

## ORIGINAL ARTICLES

### Towards An Effective Method for Leachate Treatment from Egyptian Sanitary Landfill

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#### ABSTRACT

This study aimed for selecting effective and most economical way of biological treatment of leachate from sanitary landfill which is represented in using SBR method and applying another three suggested methods in order to reuse this treated leachate in irrigation. Samples were collected from ONEX sanitary landfill, Alexandria, Egypt. Samples were analyzed according to Egyptian standards and standards methods for the examination of water and wastewater. The SBR method was selected and another three suggested ways are applied to choose the best way among these ways. After that, a full design of SBR leachate treatment plant was designated. Results showed that Sequencing Batch Reactor (SBR) method could treat BOD up to 15000 ppm with efficiency 95 %, while, some methods of leachate treatment treated COD up to 200.000 ppm, with efficiency 99.5 %.

**Key words:** Sanitary Landfill; Wastewater Treatment; Biological Leachate Treatment.

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#### Introduction

Sanitary landfill leachate is a highly and complex polluted wastewater. Its quality is the result of biological, chemical and physical processes in landfills combined with the specific waste composition and the landfill water regime. With increasing leachate effluent quality standards the efforts for leachate treatment also increase. Treatment procedures must consider the relatively small flow rates and the complex leachate composition which makes it different from sewage and other kinds of waste water (Stegmann, R., *et al.*, 2005).

Solid waste problem is considered one of the most problems that Egypt suffers from until now as citizen has the right of living at clean environment. The problem represents in how to overcome the solid wastes even if these methods are primitive methods such as using open garbage dumps, open burning and sanitary landfill in which there is no problem to use it as preliminary and effective solution (Stegmann, R.1., *et al.*, 1992; Ding, A., *et al.*, 2001).

Sanitary landfill is an engineering system that treats and buries wastes as it must be designed and operated in order to save human health. Sanitary landfill produces leachate water which has bad side effects because it contains difficult decomposition material and bad odors. So that, there must be a solution to treat it and dispose it finally (Fikret, K., M.Y. Pamukoglu, 2004).

#### 2. Objectives:

The present study aims to selecting an effective and most economical way of biological treatment of leachate from sanitary landfill which is represented in using Sequencing Batch Reactor (SBR) method and applying another three suggested methods in order to reuse this treated leachate in irrigation.

#### Materials and Methods

##### 3.1. Leachate treatment plant:

The SBR method is used to treat the leachate water because of the high efficiency of treatment that reaches 95 %, it is also easy to apply one more way and method, and it can be applied experimentally in an easy way.

The experimentally leachate treatment plant consists of (Figure 1):

- 1- Primary sedimentation tank with capacity 40 liters.
- 2- Opened plastic screen.
- 3- Layer of sponge with 2 cm height.

- 4- Opened sand filter lined with sponge with capacity 30 liters.
- 5- SBR tank with capacity 50 liters.
- 6- Air blower.

### 3.2. Leachate treatment process:

There are 3 methods that are used to leachate treatment with applying SBR method. In the first method, the mechanical treatment is used first then the biological treatment by using the Sequencing Batch Reactor (SBR) method with consider of bacterial seeding. The second method, the biological treatment by using SBR method is used directly without using mechanical treatment with consider of bacterial seeding. The third method, the biological treatment by using SBR method is used first with consider of bacterial seeding then the sand filter is used twice; one with bacterial seeding and the other without it (Figure 2).

#### 3.2.1. The first method of leachate treatment:

The experiment is done five times and the sample is taken from leachate after passing from every tank and the samples are analyzed in the National Research Center. In this method, the mechanical treatment is used first then the biological treatment second because the value of TSS and BOD is greater than 500 ml/L.

##### A- Primary sedimentation tank:

It has a capacity 40 liters and it is used to sediment the organic and inorganic material in leachate.

##### B- Sponge screen:

It plays the role of attachment microorganisms to achieve primary treatment of organic material.

##### C- Sand filter:

It has dimensions 40\*30\*30 cm .it plays the role of sedimentation the suspended material and attachment microorganisms to achieve treatment of organic material.

##### D- SBR tank:

It has a capacity 50 liters and dimensions 60\*30\*30 cm. Three ways of biological treatment are used:

##### The first way.

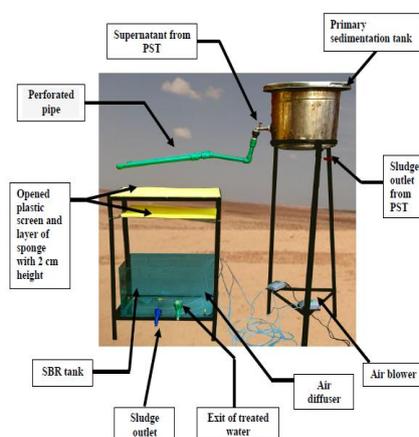
Biological treatment in SBR tank is depending on the leachate bacteria without any bacterial seeding and by using air blower to increase the activity of bacteria for 12 hours.

##### The second way:

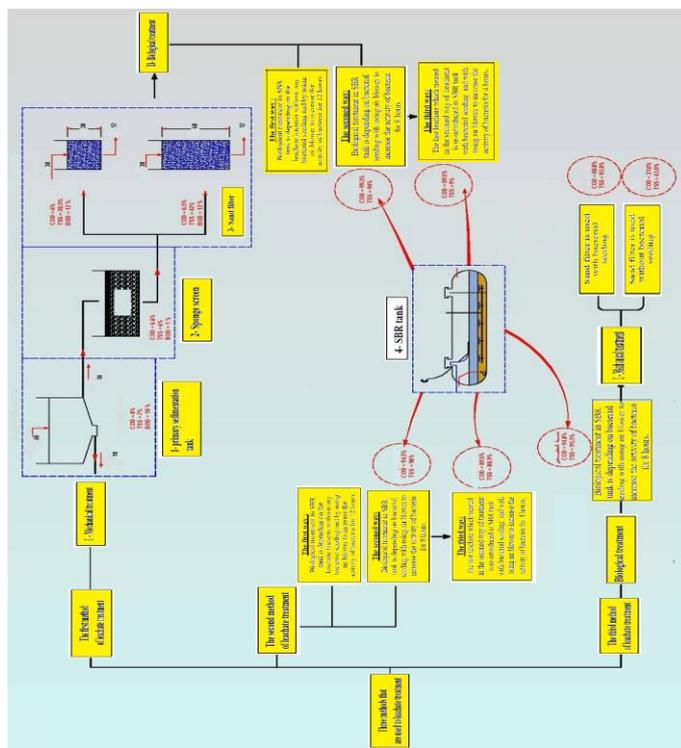
Biological treatment in SBR tank is depending on bacterial seeding with using air blower to increase the activity of bacteria for 8 hours.

##### The third way:

The last leachate which treated in the second way of treatment is re-introduced in SBR tank with bacterial seeding and with using air blower to increase the activity of bacteria for 4 hours.



**Fig. 1:** Components of experimentally leachate treatment plant by using SBR method



**Fig. 2:** Process Flow Diagram of Leachate Treatment

### 3.2.2. The second method of leachate treatment:

The experiment is done one time and the sample is taken from leachate after passing from SBR tank and the samples are analyzed at Water Pollution Research Department, National Research Center, Egypt. The biological treatment by using SBR method is used directly without using mechanical treatment, and by applying the second and third way of leachate treatment that are explained previously.

### 3.2.3. The third method of leachate treatment:

The experiment is done one time and the sample is taken from leachate after passing from every tank and the samples are analyzed at Water Pollution Research Department, National Research Center, Egypt. In this method, the biological treatment by using SBR method is used first with bacterial seeding by using air blower to increase the activity of bacteria for 24 hours, then the sand filter is used twice ; one with bacterial seeding and the other without it. Water quality and efficiency of treatment for the three ways are determined through physical, chemical and biological factors such as Chemical Oxygen Demand (COD), Biological Oxygen Demand (BOD), Total Suspended Solids (TSS), PH, Total Kjeldahl Nitrogen (TKN), Oil & Grease, Ammonia (NH<sub>4</sub>), Hydrogen Sulfide (H<sub>2</sub>S) and Total Phosphorus (TP) according to Egyptian standards and standard methods for the examination of water and wastewater (APHA, 2005).

## Results and Discussion

### 4.1. Results of the first method of leachate treatment:

Table (1) showed the average results of the raw leachate water and the treated leachate by using the first method of treatment. The results in Table (1) showed the high properties of leachate water because ONEX sanitary landfill is considered one of the oldest landfills in Egypt. Mechanical treatment reduces the water properties such as COD, BOD, and TSS by no more than 5 % because COD fraction test which is experimented in the leachate water showed that the dissolved material was 70 %, suspended material was 19 %, and collides material was 11 %. All of these prove that it is not important to use mechanical treatment to treat the leachate water (Dorata, K., *et al.*, 2006).

Using biological treatment by SBR method with bacterial seeding and using air blower to increase the activity of bacteria for 8 hours reduces the water properties 99.5% as the SBR is used twice, in the first time the

SBR reduces water properties 90 % and in the second time the SBR reduces water properties 88 % (Kennedy, K.J., E.M. Lentz, 2000).

Biological treatment in SBR tank is depending on bacterial seeding which reduces the value of COD, BOD, and TSS because the leachate water is containing of aromatic organic components which are difficult to treat it by traditional methods, so that using different types of bacteria is able to degrade these organic components (Amokrane, A., *et al.*, 1997).

#### 4.2. Results of the second method of leachate treatment:

Table (2) showed the biological treatment by using SBR method which is used directly without using mechanical treatment, and by applying the second and third way of leachate treatment that are explained previously. Results in Table (2) showed the role of biological treatment by using SBR in treating the leachate water without using mechanical treatment, as the SBR method is used twice, in the first time, the SBR reduces water properties 95 % and in the second time the SBR reduces water properties 90 %. The final results are approximately equal to the results of the first method, so, this means that there is no need of using the first method of treatment (Imai, A., *et al.*, 1993; Im, J., *et al.*, 2001).

#### 4.3. Results of the third method of leachate treatment:

Table (3) showed the biological treatment by using SBR method, then the sand filter was used twice; one with bacterial seeding and the other without it. The obtained results in Table (3) showed using biological treatment by SBR method with bacterial seeding and using air blower to increase the activity of bacteria for 8 hours reduces the water properties 95 %, then using sand filter twice. In the first time, no bacterial seeding is added on the surface of sand filter and the leachate properties are reduced by 40 %. In the second time, bacterial seeding is added on the surface of sand filter and the leachate properties are reduced by 90 %. Therefore, this experiment showed the effective role of bacteria in degrading complex components of leachate water (Kim, S.K., *et al.*, 1997; Li, X.Z., *et al.*, 1999; Li, X.Z., Q.L. Zhao, 2001).

#### 4.4. Comparison between the three methods used in leachate treatment:

A comparison was made between the results of the three methods used in leachate treatment and the Egyptian standards for the treated leachate drainage in sewer system. The final results of the three methods used in leachate treatment were not identical with the Egyptian standards for reusing the treated leachate in irrigation purposes. From the obtained results it is concluded that it is necessary to use the third method of leachate treatment because the final properties of treated leachate were matching with the Egyptian specification with less costs in comparison with other methods.

**Table 1:** Average results of the raw leachate water and the treated leachate

Parameters	Experimental stages					
	Raw leachate	Primary sedimentation	After Screen	Sand filter	Second way	Third way
COD (ppm)	195500	180000	168000	158000	10500	1100
BOD (ppm)	7500	7480	7460	7440	4050	450
TSS (mg/L)	516400	475090	443416	316810	20910	2200
pH	6.8	8.0	6.8	6.4	6.4	6.8
Oil & grease (mg/L)	3815	3605	3390	2720	302	53
TKN (mg/L)	6804	6780	6759	5944	532	24
Ammonia (mg/L)	3360	3215	3167	2540	319	11
TP (mg/L)	35	35	35	33	22	12
H2S	200	200	200	197	15	4.5

**Table 2:** Biological treatment by using SBR without mechanical treatment

	Parameters								
	COD	BOD	TSS	pH	Oil & grease	TKN	Ammonia	TP	H2S
The second way of leachate treatment	10815	4170	21540	6.4	311	550	330	23	16
The third way of leachate treatment	1135	465	2270	6.4	55	25	12	13	4.7

**Table 3:** Biological treatment by using SBR with mechanical treatment

Parameters	Raw leachate water	Biological treatment by using SBR method	sand filter without bacterial seeding	sand filter with bacterial seeding
COD (ppm)	195500	11730	8094	1407
TSS (ppm)	516400	23238	13245	1860
BOD (ppm)	7500	4100	2050	577
pH	6.8	6.4	6.4	6.4
TKN (mg/L)	6804	600	430	40
TP (mg/L)	35	21	18	14

**Table 4:** Comparison between the results and the Egyptian standards

Parameters	Egyptian standards	First method	Second method	Third method
pH	6-9.5	6.8	6.4	6.4
BOD (ppm)	600	450	465	577
COD (ppm)	1100	1100	1135	1407
TSS (ppm)	800	2200	2270	1860
TKN (mg/L)	100	24	25	40
TP (mg/L)	25	12	13	14

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