tank was so high that there was no sign of clear effluent deposited on the top part of the tank when observed through manhole (Fig. 5). A long bamboo was immersed to check the consistency of the sewage and it could be felt that the sludge was already thickened and quite high in level. As a result of this there was reduction in effective volume of the septic tank which would reduce the detention time of sewage. Clearly, there will be decreased BOD removal efficiency.

Fig. 5 Checking consistency of sewage in settling tank

D. Anaerobic reactor

The consequence of lack in desludging at the septic tank is seen in the anaerobic reactor. Sewage in this reactor unit was not clear as shown in Fig. 6.

Fig. 6 Anaerobic reactor as seen through manhole

E. Horizontal CWs

Out of the two parallel units of horizontal flow constructed wetlands, wetland 1 was on the verge of total dysfunction. Certain sections of the bed were overgrown by foreign plants and the remaining reed plants were withering. There was deposition of thick sludge on top of the filter bed. As shown in Fig. 7, the influent feeding perforated pipe from the anaerobic filter to the reed bed was completely dry and hence the reed bed was being deprived of effluents.

Fig. 7 HFCW -1 (Dry inlet pipe, withered reed plant and deposition of sludge)

Fig. 8 HFCW 1 and 2

IV. Discussion

The major problem initially noticed was the withering of reed plants in the wetlands. One of the possible reasons for this could be the clogging of the filter medium since a thick layer of sludge deposition was observed during the site visit. Clogging is the most critical operational issue of HF wetlands [1]. A series of problems were observed that triggered clogging. As the effluent coming to the wetland component has not fully met its hydraulic retention time (HRT) in the ABR unit, there is a possibility of high concentration of pollution. This directly affects the rhizome growth as nitrifying bacteria are sensitive to toxicity. Further, the reduced permeability will cause ponding of waste water and bypassing of untreated waste water as effluent [7]. One of the factors that lead to the clogging

of CW is inefficient upstream treatment process [8]. Similar effect was also observed in this study. As informed by the staff, desludging of settling tank and anaerobic reactor had not been carried out at all since the plant's operation. So, it was observed that the primary treatment units were full of sludge and, as a result, sludge was flowing down to the wetlands.

Withering of reed plants due to clogging can be the result of oxygen deficiency at the roots of reed plant due to formation of algae [9]. Moreover, hydrogen sulphides produced due to anaerobic decomposition of organic waste depletes the dissolved oxygen in water and thus cuts of the level of oxygen transported to the root zone [10].

V. Conclusion

Withering of reed plants in the study was due to the overloading of organic solid matter originating from the unmaintained settling tank and anaerobic reactor. The rehabilitation of the system includes the removal of accumulated solids from all the components. Removing solids from the wetland cell is difficult but can be done by changing the filter medium.

This case is a good example of the prevailing misconception that constructed wetland is a maintenance free system. It is not a "build-and-forget" type of system as suggested by Vymazal [4]. Little but periodic maintenance of constructed wetland and its primary treatment units is therefore mandatory for its sustainable operation.

References

1. *G. Dotro, G. Langergraber, P. Molle, J. Nivala, J. Puigagut, O. Stein and M. von Sperling, Treatment Wetlands (Volume 7), IWA Publishing, 2017.*
2. *D. Rousseau, E. Lesage, A. Story, P. Vanrolleghem and N. D. Pauw, "Constructed wetlands for water reclamation," Desalination, vol. 218, no. 1-3, pp. 181-189, 2008.*
3. *UN-HABITAT, Constructed Wetlands Manual, Kathmandu: United Nations Human Settlements Programme (UN-HABITAT), 2008.*
4. *J. Vymazal, "Czech Republic," in Constructed Wetlands for Wastewater Treatment in Europe, Leiden, Backhuys Publishers, 1998, pp. 95-121.*
5. *R. Shrestha, R. Haberl, J. Laber, R. Manandha and J. Mader, "Application of constructed wetlands for wastewater treatment in Nepal," Water Science and Technology, vol. 44, no. 11-12, pp. 381-386, 2001.*
6. *R. R. Shrestha and P. Shrestha, "Constructed Wetlands in Nepal: Chronicle, Continuance and Challenges," Environment and Public Health Organization (ENPHO), 2004.*
7. *T.Maehlum, "Treatment of landfill leachate in onsite lagoons and constructed wetlands," Centre for Soil and Environmental Research,, pp. 129-135, 1995.*
8. *P. Knowles, G. Dotro, J. Nivala and J. García, "Clogging in subsurface-flow treatment wetlands: Occurrence and contributing factors," Ecological Engineering, vol. 37, no. 2, pp. 99-112, 2011.*
9. *S. Yamasak, M. Kimura and T. Yoneyama, "Early withering of lower leaves of Phragmites australis (Cav.) Trin. ex Steud. in a eutrophic stand: role of oxygen concentration, fate of nitrogen and nitrogen uptake by the plants," Aquatic Botany, vol. 43, no. 2, pp. 143-157, 1992.*
10. *M. Parveen, T. Asaeda and M. H. Rashid, "Hydrogen sulfide induced growth, photosynthesis and biochemicalresponses in three submerged macrophytes," Flora, vol. 230, pp. 1-11, 2017.*