International Journal of Current Engineering and Technology
E-ISSN 2277 – 4106, P-ISSN 2347 – 5161
Available at http://inpressco.com/category/ijcet

Research Article

The interaction between Waste Water Contaminations and Sandy Soil

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Received 05 Nov 2018, Accepted 10 Jan 2019, Available online 15 Jan 2019, **Vol.9, No.1 (Jan/Feb 2019)**

Abstract

The soil environment is considered one of the most effective natural water-treatment systems on earth. For millions of years, it has protected the earth's pristine groundwater resources from pollutants collected in water percolating from the surface. However, contamination of soil by sewage can occur from different sources such as raw sewage overflow, septic tanks used as on-site sanitation or can result from leaking sewer lines, land application of sludge, oxidation ditch, wetland and aerated lagoons as well. The interaction between waste water contaminations and different types of soil, must be a point of concern. This interaction depends on chemical, biological and physical characteristics of both soil and waste water. The main aim of this study is to study the effect of soil on raw waste water and assess the effluent wastewater from soil. Pilot scale model was constructed at Serabium WWPT, Ismailia government, Egypt. The main component of the test units is sandy soil as a base and raw wastewater as a water head above the soil with different ratios of 1/3, 2/3 and 1/1 consequently. Raw wastewater influent was taken from the approach channel after grit removal tanks. Soil classification test was carried out by using textural classification, Medium sand and Silty sand were used for the test units. Wastewater head was permeated through soils where the period time for getting samples for analysis was twenty days as average.

Keywords: *Soil, Wastewater, Soil Composition, wetland, aerated lagoons, groundwater table*

1. Introduction

The soil environment is considered one of the most effective natural water-treatment systems on earth. For millions of years, it has protected the earth's pristine groundwater resources from pollutants; it keeps the quality and quantity of our ground water. Moreover, the soil environment provides physical, chemical and biological treatment processes such as sedimentation, filtration, adsorption, precipitation, ion exchange, hydrolysis, biodegradation, nitrification, DE nitrification and predation. The effectiveness of each process depends on soil type. Realizing the relationship between the properties of soil and its treatment capability also can be used in modifying the properties of soil to create favorable conditions for desired treatment capabilities (Sims j. and Otis R.).

Wastewater is characterized in terms of its physical, chemical and biological composition. It is spread in different types of soil in return leads to transport of contaminations and increase the proportion of toxic compounds in it. Chemicals and salts have harmful effect on the growth of plants, human and animal health. As a result, it causes pollution and deterioration of the quantity of the fabric of the mineralogical composition of the soil and therefore the physical and mechanical properties (Egyptian code for Soil mechanics).

Two main sources of water pollutants are point and non-point source of pollution. The spread of wastewater contamination in soil causes the non-point source of pollution. It is specified that more than 70% of the water pollution in the United States comes from non-point sources due to ability of soil to infiltrate wastewater and collect many contamination in blanks interfaces of the soil (Barbara Grimes).

Contaminations travel from unsaturated soil zone to the saturated soil zone and begin to infiltrate in the direction of groundwater flow. Pollutants that get into groundwater are not quickly diluted or flushed out since groundwater advances so slowly. Also, it is difficult to detect that pollution until it reaches surface water area, so pollution can be widespread in the soil. (F. stagnitti, J. - Y. Parlange et Al.).

In the United States and from 1971 to 1980, the use of untreated groundwater was the main reason for more than one-third of the waterborne disease outbreaks. Subsurface contamination was occurred by pathogenic microorganisms, and the major sources of pathogens was waste water effluents, residual sludge from waste treatment and septic tank effluents (Gabriel Bition *et al.*).

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DOI: https://doi.org/10.14741/ijcet/v.9.1.2

Land application is a popular solution for the disposal of sewage sludge that generated from waste water treatment plants. It is the most convenient solution and the least expensive. The potential bacterial contamination of soil and ground water limits. However, the land application of sewage sludge in the United States shows a significant link between waterborne disease outbreaks and the consumption of contaminated groundwater table (A. Luczkiewicz).

2. Testing Program

This section describes the experimental work performed through this study

2.1. Test unit Location and description

The practical experiments were performed in Serabium WWPT, waste water treatment plant located at Ismailia government, Egypt. A physical model was built in the plant and the work samples were analyzed in the central laboratory station of the plant. The tests were installed in the plant, and the influent wastewater for all test units was taken from the approach channel after grit removal chamber and before distribution tank at primary treatment process for first stage. Figure 1 shows the flow diagram before the influent.

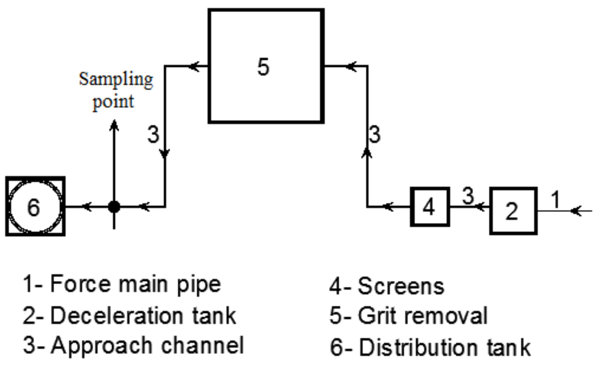

Figure 1: Flow diagram before the influent

The test units were built from nine PVC pipes 200 mm diameter and were filled with soil bed and a constant head of wastewater. Both of silty sand and medium sand were used as a soil bed. Figure 2 and Figure 3 show the grain size distribution of the used soil. For each soil type three different ratioes of (soil bed height to wastewater head) of 1/3, 2/3 and 1/1 were investigated, soils were compacted in layers, each layer did not exceed 15 cm. Table 1 shows the typical dimensions for different samples. A layer of burlap slave was installed above soil bed height to prevent soil from disintegration. A pizometer was used to observe changing in water head level even constancy before the effluent wastewater sample was taken; Figure 4 shows the details of the test unit.

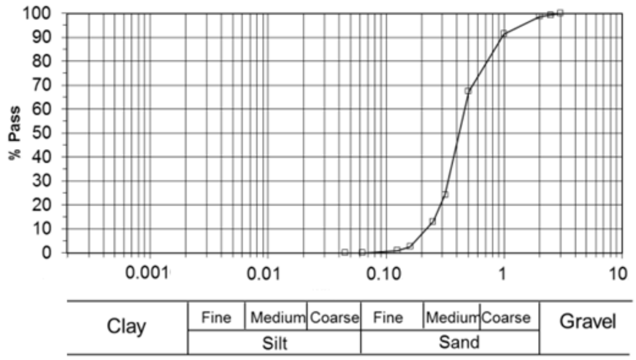

Figure 2: Grain size distribution of Medium sand soil.

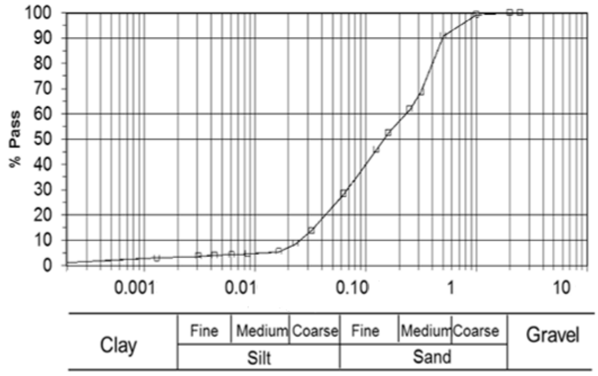

Figure 3: Grain size distribution of Silty sand soil

Table 1: Typical dimensions for different samples

Model	Wastewater head (m)	Type of soil	Soil bed height (m)	Soil bed height to wastewater head
Sample 1	0.4	Medium sand	13.33	1/3
Sample 2	0.4	Medium sand	26.67	2/3
Sample 3	0.4	Medium sand	40	1
Sample 4	0.4	Silty sand	13.33	1/3
Sample 5	0.4	Silty sand	26.67	2/3
Sample 6	0.4	Medium sand	40	1

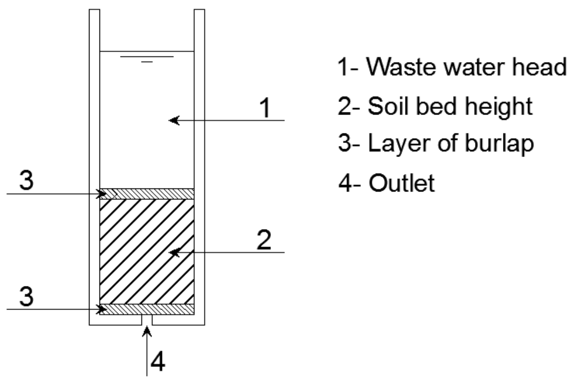

Figure 4: Details of test units for all samples

2.2. Unit installation and experimental works

During unit installation, some specifications must be considered which are listed in Table 2, the steps of the experimental program are listed in Table 3.

Table 2: Specifications during unit installation

During unit installation	• All fittings are fixed well to prevent water leakage • Units were washed with clean water • Units are free from any foreign matters • Units are in a vertical position and fixed properly

Table 3: Steps of Experimental work

Experimental work	• Operating the model and ensuring the water head in piezometers were in steady level • Before taking samples, the used bottle were inspected to be sure that they were disinfected and there was no sediment matter or deposits • The influent waste water was changed periodically each 20 days after getting effluent for analysis to prevent the activity of anaerobic bacteria. The physical model was allowed to be drained and get ventilated • After taking samples, analysis were performed on the same day • Analyses were made according to Standard Methods For The Examination of Water and Wastewater 22nd Edition (2012)

2.3. Measuring Devices

The measured parameters and the measuring devices are listed in Table 4

Table 4 Measured parameters and the measuring devices

Measured Parameter	Measuring device
PH value and Temperature	PH meter
Dissolved oxygen (DO) mg/l	DO meter
Biochemical Oxygen Demand5(BOD5) mg/l	Incubator
Chemical Oxygen demand (COD) mg/L	digital COD reactor and spectrophotometer
Total suspended solids (TSS) mg/l	vacuum pump manifold and digital oven
Total dissolved solids (TDS) mg/l	Conductivity meter
Nitrite as nitrogen (NO_2) mg/l	Spectrophotometer
Nitrate as nitrogen (NO_3) mg/l	Spectrophotometer
Total phosphorus (TP) mg/l	Spectrophotometer
Total Coliform (TC) count colony /100 ml	biosafety cabinet class and incubator

3. Results

This section describes the experimental test results for the physical model from January 2017 till May 2017. The characterized of this period showed load and less hydraulic load (winter months) especially in January, February and March. Operating cycle was operated by raw wastewater, and then the effluent was examined. After that, the influent was stopped to dry the samples and get ventilated.

Wastewater analysis was made for raw waste water before being used in operating six samples as influent discharge, results are listed in Table 5.Also wastewater analysis was made for effluent discharge from samples, and results are listed in Table 6 to Table 11.

Table 5: Results of raw wastewater analysis

Date	Jan.	Feb.	Mar.	Mar.	Apr.	May.	Av.
Temp.	16.60	18.00	16.90	22.70	26.50	27.70	21.40
PH value	6.70	6.53	7.28	7.32	7.34	7.30	7.08
(DO) mg/l	0.58	0.62	0.65	0.99	0.25	0.21	0.55
Sulfide mg/l	3.00	3.00	3.00	3.00	3.00	4.40	3.23
(BOD5)mg/l	290	200	311	209	221	118	225
(COD) mg/l	320	335	440	571	266	150	347
(TSS) mg/l	128	150	350	200	190	216.6	205.8
(TDS) mg/l	551.0	532.0	662.0	689.0	620.0	616.0	611.7
(NO2) mg/l	0.21	0.21	0.14	0.19	0.18	0.00	0.15
(NO3) mg/l	28.41	19.64	14.56	25.47	20.10	12.41	20.10
(TP) mg/l	27.23	21.64	26.75	18.93	4.41	9.28	18.04
(Tc) /100 ml	$1800*10^5$	$17000*10^5$	$600*10^5$	$90*10^5$	$20*10^5$	$14*10^5$	$3254*10^5$
Fecal colony /100ml	$400*10^5$	$2000*10^5$	$200*10^5$	$20*10^5$	$10*10^5$	$2*10^5$	$439*10^5$

Table 6: Results of wastewater analysis for effluent of medium sand sample with a ratio 1/3.

Date	Jan.	Feb.	Mar.	Mar.	Apr.	May.	Average
Temperature C0	10.70	16.30	18.00	24.20	26.60	27.20	20.50
PH value	7.15	7.11	7.15	7.12	7.28	7.12	7.16

(DO) mg/l	4.21	1.80	4.01	5.17	4.59	6.04	4.30
Sulfide mg/l	0.00	0.00	0.00	0.00	0.00	0.80	0.13
(BOD5)mg/l	89.10	67.00	45.40	56.00	43.60	40.80	56.98
(COD) mg/l	125.00	132.00	109.00	120.00	94.00	66.00	107.67
(TSS) mg/l	26.40	32.00	12.60	37.00	16.66	4.30	21.49
(TDS) mg/l	1900.00	885.00	925.00	790.00	678.00	631.00	968.17
(NO2) mg/l	0.04	1.14	4.10	1.57	0.22	5.56	2.11
(NO3) mg/l	14.40	12.80	87.64	69.70	43.10	11.65	39.88
(TP) mg/l	7.30	9.81	9.41	6.55	1.35	4.42	6.47
(Tc) /100 ml	$280*10^5$	$1400*10^5$	$26*10^5$	$2*10^5$	$0.2*10^5$	$0.4*10^5$	$285*10^5$
Fecal colony /100ml	$2*10^5$	$20*10^5$	$2*10^5$	$2*10^5$	$0.1*10^5$	$0.2*10^5$	$4*10^5$

Table 7: Results of wastewater analysis for effluent of medium sand sample with a ratio 2/3.

Date	Jan.	Feb.	Mar.	Mar.	Apr.	May.	Average
Temperature C0	10.30	15.90	19.10	25.80	32.00	32.60	22.62
PH value	7.26	7.13	7.00	6.91	6.85	6.92	7.01
(DO) mg/l	3.70	3.16	2.62	4.32	3.01	4.90	3.62
Sulfide mg/l	0.00	0.00	0.00	0.00	0	1.00	0.17
(BOD5)mg/l	85.20	58.00	38.70	57.00	52.00	52.30	57.20
(COD) mg/l	140.00	87.00	126.00	84.00	111.00	78.00	104.33
(TSS) mg/l	23.00	21.30	49.00	32.00	21.00	13.33	26.61
(TDS) mg/l	1895.00	1310.00	1222.00	1030.00	1105.00	914.00	1246.00
(NO2) mg/l	0.03	5.52	0.31	1.85	1.04	5.41	2.36
(NO3) mg/l	13.00	15.20	15.84	69.46	368.16	165.80	107.91
(TP) mg/l	5.00	7.67	10.67	9.35	1.00	2.21	5.98
(Tc) /100 ml	$160*10^5$	$9*10^5$	$0.2*10^5$	$2*10^5$	$0.6*10^5$	$1.4*10^5$	$29*10^5$
Fecal colony /100ml	$0.2*10^5$	$1*10^5$	$0.1*10^5$	$1*10^5$	$0.2*10^5$	$0.2*10^5$	$0.45*10^5$

Table 8: Results of wastewater analysis for effluent of medium sand sample with a ratio 1/1.

Date	Jan.	Feb.	Mar.	Mar.	Apr.	May.	Average
Temperature C0	10.3	17.4	18.4	25.1	31.7	31.2	22.35
PH value	7.04	7	6.9	6.88	7.01	6.93	6.96
(DO) mg/l	2.84	3.49	4.76	3.5	2.45	2.39	3.24
Sulfide mg/l	0	0	0	0	0	0.8	0.13
(BOD5)mg/l	86.2	64	35.2	55.5	52	66.9	59.97
(COD) mg/l	115	128	118	122	107	83	112.17
(TSS) mg/l	27	23	40.9	38	32	8.6	28.25
(TDS) mg/l	2140	1250	970	947	1130	880	1219.50
(NO2) mg/l	0.115	7.14	0.114	1.046	0.42	0.09	1.49
(NO3) mg/l	24.3	85	12.86	82.4	367.4	150.8	120.46
(TP) mg/l	6.4	13.3	19.67	7.04	1.84	3.32	8.60
(Tc) /100 ml	$3.3*10^5$	$330*10^5$	$260*10^5$	$12*10^5$	$0.2*10^5$	$0.4*10^5$	$10098*10^5$
Fecal colony /100ml	$0.6*10^5$	$20*10^5$	$20*10^5$	$2*10^5$	$0.1*10^5$	$0.2*10^5$	$7.2*10^5$

Table 9: Results of wastewater analysis for effluent of silty sand sample with a ratio 1/3

Date	Jan.	Feb.	Mar.	Mar.	Apr.	May.	Average
Temperature C0	10.30	18.00	19.10	25.60	25.20	32.00	21.70
PH value	7.81	7.85	7.69	7.80	8.29	8.32	7.96
(DO) mg/l	12.02	14.40	4.78	1.57	8.59	11.59	8.83
Sulfide mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00
(BOD5)mg/l	42.60	123.40	35.70	60.00	11.91	10.00	47.27
(COD) mg/l	455.00	191.00	103.00	90.00	160.00	82.00	180.17
(TSS) mg/l	102.00	143.00	60.00	62.00	15.00	24.00	67.67
(TDS) mg/l	11010.00	4020.00	1223.00	878.00	1125.00	1050.00	3217.67
(NO2) mg/l	7.44	0.28	0.10	0.04	4.83	1.24	2.32
(NO3) mg/l	91.00	31.76	22.87	19.50	90.80	96.26	58.70
(TP) mg/l	2.60	7.36	4.42	4.60	3.10	4.42	4.42
(Tc) /100 ml	$14*10^5$	$9*10^5$	$0.2*10^5$	$4*10^5$	$0.02*10^5$	$0.01*10^5$	$4.5*10^5$
Fecal colony /100ml	$1*10^5$	$1*10^5$	$0.1*10^5$	$2*10^5$	$0.01*10^5$	$0.004*10^5$	$0.68*10^5$

Table10: Results of wastewater analysis for effluent of silty sand sample with a ratio 2/3

Date	Jan.	Feb.	Mar.	Mar.	Apr.	May.	Average
Temperature C0	8.90	19.30	22.00	25.80	25.79	29.20	21.83
PH value	7.77	7.93	7.86	7.83	7.85	7.64	7.81
(DO) mg/l	6.50	8.09	4.00	5.39	5.71	6.30	6.00
Sulfide mg/l	0.00	0.00	N.D	0.00	0.00	0.00	0.00
(BOD5)mg/l	59.70	171.60	43.80	95.00	75.00	48.00	82.18
(COD) mg/l	544.00	438.00	229.00	190.00	150.00	78.00	271.50
(TSS) mg/l	113.50	363.00	430.00	288.00	220.00	106.00	253.42
(TDS) mg/l	13330.00	4400.00	4060.00	1615.00	1225.00	1102.00	4288.67
(NO2) mg/l	3.94	5.42	0.11	0.06	0.05	0.04	1.60
(NO3) mg/l	104.00	95.60	23.60	23.20	22.80	22.30	48.58
(TP) mg/l	4.90	58.20	33.86	8.00	4.60	4.06	18.94
(Tc) /100 ml	$260*10^5$	$14*10^5$	$2*10^5$	$9*10^5$	$0.4*10^5$	$0.3*10^5$	$47*10^5$
Fecal colony /100ml	$10*10^5$	$1*10^5$	$1*10^5$	$2*10^5$	$0.2*10^5$	$0.1*10^5$	$2.4*10^5$

Table 11: Results of wastewater analysis for effluent of silty sand sample with a ratio 1/1

Date	Jan.	Feb.	Mar.	Mar.	Apr.	May.	Average
Temperature C0	11.2	18.2	19.3	25.2	25.3	31	21.70
PH value	7.88	7.62	7.72	7.6	7.36	7.41	7.60
(DO) mg/l	9.2	0	0.12	2.16	2.08	1.68	2.54
Sulfide mg/l	0	0	0	0	0	0	0.00
(BOD5)mg/l	43.9	31	104	102	59.5	33	62.23
(COD) mg/l	174	147	251	167	189	95	170.50
(TSS) mg/l	21.3	20	130	216.6	60	100	91.32
(TDS) mg/l	2050	1055	933	947	1030	1070	1180.83
(NO2) mg/l	0.036	0.08	0.054	0.0432	0.053	2.35	0.44
(NO3) mg/l	18.26	14.2	15.56	13.9	16.03	47.1	20.84
(TP) mg/l	9.5	4.59	4.64	15.2	3.98	5.3	7.20
(Tc) /100 ml	$110*10^5$	$17*10^5$	$.2*10^5$	$33*10^5$	$.2*10^5$	$0.02*10^5$	$26.7*10^5$
Fecal colony /100ml	$10*10^5$	$2*10^5$	$.1*10^5$	$2*10^5$	$.2*10^5$	$0.01*10^5$	$2.4*10^5$

4. Data analysis

4.1 Temperature and PH

Temperature influences chemical, physical and biological processes in wastewater bodies. For high degrees of temperature, the rate of chemical reactions increases with both of evaporation and volatilization of substances from the wastewater. Also the solubility of some gases is increased such as O2, CO2, N2, and CH4. In warm waters, respiration rates, oxygen consumption and decomposition of organic matter are increased.

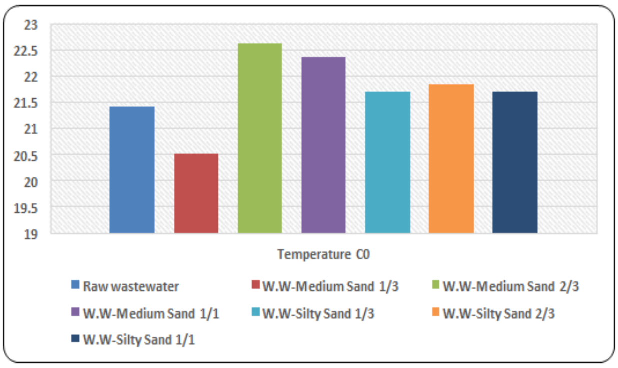

Figure 5: The effect of soil on the temperature of waste water

Also growth rates are increased, which is the most noticeable for bacteria and phytoplankton, it almost doubles their populations in very short time periods leading to increased water turbidity and algal blooms. Figure 5 illustrates that soil effects on wastewater temperature and the weather affects on the used soil. If the weather has a low temperature, soil temperate is low so that effluent wastewater temperature is low and vice versa, thermal conductivity of soil controls the change in effluent wastewater temperature.

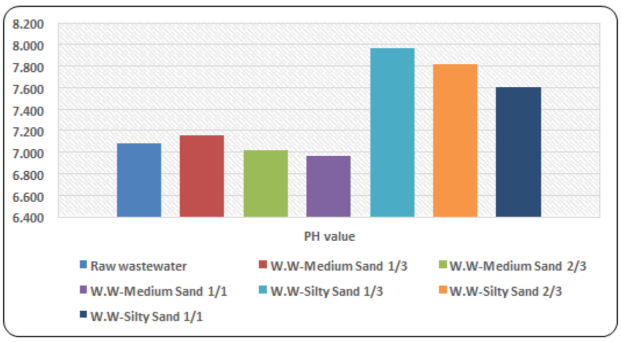

Figure 6: The effect of soil on the pH value of waste water

The pH value plays an important role in wastewater quality assessment since it affects many biological and chemical processes within a wastewater body and all processes associated with wastewater supply and treatment. Figure 6 illustrates that soil type effects on raw wastewater PH value due to presence of salts, minerals, organic and inorganic matter, the effect of chemical composition of soil and its surface area. Results of silty sand almost doubles the pH value

4.2 Dissolved oxygen (DO)

Dissolved oxygen refers to the level of free, non-compound oxygen present in wastewater or other liquids. It is an important parameter in assessing water quality because of its influence on the organisms living and respiration within a body of water. The solubility of oxygen decreases as temperature and salinity increase. The value of DO indicates both of the degree of pollution by organic matter, the destruction of organic substances and the level of self-purification. Dissolved oxygen controls the type of used bacteria for wastewater treatment.

Figure7 shows that soil affects positively on raw wastewater dissolved oxygen value. For effluent of medium sand samples, DO value was improved, more than raw wastewater. For silty sand soil, values of dissolved oxygen are significantly varied from time to another, for average DO value, it was observed that DO concentration is inversely related to soil depth.

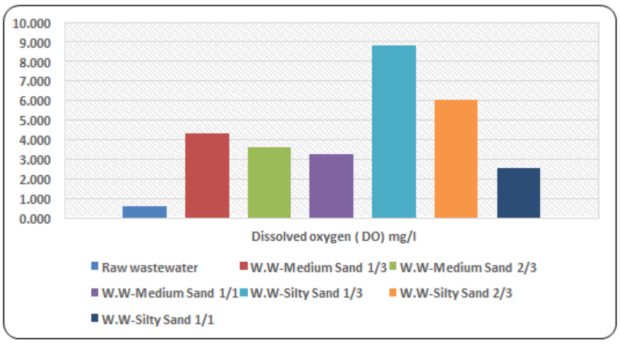

Figure 7: The effect of soil on the dissolved oxygen value of waste water

3. Sulfide

During the collection and treatment of wastewater, Hydrogen sulfide (H_2S) is formed from septic conditions, it is known with its rotten egg smell; this formation is a major problem for municipal wastewater systems. It is produced by the biological reduction of sulfates and the decomposition of organic material by anaerobic bacteria. Figure 8 illustrate that soil has reduced the hydrogen sulfide from the effluent wastewater. The removal efficiency of silty sand soil is more efficient than medium sand. This is due to soil adsorption phenomena. Hydrogen sulfide removal efficiency is inversely related to soil grain size particle.

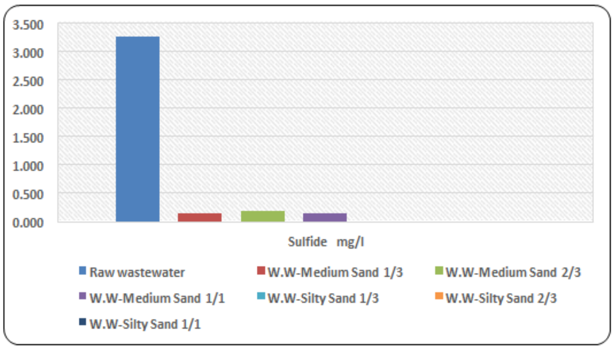

Figure 8: The effect of soil on the sulfide value of waste water

4. Biochemical Oxygen demand (BOD5)

It is defined as the amount of dissolved oxygen demanded by aerobic biological organisms to break down organic material present in a certain water sample at certain temperature over a specific time period. The BOD5 is an important variable in wastewater quality assessment.

Average BOD5 in raw wastewater was recorded to be 224.833mg/l. The average removal percentage for medium sand and silty sand units with ratios (1/3), (2/3) and (1/1) were calculated to be 74.66%, 74.56%, 73.33% and 78.98%, 63.45%, and 72.32%. This is due to soil filtration, adsorption, and biodegradation. All of these processes depend on soil properties and operation cycle, which provides an opportunity for aerobic decomposition of retained organic matter. Medium sand showed higher efficiency than silty sand in organic matter removal. Figure 9 shows analysis of biochemical oxygen demand for different samples.

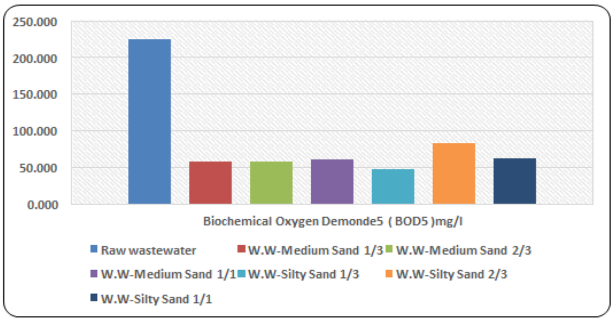

Figure 9: The effect of soil on the BOD5 value of waste water

5. Chemical Oxygen demand (COD)

It is defined as a measure of the oxygen equivalent to the organic matter in a wastewater sample that is susceptible to oxidation by a strong chemical oxidant. It is widely used as a measure of the susceptibility to oxidation of the organic and inorganic materials present in wastewater bodies. Figure 10 illustrates that, the medium sand has shown higher efficiency in reducing COD value than silty sand cells.

In general, soil filtration, adsorption, biodegradation, ion exchange process and soil structure that retains and reduces many of organic and inorganic materials. For medium sand soil, COD value was reduced significantly. For silty sand soil, soil contains a lot of organic and inorganic matters that are dissolved and suspended in the effluent wastewater from silty sand cells that pollute the effluent wastewater and increase COD value. By the time, COD value is decreased due to decrease organic and inorganic concentration by operating model.

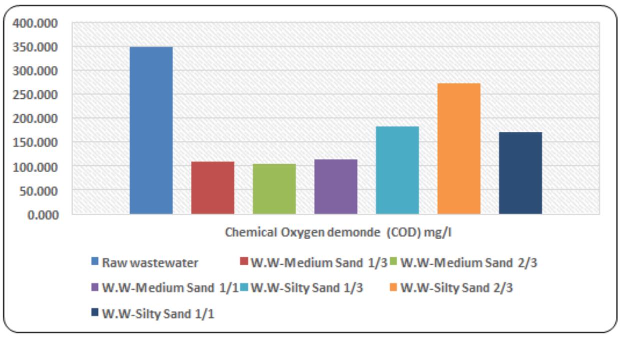

Figure 10: The effect of soil on the COD value of waste water

6. Total suspended solids (TSS)

It is non-filterable residue. Fixed solids and volatile solids. It is a water quality parameter used to determine the quality of wastewater after treatment in a wastewater treatment plant. Figure 11 shows analysis of total suspended solids of different samples. Average TSS in raw wastewater was recorded to be 205.7mg/l. The average removal percentage for medium sand and silty sand units with ratios (1/3), (2/3) and (1/1) were calculated to be 89.55%, 87.07%, 86.27% and 67.11%, -23.16% and 55.62%.

For Medium Sand Soil. It retained many of suspended solids from the influent of raw wastewater. For silty sand soil, the soil contains many solids that suspended in the effluent of silty sand samples so that TSS value increase due to soil physical properties and soil components for the used sample.

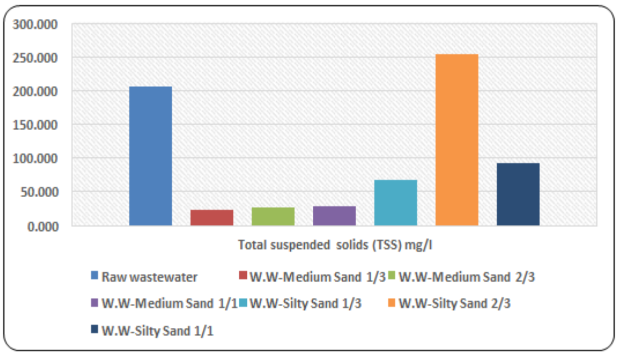

Figure 11: The effect of soil on the TSS value of waste water

7. Total dissolved solids (TDS)

It is defined as that the solids must be small enough to survive filtration through a filter with two micrometer (nominal size or smaller) pores. Conductivity, or specific conductance, is sensitive to variations in dissolved solids, mostly mineral salts. Figure 12 shows that average TDS in raw wastewater was recorded to be 611.67mg/l and the effluent of wastewater from medium sand and silty sand units of ratios (1/3), (2/3) and (1/1) were recorded to be 968.16.mg/l, 1246mg/l, 1219.5mg/l and 3217.6mg/l, 4288.6mg/l and 1180.8mg/l.

Soil contains salts, minerals, organic and inorganic matter that dissolved in effluent wastewater from samples and increase TDS that depends on soil chemical and physical component. By time, due to decreasing salts, minerals, organic and inorganic matter concentration in soil, TDS value decrease. Silty sand samples contain a high concentration of matters that dissolved in effluent wastewater more than medium sand samples.

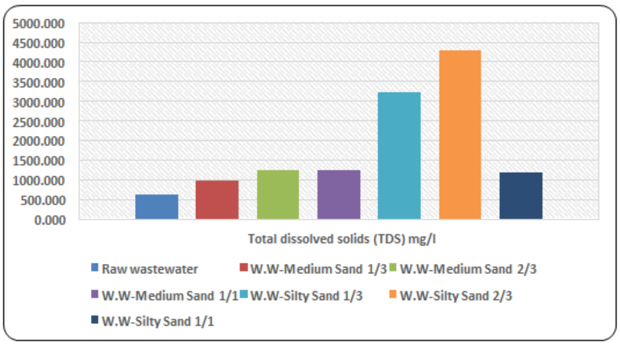

Figure 12: The effect of soil on the TDS value of waste water

8. Nitrite, Nitrate and Total Phosphorus

Nitrogen compounds and Phosphorus compounds are called Nutrients. Nitrogen provides living organisms with proteins. The combined nitrogen found in natural water is called nitrate ion (NO3-). It may be converted to nitrite (NO2-) by denitrification processes. Both of (NO3-) and (NO2-) are called the organic nitrogen, it is subject to the seasonal fluctuations of the biological community because it is formed in water by phytoplankton and bacteria, and cycled within the food chain. High concentrations of organic nitrogen indicate pollution of a water body.

Phosphorus exists in water bodies as both dissolved and particulate species, it is an essential component of the biological cycle in water bodies, and it is responsible for algal growth and, controls the primary productivity of a water body. Its concentrations can be increased due to human activities. High concentrations can indicate the presence of pollution and are largely responsible for eutrophic conditions.

Figure 13 shows that average value of NO2 in raw wastewater was recorded to be 0.155mg/l and the effluent of wastewater from medium sand and silty sand units with ratios (1/3), (2/3) and (1/1) were recorded to be 2.11.mg/l, 2.36mg/l, 1.49mg/l and 2.32mg/l, 1.60mg/l and 0.44mg/l. The average increase percentage for medium sand and silty sand units with ratios (1/3), (2/3) and (1/1) were calculated to be 1259.96%, 1424.33%, 860.71% and 1400.06%, 935.84%, and 181.61%.

Figure 14 shows that average value of NO3 in raw wastewater was recorded to be 20.1mg/l and the effluent of wastewater from medium sand and silty sand units with ratios (1/3), (2/3) and (1/1) were recorded to be 39.9.mg/l, 107.91mg/l, 120.46mg/l and 58.69mg/l, 48.58mg/l and 20.84mg/l. The average increase percentage for medium sand and silty sand units with ratios (1/3), (2/3) and (1/1) were calculated to be 98.43%, 436.91%, 499.35% and 192.06%, 141.73%, and 3.70%.

Figure 15 shows that average TP in raw wastewater was recorded to be 18.04mg/l. The average removal percentage for medium sand and silty sand units with ratios (1/3), (2/3) and (1/1) were calculated to be 64.12%, 66.83%, 52.36% and 75.52%, -4.97% (increase percentage), and 60.08%.

When raw wastewater permeates through the used soil. it breaks down nitrogenous organic and inorganic matter that in return increases nitrite and nitrate concentrations in the effluent wastewater from the model. During the operation of the test samples, algae blooms were observed on the water surface of the sample and on the wall of the sample) i.e., the inner wall of pipe), which gives evidence of the presence of nutrients in the wastewater head above submerged soil bed.

It is observed from analysis the high difference between NO2 concentration value with time and either NO3 concentration value with time, this is depending on the cycle of operating model, that depends on operating the model with raw wastewater to get the effluent then draining the residual wastewater to allow the used soil to be dried and ventilated. This operation cycle effects the biodegradation cycle, biota growth and decay and oxidization of nitrite to nitrate, so that nitrite and nitrate value is facultative. Soil carries negative charges. Wastewater in the soil dissolves nutrients and other chemicals. Nutrients that have positive charges. They are attracted to the negatively charged organic and mineral matter, and this prevents them from being lost through leaching. Nitrate and nitrite have a negative charge so it is not protected from leaching in most soils.

For medium sand soil, it decreases phosphorus components from effluent wastewater and either for silty sand soil but for silty sand sample with a ratio (2/3), phosphorus concentration increases in February and March as a result of erosion of remain phosphorus – bearing rocks in soil. In general, soil decreases phosphorus components from effluent wastewater by two major processes are adsorption and ion exchange. Phosphorus components are desorbed from the soil by bacteria and organisms, which is consumed in the process of metabolism.

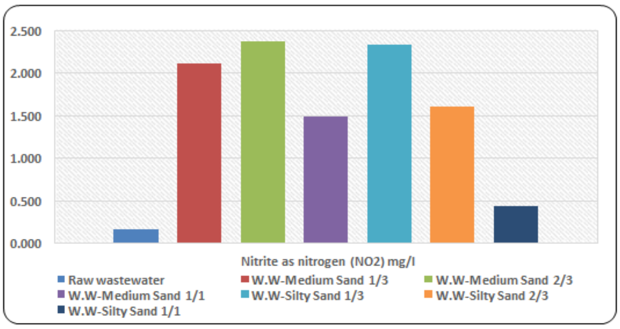

Figure 13: The effect of soil on the NO2 value

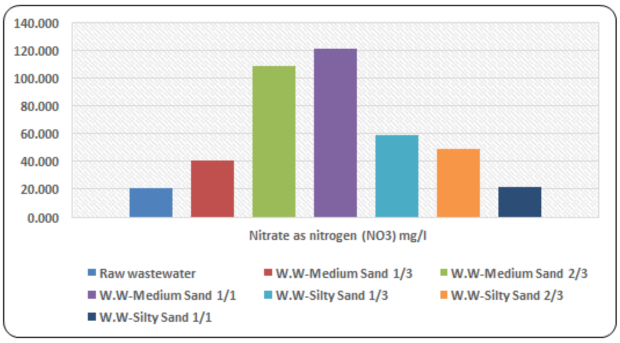

Figure 14: The effect of soil on the NO3 value

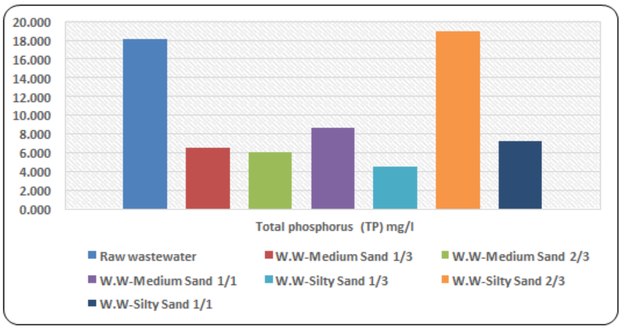

Figure 15: The effect of soil on the phosphorus value of waste water

9. Total Coliform Count Colony and Fecal Colony

The routine isolation of pathogens cannot be performed because they are existed in relatively small numbers compared with other types of micro-organism; also each type of pathogen requires a unique microbiological isolation technique. The analyses are performed for the presence of the indicator organisms that inhabit the gut in large numbers and are excreted in human faeces, their presence in water is evidence of fecal contamination and, therefore, of a risk that pathogens are present. If they are present in large numbers, the contamination is considered to be recent severe. Bacteria in water are, in general, not present individually, but as clumps or in association with particulate matter.

The term total coliforms refers to a large group of Gram-negative, rod-shaped bacteria that share several characteristics. The group includes thermotolerant coliforms and bacteria of faecal origin, as well as some bacteria that may be isolated from environmental sources. Thus, the presence of total coliforms may indicate faecal contamination. The term fecal coliform has been used in water microbiology to denote coliform organisms which grow at 44 or 44.5 C and ferment lactose to produce acid and gas.

Figure 16 shows that average total Coliform count colony in raw wastewater was recorded to be 32540*10^4colony /100ml. The average removal percentage for medium sand and silty sand units with ratios (1/3), (2/3) and (1/1) were calculated to be 91.25%, 99.11%, 96.90% and 99.86%, 98.54%, and 99.18%.

Figure 17 shows that average fecal colony count in raw wastewater was recorded to be 4386.67 *10^4colony/100ml. The average removal percentage for medium sand and silty sand units with ratios (1/3), (2/3) and (1/1) were calculated to be 99.0%, 99.9%, 98.37% and 99.84%, 99.49%, and 99.46%.

Both of figures, showed that soil has a great ability to remove pathogenic bacteria and organisms (total coliform and fecal coliform organisms). Silty sand soil has a higher efficiency in removing this type of organisms than medium sand soil.

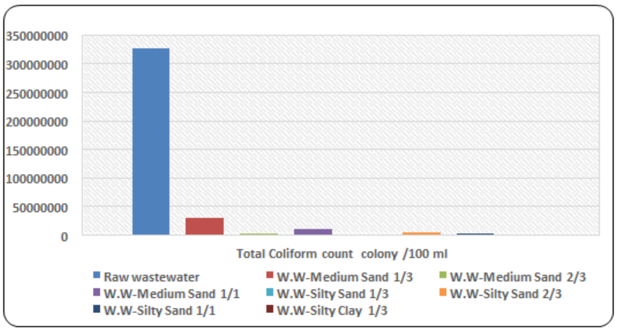

Figure 16: The effect of soil on average total Coliform count of waste water

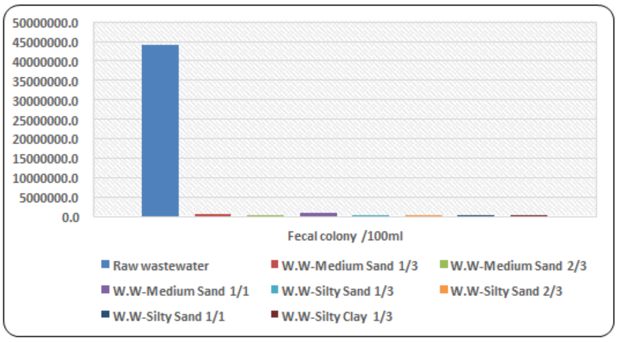

Figure 17: The effect of soil on average fecal colony count of waste water

Conclusions

The following conclusion can be deduced from the pervious research

- The use of the soil especially medium sand as a filter in primary treatment process after primary sedimentation tank in wastewater treatment plants for increasing efficiency and reducing organic load for biological treatment process.
- Using the effluent wastewater from soil filtration to increase nutrient concentration for irrigation.
- Weather affects soil temperature that affects contact on wastewater effluent.
- Soil neutralize acidity and increase the alkalinity for effluent wastewater.
- Dissolved oxygen value was increased – depends on operating system.
- Medium sand, and Silty sand soil reduce or remove hydrogen sulfide fromwastewater effluent.
- Biochemical oxygen demand value was decreased by used soil.
- Chemical oxygen demand was decreased by time - depends on organic andinorganic matter concentration in used soil.
- Total suspended solids were decreased - depends on solids concentration in usedsoil-.
- The soil increases total dissolved solids value that decreases gradually by time.
- Nitrite and nitrate components were increased.
- Total phosphorus components were decreased.
- Total coliform count colony and fecal count colony values were decreased.

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