Scientific Journal of Impact Factor (SJIF) : 3.134

ISSN (Print) : 2348-6406
ISSN (Online): 2348-4470

International Journal of Advance Engineering and Research Development

Volume 1, Issue 11, November -2014

USE OF ARTIFICIAL MEDIA IN BIOLOGICAL TREATMENT SYSTEM

Yadav P. G.[1], Adhau R. S.[2], Chorey N. W.[3]

[1] Civil Engineering, Department,PRMIT&R,pg.yadav91@gmail.com
[2]Civil Engineering, Department,PRMIT&R,adhau.rutuja1@gmail.com,
[3]Civil Engineering, Department,PRMIT&R,chorey.neelam@gmail.com

Abstract— *Water is one of the most important elements involved in the creation and development of healthy life. Since water is such a vital resource for survival of both plants and animals, it is our responsibility to manage this resource, not only as a social, industrial and commercial good but also for the sustainable benefit of all present and future living matter. With the introduction of stringent effluent standards it is the responsibility of wastewater engineer to treat the wastewater to satisfy the requirements of receiving body. Current and future fresh water demand could be met by enhancing water use efficiency and demand management. Thus, wastewater/low quality water is emerging as potential source for demand management after essential treatment.*

Biological treatment is an important and integral part of any wastewater treatment plant that treats wastewater from either municipality or industry having soluble organic impurities or a mix of the two types of wastewater sources. This paper reviews the use of artificial media for domestic wastewater treatment.

Research on alternate filtration media, has expanded the options available for improving effluent quality. This paper intends to provide an overall vision of the use of artificial media as an alternative for natural media.

Index Terms— *Effluent, Domestic Wastewater, Packing materials, Media, Aerocon Media*

I. INTRODUCTION

Increasing affluent lifestyles, continuing industrial and commercial growth in many countries around the world in the past decade has been accompanied by rapid increases in both the municipal and industrial solid waste production. One of the many byproducts of civilization is waste. Waste arises from households, industrial factories, and other facilities to purge the unwanted wastes, sewage systems were created in populated areas. Sewage systems wash down the waste with water, disposing the resulting wastewater in the desired locations. The increase in population and the expansion of cities have led to a greater disposal of wastewater into the environment improper disposal of wastewater has led to outbreaks of disease arising from wastewater in many parts of the world. These outbreaks increased the need for wastewater management and treatment, driving the demand for wastewater treatment to higher levels

Wastewater is any water that has been adversely affected in quality by anthropogenic influence. It comprises liquid waste discharged by domestic residences, commercial properties, industry, and/or agriculture and can encompass a wide range of potential contaminants and concentrations. In the most common usage, it refers to the municipal wastewater that contains a broad spectrum of contaminants resulting from the mixing of wastewaters from different sources. Wastewater also known as sewage originates from residential commercial and industrial area.

Wastewater engineering is that branch of environmental engineering in which the basic principles of science and engineering are applied to solving the issues associated with the treatment and reuse of wastewater. The ultimate goal of wastewater engineering is the protection of public health in a manner commensurate with environmental, economic, social, and political concerns. When untreated wastewater accumulates and is allowed to go septic, the decomposition of the organic matter it contains will lead to nuisance conditions including the production of malodorous gases. In addition, untreated wastewater contains numerous pathogenic microorganisms that dwell in the human intestinal tract. Wastewater also contains nutrients, which can stimulate the growth of aquatic plants, and may contain toxic compounds or compounds that potentially may be mutagenic or carcinogenic. For these reasons, the immediate and nuisance-free removal of wastewater from its sources of generation, followed by treatment, reuse, or dispersal into the environment is necessary to protect public health and the environment.

Besides that, the purpose of wastewater treatment is to remove pollutants that can harm the aquatic environment if they are discharged into it. Because of the deleterious effects of low dissolved oxygen concentrations on aquatics life, wastewater treatment engineers historically focused on the removal of pollutant that would deplete the DO in receiving waters.

Wastewater treatment methods can be classified as primary, secondary, and tertiary treatment. In primary treatment, physical barriers remove larger solids from the wastewater. Remaining particulates are then allowed to settle. Secondary treatment consists of a combination of biological processes that promote biodegradation by micro-organisms. Tertiary treatment processes are used to further purify the wastewater of pathogens, contaminants, and remaining nutrients such as nitrogen and phosphorus compounds.

The biological wastewater reactors are classified into attached growth and suspended growth. Attached growth technologies work on the principle that organic matter is removed from wastewater by microorganisms. These microorganisms are primarily aerobic, meaning they must have oxygen to live. They grow on the filter media (materials such as gravel, sand, peat, or specially woven fabric or plastic, essentially recycling the dissolved organic material into a film that develops on the media. Suspended growth treatment systems, such as biological treatment of water, involve the use of naturally occurring microorganisms in the surface water to improve water quality. Under optimum conditions, the organisms break down material in the water and improve the water quality. Suspended growth aerobic treatment is a process used to provide secondary and (in some cases) tertiary treatment of effluent.

II. PRACTICAL EXPERIENCES OF THE RELATED WORK

A brief review of the work that is related to the use of l media is presented

Affam and Adlan (2009) [6] This study was conducted to investigate the removal of COD, BOD, turbidity and colour from leachate using vertical upflow filtration technique. Limestone media with a density of 2554 kg/m3 was crushed and graded in sizes of4 - 8 mm, 8 - 12 mm, and 12 - 18 mm. The three media size ranges (4 - 8 mm, 8 - 12 mm, and 12 - 18 mm) were used to assess the influence of flow rate, pore size and media density on BOD, COD, colour and turbidity removal efficiency. Filter media size were stacked in decreasing size from bottom towards the top for all experiments. The media was washed with 20 liters of dilution water before leachate was passed through the column. Five hydraulic loading rates (100 mL/min, 80 mL/min, 60 mL/min, 40 mL/min and 20 mL/min) were initially assessed in this study to determine the influence of interstitial fluid velocity on removal efficiency of the various parameters. Trial runs were done before the main experiment at an interval of 24 h analysis. Leachate was between pH 7.94 to 8.12 before experiments but increased to pH 8.42 after the filtration process. Maximum headloss at steady flow rate 20mL/min was 0.5 cm. The optimum treatment was achieved with 4–8 mm, 8–12 mm & 12–18 mm media size in combination and removal efficiency was 22 to 81%, 22 to 75%, 32 to 86%, and 36 to 62% for BOD, COD, turbidity and colour, respectively. Vertical upflow roughing filter can be used for pre-treatment of leachate before further treatment.

Rehman et al. (2012) [4] aimed towards designing and construction of efficient plastic media-trickling filter (TF) for the treatment of domestic wastewater. A shower rose was used as wastewater distribution system supported on the top of stone media bed. A net distance between the bottom of shower rose and top of filter bed surface was 9 inches. The flow of water was controlled by electric dimmer connected to the water pump. It was run under different treatment times (12, 24, 36 and 48 hrs) at 5-15ºC. After 48 hrs HRT, treated wastewater was then passed through SF. Parameters like COD, BOD5, TSS, turbidity, NO3, NO2, SO4, PO4 and pathogenic indicator microbes were monitored after treatment of 12, 24, 36 and 48 hrs. The efficiency of the TF was improved with increase of time from 12 to 48 hrs. Maximum efficiency of TF was observed after 48 hrs treatment viz. 93.45, 93, 86.25, 57.8, 63.15, 25, 32.43, 99.95 and 86.3% reduction from the zero time value for BOD5, COD, TSS, PO4, SO4, NO3, NO2, turbidity and fecal coliforms respectively. Finally 48 hrs treated sample was passed through sand filter (SF) for further final polishing and approximately, 95.72, 95, 100, 73.5, 65.8, 58.3, 37.83, 100 and 91.5% reduction in BOD5, COD, TSS, PO4, SO4, NO3, NO2, turbidity and fecal coliforms was observed. This study showed that plastic media-trickling filter along with sand filter is a promising technology for wastewater treatment and can be scaled up for small communities in the developing countries.

Valsa Remony Manoj, Namasivayam Vasudevan (2011) [6] focused on removing nitrate nitrogen at two different nitrogen loading rates (60 (NLR I) and 120 (NLR II)mg^{-1} l) from simulated aquaculture wastewater. Two independent acrylic cylindrical columns, each with an inner diameter of 5.25 cm and a height of 45.72 cm were used as biofilters with a volume of 3.9 l in the study. Coconut coir fibre and a commercially available synthetic reticulated plastic media (Fujino Spirals) were used as packing medium in two independent upflow anaerobic packed bed column reactors. A common influent storage tank of 40 l capacity was placed above the reactors. The hydraulic residence time (HRT) of the simulated wastewater in the bioreactors were 6.72hr. 60 NLR experiments were run for 10 weeks after start up period immediately followed by 120 NLR for a period of 28 weeks. Effluent samples were collected in cleanly labeled 1 l sampling bottles during operation on a weekly basis for analysis. He concluded that maximum removal of 97% at NLR- I and 99% at NLR – II of nitrate nitrogen was observed in either media. Greater consistency in the case of COD removal of upto 81% was observed at NLR-II where coconut coir was used as support medium compared to 72% COD removal by Fujino Spirals. The results indicated that the organic support medium is just as efficient in nitrate nitrogen removal as a conventionally used synthetic support medium.

Xing Liu et al. (2009) [7] studied the use of waste oyster shells as a BAF medium. Oyster shell was selected due to its availability, the characteristic shape, good rigidity, outstanding chemical constitutes and biological stability. Oyster shell is also good for removing phosphorus from wastewater by producing calcium phosphate precipitation. Moreover, its high roughness surface makes the microorganisms grow and adhere easily. Two parallel lab-scale BAF reactors were made of Plexiglas. The reactors were packed with oyster shell and plastic ball, respectively. The reactors had an upflow configuration with 1.15 m in height and 0.10 m in inner diameter. The medium was 1.0 m height, with an effective volume of 7.8 L. Since the air was introduced into the reactors with an air diffuser, located at 0.3 m from the downside inlet, an anaerobic area between the air diffuser and downside inlet was formed. The air flow rate was controlled, using an air flowmeter. The two BAFs were operated at the conditions of water temperature ranging from 17.3 °C to 23 °C and

DO ≥2mg/L. Four HRTs, 12 h, 8 h, 4 h and 2 h were adopted, coincided with hydraulic loadings 0.071, 0.11, 0.22 and 0.44 m3/m2 h, respectively. The results indicated that oyster shell BAF and plastic ball BAF had average chemical oxygen demand (COD) removals of 85.1% and 80.0%, when hydraulic retention time (HRT) was longer than 4 h, and 65.7% and 68% with HRT of 2 h, respectively. In terms of removing ammonia nitrogen (NH3-N), oyster shell BAF and plastic ball BAF had average removals of 98.1% and 93.7% for HRT longer than 4 h, and 47.2% and 65.1% for HRT of 2 h, respectively.

Mukhopadhay and Majumder (2008) [9] constructed a pilot plant in the Department of Water Resources Engineering, Jadavpur University to investigate the possibility of horizontal roughing filter‘s ability to treat waste water. The structure of the plant was made up from the fibre glass sheeting which consisted of three chambers of each measuring 450 mm × 300 mm. The filter medium namely gravel was placed in the three separate chambers starting from the coarse size to the finer ones in the direction of flow and the whole system was operated in series. The first compartment was filled up of gravel size 15 mm–10 mm having the average size 12.5 mm the second compartment consisted of average gravel size 7.5 mm and the third one of average size 2.5 mm. Each compartment was being separated by the perforated fiber glass partition to avoid mixing of the gravels of different chambers. The filter bed was provided with the under drainage system to enable flushing after a certain running period of interval for hydraulic sludge extraction by observing the filter resistance. A constant flow rate of 0.75 m/h was maintained through all the compartments by the help of a peristaltic pump. The suspended solids (SS) concentration of raw water for all the chambers at the inlet and the SS concentration at the out let was measured by the help of standard procedure describe in the Standard methods. The experiment was carried out both in low flow (dry season) and high flow (rainy season) periods during the span of 70 days. The local pond water was used as raw water which has the concentration of suspended solids ranges from 40 mg/ℓ to 150 mg/ℓ. According to Weglin’s design guideline this range is medium range of concentration (100–300) mg/ℓ for which filtration rate is 0.75 m/h – 10 m/h are recommended. So a constant flow 0.75 m/h was chosen in carrying out the project.

Daigger et al. (2011) studied The modem trickling filter typically includes the following major components: (1) rotary distributors with speed control; (2) modular plastic media (typically cross-flow media unless the bioreactor is treating high-strength wastewater, which warrants the use of vertical-flow media); (3) a mechanical aeration system (that consists of air distribution piping and low-pressure fans); (4) influent/recirculation pump station; and (5) covers that aid in the uniform distribution of air and foul air containment (for odor control). Covers may be equipped with sprinklers that can spray in-plant wash water to cool the medias during emergency shutdown periods. Trickling filter mechanics are poorly understood. Consequently, there is a general lack of mechanistic mathematical models and design approaches, and the design and operation of trickling filter and trickling filter/suspended growth (TF/SG) processes is empirical. Some empirical trickling filter design criteria are described in this paper. Benefits inherent to the trickling filter process (when compared with activated sludge processes) include operational simplicity, resistance to toxic and shock loads, and low energy requirements. However, trickling filters are susceptible to nuisance conditions that are primarily caused by macro fauna. Process mechanical components dedicated to minimizing the accumulation of macro fauna such as filter flies, worms, and snail (shells) are now standard. Unfortunately, information on the selection and design of these process components is fragmented and has been poorly documented. The trickling filter/solids contact process is the most common TF/SG process.

Ochieng and Oteino (2006) [2] study aimed at verifying these criteria based on gravel as a filter medium and two other possible alternative filter media, namely broken burnt bricks and charcoal maize cobs. Gravel was used as a control medium since it is one of the most commonly used roughing filter media and also because it was used in developing these criteria. The per cent reduction in raw water suspended solids (SS) concentration was compared against the expected model prediction. SS was used as a parameter of choice since the “1/3 – 2/3” filter theory is based on SS reduction. The study also endeavoured to determine the suitability of the extension of this criterion to filter material other than gravel. In this case, alternative locally available filter material, i.e. charcoal maize cob and broken burnt brick were tested. A pilot plant study was undertaken to meet this objective. The pilot plant was monitored for a continuous 85 days from commissioning till the end of the project. Results showed that in general, filters filled with charcoal maize cobs and broken burnt bricks were off model prediction by 13% compared to gravel’s 15%. The performances also varied in both low- and high-peak periods. It is concluded that the Wegelin’s design criteria should be used as a guideline step followed by actual field and laboratory tests to establish the actual filter design parameters in line with the filter media in use and the quality of the raw water to be treated.

III. EXPERIMENTAL SETUP

The proposed Multi – media filter model will be based upon the concept of attached growth process. The study will be carried out to study the behaviour of the attached growth system and to study the performance of the various packing material used in the media filter. The model will be fabricated with GI sheet and will consists of three reactors placed in series with the total reactor volume 90 liters. The model will be packed with different packing media. The depth of the media will be kept accordingly. The Inlet and outlet arrangement were provided at appropriate locations.

A inlet chamber will be provided before the three reactors so that the wastewater will first get collected in the collecting chamber and then enter the reactors. A perforated system will be provided in the reactors to facilitate the uniform distribution of wastewater throughout the reactor. The wastewater will be collected in the collection chamber and finally be removed through the outlet.

IV. WORKING OF MODEL

The wastewater will be fed into the inlet tank cum pre-sedimentation tank having capacity of 55 liters. The wastewater will then enter the inlet chamber.

The wastewater from the inlet chamber will flow in sequence i.e. from the first reactor to the last reactor, passing through the packed media and then enter the collecting chamber and will be collected from the outlet. The wastewater from the inlet chamber will enter the first reactor through the perforated PVC pipes. The perforated PVC pipes are provided so as to provide uniform distribution throughout the reactor. The wastewater will thus pass uniformly through the first reactor and will get partially treated and enter the second reactor. The wastewater partially treated in the first reactor will move to the second reactor in upflow regime.

The wastewater will thus rises uniformly at the same time it will get treated. The wastewater from the second reactor will enter the third reactor in a uniform manner through the perforated PVC pipes.

The wastewater will thus pass uniformly through the third reactor and get treated and will enter the collecting chamber by the upflow movement. Thus, the wastewater will pass through all the three reactors in the downflow - upflow – downflow regime and will get collected in the collecting chamber and after reaching the outlet level the treated effluent will collected in the outlet tank.

The model will be operated for varying detention time. Sampling will be done at the end of the detention period and the various characteristics of the influent and the effluent will be determined. The working of the experimental model will also be observed by varying the packing of the filter media. Different filter media such as burnt bricks, aerocon media, plastic media etc. will be used.

V. EXPECTED RESULTS

It is expected that that materials such as burnt bricks and porous aerocon media may prove to be more efficient in improving the effluent quality in terms of its BOD and suspended solid content. It is expected that the BOD removal will be in the range of 65-70% and 60-70% when Aerocon media and burnt brick bats are used. It is also expected that BOD removal using plastic media would be in the range of 40 – 50%. It is expected that the artificial media will significantly assist in the removal of COD, TSS and will improve the pH quality of the effluent.

VI. CONCLUSION

Artificial media has a potential in biological wastewater treatment. Artificial media filtration technology is also a recent development which involves use of media other than the conventional media as opposed to sand used in the conventional filters. It can also be concluded from the study that the Artificial Media filter may be considered as efficient pre-treatment process for wastewater treatment. The recent developments in the media types such as porous aerocon media and plastic media has expanded new areas for study. Also, the above media may enhance the performance of the treatment system. Hence, this technology is environment friendly and cost effective.

REFERENCES

[1] Nkwonta, O. (2010), "A comparison of horizontal roughing filters and vertical roughing filters in wastewater treatment using gravel as a filter media", *International Journal of the Physical Sciences Vol. 5(8), pp. 1240-1247*
[2] Nkwonta, O., Ochieng, G., (2009), "Roughing filter for water pre-treatment technology in developing countries: A review", *International Journal of Physical Sciences Vol. 4 (9), pp. 455-463*
[3] Parjane, S., B., Sane, M., G.,(2011), "Performance of grey water treatment plant by economical way for Indian rural Development" *International Journal of ChemTech Research Vol.3, pp 1808-1815*
[4] Rehman, A., Naz, I., Khan, Z., U., Rafiq, M., Ali, N., Ahmad, N., (2012) "Sequential Application of Plastic Media-Trickling Filter and Sand Filter for Domestic Wastewater Treatment at Low Temperature Condition", *British Biotechnology Journal 179-191*
[5] Santos, C., Taveira-Pinto, F., Cheng C., Y., Leite, D., (2012), "Development of an experimental system for greywater reuse", *Desalination 301–305.*
[6] Valsa, R., M., Vasudevan, N., (2012), "Removal of nutrients in denitrification system using coconut coir fibre for the biological treatment of aquaculture wastewater", *Vol. 33, 271-276*
[7] Xing Liu, Y., Ou Yang, X., Xing Yuan, D., Yun Wu,X. (2010) "Study of municipal wastewater treatment with oyster shell as biological aerated filter medium", *Desalination vol. 254, 149–153*
[8] Parjane, S., B., Sane, M., G.,(2011), "Performance of grey water treatment plant by economical way for Indian rural Development" *International Journal of ChemTech Research Vol.3, pp 1808-1815*
[9] Mukhopadhay B., Majumder M., Barman R., Roy P., Mazumder A. (2009) "Verification of filter efficiency of horizontal roughing filter by Weglin's design criteria and Artificial Neural Network*", Drinking Water Engineering and Science, Volume 2, pp. 21–27*

