The Performance of Oxidation Pond for Wastewater Treatment in Rural Areas a Case Study “Al-Dewaniyah Province"

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Received on: 17/9/2013 & Accepted on: 9/1/2014

ABSTRACT

This research is concerned with study and checks the suitability of waste oxidation ponds (WOP) for treating wastewater in Al-Dewaniyah province by taking a sample of community of 10000 populations.

Experimental work had three cases depending on many considerations such as economical and specification of final effluent. A model of two ponds (facultative and aerobic) in series was used as first case of experimental work. Then third pond with aeration process to aerobic pond were added to the series as second case to improve the effluent. At last, sand filter was used to polish the final effluent from aerobic pond.

The three ponds had the same surface area (5.75m*2m) but with different depths, where it was 2m for anaerobic pond, 1.5m for facultative pond and 0.75m for aerobic pond. From the tests taken for the three cases, the results obtained for the last two cases were much better when compared with first case. In the experimental work a sand filter used for algae removal. Sand filter contributed in improving final effluent by decreasing total suspended solid (TSS) also in increasing removal efficiency of biochemical oxygen demand (BOD) and chemical oxygen demand (COD).At the end, the results of this work could be an invitation to use waste oxidation pond for wastewater treatment in rural areas or even small communities in Iraq but it may need more examinations to get best results.

Keywords: Waste Oxidation Pond, Wastewater Treatment, Filter.

دراسة اداء برك الاكسدة في معالجة مياه الصرف الصحي في المناطق الريفية دراسة حالة (مدينة الديوانية)

الخلاصة

يهتم هذا البحث بدراسة ومراجعة مدى ملاءمة برك الاكسدة لمعالجة مياه الصرف الصحي في محافظة الديوانية عن طريق أخذ عينة من المجتمع من 10000 نسمة.

https://doi.org/10.30684/etj.32.4A.18
2412-0758/University of Technology-Iraq, Baghdad, Iraq

كان العمل التجريبي ينطوي على ثلاث حالات اعتمادا على اعتبارات كثيرة منها اقتصاديةومنها مواصفات مياه الصرف النهائية الناتجة بعد المعالجة. تم استخدام حوضين (الاختيارية والهوائية) كموديل في الحالة الاولمن العمل التجريبي. ثم أضيفت بركة الثالثة (الحوض اللاهوائي) مع عملية تهويةللبركة الهوائية إلى السلسلة المستعملة في الحالة الاولى لتحسين عملية المعالجة. استعمل مرشح رملي لتحسين نوعية المية الناتجة من حوص المعالجة الهوائيةو المساعدة في ازالة الطحالب المتكونة ، لذا فان الحالة الثالثة تضمنت اضافة مرشح رملي للتخلص من الطحالب.
كانت المساحة السطحية للبرك الثلاثة متساوية وهي بأبعاد (5.75 * 2) م ولكن بأعماق مختلفة، 2م للبركة اللاهوائية، 1.5م للبركة الاختيارية 0.75م للبركة الهوائية.من الفحوصات التي اجريت للحالات الثلاث، ومقارنة النتائج المستحصلة عليها بين الحالات الثلاثة وجدت النتائج للحالتين الثانية والثالثة هي اكثر كفاءة مقارنة مع الحالة الأولى. المرشح الرملي ساهم في تحسين الطرح النهائي من خلال خفض إجمالي المواد الصلبة العالقة بالاضافة الى مساهمته في زيادة كفاءة إزالة الأوكسجين الحيوي المستهلك (BOD) والاوكسجين الكيميائي المستهلك(COD).تدعو نتائج البحث استخدام برك الاكسدة لمعالجة مياة الصرف الصحي للمناطق الريفية او المجمعات الصغيزة و لكنها قد تحتاج الى مزيدمن الابحاث للحصول على افضل النتائج.

INTRODUCTION

Several techniques are used to treat domestic wastewater. These can be classified into two groups: conventional and non-conventional treatment plants. The former has high-energy requirements. The later is solely dependent on natural purification processes.

The conventional systems of wastewater treatment includes trickling filters, activated sludge systems, biodisc rotators and aerated lagoons. The non-conventional systems, which are also called eco-technologies include constructed wetlands and waste stabilization ponds (WSPs). Among these technologies, the widely recommended ones for developing countries are the WSPs (Awuah, 2006).

Oxidation ponds are also called stabilization ponds or lagoons and serve mostly small rural areas, where land is readily available at relatively low cost (Bitton, 2005).

Waste oxidation ponds are biological treatment systems, which processes and operations are highly dependent on the environmental conditions such as temperature, wind speeds and light intensity which highly variable and any given combination of these environmental parameters is usually unique to a given location (Gray, 2004).

There are many advantages of using this kind of biological treatment like easy to operate, low energy required, less equipment maintenance, and better sludge thickening. However, the effluent quality from fixed- film system are relatively poorer than suspended growth systems in terms of biochemical oxygen demand (BOD) and suspended solid (SS) (Metcalf & Eddy, 2003).

If pond systems are correctly designed and managed inorder to facultative anaerobic and aerobic bacteria and green micro-algae, then such systems would decompose waterborne organic wastes effectively and efficiently, and would help in reducing some of the problems associated with the treatment and disposal of wastewater. In addition, about 90% of the ponds in the United States are used in small communities with less than 10,000 residents and are to be very effective in wastewater treatment (Gray, 2004).

This study was conducted to establish proper design guidelines for installation of WOP in Al-dewaniyah province to provide a solution for the problem of the wastewater generated from hundreds of villages and small towns in the province. For this purpose a typical representative communities of 10000 population was selected by making a model depending on a scale.

WASTEWATER TREATMENT IN WOPS

Louisiana Administrative Code (2004) defines that an oxidation pond is a shallow pond designed specifically to treat sewage by natural purification processes under the influence of air and sunlight. The oxidation process consists largely of the interactions of bacteria and algae. Bacteria digest and oxidize the constituents of sewage and render it harmless and odor free. Algae utilize carbon dioxide and other substances resulting from bacterial action and through photosynthesis produce the oxygen needed to sustain the bacteria in the treatment process. During the detention period, the objectionable characteristics of the sewage largely disappear (Louisiana Administrative Code, 2004).

Pena and Mara (2004) indicates that the arrangement of WOPs, wastewater is first subjected to preliminary treatment -screening and grit removal - to remove large and heavy solids. The design of this preliminary treatment stage is the same as that used for conventional electro mechanic WWTP, but for WOPs the simplest systems are generally used (manually raked screens and manually cleaned constant-velocity grit channels).

Basically, primary treatment is carried out in anaerobic ponds, secondary treatment in facultative ponds, and tertiary treatment in maturation ponds. Anaerobic and facultative ponds are for the removal of organic matter (normally expressed as BOD) and maturation ponds for the removal of faecal viruses, faecal bacteria (for example, Salmonella spp., Shigella spp., Campylobacter spp. and pathogenic strains of Escherichia coli), and nutrients (nitrogen and phosphorus) (Pena and Mara, 2004).

TYPES OF WOPS AND THEIR SPECIFIC USES

Kayombo et al.(1998) refers that WSP systems comprise a single string of anaerobic, facultative and maturation ponds in series, or several such series in parallel. In essence, anaerobic and facultative ponds are designed for BODremoval and maturation ponds for pathogen removal, although some BOD removal also occurs in maturation ponds and some pathogen are removed in anaerobic and facultative ponds. In most cases, only anaerobic and facultative ponds will be needed for BOD removal when the effluent is to be used for restricted crop irrigation and fish pond fertilization, as well as when weak sewage is to be treated prior to its discharge to surface waters.

The types of waste oxidationpond are:-

Aerobic ponds

An aerobic oxidation pond contains bacteria and algae in suspension; aerobic conditions (the presence of DO) prevail throughout its depth. There are two types of aerobic ponds, shallow ponds and aerated ponds **(**AFM, 1988**).**

- **Shallow ponds**

Shallow oxidation ponds obtain their DO via two phenomena, oxygen transfer between air and water surface, and that produced by photosynthetic algae.**(**AFM, 1988)**.**

- **Aerated ponds**

An aerated pond is similar to an oxidation pond except that it is deeper and mechanical aeration devices are used to transfer oxygen into the wastewater. The aeration devices also mix the wastewater and bacteria. On the other hand, the disadvantage is that the mechanical aeration devices require maintenance and use energy (Shilton, 2001).Its detention times are in the order of 1 to 10 days, depending on organic loading rate, temperature, and the degree of treatment required (Liu, 2007).

Aerobic-anaerobic (facultative) ponds

Facultative ponds (FPs) are characterized by having an upper aerobic and lower anaerobic zone, with active purification occurring in both. Facultative pond designed for BOD removal and sized on the basis of volumetric BOD loading (g BOD/m^2.d) (Hassan, 2011). Facultative ponds are often categorized as either primary or secondary ponds, treating raw or settled wastewaters respectively. As organic matter enters the basin, the settle able and flocculated colloidal matter settles to the bottom to form a sludge layer where organic matter is decomposed anaerobically. The remainder of the organic matter, which is either soluble or suspended, passes into the body of the water where decomposition is mainly aerobic or facultative, although it is occasionally anaerobic (Gray, 2004).

Three zones exist infacultativepond :**(** AFM, 1988)

- **A surface zone** where aerobic bacteria and algae exist in a symbiotic relationship.
- **An anaerobic bottom zone** in which accumulated solids are actively decomposed by anaerobic bacteria.
- **An intermediate zone** that is partly aerobic and partly anaerobic in which the decomposition of organic wastes is carried out by facultative bacteria. Because of this, these ponds are often referred to as facultative pond.

Gawasiri (2003) indicates that the facultative ponds normally follow anaerobic ponds in a WOP system. Facultative ponds usually have a depth of 1.5-2.0 meter .(Earnest F. Gloyna, 1971; Mara, D. D., Mills, S. W., Pearson, H. W., & Alabaster, G. P. ,2007) while Liu (2007) referred that facultative pond depth ranges between 1.2 to 1.5m.

Maturation ponds

Maturation ponds are widely used throughout the world as a tertiary treatment process for improving the effluent quality from secondary biological processes, including facultative ponds. (Gray, 2004).

Pena and Mara (2004) indicated that maturation ponds receive the effluent from the facultative ponds and their size and number depends on the required bacteriological quality of the final effluent. They are shallower than facultative ponds with a depth in the range 1−1.5 m, with 1 m being optimal (depths of less than 1 m encourages rooted macrophytes to grow in the pond and so permits mosquitoes to breed).

Anaerobic ponds

Anaerobic ponds are commonly 2 – 5 m deep and receive wastewater with high organic loads (usually greater than(100) g BOD/m^3 .day, equivalent to more than (3000) kg/ha.day for a depth of(3) m(Kayombo et al., 1998,). They normally do not contain dissolved of solids, and subsequent anaerobic digestion in the resulting sludge. The process of anaerobic digestion is more intense at temperatures above(15)^{o}C.designed for BOD removal and sized on the basis of volumetric BOD loading (g BOD/m^3.d) (Hassan, 2011).

Sazbo and Engle (2010) found when no oxygen is available, anaerobic degradation may occur by anaerobic microorganisms. The benefit of anaerobic digestion is that it can deal with highly concentrated waste water and can achieve good purification results within short retention times. The anaerobic pond should be installed as the first treatment step, when the load of waste water is the highest.

Controlled discharge ponds

Controlled discharge ponds have long hydraulic detention times and effluent is discharged when receiving water quality will not be adversely affected by the discharge. Controlled discharge ponds are designed to hold the wastewater until the effluent and receiving water quality are compatible.

Complete retention ponds

Complete retention ponds rely on evaporation and/or percolation to reduce the liquid volume at a rate equal to or greater than the influent accumulation. Favorable geologic or climatic conditions are prerequisite.

EXPERIMENTAL WORK AND DATA COLLECTION

The experimental work was conducted in the period from 20.11.2011 to 1.07.2012.

All test in the experimental work were done in the laboratory of WWTP of Aldewaniyah and the laboratory of the engineering collage in AlQadissiyah university. According to references on this study like basic principles available in Aldewaniyah sewage directorate, previous tests for recent years, and other of scientific references.

Experimental work in this search included the following tests :-

1- Biochemical oxygen demand (BOD) test.
2- Chemical oxygen demand (COD) test.
3- Total suspended solid TSS.
4- PH.
5- Nitrate and nitrite.
6- phosphate

DESCRIPTION OF OXIDATION PONDS AND THE ARRANGEMENT OF THE PONDS IN THE MODEL

The experimental model contains three ponds: anaerobic pond, facultativepond and aerobic pond. Also there is collecting basin at the end of the series.

Anaerobic pond

The first pond in the series is anaerobic pond which made with dimensions (5.75*2*2)m and detention time (8) days. Anaerobic pond was used because of the high organic load in the influent wastewater enters the ponds as shown in the results of the tests.

Facultative pond

It is the second pond receives wastewater from anaerobic pond. It was made with dimensions (5.75*2*1.5) m and detention time (6) days.

Aerobic pond

The third pond of the series of ponds is the aerobic pond. It was made with dimensions (5.75*2*0.75) m with detention time (3) days. This pond was supplied with two mixing pumps operate as aerators in the pond.

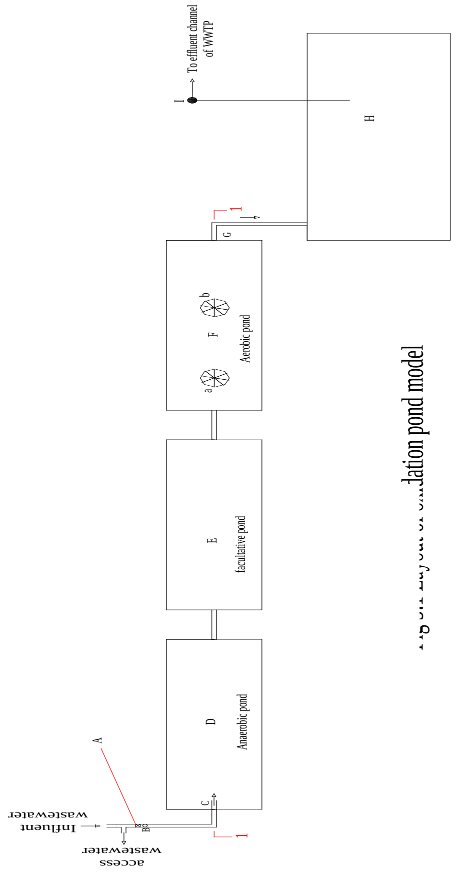
Figure (1) below shows the three ponds above and the three cases were used in the experimental work.

Fish pond

At the end of the ponds in the arrangement mentioned above, a basin used for collecting the effluent wastewater. In this basin number of small fishes (about 20) were put to measure the suitability of treated wastewater for growing and living in this basin and this will be as indicator of oxygen level in treated wastewater. This basin has the same dimensions of the other ponds in the experimental work.

Sand filter

For decreasing TSS in the final effluent from the arrangement of ponds, sand filter was used for this purpose. The filter in the experimental work contained four layers: sand (0.6-0.65)mm, fine gravel (2.5-6.5)mm, mid gravel (6.5-9.5)mm and coarse gravel (9.5-13) mm as shown in Figure (2).



Symbol	Name	D$etails
A	Gate valve	Used for controlling on the quantity of influent discharge
B	Flow meter	Used for measurement the flow
C	Inlet pipe	Entering the first pond at the mid depth
D	Anaerobic pond	The first pond with dimensions (5.75*2*2) m .
E	Facultative pond	The second pond with diemensions (5.75*2*1.5) m
F	Aerobic pond	The third pond with diemensions (5.75*2*0.75) m
G	Outlet pipe	For drainage effluent wastewater from aerobic pond to the fish pond
H	Fish pond	A basin used for collecting the treated wastewater
I	Sand filter	
a,b	Mixing pump	

Figure (1) layout of oxidation ponds model

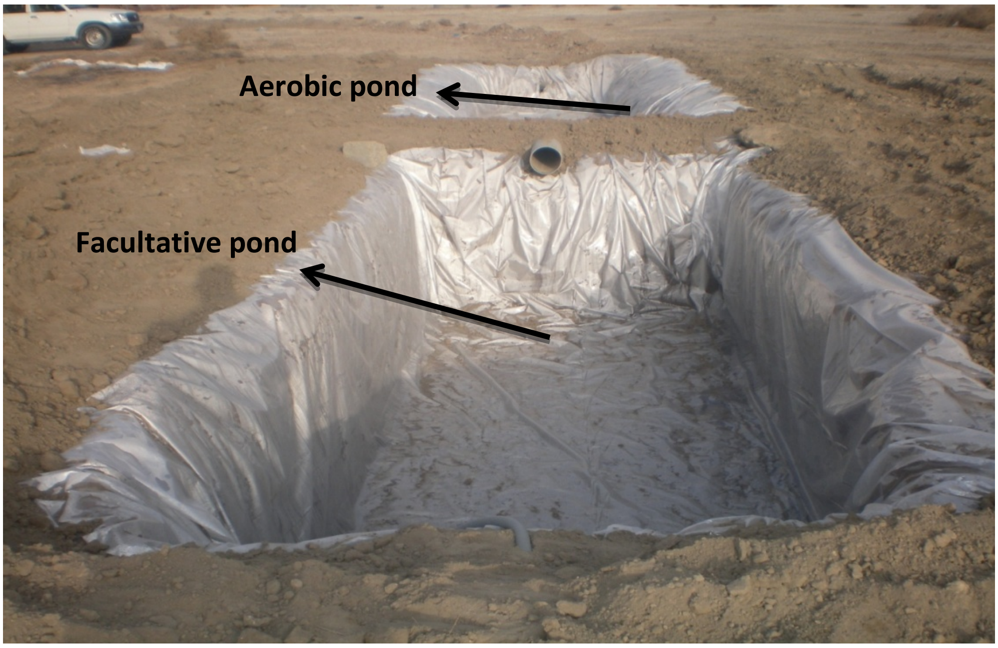
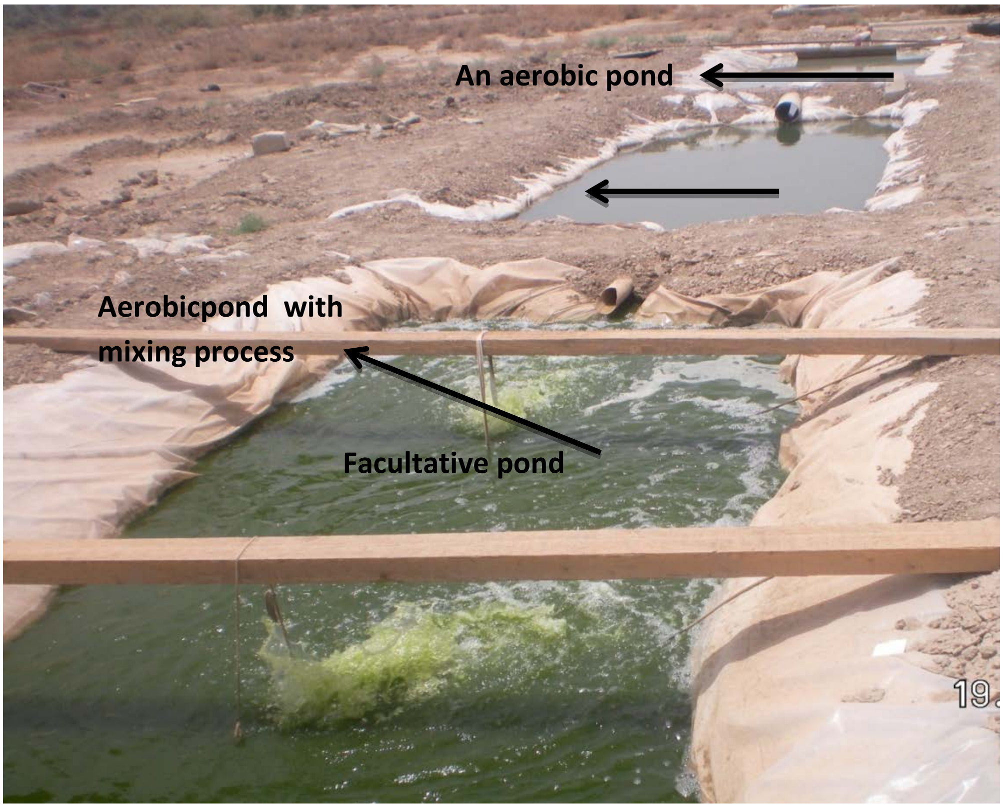


Figure (2) Picture shows facultative and aerobic ponds in the first case.



Figure(3) Picture shows series of anaerobic, facultative and aerobic ponds in second and third case.

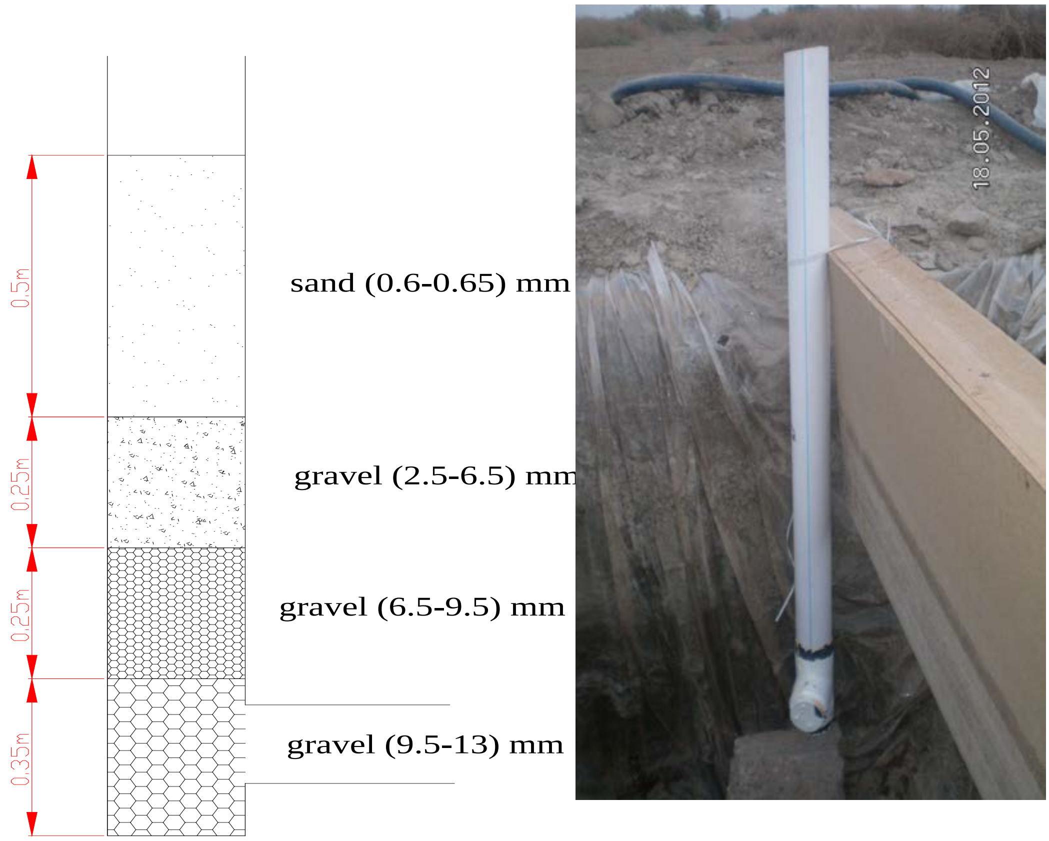


Figure (4) Cross section in sand filter

Figure (5) Picture shows the fish pond .

All the ponds were lined by two layers of thick nylon to prevent leakage of water into the soil to avoid the change in the influent or effluent discharges. At the end of the ponds has been established basin for collecting treated wastewater.

The quantity of influent wastewater was constant to be (2 l/min) which was measured by flow meter and using a valve. The overflow was drained to an open channel in the WWTP (by pass). The quantity of influent wastewater was determined by using Mara equation for facultative pond depending on many parameter as mentioned below by using Mara equation:-

$$A = \frac{Q(Li-60)}{18 * D * (1.05)10-20} \quad \ldots (1)$$

Q = influent discharge (2500 m^3/day)
Li = Influent BOD mg/l (250 mg/l)
T= Average temperature of the coldest month (^{0}C) , 10 °C
D = depth (m)

$A = \frac{2500(250-60)}{18*1.5*(1.05)10-20}$ = 28656.48 m^2

By using Scale 1:50 L: W = 1:2 1:3
L = 286.5 m W = 100 m By using scale 1:50
L = $\frac{286.5}{50}$= 5.73 ≈ 5.57 m W = $\frac{100}{2}$ = 2m
Use detention time = 6 day $Q = \frac{17.2}{6}$ = 2.875 m^3/day ≈ 2 l/min

Then the determinate flow for facultative pond was dependent for anaerobic and aerobic ponds. By using dimensions as the dimensions of facultative pond with changing the depths and detention times of anaerobic and aerobic ponds according to specific limits of the ponds.

Anaerobic pond :-
By using depth = 2m
Detention time = (Volume/Discharge) t = (5.75*2*2)/ 2.875 = 8 day

Aerobic pond :-

By using depth = 0.75m t = (5.75*2*0.75)/ 2.875 = 3 day

RESULTS OBTAINED FROM THE THREE CASES OF EXPERIMENTAL WORK

When the median results of BOD and COD in the Tables (1, 2, and 3) below are Checked and compared with these two parameters for the same points, BOD/COD ratio is clearly noticed to be greater than (0.5) which acts as indicator that biological decomposition processes generally start quickly and proceed rapidly for all points in the first case and most the points beyond the final two points in the second case. In the points (9, 10, 11) ranges between (0.3 to 0.5) which means that decomposition may proceed more slowly because degrading microorganisms need to become acclimated to the wastewater.

Values in the Tables (1, 2, 3) show that it's concentrations in the first case is lower than the other two cases also in the effluent point. The raise of TSS concentration in the effluent in the second case mainly caused by algae. The occasional high concentration of total suspended solids (TSS), which can exceed 100 mg/L, in the effluent is the major disadvantage of pond systems so sand filter used in the third case contributes in decreasing the median TSS concentrations between second and third cases from 112 to 79.5 mg/l.

Table (1) BOD, COD, TSS tests in the first case*

* First case includes using facultative and aerobic pond.

** Point means location where sample was taken.

*** Count means the number of samples were taken from one location.

Point** of sample	COD				BOD							
	Count ***	Mean	Median	Standard deviation	Count ***	Mean	Median	Standard deviation	Count ***	Mean	Median	Standard deviation
0	11	354.45	355	18.3	3	241.3	253	38.8	11	134.5	126	25
1	11	258.27	254	24.8	3	215.7	224	41.1	11	113	113	23.1
2	11	238.55	240	11.8	3	202.3	212	36.5	11	102	95	23.6
3	11	232.82	235	9.91	3	166	182	28.6	11	93.55	86	18.8
4	11	212.09	212	12	3	143.7	151	21.9	11	84.91	83	16.1
5	11	199.91	199	11.8	3	126.7	132	23.5	11	77.64	77	13.9
6	11	190.45	191	14.2	3	111.3	111	18.5	11	71.91	74	12.1
7	11	177.36	181	15.1	3	91.33	98	12.4	11	58.55	61	7.09

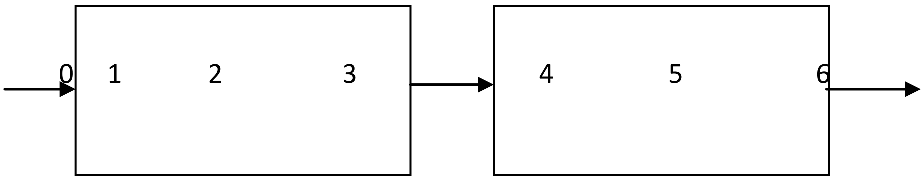


Table (2) BOD, COD, TSS tests in the second case*

Point of sample	COD				BOD				TSS			
	Count**	Mean	Median	Standard deviation	Count**	Mean	Median	Standard deviation	Count**	Mean	Median	Standard deviation
0	4	484.25	464	143.6	3	232.33	235	49.1	3	669.33	775	187
1	4	389	403.5	142.9	3	186.67	187	24.5	3	464	491	112
2	4	317.25	323.5	85.77	3	168.33	170	2.89	3	365.33	320	93.6
3	4	283.25	298	63.18	3	151.67	151	3.06	3	277.33	301	50.8
4	4	243	245.5	40.9	3	127	127	4	3	187.33	170	32.7
5	4	213.5	202.5	33.87	3	116	122	17.8	3	149.33	141	23.6
6	4	194.25	184.5	37.05	3	100.67	112	24.1	3	120.33	121	10
7	4	176	170.5	12.08	3	108	123	29.5	3	139.33	141	3.79
8	4	190.75	188	13.94	3	130.67	144	45.5	3	168.67	167	7.64
9	4	162.25	163	9.215	3	84	87	32.6	3	147.33	149	6.66
10	4	115	116	14.31	3	49	42	15.7	3	102	112	18.2

* Second case includes using anaerobic, facultative, and aerobic ponds respectively with flow direction.
** Count means the number of samples were taken from one location.

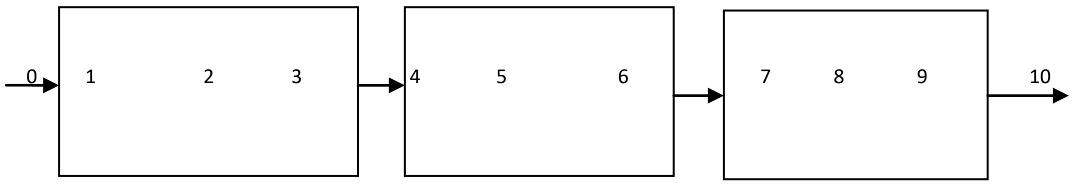
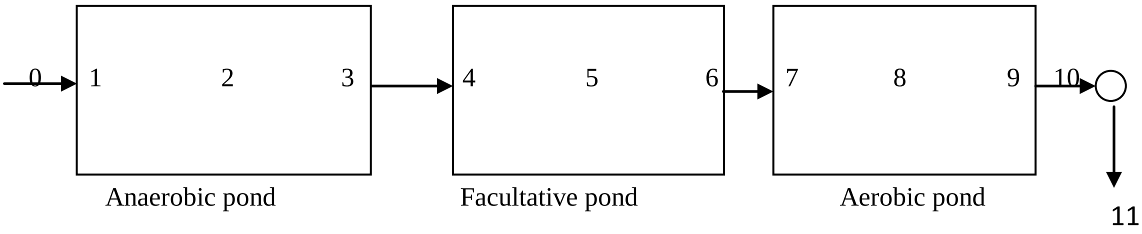


Table (3) BOD, COD, TSS tests in the third case*

Point of sample	COD				BOD				TSS			
	Count**	Mean	Median	Standard deviation	Count**	Mean	Median	Standard deviation	Count**	Mean	Median	Standard deviation
0	4	714.75	704	191.3	3	371.7	295	201.3	4	668.5	645	275.4
1												
2	4	287.5	282	38.48	3	152	132	64.37	4	261.3	280	48.36
3												
4												
5	4	201.25	213	26.95	3	99.33	96	12.34	4	156.5	157	33.32
6												
7												
8	4	265.25	252.5	79.08	3	127.3	112	28.31	4	255	251.5	26.57
9												
10	4	168.75	168.5	15.37	3	74.33	75	7.024	4	183.3	175	22.17
11	4	106.25	106.5	18.57	3	39	38	5.568	4	77.75	79.5	14.5

* Third case includes using anaerobic, facultative, aerobic ponds and sand filter respectively with flow direction.
** Count means the number of samples were taken from one location.



Comparison between the three cases in removing BOD, COD and TSS

The results obtained from the experimental work refer that there is clear improvement in BOD, COD, and TSS removal between first case and second case. Despite removal efficiency of TSS in table (3) show low improvement between second case and third case for median values, but sand filter affects clearly in removing the dark green color of effluent which avoids to grow of algae in the stream or in the basin ofthe storage . All results were drawn in figures (6,7,8).

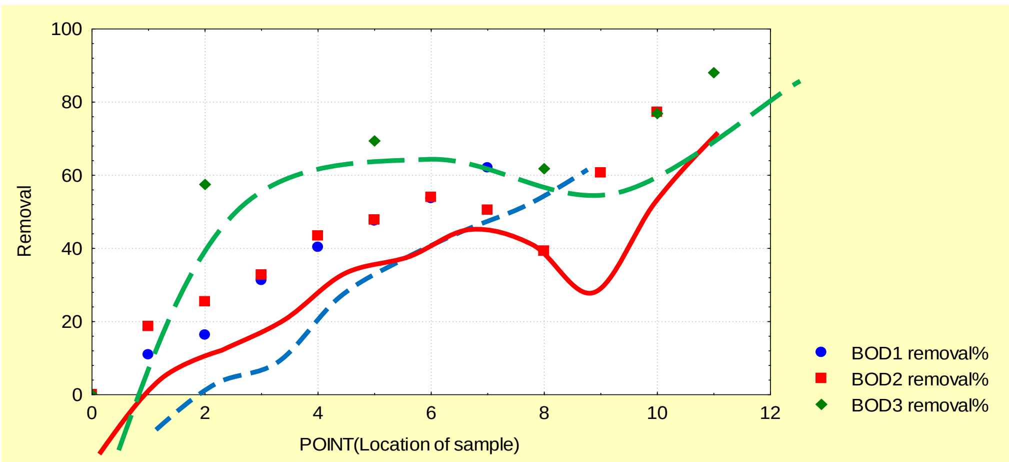


Figure (6) Comparison between BOD removal for the three cases.

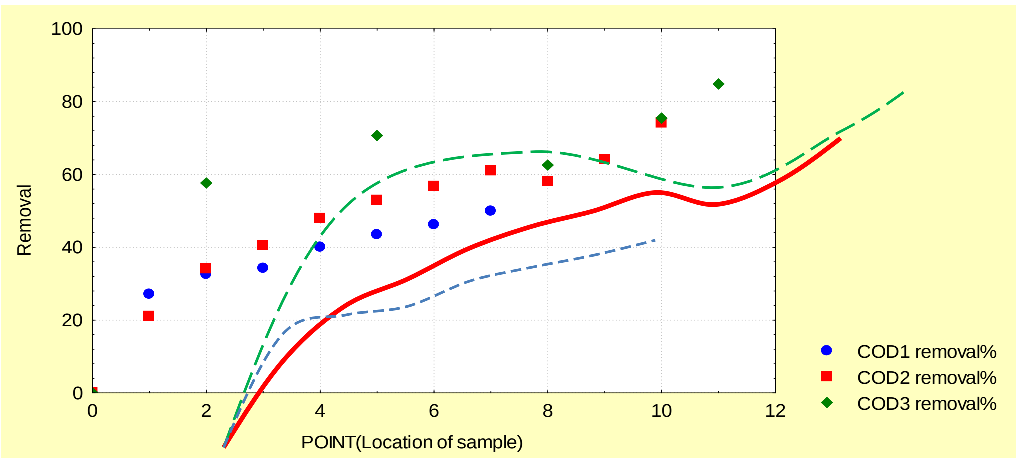


Figure (7) Comparison between COD removal for the three cases.

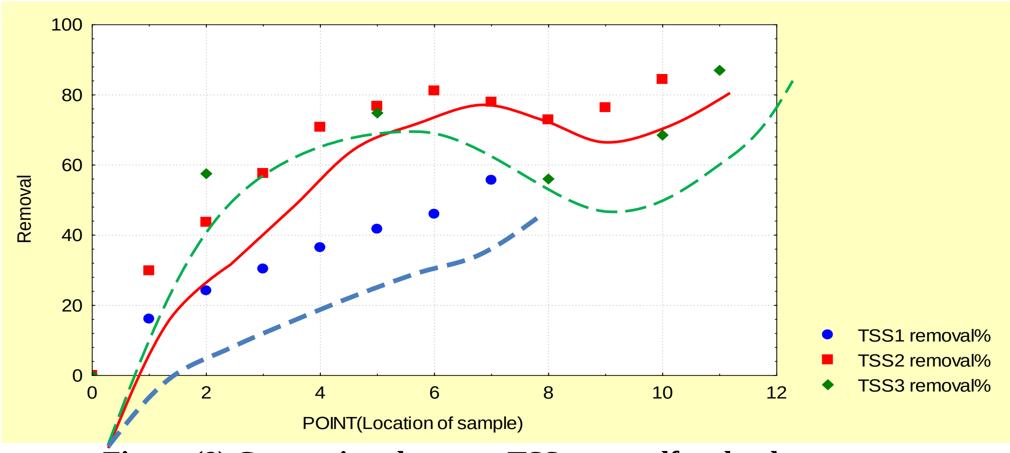


Figure (8) Comparison between TSS removalfor the three cases.

The value of DO in the tables in appendix(A) refer to the rising in the levels of oxygen concentrations which causes in nitrification process.At DO concentrations less than 0.5 mg/l, the growth rate of algae is minimal. Nitrification requires a long retention time, a low food to microorganism ratio (F/M), a high mean cell residence time (measured as MCRT or sludge age), and adequate buffering (alkalinity) . But the obtained results from experimental model show the high values of DO in theeffluents point, aerobic tank and also the second half in the experimental facultative pond .Figure (9) shows the uniformly decreasing in NO2 concentration that can be neglected and regarded as nil . In other side Fig (10) shows the increasing in the NO3 values to be identical with the standard specifications of treated sewage.

The phosphate content of the pond effluent was similar to those of the standard specifications of treated wastewater. The results in Fig (11) show that the phosphate content decreased uniformly as be away from the influent point. Bacteria and algae exert a considerable pressure on available phosphate as they are capable of utilizing phosphate for their physiological activities.

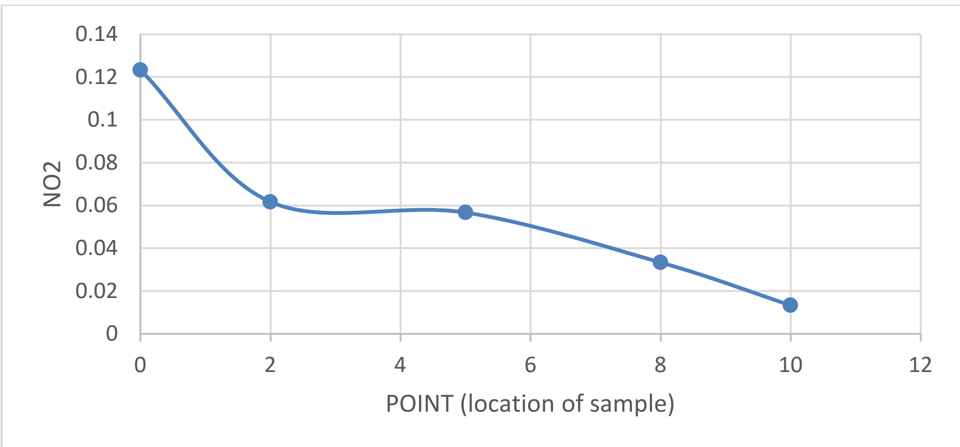


Figure (9) shows decreasing in NO_2 towards the effluent point.

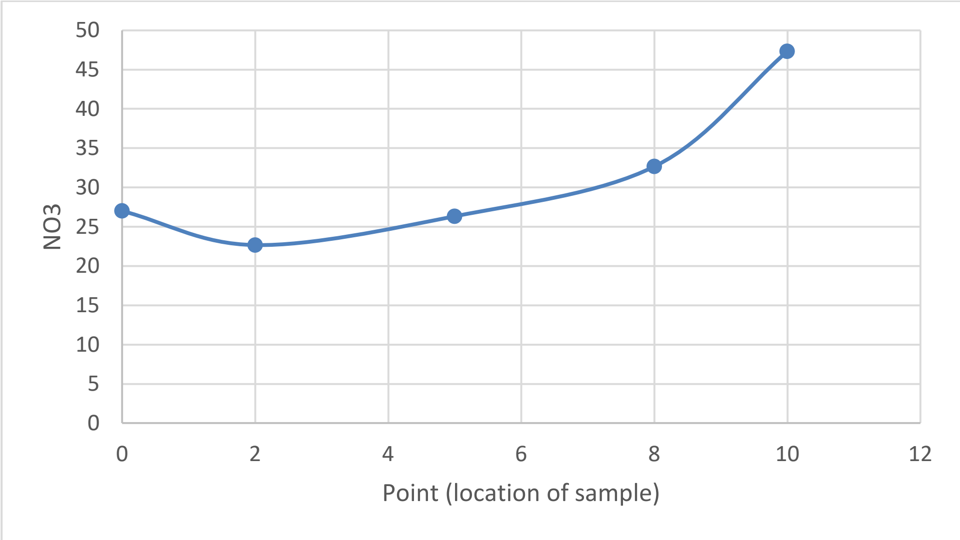


Figure (10) Shows nitrification process in the experimental pond.

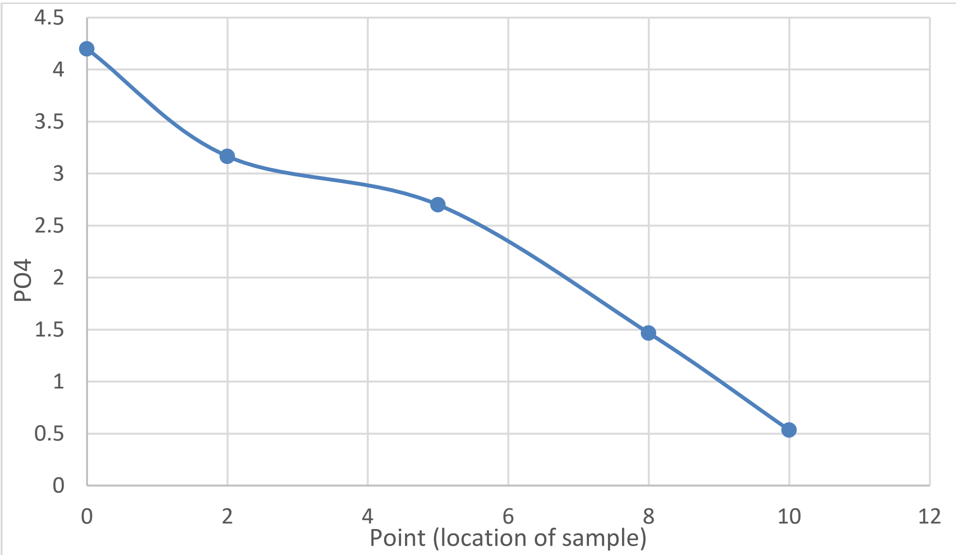


Figure (11) Shows decreasing of PO_4 in oxidation pond.

QUALITY OF EFFLUENT (TREATED) WASTEWATER

In experimental work, treated wastewater are collected in the fish pond as mentioned in 5.4. Number of fishes (about 20) were put in the effluent pond as indicator for presence of dissolved oxygen with suitability levels for the purpose of reasoning through the survival of these fish alive and growth for the purpose of throwing into rivers or in agriculture to some trees or crops. From the experimental work, dissolved oxygen rose from (0.09)mg/l and (0.1)mg/l to (7.1)mg/l and (6. 6)mg/l respectively. These fishes were alive and continued to grow after it suffered for several days at the beginning due to changing living environment for them between the river and the treated wastewater basin but this matter needs more studies to see if there was a group of compounds or elements have been concentrated greater than acceptable limits in the bodies of these fishes. Figure (12) shows the difference between treated water in the three cases.

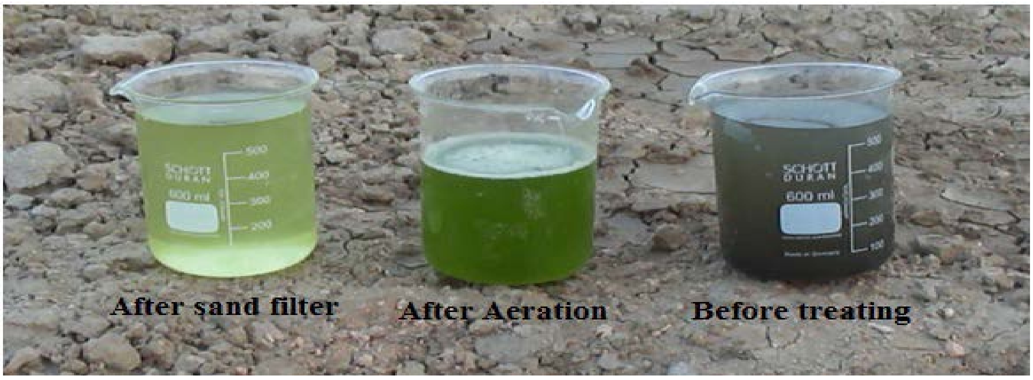


Figure (12) Picture show the difference in color without and with using sand filter.

Table (11) a comparison between effluent treated wastewater between Al-Dewaniyah WWTP and experimental model of waste oxidation pond under research for June month (personal information from Al-Dewaniyah sewage directorate).

Table (11) a comparison between conventional WWTP of Al-Dewaniyah city and experimental modeltheresearch .

Al-Dewaniyah WWTP (Conventional activated sludge)						Waste stabilization pond (Experimental model)					
BOD	COD	TSS	NO_3	NO_2	PO_4	BOD	COD	TSS	NO_3	NO_2	PO_4
95.8	143.5	98.6	29.6	Nil	3.4	39.5	112.67	72.67	48	0.02	0.5

CONCLUSIONS AND RECOMMENDATIONS
CONCLUSIONS

According to the results from the experimental work on the model of ponds which contained anaerobic, facultative, and aerobic process, the following conclusions may be listed below:-

1- Raising of TSS, BOD, COD and most of the other characteristics of influent raw wastewater to waste oxidation pond because of the break down most of the mechanical parts (including bar screen and grit chamber) of Al-Dewaniyah WWTP which started working in 1983 that affects the characteristics of influent raw wastewater of the experimental model.
2- As proceeded, the value of wastewater parameters, especially TSS which reached 675 mg/l, enters the model is higher than the design parameters most of the period of the field work of the search which affects the effluent results.
3- From the first case in the experimental work, it is clearly noticed that positive effects of the bar screen and grit chamber when they were working. This shows the importance of the pretreatment of the influent wastewater to the model.

4- Aeration process contributed strongly in increasing the BOD removal between the first two cases from 61% to 82%
5- Sand filter contributed in decreasing the concentration of TSS in the effluent treated wastewater between second case and third case from 112 mg/l to 79.5 mg/l respectively. Beside it’s effect in changing effluent color. Also sand filter contributed with low level in decreasing BOD and COD concentrations between second case and third case in the effluent treated wastewater from 49 mg/l to 39 mg/l and from 115 mg/l to 106.25 mg/l respectively.
6- The anaerobic pond acts as shock resistance for the influent wastewater as shown in the results which show the difference between the zero point (influent point) and point (No1) in the front of anaerobic pond.
7- For the nitrate and nitrite concentrations, it is clearly noticed that nitrification process occurs in the oxidation pond model which indicates that there was a sufficient quantity of DO in the treated wastewater.
8- Regarding the phosphate concentrations, it is clearly noticed that there is no eutrophication actions in the treating process which indicates that there was a moderate aerating in the model.

Recommendations

1- Needing more studies on waste oxidation pond to show the suitable arrangement of different types of ponds and the necessity using of aerators in Iraq.
2- For decreasing TSS concentrations in the effluent treated wastewater by using sand filter, it was needed for more examinations on designing and filling materials of filters which used for algae removal.
3- Needing for researches in our country to determine the accumulation of heavy metals and toxic materials in plants, fish, or any bodies where treated wastewater by using waste oxidation pond is discharged to it to see if there was a group of compounds or elements have been concentrated greater than acceptable limits.

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APPENDIX A

Tests of NO2 , NO3 ,PO4

1- Sunday 27.05.2012

Sample No	PO_4	NO_3	NO_2
0	4.20	28	0.12
1			
2	3.00	23	0.06
3			
4			
5	2.70	26	0.05
6			
7			
8	1.50	33	0.04
9			
10	0.60	48	0.01

2- Wednesday 30.05.2012

Sample No	**PO_4**	**NO_3**	**NO_2**
0	4.10	23	0.13
1			
2	3.20	22	0.065
3			
4			
5	2.90	27	0.07
6			
7			
8	1.20	32	0.02
9			
10	0.50	46	0.01

3- 4.06.2012 Monday

Sample No	**PO_4**	**NO_3**	**NO_2**
0	4.30	30	0.12
1			
2	3.30	23	0.06
3			
4			
5	2.50	26	0.05
6			
7			
8	1.70	33	0.04
9			
10	0.50	48	0.02