Static study of activated sludge treatment plant and its ideal adjustment

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Abstract: This paper evaluates the effluent quality and performance efficiency of activated sludge system at Edko wastewater treatment in Egypt. Grab samples were collected at the influent and effluent of the plant, and analyses for Biochemical Oxygen Demand (BOD_5), Total Suspended Solids (TSS) and Chemical Oxygen Demand (COD) using standard methods. Influent wastewater was of low strength while the effluent wastewater had average BOD_5, COD, TSS and SVI concentration of 14 mg/L, 79 mg/L, 30 mg/L respectively. All effluent Concentrations of BOD_5, COD and TSS were in limit standards of WHO and EG code. and ideal conditions for operation are MLss is 1350 mg/L, Do in aeration tank 1.8 mg/L and SV_{30} 380cm^3.
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Key words: Biochemical Oxygen (BOD5), Total Suspended Solids (TSS), Chemical Oxygen Demand (COD), sludge volume Index (SVI), Egyptian Code (EG Code)

1. Introduction:

One of the most common forms of pollution control is a wastewater curing. The country has a large in particular of combination sewers and pumping stations, as well as handling plants (Environmental Protection, 1998).

Most plants treated were constructing to immaculate wastewater for emptying into streams or for reuse. Small organisms and bacteria in the water used the sewage and other organic matter, rotational it into novel bacterial cells; carbon dioxide and other products (Environmental Protection,1998).

Sewage is water collected from homes, industrial establishments and may be rain water (Raynolds, T., & Richards, P. 1996)., and collected to a treatment plant for processing (Malawi Government,2008). With increasing world population, the quantity of wastewater generated will increase (Sun, Y., 2016, Chen, Z., 2016 Wu, G., Wu, Qi., Zhang, F., Niu, Z., & Hu, H. (2016), therefor more stringent regulations will be placed on waste management practices (Tyagi, VK.,2013 & Lo, SL.,2013).

So wastewater treatment systems should be designed and operated by the method allow effluent water reuses and another aim protecting the environment and public health (Pongrácz, E.,2004 & Pohjola, J.,2004).

Failing which, there will be profound effects on the existence of life (Sverdrup, HU.,2011 & Ragnarsdottir, KV.,2011).

The treating of wastewater by hanging biological evaluation treatment is familiar as the operative sludge operation. In the operative sludge operation, microorganisms are blended with organic matter in the wastewater therefore that the bacteria and fungus grow by utilizing the organics as food. As the microorganisms grow and are blended by the excitation of the air, the personal organisms collected together (flocculate) to form an active mass of microbes called "activated sludge".

Sludge's a minute portion of matter produced in wastewater by the growth of organisms in aeration tanks. The activated belong the truth that the minute portion of matter swarming with bacteria, fungi, and protozoa. sludge's particles of activated sludge have within much alive organisms that can feed on the incoming wastewater various from primary sludge in that. Moreover the activated sludge is added to wastewater and the mixture is aerated and agitated after that a certain quantity of time, the activated sludge is opportunity for to reach an agreement about by precipitation and is disposed of (wasted) or use again (returned to the aeration tank (pipeline journal, 2003). The wastewater continuous stream until the aeration containers where air is vaccinated to blend the operative sludge with the wastewater combine to create "mixed liquor suspended soild" and to equipping the oxygen which the bacteria and fungi is become mechanical failure the organics by it. The mixed liquor in the aeration tank flows to the final clarifiers where the activated sludge is settled out. Generally of the settled sludge is returned to the aeration tank to preserve a high of a particular of microbes to statement happening in a short time breakdown of the organic material. Activated sludge named (active biological material) produced by activated sludge plants. This sewage sludge is settling tank and back to aeration tank (Metcalf & Eddy, Inc.,2003; McGraw Hill, 2003).

The systems of wastewater treatment should be designed and operated in a way that they discharge effluent that would meet reuse criteria. To encourage meeting these criteria, wastewater management regulations should shift from the current focus of protecting the environment and public health to resource recovery (Pongrácz, E., 2004; Pohjola, J.,2004). If can not do that, there will be problem effects on the life (Sverdrup, HU.,2011 & Ragnarsdottir,. KV,2011).

Definition of activated sludge process is biological wastewater treatment processes which make rapidity up analysis of waste. (Pipeline journal, 2003) Normally, saline wastewaters that are obtained from different industrial activities such as leather factory, marine products, drugs, and industries related to the extraction of crude oil and gas refining, are rich in organic compounds and have at least 1 to 3.5 g of TDS (Shahata A,2016; Urase T,2016; Rovirosa N, Sanchez E, Cruz M, Veiga MC, Borja R,2004).

2. Methodology

The experimental work of this study was performed in Edko –Beheria –Egypt, which Edko sewage treatment plant is using activated sludge for wastewater treatment. The plant has a potential capacity is 20000m^3/day, with 2 aeration tanks and two finial settling tanks. All tanks had similar operation conditions. The experimental work was conducted in the period from 07/05/2018 to 07/08/2018.

According to references on this study like basic principles available in Edko sewage directorate, 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- Temp.
6- MLss.

7-SVI

2.2 Sample collection and data analysis

Four sampling stations were identified at the inlet and outlet of the aerobic tank, primary settling and finial settling. One grab sample was collected in 1 liter sample bottle at each of the locations. Sample bottles were thoroughly cleaned with distilled water and rinsed with a portion of the sample before use. The samples were collected over a three months period (May to June 2018).

The samples collected were analyzed for BOD5, TSS, COD, Mlss, PH, Temp. and SVI using standard methods (APHA,1995).

All the parameters were measured from the same sample collected at each sampling location. Samples were analyses for Biochemical Oxygen Demand (BOD_5), Chemical Oxygen Demand (COD) and Total Suspended Solids (TSS). Biochemical Oxygen Demand (BOD_5) was measured using the Winkler method in which the dissolved oxygen in the sample was determined before and after incubating in the dark for five days at 20ºC, Chemical Oxygen Demand was measured using the reactor digestion method. The COD was a measure of the oxygen consumed by organic matter when it was digested with boiling acid potassium dichromate ($K_2Cr_2O_7$) solution. The sample was heated at 150ºC in a sealed tube with excess potassium dichromate and silver sulfate catalyst in strong sulfuric acid where Total Suspended Solids were determined by filtering the sample through a weighed glass fiber filter paper and determining the increase in weight of the paper. all this experimental done according to (APHA,1995).

A questionnaire was used to collect data from key informants on routine operation & maintenance carried out at the treatment works. MS Excel and Statistical Analysis Software (SAS) were used to perform statistical analysis of the data. The final effluent quality was compared with World Health Organization guidelines and EC (Egyptian Code) standards for municipal/industrial wastewater effluent quality and Sludge volume index calculation:

$$\text{SVI (mL/g)} = \frac{\text{Settled Sludge Volume (mL/L)}}{\text{Mixed Liquor Suspended Solids (g/L)}} \times 1{,}000$$

3. Result and Discussion

3.1 Influent and effluent (After Treatment) wastewater quality characteristics

The wastewater treatment using plants and these plants was contained big pieces of wood, rags, plastics and other debris. Meanwhile, the small pieces as sand, eggshells and other coarse inorganic material is sitting in the flow in supplement to organic matter from household, commercial and institutional water use.

In table 1 show the influent wastewater characteristics after sand removal effluent and aeration tank at Edko wastewater treatment plant. Values are means (±standard deviation) in summer season (three month) study period for BOD, COD, TSS, DO, PH, MLss, TSS, SVI and TDS. all result in influent assumed that the moderate contaminated inter to plant and the plant work with high efficiency and the result under WHO and Egyptian code limit.

Table (2) The averages and median, the upper result (UR) and lower result (LR) of the data were also computed to better reflect the distribution of the data and eliminate the impact of noise and outliers presents

the concentration of COD, BOD_5, TSS, temp., DS, DO and PH influent of Edko.

Temperature, pH, inoculums size, and salinity and incubation time, physical parameters were conducted by study 2011 which optimize PH for the production of a salt tolerant enzyme secreted by a salt *tolerant Pseudomonas Aeruginosa strain* isolated from a type of saline wastewater (Sivaprakasam S, 2011; Dhandapani B, 2011 and Mahadevan S.2011).

Table 1: Characteristics of the influent, aeration tank and effluent wastewater at Edko WWTP.

Place/ Parameter	Temp.	PH	COD (mg/L)	DO (mg/L)	BOD (mg/L)	TSS (mg/L)	Mlss (mg/L)	SVI
Influent	**35±10**	**7±0.6**	**450±50**	**0.4±0.2**	**180±30**	**200±40**	---------	------
Aeration tank	-------	-------	---------	**±0.41.5**	----------	---------	**1300±100**	**95±5**
Effluent	**27±5**	**6.4±0.2**	**40±10**	**4±2**	**20±6**	**25±5**	----------	------

Table (2): Wastewater influent quality characteristics at Edko WWTP (mg/L).

Parameter	COD (mg/l)	BOD (mg/l)	TSS (mg/l)	Temp.C^0	PH	TDS	DO (mg/l)
UR	**642**	**377**	**420**	**37**	**7.5**	**2211**	**0.6**
LR	**215**	**117**	**130**	**23**	**7.1**	**691**	**0.4**
Average	**380**	**219.8**	**225.5**	**30.2**	**7.4**	**873**	**1.1**
SD	**80.78**	**58.5**	**59.5**	**4.5**	**4.5**	**344.6**	**0.5**
Median	**380**	**220**	**210**	**29**	**7.4**	**819**	**0.6**
N	**88**	**88**	**88**	**88**	**88**	**88**	**88**

EC=Egyptian code of Standards, value represents maximum permissible discharge limit into inland water; WHO=World Health Organization, guideline value, N= number of grab samples

Where from the PH result UR 7.5, LR 7.1 and Temp result UR 37 and LR 23, all of them considered moderate contamination, where the COD and BOD are achieves the domestic wastewater equation (COD =(1.7-2) BOD that UR of COD and BOD 642,377 mg/l at applicate the equation COD will be 640mg/l.

The average result of COD and BOD in influent of plant were 450 ±50 and 180±30 mg/l respectively was moderate contaminate in wastewater level, where the average result in effluent were40±10 and 20±6 mg/l indication the plant work with high efficiency and the result under WHO and Egyptian code limit.

Table (3) presents the concentration of COD, BOD5, TSS, PH and SVI compared against WHO and Egypt standards. In addition to averages and median, the upper result (UR) and lower result (LR) of the data were also computed to better reflect the distribution of the data and eliminate the impact of noise and outliers.

Table (3): Wastewater effluent quality characteristics at Edko WWTP (mg/L).

Parameter	COD (mg/l)	BOD (mg/l)	TSS (mg/l)	Temp. (C^0)	PH	DO (mg/l)	TDS
UR	59	34	45	31	7.5	6	871
LR	30	12	27	27	7.1	3	611
Average	88.98	89.77	84	30.2	7.4	4.2	735.2
SD	6.02	4.33	4.38	3.38	0.048	3.4	69.6
Median	66	40	50	29	7.3	4.2	
N	88	88	88	88	88	88	88
EC	80	60	50	35	8.2	4	…….
WHO	60	20	30	35	8.2	4.6	……..

UR=upper result, representing 75%; LR=lower result, representing 25%; N=number of sample; CV=coefficient of variation, EC=Egyptian code of Standards, value represents maximum permissible discharge limit into inland water; WHO=World Health Organization, guideline value.

This kind of biological treatment are many characteristics of utiliz as easy to operate, low energy wanted, not so much equipment maintenance, and the best sludge thickening. Meanwhile, also the effluent quality from fixed- film system are comparatively poorer than suspended growth systems in period of biochemical oxygen demand (BOD) and suspended solid (SS) (Pena, M. V,2004. and Mara, D., 2004; Metcalf & Eddy, 2003).

Where UR and LR result of effluent BOD was 34 and 12 mg/l, the concentration of COD, TSS and BOD

of 75% (upper quartile) of the data was in the permissible discharge limit (Chipofya, V. H.,2010).

Activated sludge consists of a mixed community of microorganisms, approximately 95 percent bacteria and 5 percent higher organisms (protozoa, rotifers, and higher forms of invertebrates) where The Mlss upper result 1891, low result 950 and average is 1323 mg/l. when the result of DO in aeration tank was high where average was 2.64 mg/l it is un useful and electrical waste.

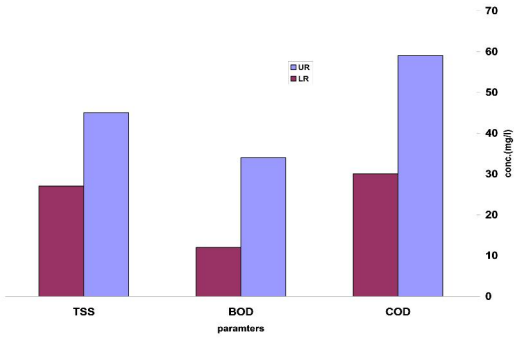

Fig. (1): show Tss, BOD and COD in effluent of WWTP

Table (4): Wastewater aeration quality characteristics at Edko WWTP (mg/L)

Parameter	MLSS (mg/l)	DO (mg/l)	SVI
UR	1891	3.6	128
LR	950	1	50
Average	1323	2.64	100.7
SD	315	0.62	78.6
Median	1200	3	87
N	88	88	88
EC	1500	2	75-85

The sludge samples are mixed and stairs for lengths differ of period time, after that take time to precipitate. The nature and precipitate characteristics of the mass are noted, adding to the pureness of the supernatant. Chemical analysis appears sludge situations and can cautions of close process problems. The action with the plant's National Pollutant Discharge Elimination System (NPDES) statement neded specific chemical analyses such as heavy metals and pathology (Abdou S. El-Tabl, 2016; Mohammed A. Wahba,2016 and Sara M. Yonues,2016).

Air may be supplied by mechanical or diffused aeration. Mixing is by aeration or mechanical means highly treated effluent with low solids production (**Pipeline journal, 2003**).

Where found DO in aeration tank was upper result was 3.6, lower result 1 mg/l and standard deviation was 0.62.

When SVI = 100 to 200 mL/g the greatest operation sludge plants shown to produce a pure, the degree of excellence of quality streaming with an SVI in this zone. The sludge typically settles extra not quickly and prevents many the form of minute separate particles case as it shapes a regular covering all cases before resolution.

Microscopic investigation of this MLSS would showed that regularly formed floc a minute portion of matter with free filaments collect a backbone for floc-forming microorganism to join and colonize.

In the settle ability experiment, the sludge top shapes a covering all cases and appears to cause to form into moderate clumps together before beginning to settle. This generally occurs in the first five minutes of the experience. As the a minute portion of matter bring with each other, they form greater a minute portion of matter that have a particular gravity greater than water. As the sludge settles, you could be noticed that channels meanwhile the sludge that are shaped by the liquid by compressed out of the sludge as it compacts. Where SVI upper limit 128 and average 100.7.

3.2 Operation and Maintenance Works at Edko Wastewater Treatment Works:

The Operation and Maintenance manual for the treatment works highlights several activities that must be undertaken in order to keep the treatment works functioning properly. Routine maintenance requirements and responsibilities for management of activated sludge must be clearly defined. Regular monitoring of the activated sludge for effluent quality is required in order to optimize the operational capacity (Jan, et al., (2013). At Edko WWTP, there are certain operation and maintenance works which were carried out at all. The frequency of the activities carried out varied with respect to the recommendations of the manual. Certain activities were carried out more frequently than required so the treatment process done standard and Ideal adjustment condition for operation, influent average of COD, BOD and TSS are 380,219.8 and 25.5mg/l. in the aeration tank average Mlss and DO are 1350 and 1.8 mg/l.

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