Environmental Assessment of Wastewater Treatment Plants (WWIPs) for Old Rustamiya Project

Eman S. Awad, Abdul Hameed M.J. Al Obaidy, Hanaa R. Al Mendilawi

Abstract— **Influent and effluent wastewater samples were collected during January 2011 to December 2013 from Old Rustamiya Project, Baghdad. The present study focuses on the levels of biological pollution in order to assess the effluent (treated) wastewater produced from Rustamiya WWTP for stage0 and stage1 and to evaluate its suitability for discharged into river.**

Parameters measured were pH, Total Suspended Solid (TSS) and biological parameters COD and BOD5. The results concluded that the removal of BOD is highest throughout the year as the efficiency of WWTPs range between 91.21 and 92.95 in the whole period of study. The results also showed that about 88.71% and 87.47% COD removal can be achieved in stage0 and stage1, respectively, and the values of TSS and pH for the final effluent produced from Al-Rustamiya WWTP meet the values determined by the Iraqi National Standards set by Regulation 25 of 1967.

Index Terms— **BOD, COD, Efficiency, Rustamiya, WWTP.**

I. INTRODUCTION

The problem of getting rid of wastewater is one of the main problems facing the world in the time being. That is due to bad effects of wastewater on human and environment when discharged into rivers [1]. The amount of collected and treated wastewater is likely to increase considerably with population growth, rapid urbanization, and improvement of sanitation service coverage [2]-[5]. Wastewater originates from domestic, commercial, and industrial sources. In many networks the domestic component is the largest. The defining variable is domestic water consumption, which is linked to human behavior and habits. Very little water that is used by households is actually consumed, but rather is degraded in quality and then discharged as wastewater [6]-[8].

The sewerage network that was established between 1960 and 1980 worked on the basis of the separate system, but a combined system has been adopted since 1980. In general, the quantity of wastewater generated within the urban and rural areas of the mayoralty of Baghdad are estimated at 1,426,013 and 2,354 cubic meters per day respectively. However, the capacity of all wastewater treatment plants in the mayoralty of Baghdad was estimated at 789, 200 cubic meters per day, in which it represents as 55% of the total capacity of wastewater. The secondary treated wastewater effluent for Iraqi (WWTP) was designed to produce an average of final effluent quality of biological oxygen demand (BOD) and total suspended solids (TSS) as 20 and 30 mg/L, respectively to meet the Iraqi National Standards set by the Regulation 25 of 1967. It reported that each day 500,000 cubic meters of raw sewage are discharged into Iraqi waterways [9]. Therefore, the objective of this research was focuses on the levels of biological pollution in order to assess the effluent (treated) wastewater produced from Rustamiya WWTP for stage0 and stage1 and to evaluate its suitability for throwing into river.

II. MATERIAL AND METHODS

A. Study Area

The Iraqi capital, Baghdad, has the highest level of sanitation provision with about 80% of the population connected to sewer conveying sewage to treatment facilities.

Al-Rustamiya Project is the oldest sewerage network in Iraq which provision of services to a third of the population of Baghdad and distracts sewage into the Diyala River after treatment. The project is located on the banks of Diyala River south of the Baghdad city at Rustamiya area. The project serves areas of Baghdad which sited between Al-Jaish channel at the east and the Tigris River at the west, starting from the Adhamiya district in the north down to the Rustamiya area in the south, show in Fig. 1.

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Fig.1: Map of Old Rustamiya Project in Baghdad city

Basic stage was created, which call zero phase (Stage 0), at 1960 with design capacity (40,000 m3/day) and in 1974 was added the first expansion (Stage 1), which partly merge with the basic stage with design capacity (45,000 m3/day) and finally, was added second expansion (Stage 2) at 1981 with design capacity (90,000 m3/day) and thus became the total capacity of the project (175,000 m3/day).

B. Sampling and Analysis

Influent and treated wastewater samples from Old Rustamiya project were collected during January 2011 to December 2013. Influent wastewater samples were collected using clean polyethylene containers. Whereas treated wastewater samples were collected from the treatment plants for stage0 and stage1 just before discharged into river. Samples were analyzed immediately after collection for four parameters (Biological Oxygen Demand, Chemical Oxygen Demand, pH and Total Suspended Solid). Procedures followed for analysis have been in accordance with the Standard Method for Examination of Water and Wastewater [10]. Biological Oxygen Demand (BOD) was determined by the 5 Day BOD test whereas Chemical Oxygen Demand (COD) was determined in the laboratory by the standard Open Reflux Method. pH was directly measured in site using portable measuring device (HANNA instruments, HI 9811, Italy) and Total Suspended Solid (TSS) was determined by gravimetric method (dried at 103C$^{\circ}$).

III. Results and Discussion

Descriptive statistics of all measured parameters are presented in Table.1. An explanation of the observed characteristics follows in the following sections.

A. Biological Oxygen Demand (BOD)

Measurement of BOD has long been the basic means for determining the degree of water pollution. It is the most important measurement made in the operation of a sewage treatment plant. Biochemical Oxygen Demand (BOD) is the amount of oxygen that bacteria take from water when they oxidize organic matter by biochemical action of bacteria. Bacteria in water live and multiply when organic matter is available for food and oxygen is available for oxidation. To determine BOD, the amount of oxygen the bacteria use is calculated by comparing the amount left at the end of five days with the amount known to be present at the beginning. At room temperature, the amount of oxygen dissolved in water is 8 mg/L. At freezing, it increases to 14.6 mg/L. During the five-day period of a BOD test, the bacteria oxidize mainly the soluble organic matter present in the water. Very little oxidation of the solid (insoluble) matter occurs in that short time [11], [12].

The influent wastewater BOD concentration and effluent (treated) wastewater BOD concentration for stage 0 and stage 1 are shown in Fig.2 for 2011 to 2013. The influent BOD concentration ranges from 80 to 1940 mg/l whereas the effluent BOD concentration ranges from 3 to 240 mg/l and 5 to 170 mg/l for stage0 and stage1, respectively. Efficiency (E %) of the Wastewater Treatment Plants (WWTP) was calculated by the BOD of influent wastewater (WW) and the BOD of the effluent wastewater leaving the plant by using (1) [13] :

$$E\% = \frac{\text{BOD conc .of influent WW} - \text{BOD conc .of effluent WW}}{\text{BOD conc .of influent WW}} \text{ x100} \qquad (1)$$

Table 2 represents the efficiency of the wastewater treatment plant situated at Rustamiya, Baghdad City. From Table 2 it has been concluded that the removal of BOD is highest throughout the year as the efficiency of WWTPs range between 91.21 and 92.95 in the whole period of study.

Table 2: Efficiency of the wastewater treatment plants (WWTP)

WWTPs	Efficiency%		
	2011	2012	2013
TWW stage0	91.21	92.24	92.95
TWW stage1	92.08	91.54	92.72

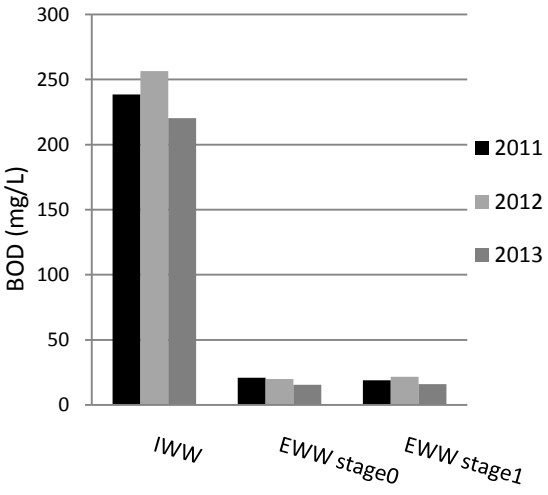

Fig. 2: Influent and effluent wastewater BOD concentration for stage0 and stage1.

Table 1: Statistical Summary of the analytical data

a. Influent Wastewater (IWW)

Characteristics	Minimum	Maximum	Mean	Standard deviation	Minimum	Maximum	Mean	Standard deviation	Minimum	Maximum	Mean	Standard deviation
	2011				2012				2013			
BOD (mg/L)	80	640	238.54	74.35	130	1940	256.47	132.8	80	800	220.27	71.15
COD (mg/L)	200	665	357.35	94.08	107	583	340.36	112.01	210	861	401.79	137.47
TSS (mg/L)	101	811	257.36	111.99	93	909	258.33	119.45	75	1860	233.08	158.57
pH (Standard unit)	6.48	7.86	7.18	0.16	3.79	8.96	7.11	0.44	7	7.61	7.24	0.09

b. Effluent Wastewater (EWW) for stage 0

Characteristics	Minimum	Maximum	Mean	Standard deviation	Minimum	Maximum	Mean	Standard deviation	Minimum	Maximum	Mean	Standard deviation
	2011				2012				2013			
BOD (mg/L)	3.00	240.00	20.97	21.89	5.00	160.00	19.91	12.99	4.00	49.00	15.53	6.36
COD (mg/L)	14.00	98.00	40.77	16.92	10.00	96.00	43.80	21.84	11.00	85.00	36.86	16.51
TSS (mg/L)	2.00	68.00	28.16	13.11	10.00	63.00	32.58	11.98	5.00	51.00	23.94	9.20
pH (Standard unit)	6.73	7.94	7.35	0.16	7.02	7.78	7.48	0.13	7.11	7.73	7.45	0.12

c. Effluent Wastewater (EWW) for stage 1

Characteristics	Minimum	Maximum	Mean	Standard deviation	Minimum	Maximum	Mean	Standard deviation	Minimum	Maximum	Mean	Standard deviation
	2011				2012				2013			
BOD (mg/L)	7.00	170.00	17.67	11.81	6.00	140.00	21.69	12.51	5.00	41.00	16.03	7.23
COD (mg/L)	12.00	102.00	40.51	17.64	21.00	218.00	49.55	31.24	15.00	89.00	42.29	20.21
TSS (mg/L)	5.00	63.00	28.58	11.90	9.00	64.00	32.19	12.15	4.00	55.00	24.97	10.77
pH (Standard unit)	7.03	7.75	7.36	0.14	6.90	7.73	7.48	0.12	7.10	7.81	7.45	0.11

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B. Chemical Oxygen Demand (COD)

The chemical oxygen demand (COD) test is used to measure the total organic content of industrial wastes and municipal and natural wastewaters. During the determination of COD, organic matter is converted to carbon dioxide and water using a strong chemical oxidizing agent (dichromate) in the presence of a catalyst and strong acid. In the COD test, organic materials are oxidized regardless of the biological assimilability of the substances. As a result, COD values are greater than BOD values and may be much greater when significant amounts of biologically resistant organic matter are present [14].

The COD test did not observed different values between three years as shown in Fig. 3. The highest value of 861 mg/L was reported at 2013 for influent, 116 mg/l and 289 mg/l for effluent wastewater stage0 at 2012 and stage1 at 2011, respectively, whereas, the lowest value of 107 mg/L was observed at 2012 for influent, 10 mg/l and 12 mg/l for effluent wastewater stage0 at 2012 and stage1 at 2011, respectively. It is clear that about 88.71% and 87.47% COD removal can be achieved in stage0 and stage1, respectively.

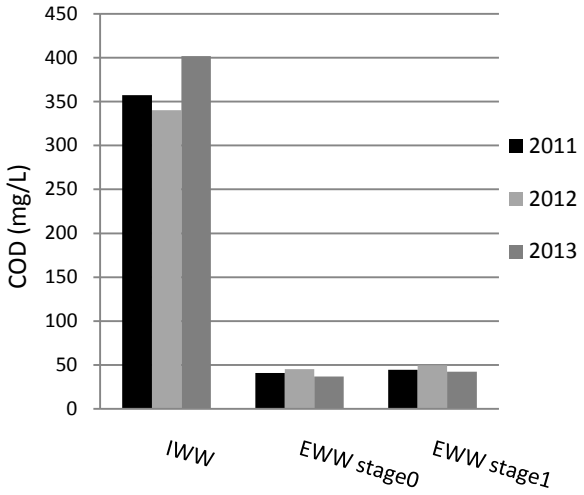

Fig. 3: Influent and effluent wastewater COD concentration for stage0 and stage1.

C. Total Suspended Solid (TSS)

The Total Suspended Solid (TSS) values of three years show approximately the same values as shown in Fig.4 for influent wastewater TSS and effluent wastewater TSS for stage0 and stage1. The influent TSS ranges from (75-1860) mg/l whereas the effluent TSS ranges from (2-68) mg/l and (4-64) mg/l for stage0 and stage1, respectively. The values of TSS for the final effluent produced from Al-Rustamiya WWTP meet the range values of 60 determined by the Iraqi National Standards set by Regulation 25 of 1967.

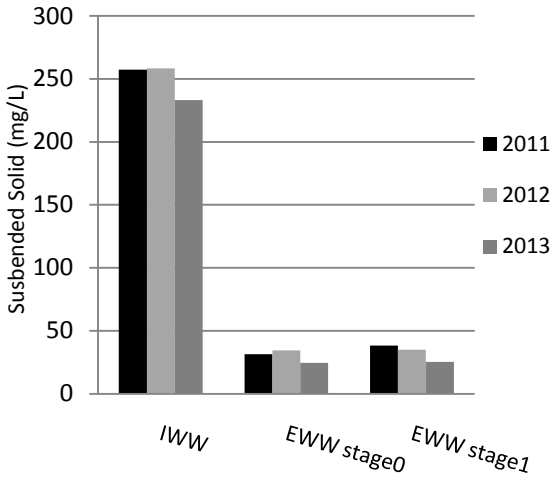

Fig. 4: Influent and effluent wastewater TSS for stage0 and stage1.

D. Hydrogen Ion Activity (pH)

The pH values did not show different values between three years for influent wastewater pH value and effluent wastewater pH value for stage0 and stage1. The influent pH value ranges from (3.79-8.96) whereas the effluent pH value ranges from (6.73-7.49) and (6.90-7.81) for stage0 and stage1, respectively. The values of pH for the final effluent produced from Al-Rustamiya WWTP meet the range values of 6.5-8.5 determined by the Iraqi National Standards set by Regulation 25 of 1967.

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