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Changes of EC and TSS at Different Stages of Biological Wastewater Treatment with an Effort to Leachate Filterability

(Case Study: Composting Factory in the West of Golestan Province)

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ABSTRACT: Leachate is the liquid that passes through the garbage and leaks out of solid waste containing soluble substances, suspended particles or derived from the original waste. Hence, the formation of leachate management is a key process to remove potential contamination of underground water resources. So, the objective of this study was to pay special attention not only to a correct strategy but also to find the most appropriate conditions for biological activities in different seasons that predict the refinery efficiency in different seasons and its effectiveness for reducing climate factors such as temperature and amend via continuous and regular monitoring of the two parameters of EC and TSS and emphasizing the leachate filterability. To do so, this study carried out sampling in five stations at Composting Factory of Aq-qala over 1258 days with 135 times. The changes of EC and TSS between 2010 and 2014 have been analyzed. The average concentrations of EC, removal efficiency and TSS was 32.45, 67.7% and 3611.4 mg/l, 97.5% (high efficiency and optimum) respectively in crude leachate and 10.47 ms/cm, and 89.8 mg/l respectively in final leachate which determined high efficiency and optimal performance. Most importantly, refinery was tolerated at EC= 61.12 ms/cm (high EC) and it worked without problem. They were observed maximum efficiency, reducing EC and TSS in anaerobic unit and the best result in the first half of Spring and Autumn in the final output (EC= 7.1, TSS=10), and the lowest efficiency was achieved in the mid of Summer (EC=18.3) and late winter (TSS=200), which was related to the temperature and bacterial population.

KEYWORDS: Aeration, Anaerobic, Composting Factory of Aghghala, Crude Leachate, EC, TSS.

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1. INTRODUCTION

Leachate is the liquid that passes through the garbage and leaks out of solid waste, containing soluble substances, suspended particles or derived from the original waste and multiple chemical elements which are generally toxic(APA,1993). Special features of combining municipal solid waste in Iran including high percentage of putrescible materials and humidity as well as the specific climate conditions such as low rainfall and high evaporation has caused the output leachate with high contamination in comparison to industrialized countries(caboli, 2013). Contamination of organic matter, suspended solids, Nitrogen, phosphor and heavy metals in municipal solid waste's leachate has been leading a high pollution potential for leachate (Shushtary, et al., 2007). The formation of leachate management is a pivotal process to remove potential contamination of underground water resources (Chopanglos and Krys, 2010). There are several methods for wastewater treatment, all of which are divided into three main forms: physical, chemical and biological. Generally, biological treatment methods are classified into aerobic (Aerobic bacteria convert the organic materials into carbon dioxide, water and new microorganisms cells, by the oxygen dissolved or injected into the wastewater) and anaerobic groups (Anaerobic bacteria convert organic compounds into methane, hydrogenated acids, carbon dioxide, water and new cells, by the oxygen available at chemical compounds such as sulfate and nitrate). Anaerobic treatment system is usually used as a pre-treatment, because of its low efficiency. Thus, in order to more stabilization of wastewater, it should be used the aerobic system in the following of anaerobic ones (Mohamad Nejad and Saleh, 1385). Leachate treatment (usually the biological) is one of the solutions of its management systems. Facilities and equipment usually used for the treatment primarily depend on the properties of leachate (Chopanglos and Krys, 2010). Chemical and biological properties of leachate generally depend on the type of waste and the amount of waste degradability (Alizadeh Shushtari et al, 2007).

2. THEORETICAL FRAMEWORK

There are two issues in the analysis of acceptable cases of leachate quality in the bylaws cited in Japan, the first one considering the essential issues in leachate analysis such as temperature, pH, COD4, BOD5. The other one, Analysis cases of leachate, if necessary, such as total nitrogen, EC6, TSS7. It is totally emphasized that if the purpose is to determine the purification process of leachate, the continuous monitoring is necessary in checking the leachate quality and the cross sectional analysis is not suitable (Yasumasa, 2013). Tatsi and Zouboulis (2002) showed that the features of leachate are influenced by the leachate age (new and old leachate). As these investigators showed the measured values of other features (concentration of cations and anions, EC, BOD, COD) are more in new leachate rather than old one, except for ph.

The generated leachate in acidic stage of decomposition of waste contains large amounts of volatile fatty acids. So the organic materials are constituted in leachate and they are biologically easily decomposable (Bigdeli, 2012). In addition to being attributed to abundant soluble salts existed in the remains of cooked foods, electrical conductivity capability (EC) on the top of leachate is also related to the existence of a lot of minerals in leachate which are created from mineralization process during the anaerobic decomposition of waste (Al - Yakutat and Hamuda, 2003).

[4] Chemical Oxygen Demand
[5] Biological Oxygen Demand
[6] Electrical Conductivity
[7] Total suspended solids

3. THE EXPERIMENTAL FOUNDATIONS:

According to Hasani et al (2009), during the operation period, the average concentration of EC input in anaerobic reactor of the intended research (with downward and upward flow) equals 32/5 ms/cm. Maximum and minimum, respectively, EC= 49, EC= 22, and average output of anaerobic reactor equals 23/5, and the maximum and minimum of EC output were reported also in this period, respectively, EC = 35 and EC=15. The average removal efficiency of EC in the reactor was 28/15%. It is interesting to note that the reactor has experienced high ECs (49 ms/cm), and although it continued to operate without any problem. The suspended materials in the wastewater are a portion of the total foreign material (TSS) whose determination is necessary to predict the amount of sludge wastewater treatment. Suspended materials are found in two forms of settle able solids and non - settle able solids in wastewater. In terms of substance, suspended materials have either organic source (putrescible) or mineral source (inorganic) and are stable. Close to 40% of soluble materials in municipal wastewater and 72 to 75 percent of the suspended materials in it contain organic source, and the rest of the foreign substances are formed by minerals (monzavi, 2007).

In this context, the purpose of this research was to pay special attention to the correct principal governance and find the most suitable conditions for biological activities with continuous and regular monitoring of the parameters of EC and TSS (total suspended solids) in different seasons of the year from the startup of the treatment in protracted years in septic tank units (crude leachate), anaerobic units, primary air, secondary air and leachate output, until leader predicts the efficiency of treatment in different seasons of year and amends its performance to reduce the environmental pollutants.

4. METHODOLOGY

The research was conducted from the beginning of the work of Wastewater Treatment Compost factory at West of Golestan province (Agh Ghala) during 1258 days, and strategic monitoring of EC was done in different stages including septic tanks unit (crude leachate), anaerobic units, Initial aeration, secondary aeration and the output of leachate TSS for crude leachate, anaerobic units and final output in the laboratory test of leachate treatment plant. In this research, the performance of anaerobic ponds was applied with downward and upward flow in two concrete cubic rectangular shaped tank each of which was with the dimensions of 4.7 m × 4.2 m × 13.3m and useful volume of 237.5 m 3 as anaerobic tanks connecting in series, so that the first output constitutes the input above the tank. It was used the acne in these tanks (media made of pottery building). In order to accelerate the launching of anaerobic reactors, it was used new cattle manure. Primary and secondary aeration ponds with 300 diffusers in respect of beneficial volumes of 300 m3 540 m3 with primary and secondary sedimentation units were used for the return of sludge and feeding anaerobic, aeration and chlorinator ponds. This work was described as raw leachate with the maximum flow 25 m3 / d and various concentrations of COD with an average77000 mg/l and the acidic pH Equals 4/5 – 6/5 and the mean (EC = 32. 5 ms/cm and TSS = 3600mg / l) was daily moved to anaerobic ponds by pumping, and sampling was firstly initiated from the section of outlet valve septic tank, the end of the anaerobic unit (spillway to the first aeration unit) and half a meter from the bottom of aeration ponds on average once 4/5 days at the first year of the date 31/4 / 91. It was used the EC meter device (Portable) for testing EC and TSS(Initially filter paper is placed inside the oven104 ° C for 30 minutes until its moisture is taken and then the intended sample with specified volume is poured on the filter paper in the Buchner funnel, and now you can smooth and dewatering by the vacuum pump. When samples' water was completely taken, the filter paper is placed inside the 104 ° C oven for an hour, and then remove the filter paper from the oven and put inside a desiccators to be cool, and after a few minutes remove the filter paper from the desiccators and weigh). The analysis of samples was performed by EXCEL software.

5. FINDINGS

Raw leachate has been entered to septic tank from the site of composting process, after collecting through the channels for collecting and transmission, and samples were prepared from the output of septic tanks. This sampling was carried out during 1258 days. Table 1 indicates the seasons of the year, amount of concentration (the maximum, minimum and average) at certain times. The highest concentrations of EC were observed in early autumn and the lowest in the second half of autumn.

Table 1: EC Concentration in different seasons in raw leachate (from July 2010 to February 2014)

the raw leachate	maximum	minimum	average
Date	18/10/2012	17/11/2010	-
Season	the second half of autumn	early autumn	The first half of the spring and the late summer
EC(ms/cm)	61.12	7.55	32.4
Number of days of commissioning	213	230	In the years 2010-2014

According to figure 1, the charts the changes in the concentration of raw leachate were obtained with decreasing tangible gradient from the year 2010 to 2014.

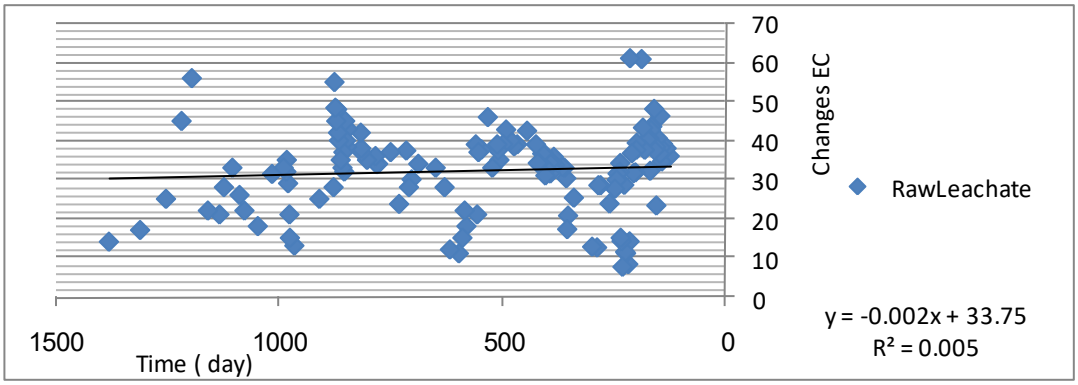


Figure 1: EC Changes in raw leachate during the test time

The leachate of anaerobic unit was sampled from tail end and the overflow during 1258 days. Table 2 shows the seasons of the year, amount of concentration (the maximum, minimum and average) at certain times, that highest concentrations of EC was observed in the second half of the summer and the lowest in the late winter in 2011.

Table 2: leachate EC Concentration in anaerobic unit in different seasons (July 2010 to February 2014)

anaerobic leachate	maximum	minimum	average
Date	10/7/2011	14/3/2012	-
Season	The second half of the summer	late winter	In late winter and summer - early spring and mid-fall
EC(ms/cm)	26.6	10.9	17.89
Number of days of commissioning	559	688	In the years 2010-2014

In figure 2, the graph of gradient also shows the tremendous changes in reducing EC concentration from 2010 to 2014.

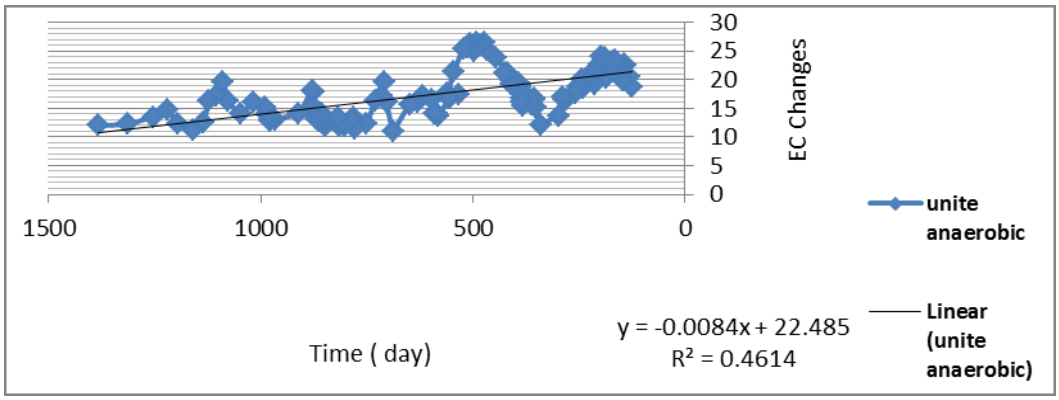


Figure 2: EC Changes in anaerobic leachate during the test time

The leachate of initial aeration unit was sampled from half a meter part of the pond's floor during 1258 days. Table 3 indicates seasons of the year, amount of concentration (the maximum, minimum and average) at certain times, and the highest concentrations of EC was observed in the mid of summer and the lowest in the late autumn. Figure 3 also shows the changes graph with substantially gradient decrease.

Table 3: leachate EC concentration of initial aeration unit in different seasons (from July 2010 to February 2014)

Initial aeration unit	maximum	minimum	average
Date	4/8/2011	20/12/2011	-
Season	The mid of Summer	late Autumn	The early Autumn, winter and spring season
EC(ms/cm)	21.1	7.52	12.8
Number of days of commissioning	498	584	In the years 2010-2014

The leachate of secondary aeration unit was also sampled from half a meter part of the pond's floor from 5/3/2011(after the overflow of initial aeration unit). Table 4 determines the seasons of the year, amount of concentration (the maximum, minimum and average) at certain times.

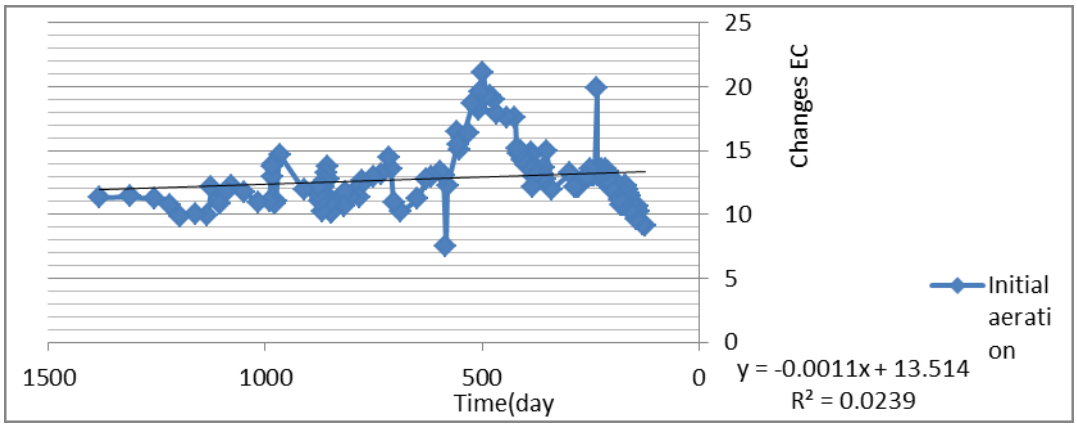


Figure 3: EC Changes in leachate of initial aeration during the time

The highest concentrations of EC was observed in the middle of summer and the lowest in the first half of autumn of the second year of treatment leadership and average concentration in the early spring and summer and the late winter all the years.

Table 4: EC concentration of leachate of secondary aeration unit in different seasons(March 2011 to February 2014)

secondary aeration unit	maximum	minimum	average
Date	7/8/2011	1/11/2011	----------
Season	The mid of Summer	Mid-Summer	The early spring and summer - late winter
EC(ms/cm)	19.35	7.4	12.32
Number of days of commissioning	506	589	In the years 2010-2014

Figure 4 also shows the diagram of EC changes with a greater reduction compared to initial aeration. Ultimately, the output leachate was sampled after the aeration and drumsticks units were sampled.

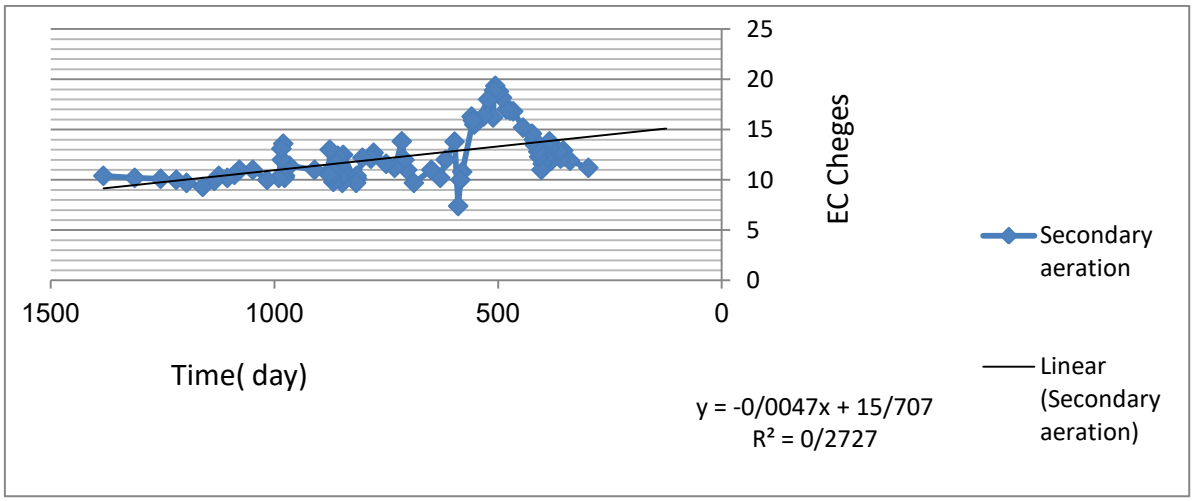


Figure 4: EC changes in secondary aeration leachate during the test time

Table 5 shows the seasons of the year, the amount of EC concentration (the maximum, minimum and average) at certain times that the highest concentrations of EC was observed at

mid-summer and the lowest in the first half of spring of the second year of treatment leadership.

Table 5: EC concentration of final output leachate in different seasons (March 2011 to February 2014)

The final output	maximum	minimum	average
Date	7/8/2011	21/7/2011	-
Season	The mid of Summer	The first half of spring	Late spring and summer - early autumn
EC(ms/cm)	18.3	7.1	10.47
Number of days of commissioning	506	519	In the years 2010-2014

Figure 5 can provide the changes diagram with noticeably gradient decrease in the following years of exploitation. Raw leachate sampling for TSS test was also carried out during 1258 days.

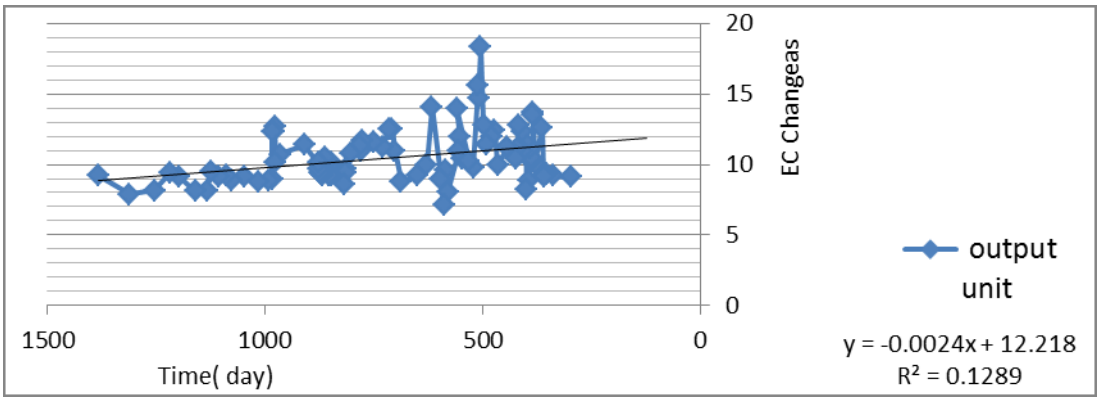


Figure 5: EC Changes for The final output leachate during the test

Table 6 shows the seasons of the year, the amount of concentration (the maximum, minimum and average) at certain times. The highest concentration of TSS was observed in early autumn and the lowest in mid-autumn of the year 2010. But the highest concentration was averagely observed all the years in the mid-summer.

Table 6: TSS concentration (mg / l) from the raw leachate in different seasons (July 2010 to February 2014).

the raw leachate	maximum	minimum	average
Date	3/10/2010	3/11/2010	----------
Season	early autumn	Mid- autumn	summer
TSS (mg / l)	11300	633.3	3611
Number of days of commissioning	247	226	during the years 2010-2014

In figure 6, the diagram of TSS concentration changes can be seen with noticeably gradient decrease from 2010 to 2014. The leachate of anaerobic unit was also sampled from the end part and overflows during 1258 days, as crude leachate, that the highest concentration was observed in early spring 2013 and the lowest concentration in the first half autumn 2010.

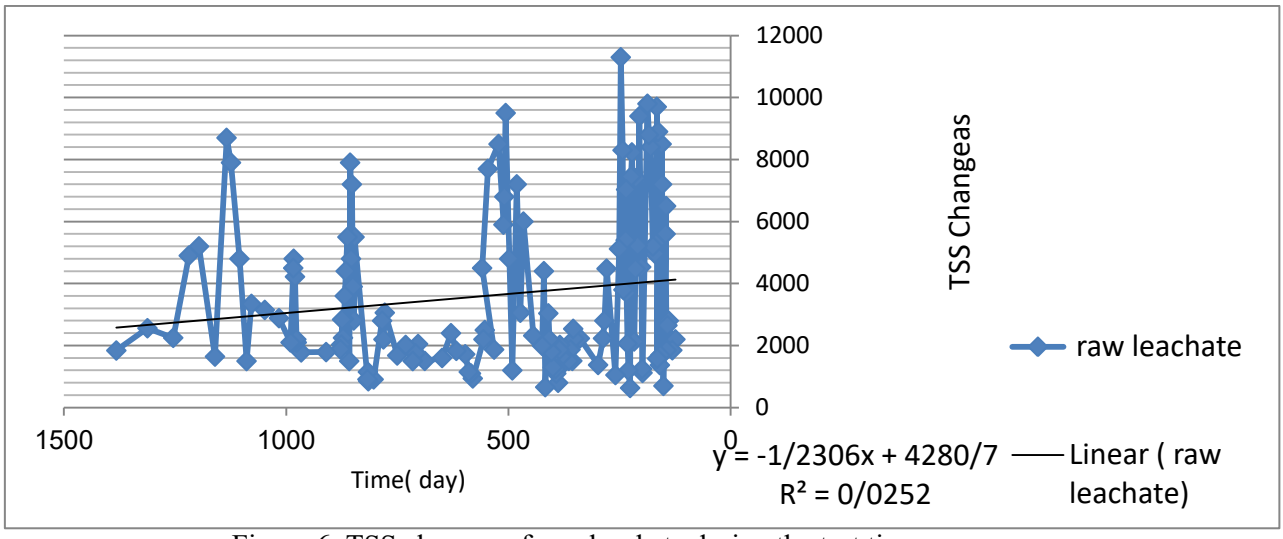


Figure 6: TSS changes of raw leachate during the test time

Table 7: TSS concentration from the leachate of anaerobic unit in different seasons (July 2010 to February 2014)

anaerobic leachate	maximum	minimum	average
Date	9/4/2013	30/10/2010	-
Season	The early Spring	The first half of Autumn	The early and late winter - early summer
TSS (mg / l)	1460	50	322.2
Number of days of commissioning	1048	222	In the years 2010-2014

In figure 7, TSS gradient changes the graph indicates intangible increase during 2010 to 2014, that represents the moderated changes of leachate input from septic tank unit (crude leachate).

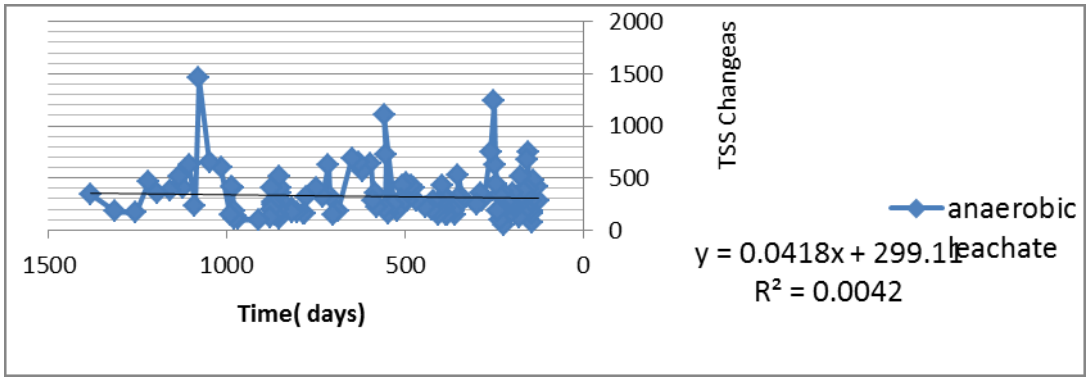


Figure 7: TSS changes for anaerobic leachate during the test time

The final output of leachate was sampled from the end of the first year of exploitation to February 2014. Table 8 presents the highest concentrations in the late winter and the lowest concentration in the first half of autumn.

Table 8: TSS concentration from the final output of leachate in different seasons (March 2011 to February 2014)

The final output	maximum	minimum	average
Date	19/3/2011	24/7/2011	-
Season	late winter	First half Autumn	The early And the second half Spring
TSS	200	10	89.8
Number of days of commissioning	364	506	In the years 2010-2014

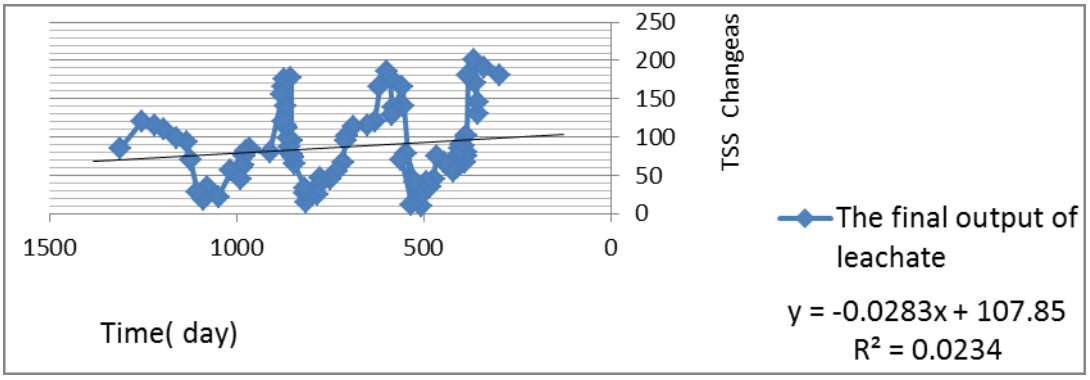


Figure 8: TSS changes for raw leachate during the test time

In figure 8, it can be observed the changes graph with a significant gradient decrease which shows the improvement of filterable condition of TSS concentration during the years after are exploitation and this gradient also has a decreasing trend.

6. DISCUSSION

The diagram (Fig. 9) indicates the comparison of raw leachate changes (input) and output leachate during the exploitation. In this system, it was calculated the medium efficiency of removed concentration, 67.7%. Considerable note at this research is that wastewater treatment has experienced high EC of 61.12 (Input of anaerobic unit), and despite this, continued his work without any problem. For leachate output, it was observed the average concentrations (10.47) and maximum and minimum, respectively (18.3) in the mid- summer and (7.1) in the first half autumn with fairly modest changes (Figure 10).

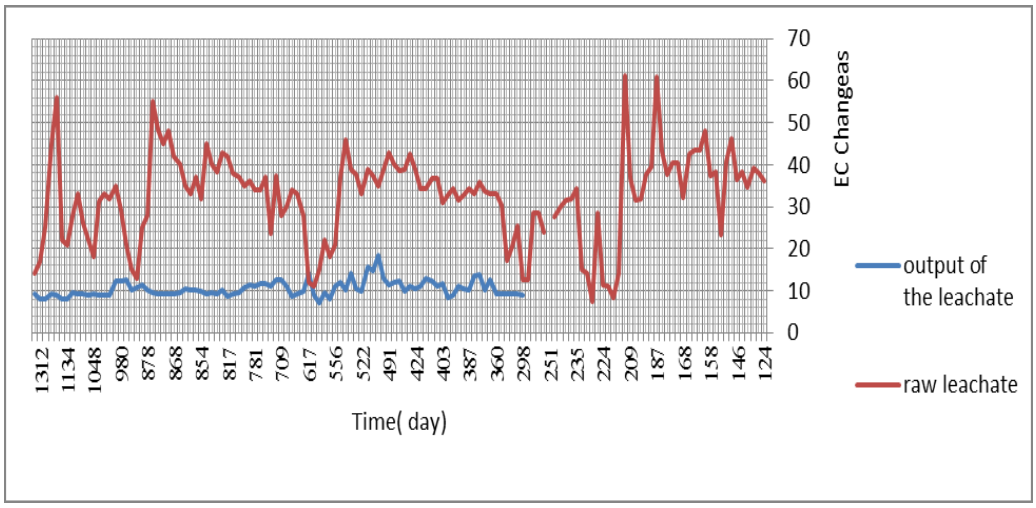
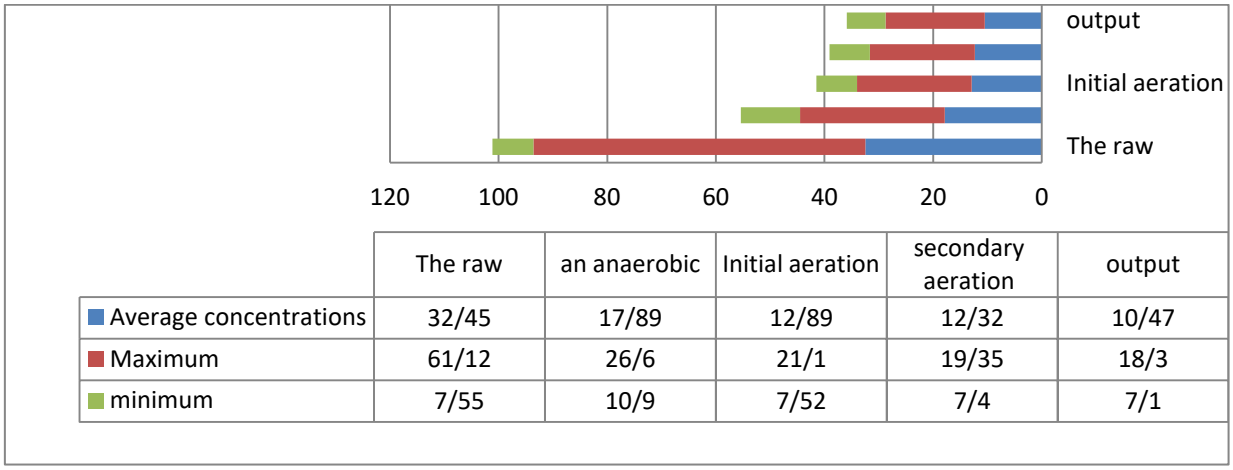


Figure 9: Changes for EC as comparison chart for anaerobic and raw leachate during the time



	The raw	an anaerobic	Initial aeration	secondary aeration	output
Average concentrations	32/45	17/89	12/89	12/32	10/47
Maximum	61/12	26/6	21/1	19/35	18/3
minimum	7/55	10/9	7/52	7/4	7/1

Figure 10: Average change of EC in different stages of the treatment plant during exploitation

In raw leachate unit, they were recorded maximum concentration (TSS = 11300 mg/l) in the early autumn and lowest (TSS = 633.3 mg/l) in the first half of autumn and the average (TSS = 3611.4 mg/l), but in leachate unit of the final output, maximum concentrations (TSS = 200 mg/l) were shown in the late winter and minimum(TSS = 10 mg/l) in the first half of autumn with an average (TSS = 89.8 mg/l) removal efficiency of 97.5 percent, which reflects the high efficiency and optimum performance, according to (Figure 11).

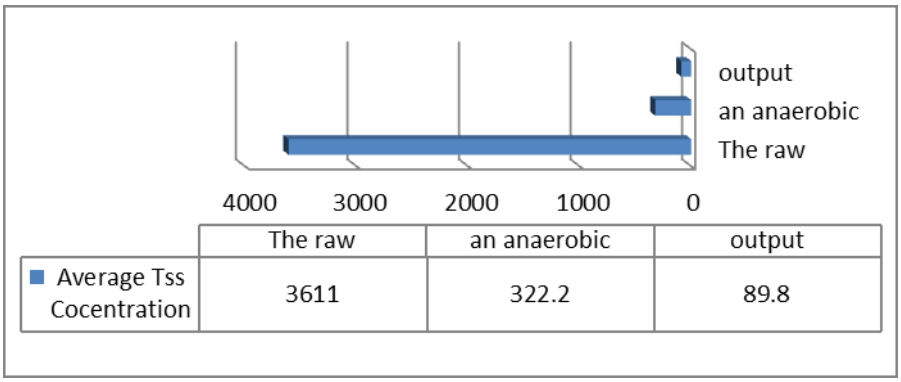


Figure 11: Average changes of TSS in different stages of the treatment plant during the exploitation

7. Conclusions

In this treatment plant, anaerobic reactor unit showed the best performance and was able to adapt with high concentrations of TSS and EC, and the lowest performance was also observed in the secondary aeration unit. The lowest concentration EC= 7.1, TSS = 10 was obtained in the final output in the first half of the spring and autumn (very good results), and maximum concentration, EC = 18.3, TSS = 200, respectively in mid-summer and the late winter (undesirable results). It seems that the results with highest concentrations of the two mentioned parameters in the mid-summer is related to the existence of plenty soluble salts and high minerals during anaerobic decomposition, and late winter is related to bacteria population and temperature inside the treatment plant that were consistent with former researchers' studies.

8. Applied Suggestions

In compost factories and landfill centers, there is a potential risk of underground water resources contamination which is not observable, but its outbreak and manifestation requires to spend much money and time; therefore it should be attempted more to manage the output leachate including design, the construction of wastewater treatment and principal guidance for its different stages, and it is obtainable by continuous monitoring the essential parameters in the analysis of its leachate.

Considering the results of the study, it is suggested that biological wastewater treatment plants should be assessed as an appropriate strategy to treat the leachate in different units of the country, and operate after feasibility assessment.

It is suggested that despite the high performance of anaerobic reactors (with upward and downward flow and sticking growth substrate in the form of combination) with aeration systems in the present study, the improvement of the required standards is provided, considered and attempted in leachate quality study.

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ETHICAL CONSIDERATION

Authenticity of the texts, honesty and fidelity has been observed.

AUTHOR CONTRIBUTIONS

Planning and writing of the manuscript was done by the authors.

CONFLICT OF INTEREST

Author/s confirmed no conflict of interest.

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