American Journal of Biomedical Science and Engineering
2017; 3(1): 1-7
http://www.aascit.org/journal/ajbse
ISSN: 2381-103X (Print); ISSN: 2381-1048 (Online)

American Association for Science and Technology

Keywords
Biofilm Reactor,
Media (EMM) and NH_3-N,
COD,
NO_3-N and TSS

Received: December 31, 2016
Accepted: January 6, 2017
Published: June 3, 2017

Effective Treatment of Industrial Effluent by Using Biofilm Reactors

S. A. Tweib[1, *], A. Y. A. Alhaj[2], M. A. Elahmer[3], F. A. Abdussamad[4], A. M. Fellah[5]

[1]Department of Chemical and Process Engineering, Higher Institute of Sciences and Technology, Soq Alkamis, Msehel, Libya
[2]Department of Life Sciences, Azzaytuna University, Bani Walid, Libya
[3]Department of Medicinal Plant, Biotechnology Research Center (BTRC), Tripoli, Libya
[4]Department of Food Life Sciences, Biotechnology Research Center (BTRC), Tripoli, Libya
[5]Department of Research & Scientific Studies, Biotechnology Research Center (BTRC), Tripoli, Libya

Email address
Tweib123@yahoo.com (S. A. Tweib)
[*]Corresponding author

Citation
S. A. Tweib, A. Y. A. Alhaj, M. A. Elahmer, F. A. Abdussamad, A. M. Fellah. Effective Treatment of Industrial Effluent by Using Biofilm Reactors. *American Journal of Biomedical Science and Engineering*. Vol. 3, No. 1, 2017, pp. 1-7.

Abstract
This research is conducted to improve the water quality of oxidation pond using biofilm reactor. Another goal to be achieved is to compare the water effluent to the water quality standard in Libya as well as studying the condition of water experimentally to analyze critical parameters that identify the water quality. This study included: studying efficiency of biofilm in treating effluent, determination of the most suitable conditions, i.e. HRT for polishing effluent and obtaining the percentage removal of COD, NH_3-N, NO_3-N and TSS. The potential of biofilm reactor is to remedy toxic liquid effluents, especially as the chlorinated organics of the waste water has gained remarkable reorganization. Biofilm reactors have biomass activity even at a very low concentration of the target organics which rendering the reactor more efficient for the purpose of removing toxic compounds in waste water. However, bio film process has been found to be less sensitive to the presence of toxic compounds and to the laboratory materials and more resistant to shock loading then to disperse growth system. Such characteristics are essential as the floor space become expensive and yet there is a great need to treat and polish industries effluents before reuse.

1. Introduction

Waste water is simply water that has been used and discharged as waste. It is usually contain various pollutants; depending on what it was used [1]. Called an expression of waste water to all types of waste water from various domestic and commercial activities and add to it in the major cities of industrial waste water. Generally, waste water consists of about 99 percent water and about 1 percent of impurities and harmful pollutants [2]. The term sewage usually refers to water borne waste of public sewer network to the treatment plant or to any natural mouth away from the city. Basically, it can be classified into two major categories by source which is domestic or sanitary waste water and industrial waste water. Domestic waste water comes from residential sources including toilets, sinks, bathing, and laundry [3]. It can contain body wastes covering intestinal disease organisms, the industrial waste water is discharged by manufacturing processes and commercial enterprises [4]. Process waste water can contain rinse waters including

such things as residual acids, plating metals, and toxic chemicals. Waste water is treated to remove pollutants (contaminants). Waste water treatment is a process to improve and purify the water, removing some or all of the contaminants, making it fit for reuse or discharge back to the environment [5]. Discharge may be to surface water, such as rivers or the ocean, or to ground water that lies beneath the land surface of the earth. Properly treating waste water assures that acceptable overall water qualities are maintained. Health problems and diseases have often been caused by discharging untreated or inadequately treated waste water in several parts all over the world [6]. Such as discharges are called water pollution, and outcome in the spreading of disease, fish kills, and destruction of other forms of aquatic life. The pollution of water has a serious influence on all living creatures, and can negatively affect the use of water for drinking, household needs, recreation, fishing, transportation, and commerce. Sewage is composed of domestic waste, which includes the remnants of fat foods and detergents used in washing and cleaning, organic matter and domestic wastes as well as an industrial waste water left over from the factory and contain different ratios of organic materials and chemicals, in addition to rinse water for backyard dirt and carries with it some of the material outstanding. The major dangers lie in the waste water is the pathogen city of the bacteria move with waste water and sludge, which can cause numerous diseases, and most significant of these pathogenic prions in sewage, including harmful bacteria that cause typhoid, cholera, dysentery and other diseases infectious organisms, protozoa. Nowadays, current mainstream technologies for waste water treatment, such as the activated sludge process with nitrogen and phosphorous removal, are too costly to provide a satisfactory solution for the growing waste water problems in developing regions. The treatment of waste water should be geared towards the effective reuse of nutrients itself [7]. If this nutrients containing nitrogen in the form of ammonium cation release to the environment is uncontrolled, it will contribute to the serious pollutions problem and also affect the human health [8]. Some of the disadvantages of ammonium-nitrogen are toxicity, manufacture of surface water, cause of corrosion and cause of methemoglobinemia in infants [9]. Biological treatment is an environmentally sound approach to decrease nitrogen and phosphorus levels and has been applied for almost 50 years in special reactors 3 termed high-rate ponds [10]. The study shows that there are obvious advantages of eliminating ammonium from waste water using biological treatment. First, it does not generate secondary pollution by generation of ammonia (NH_3) and second the biomass can be harvested and as a slow-release fertilizer or soil conditioner [11], [12]. Besides the treatment is environmentally approach is also give low cost of operating.

2. Materials and Method

In this research biofilm reactor was placed to polishing Influent of waste water from waste water treatment plant. Supplied to the system and designed to absorb sun rays with the aid of the bottom which was painted black, the biofilm reactor has measurements of 90 cm height and 60 cm wide [13]. This is an experimental study, targeted at ensuring the possibilities of removing ammonium- nitrogen (NH_4-N), Chemical oxygen demand (COD), nitrate – nitrogen (NO_3-N) and measurement of suspended solids in water, to improve it quality. Input of waste water sample was collected from an open oxidation pond before treatment in biofilm reactor where, the pond received waste water from houses, shopping, the hostels, laboratories and faculties. For output of waste water sample was collected from biofilm reactor after treatment.

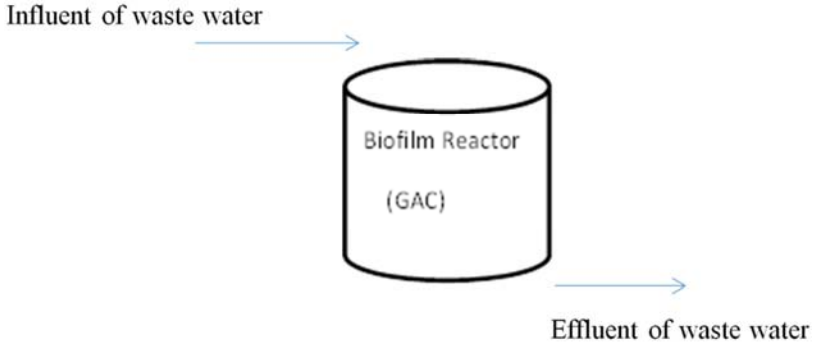


Figure 1. *Biofilm Reactor.*

2.1. Media Selection

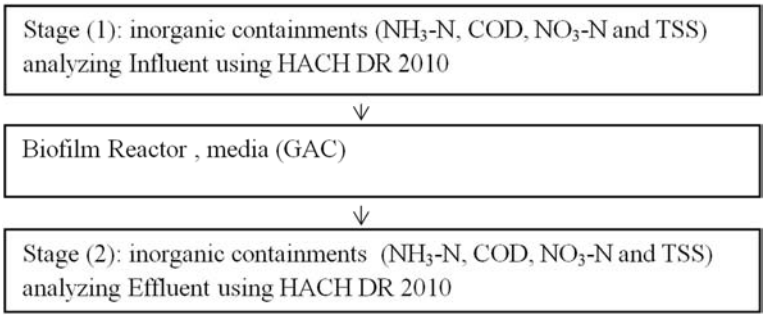
The selection of a appropriate medium is critical in terms of design and operation of the process and in enabling the required effluent standards to be reached. The plastic media should be resistant to attrition, have suitable specific weight, high specific surface areas, and chemically stable. The size of a plastic media also affects the process performance and should be carefully selected for different applications. Media for reactor can be either denser than water to give sunken media or less dense than water to produce floating media. Sunken media are normally made of natural products such as sand, shale or phyllosiliates, for example, baked clay or pozzolana [14], [15]. Floating media tend to be produced from synthetic materials such as polystyrene beads and pure polypropylene. Normally, denser media will need higher flow

rates when backwashed and resistant to attrition during the backwash sequence. In a prior biological filter, there is packed bed comprising small granular media sized typically between 2 and 6 mm, the depth of the packed media bed being typically 1.5 to 2.5 meters. An advantage of small granular media is the large surface area available for the growth of the bacteria and micro-organisms responsible for treatment. This leads to high concentrations of attached biomass and hence much small reactor volumes can be used. In addition, physical and biological filtrations are accomplished within the packed media bed resulting in treatment and solids removal in a single treatment vessel.

2.2. Granular Activated Carbon (GAC)

Regeneration process for granular activated carbon system which removed contaminants from ground water and mineralization process for the removed contaminants by biological strategy are combined. Granular carbon generally used in percolation columns, through which the liquor flows continuously. Advantages of granular carbon treatment are include very suitable for continuous process, greatly reduced carbon consumption in comparison with powdered carbon, easy clean handling and can be regenerated (depending on the application).

2.3. Flow Chart of the Research Work



3. Results and Discussion

In this research, the reactor was operated for more than 100 days on a continuous with ambient temperature (30 ± 2°C). The study has been investigated with 2, 4, 6, 8 and 24 HRT to remove the NH_3-N, COD, NO_3-N and TSS at demystification process at the same temperature. For each operating condition, the reactor was operated over 2 to 4 weeks period. The consequence of this experiment has been explained in the tables as make it easily references to the graphs

3.1. Data Value of COD, NO_3-N, TSS and NH_3-N

Table 1 and 2 show the average values obtained of the laboratory of the elements of the large of research before treatment and after treatment. The values indicated that the treatment has effective by using biofilm.

Table 1. *The average values of influent and effluent concentration of NH_3-N, NO_3-N, COD and TSS for different hydraulic retention time HRT.*

HRT (hrs)	COD		NO_3-N		TSS		NH_3-N	
	Influent	Effluent	Influent	Effluent	Influent	Effluent	Influent	Effluent
2 (A)	38.69	20.54	1.47	0.70	27.62	21.00	2.26	1.93
4 (B)	56.15	20.15	1.51	0.72	31.77	19.38	2.25	1.67
6 (C)	58.38	17.84	1.63	0.78	30.77	20.92	2.38	1.65
8 (D)	44.69	16.62	1.71	0.84	28.85	18.15	2.36	1.86
24 (E)	46	16	1.66	0.78	28.00	18.00	2.29	1.83

Table 2. *Average removal percentage of NH_3-N, NO_3-N, COD and TSS for different hydraulic retention time HRT.*

HRT (hrs)	COD%	NO_3-N%	TSS%	NH_3-N%
2	40.87	53.09	24.11	17.51
4	57.55	51.14	40.90	27.75
6	66.90	46.66	51.57	31.37
8	56.95	58.90	35.13	26.88
24	58	60	34	27

3.2. Removal of NH_3-N

The influent and effluent concentrations of NH_3-N for dissimilar HRT are presented in figure 3 below. The maximum ammonia removal during this research period is 37.89 at 2 HRT. At figure A, the range of influent and effluent concentrations of NH_3-N for different HRT were 2.03 to 2.6 mg/L and 1.35 to 2.72 mg/L, respectively where the average NH_3-N removal was 17.51%. On the other hand, the removal efficiency was decreasing for the increasing HRT from 2 to 4 hours. The range of influent and effluent concentration of ammonia-n was 2.01 to 2.45 mg/L and 0.51 to 2.18 mg/L, respectively where the average NH_3-N removal was 27.75% see in figure B. Throughout the 4 hour HRT, the maximum NH_3-N removal was 77.82%. From figure C,

during the 6 hour the range of influent and effluent concentration of ammonia-N was 2.02 to 3 mg/ L and 0.34 to 2.39 mg/L, respectively. The average NH_3-N removal was 31.37% and the maximum removal was 85.21%. At figure D during the 8 hour the range of influent and effluent concentration of ammonia-N was 1.97 to 3 mg/L and 0.86 to 2.52 mg/L respectively where the average NH_3-N removal was 26.88% and the maximum removal was 56.34%. From figure E during the 24 hour the range of influent and effluent concentration of ammonia-N was 2.01 to 3 mg/L and 0.84 to 2.52 mg/L, respectively where the average NH_3-N removal was 27%. The maximum removal was 64.25%. The effective HRT was 24 during the study period to remove ammonia-nitrogen and the maximum removal was 64.25%. The percent of ammonia removal was increased for the increasing HRT value. A HRT of 2 hours was used initially and then changed to 4 hour, 6 hour, 8 hour and 24 hour at the same temperature. During this period also, the removal of nitrogen was low. This phenomenon occurred probably because of the inability if heterotrophic bacteria to degrade COD and convert organic nitrogen to ammonia.

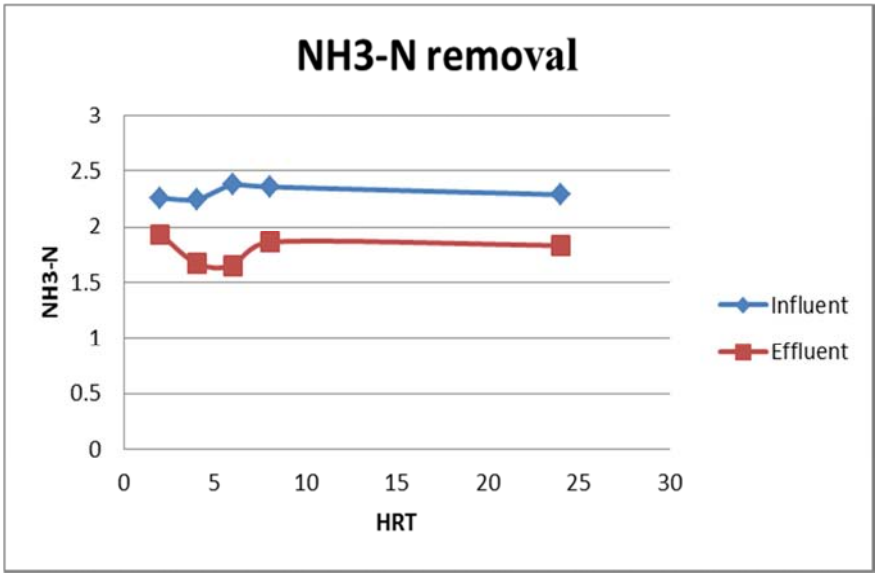


Figure 2. *Average removal of NH_3-N for different HRT.*

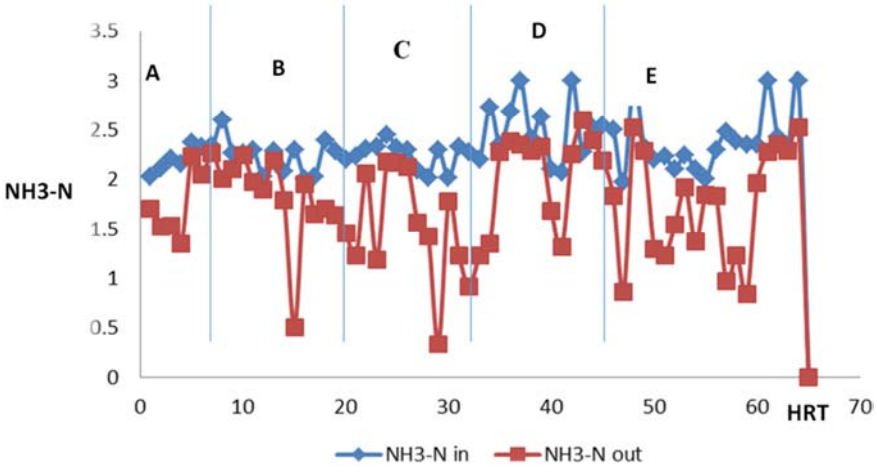


Figure 3. *Influent and effluent concentrations of NH_3-N for different HRT.*

3.3. Removal of Nitrate

The change in nitrate concentration within the bioreactor at different HRT is presented in figure 4 below. At HRT of 2 and 24 hours, significant differences in the NO_3-N removed were observed during the experimental period. Denitrification is the reduction of nitrate to nitrogen gas by certain heterotrophic bacteria. As illustrated in figure A, the range of influent and effluent concentration of nitrate was 1.2 to 2 mg/L and 0.2 to 1.6 mg/L, respectively, where the average nitrate removal was 53.09%. The maximum removal of NO_3-N was 85.29% at 2 hours HRT. At figure B the range of influent and effluent concentration of nitrate was 0.8 to 2.5 mg/L and 0.2 to 1.8 mg/L, respectively, where the average nitrate removal was 51.14% at 4 hours. The maximum removal of NO_3-N was 83.33% respectively when the HRT was 6 hours. The range of influent and effluent concentration of nitrate was 0.9 to 2.5 mg/L and 0.3 to 1.28 mg/L, respectively the average nitrate removal was

46.66% see in figure C. Maximum removal of NO_3-N was 81%. From figure D the range of influent and effluent concentration of nitrate was 1.2 to 2.8 mg/L and 0.2 to 2.2 mg/L, respectively, where the average nitrate removal was 58.90% at 8 hours. The maximum removal of NO_3-N was 86.66%. From figure E the range of influent and effluent concentration of nitrate was 1.3 to 3 mg/L and 0.3 to 1.9 mg/L, respectively, where the average nitrate removal was 60% at 24 hours. The maximum removal of NO_3-N was 88%. During the study period, suggest that the removal of nitrate in takes place deeper in the bio film, as long as organic material is present. Denitrifying bacteria, the microorganisms capable of reducing nitrogen oxides to molecular nitrogen, are mostly heterotrophic and use organic substrates as electron donors for respiration and growth.

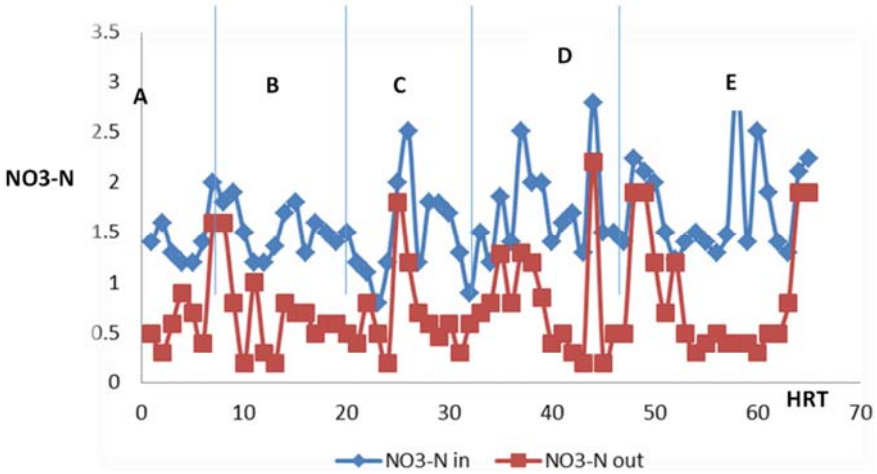


Figure 4. *Influent and effluent concentrations of NO_3-N for different HRT.*

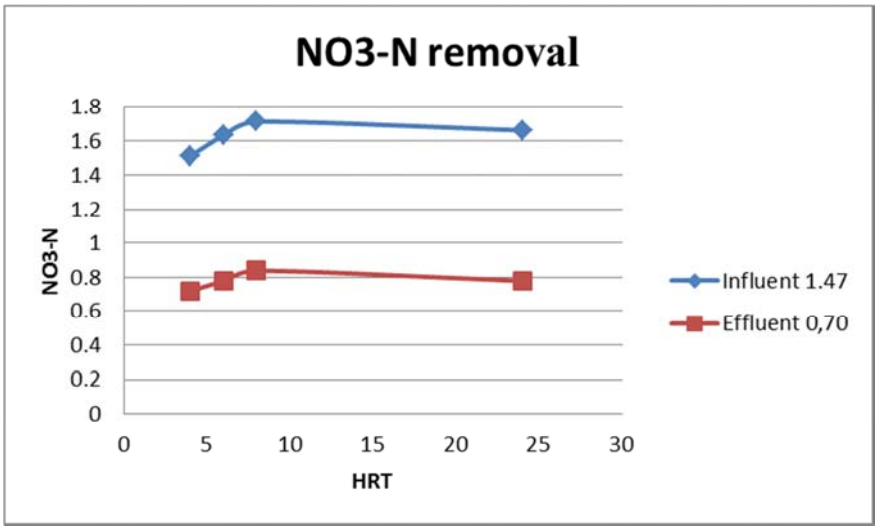


Figure 5. *Average removal of NO_3-N for different HRT.*

3.4. Removal COD

From figure 7 daily difference of influent and effluent concentration of inorganic contaminant was studied during the operation period. At figure A the range of influent and effluent concentration of COD was 31 to 68 mg/L and 10 to 32 mg/L, respectively. The average COD removal was 40.87%. The maximum removal of COD was 83.87% during this study period. During figure B the range of influent and effluent concentration of COD was 32 to 116 mg/L and 9 to 36 mg/L, respectively, where the average COD removal was 57.55%. The maximum removal of COD was 91.37% during this study period. From figure C the range of influent and effluent concentration of COD was 44 to 117 mg/l and 4 to 31 mg/L, respectively, where the average COD removal was 66.90%. The maximum removal of COD was 95.40% during this study period. During figure D the range of influent and effluent concentration of COD was 26 to 70 mg/l and 7 to 30 mg/L, respectively, where the average COD removal was 56.95%. The maximum removal of COD was 89.06% during this research period. From figure E the range of influent and effluent concentration of COD was 47 to 70 mg/L and 7 to 22 mg/L, respectively, where the average of COD removal was 58.%. The maximum removal of COD was 90.90% during this study period. Based on the changes in HRT, the COD removal pattern was found to be affected at the beginning of the experiments. Demystification needs an available and easily biodegradable C source as an electron donor. The demystification efficiency could be enhanced by using some

external carbon sources. Sometimes the research showing more concentration of COD because the reactor was taken sample from water oxidation pond, it received wastewater from houses, shopping, the hostels, laboratories and faculties.

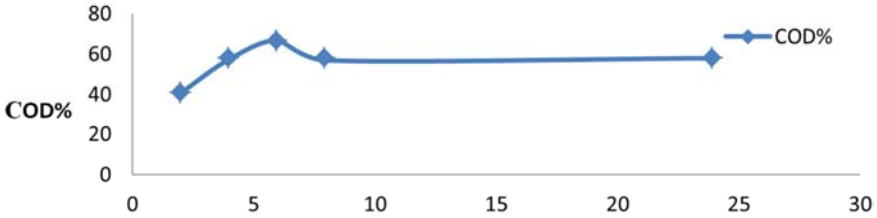


Figure 6. *Average removal of COD for different HRT.*

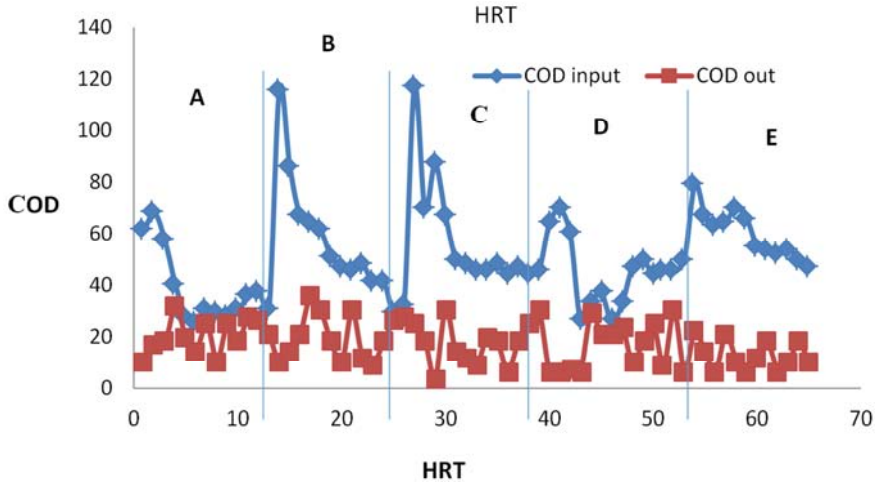


Figure 7. *Influent and effluent concentrations of COD for different HRT.*

3.5. Removal of TSS

As figure 8 daily variation of influent and effluent concentration of inorganic contaminant and suspended solids was studied during the operation period. From figure A the range of influent and effluent concentration of TSS was 20 to 37 mg/L and 15 to 29 mg/L, respectively, where the average TSS removal was 24.11%. The maximum removal of TSS was 32.43% throughout this study period. At figure B the range of influent and effluent concentration of TSS was 18 to 39 mg/L and 9 to 28 mg/L, respectively, where the average TSS removal was 40.90%. The maximum removal of TSS was 83.33% during this research period. From figure C the range of influent and effluent concentration of TSS was 19 to 38 mg/L and 9 to 28 mg/L, respectively, where the during this study period. From figure D the range of influent and effluent concentration of TSS was 21 to 38 mg/L and 9 to 28 mg/L, respectively, where the average TSS removal was 35.13%. The maximum removal of TSS was 50% during this study period. As figure E the range of influent and effluent concentration of TSS was 21 to 44 mg/l and 9 to 24 mg/L, respectively, where the average TSS removal was 34%. The maximum removal of TSS was 88% through this research period. At the HRT of 24 was maximum suspended solids removal during this study period.

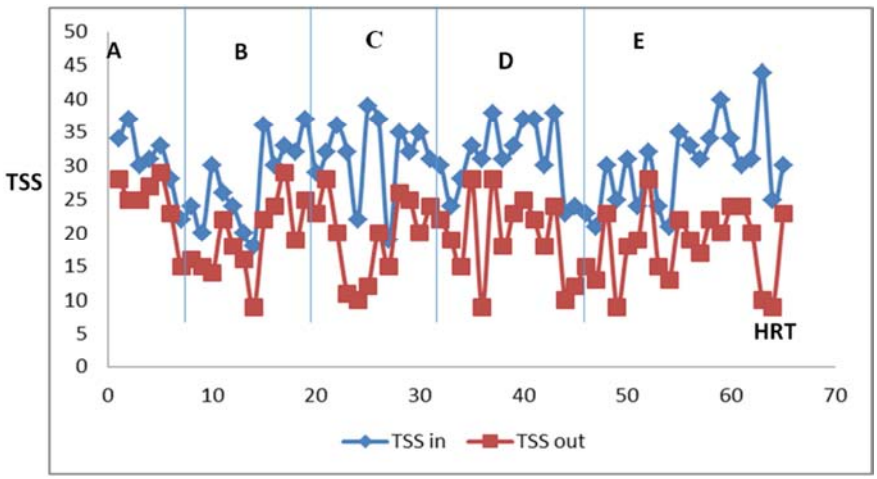


Figure 8. *Influent and effluent concentrations of TSS for different HRT.*

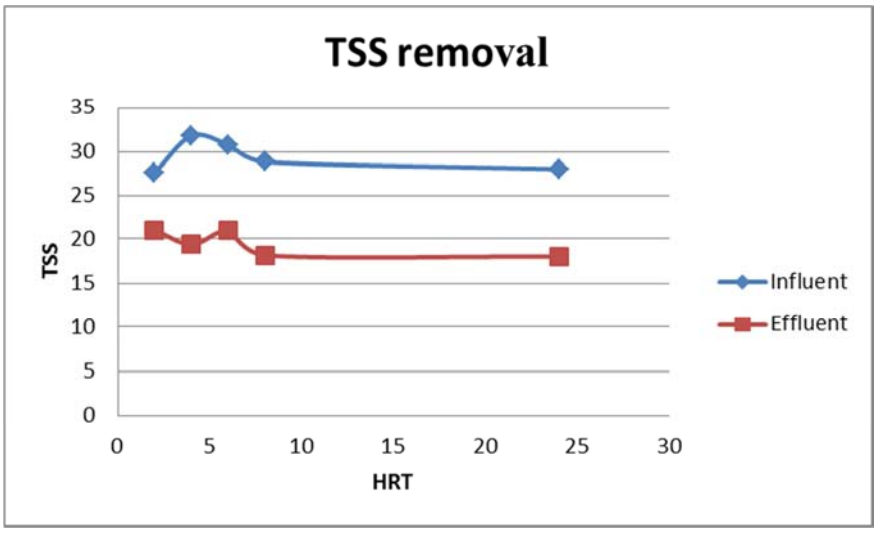


Figure 9. *Average removal of TSS for different HRT.*

4. Conclusion

In summary, the above outcome proves that the ability of biofilm on removal inorganic contaminant COD, NH_3-N, NO_3-N and TSS in various periods different hydraulic retention time (2, 4, 6, 8 and 24). It has been noticed that once prolong the duration applied the percentage of removal contaminant COD, NH_3-N, NO_3-N and TSS increased as a result, whereby it has reached of COD 88.88%, NH_3-N 64.25%, NO_3-N 88% and TSS 64%. In general, all of these values are lower than international standard.

References

[1] Tchobanoglous, G., Burton, F. L. & Stensel, H. D. 2004. Waste Water Engineering: Treatment and Reuse. 4th Edition. New York, McGraw-Hill.

[2] Jagals, P. & Lues, J. F. R. 1996. The efficiency of a combined waste stabilization pond / maturation pond system to sanities waste water intended for recreational reuse. Water Science Technology 33 (7): 117-124.

[3] James, A. 1987. An alternative approach to the design of waste stabilization ponds. Water Science Technology 19 (12): 213-218.

[4] Metcalf & Eddy 1991. Waste water engineering: Treatment, disposal and reuse (Volume 11). USA: Prentice Hall.

[5] Monod, J. 1949. The growth of bacteria cultures. Annual Review of Microbiology: 371-394.

[6] Vedry, B. Paffonia, C., Gousailles, M., Bernard, C. 1994. First months operation of two bio filter prototypes in waste water plants of archers. Water Science Technology 29: (10), 39-46.

[7] EPA. U. 1975. Process design manual for nitrogen control office of technology transfer. Washington. D. C.

[8] Focht, D. & Verstraete, W. 1977. Biochemical ecology of nitrification and nitrification. Advance Microbiology Ecology, 1, 135-214.

[9] Bitton, G. 2005. Wastewater Microbiology. 3rd Edition. Canada: Wiley-Liss.

[10] Speitel, G. E., Jr. Digiano, F. A. 1987. Biofilm shearing under dynamic conditions. Journal of Environmental and Bioengineering 37: 778-789.

[11] Taber, W. A. & Taber, R. A. 1976. In CRC Handbook of Microbiology, Ed.

[12] Costerton, J. W. Philip, S. & Stewart, E. P. 1978. Bacterial Biofilm: A Common Cause of Persistent Infections.

[13] APHA. 1999. Standard Methods for the Examination of waste and waste water. 20th Edition. New York. Water Environment Federation.

[14] Lazarova, V., Capdeville, B., Nikolov, L. 1992. Biofilms performance of a fluidized bed Biofilm reactor for drink water denitrification. Water Science Technology 26 (3/4): 555-566.

[15] Lazarova, V., Capdeville, B., Nikolov, L. 1992. Biofilms performance of a fluidized bed Biofilm reactor for drink water denitrification. Water Science Technology, 26 (3): 555-566.