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Evaluation industrial and domestic wastewater treatment plant of Diala's state company of electrical industries, Iraq

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Abstract

This study is conducted to evaluate the efficiency of plant treatment of the industrial and household wastewater of the Diala state company of Electrical Industries. Sampling was taken monthly for before and after-processing treatment during the period from November, 2014 to March, 2015. Some physicochemical factors were taken, such as temperature, pH, dissolved oxygen, Biological oxygen demand (BOD5), chemical oxygen demand (COD), electrical conductivity, and salinity. In addition, the concentration of five heavy metals lead (Pb), cadmium (Cd), iron (Fe), Copper (Cu) and Zinc (Zn) was determined. Temperature of wastewater in treatment plant showed only a significant difference between temperature before and after treatment in December, 2014. PH was not significant in all study periods before and after the treatment process.

Dissolved oxygen concentration was raised after the treatment process during all the study periods, except in February2015. Biochemical oxygen demand (BOD5) and Chemical Oxygen demand (COD) concentrations were decreased after treatment. Electrical conductivity (EC) and salinity (S‰) values were decreased only in December 2104 and February 2015. All heavy metals concentrations were not affected scientifically by the treatment. The results revealed that the treatment plant was not efficient to remove the heavy metals from the industrial and household wastewater of the factory.

Keywords; Electrical Industry, Evalution, environmental parameters, Heavy metals, Diayala Factory.

Introduction

Industrial race in the world led to the degradation of different environmental ecosystems, these activities were destroyed the environmental imbalance through the pollution risks [1]. It is important to pick up all pollutants through treatment processes and converted these pollutants to a harmless form as an aspects of water pollution treatment [2]. Some pollutants can't biodegradable and enter into the food chain, hence its important to treat these pollutants [3]. The electrical industry is one of the factors besides other factories of textile, batteries, metals, dyeing and chemicals that used water in their industries process, whereas, their wastewater enters the environment [4, 5].

The industrial wastewater possesses different types of pollutant, these pollutants are bio-degradable and non-degradable. The degradable pollutants such as: domestic wastewater, plant waste, and other residue, etc. While the non- degradable posses pesticides, mercury, a heavy metal etc. [6]. Heavy metals were the most pollutants which they have affected the growth of the different aquatic organisms and accumulated in their muscles and tissues that reduces the activities of many metabolites and led to death [7,8, 9, 10, 11]. Whereas, some of these metals were considered as micronutrient and it's important for organisms [1].

The discharge of Al-farat company, Iraq contain heavy metals concentrations higher than the permissible limits of the industrial wastewater discharge[13]. Also, they recorded change in the environmental parameters of Al-Ejame puncture that the discharge of factory wastewater release into it. The distribution of heavy metals in water, sediment and in fish in the Euphrates River and they obtained that the particulate phase of heavy metals was higher than in the dissolved phase[14]. The evaluation of industrial wastewater of the north refinery company/ Baji, Iraq, they mentioned that the industrial wastewater was led to increase the physical properties of soil[15].

Less attention to the effect of the Diyala's Factory of Electrical industries was noticed in spite of their effect on the environment. This study aimed to evaluate the efficiency of the treatment plant of Diala's state company.

Materials and Methods

The Diala's Factory of Electrical industries is located in Diyala province, east of Iraq. This company is industrial complex hat contains different factories as follows: electric meters, electric iron, steam, spark plug and ceiling fan.
Sampling was taken monthly from before and after-processing treatment from November, 2014 to March, 2015 by polyethylene bottles. Temperature and pH were measured in the field by pH- meter model Walk lab (Malaysia). Electric conductivity was measured by EC-meter (Germany). Salinity was calculated by the following question [16]:

$$\text{ppt} = \frac{14.78 - \text{EC}}{15890.45_{\text{M}}.08}$$

Dissolved oxygen, biological oxygen demand and chemical oxygen demand were determined by using DO-meter (Germany), Oxi Top (Germany) and COD- meter (Germany), respectively.

Heavy metals were determined by collecting samples before and after treatment, then filtered through filter paper (0.45ᴍm) and added for each a few drops of concentrated HNO_3 [17]. These samples were refrigerated until using atomic absorption flame spectrophotometer (Shimazdau/ Japan) to determine heavy metals.

Statistical Analysis

The Statistical Analysis System (SAS) was used to test the effect of before and after the treatment unit on the studied parameters and Least significant difference (LSD) was used to compare the significant difference between means at $p<0.05$.

Results and Discussion

To evaluate the efficiency of the treatment plant of the Diala state company sampling for physicochemical parameters and heavy metals was taken from the plant before and after.

The results showed a significant difference between the temperature of wastewater before and after the treatment plant in December, 2014, its values were ranged between 17.7°C in February 2015 to 29.1°C in December 2104 before the treatment, and 16.6°C to 26.01°C in February 2015 and November 2014, after treatment (Figure 1and Tale 1).

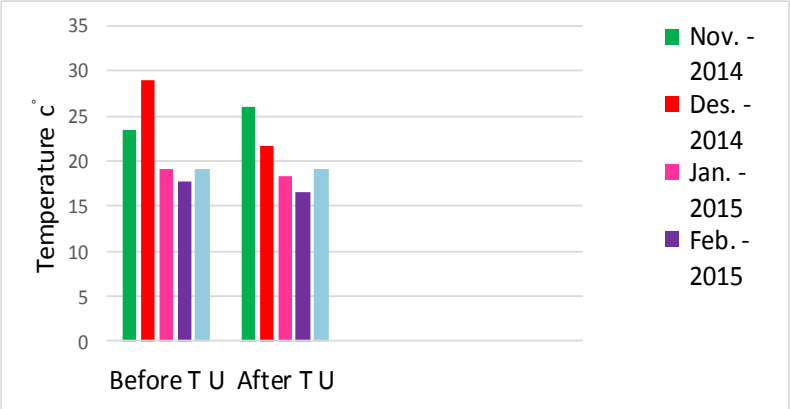

Fig.1: Mean values of Temperature before and after treatment Unit (TU) during the study period.

Table 1. Mean and LSD of All physiochemical parameters (mg/l) and heavy metals (mg/l) in treatment unit (Before and after).

		Temp.°C	pH	DO	BOD	COD	EC	S‰	Pb	Cd	Fe	Cu	Zn
Nov.2014	Before	23.40	6.94	5.17	6.30	144.00	1159.00	0.72	0.09	0.47	0.29	0.07	0.18
	After	26.01	7.33	7.85	11.09	59.00	1218.00	0.75	0.08	0.41	0.46	0.07	0.37
	LSD	3.28 NS	0.882 NS	1.07 *	2.64 *	19.84 *	94.32 NS	0.217NS	0.022NS	0.091 NS	0.077*	0.00NS	0.105*
Dec. 2014	Before	29.10	6.80	3.24	39.95	136.00	1547.00	0.96	0.53	0.99	0.45	0.16	0.25
	After	21.60	7.01	7.89	0.77	50.00	931.00	0.58	0.14	0.35	0.54	0.16	0.16
	LSD	5.03	0.556 NS	2.094*	6.596*	24.84*	198.52*	0.207 *	0.119 *	0.285 *	0.155 NS	0.00 NS	0.123NS
Jan. 2015	Before	19.20	7.23	5.17	36.66	121.00	209.00	0.12	0.01	0.26	0.16	0.70	0.23
	After	18.40	7.55	7.85	0.66	24.00	448.00	0.27	0.06	0.27	0.25	0.70	0.10
	LSD	3.41NS	0.602NS	1.33*	6.791*	19.592*	94.31*	0.113NS	0.041*	0.088NS	0.102NS	0.00NS	0.104*
Feb. 2015	Before	17.70	7.40	5.50	32.00	109.00	660.00	0.40	0.17	0.31	0.42	0.12	0.19
	After	16.60	7.40	3.95	0.70	13.00	588.00	0.34	0.45	0.30	0.48	0.10	0.10
	LSD	2.873NS	0.443NS	1.66NS	7.84*	22.45*	49.756*	0.114NS	0.184*	0.109NS	0.112NS	0.05NS	0.073*
Mar. 2015	Before	19.20	7.40	2.82	3.50	118.00	650.00	0.39	0.10	0.26	0.68	0.09	0.18
	After	19.20	7.80	4.86	0.00	15.00	795.00	0.40	0.05	0.28	0.70	0.10	0.25
	LSD	2.56NS	0.574NS	1.093*	1.25*	25.76*	67.92*	0.113*	0.042NS	0.066NS	0.075NS	0.032NS	0.087NS

L.S.D.= Least significant difference, NS= not significant, *=(P<0.05)

The rise of temperature values were depended on the different types of disposing material which they produced from electric generation or from the factories used water for cooling, also, the unit leaved to expose to environmental change. While the low temperature value related to routing the wastewater that might be reduce the temperature. There were no significant differences of temperature values between before and after treatment except in December 2014 (LSD = 5.03, P<0.05). The results recorded high BOD with rising temperature due to their effect on microorganism [17, 18].

PH values were shown no significant difference before and after the treatment process in all study periods. Its values were ranged as follows: 6.8-7.4 (before) in December 2014 and March 015, respectively, and 7.01-7.8 (after) in December 2014 and March 2015, respectively. The pH value effects on treatment plant which it caused erosion of the treatment unit, moreover, its effects on bioremediation process in the treatment unit before and after treatment in the Creek Warri treatment plan [19].

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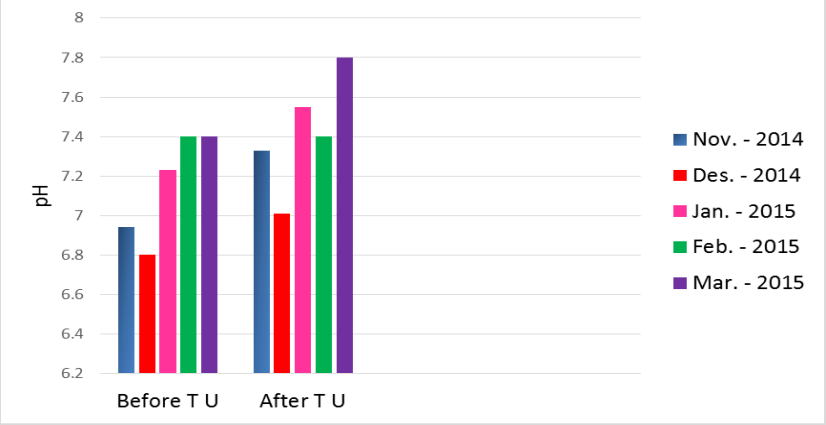

Fig. 2: Mean values of pH before and after treatment Unit (TU) during the study period.

Dissolved oxygen (DO) is an important factor in the treatment units due its effect on biodegradtion and other chemical reacts. DO is affected by other parameters such as temperature, salinity and pressure [20]. DO concentration was raised after the treatment process during all the study periods, except in February2015, the concentrations of dissolved oxygen were ranged from 2.8ppm to 5.5 ppm in March 2015 and Februray 2015 and 3.95–7.89ppm in February2015 and December 2014 before and after treatment process, respectively (Figure 3).

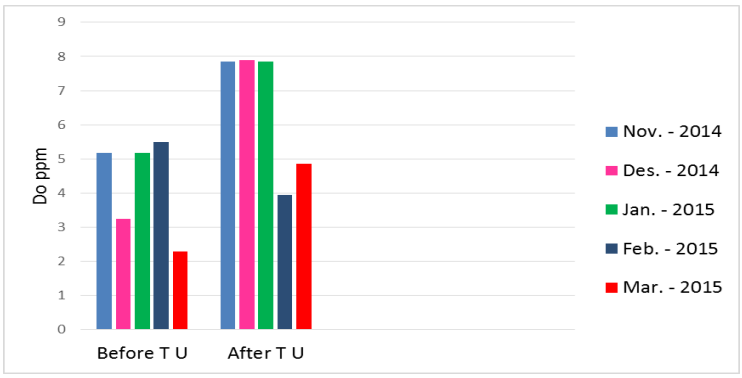

Fig. 3: Mean values of Dissolved Oxygen (DO) before and after treatment unit (TU) during the study period.

Results of DO concentrations showed an increase after the treatment that might be due to the circulation systems in the unit and exposed to outdoors. Only in Feburary 2015, its concentration, reduced after treatment due to the amount of organic materials added as activated sludge to increase the microbial activities that lead to consume DO [21].

Biochemical oxygen demand (BOD) and Chemical Oxygen demand (COD) concentrations were decreased after treatment (Figure 4), these parameters used to evaluate the treatment processes in the plant [22] their concentrations were ranged from 13ppm to 136ppm (BOD) and 0- 39.8ppm (COD), the lowest values refer to after and the highest values were before thetreatment process, these results noticed in the study Ghoualem [23].

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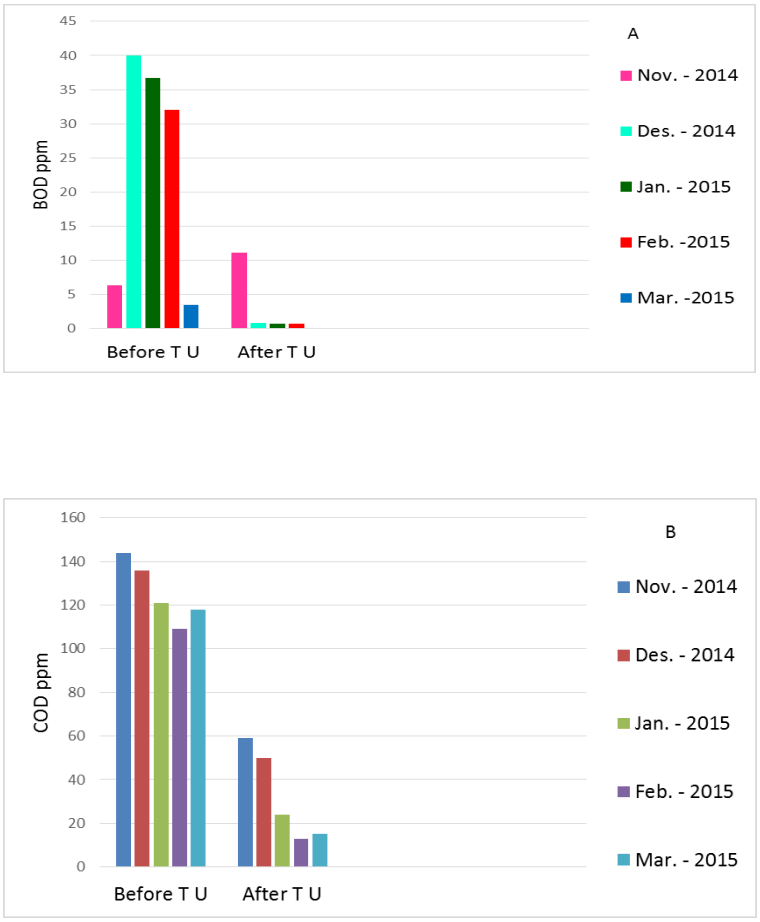

Fig. 4: Mean values of BOD (A) and COD (B) before and after treatment Unit (TU) during the study period.

The result of the BOD after treatment in November 2014 was higher than the results after the treatment in other months that it might be due to the high load of organic material and an increase in temperature value and refer to an inefficiency of the treatment unit [24]. Only this result differ from other results of BOD which they were within permissible concentration after treatment process according to the Iraqi environmental legislation [25].

While the COD concentrations after treatment were recorded within permissible concentration [25]. The ratio of BOD5/ COD ranged from 0.02 to 0.3 (before treatment) and from 0.01 to 0.18 (after treatment), so the ratio was less than 0.2 which indicated the biodegradable not process and needs other process to treat the waste [19, 26).

Electrical conductivity (EC) and salinity (S‰) values were decreased only in December 2104 and February 2015 (Figure 5), they were ranged as follows: 209-1547 µS/cm (before the treatment), 448-1218 µS/cm (after the treatment) for EC, 0.12-0.96 µS/cm (before the treatment), and 0.27-0.75 µS/cm (after the treatment) for S‰, respectively. The results of EC and S‰ were in agreement with other studies [17, 27]. The high values of both EC and S‰ were due to recycling old sludge and other material input to treatment units from different f factories [28].

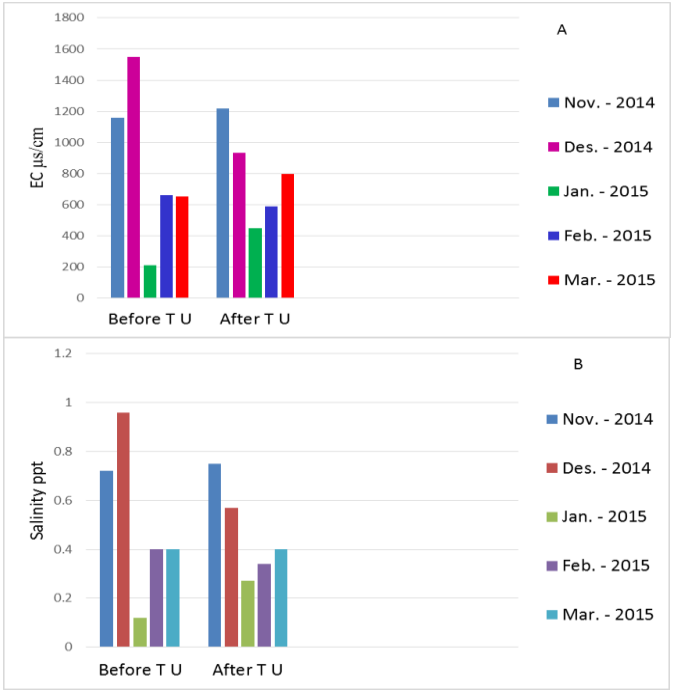

Fig. 5: Mean values of Electrical conductivity (A) and salinity (B) before and after treatment Unit (TU) during the study period.

All heavy metals concentrations were not affected significantly by the treatment. Maximum concentrations (ppm) of these metals were 0.53, 0.99, 0.68, 0.7, 0.25 for Pb, Cd, Fe, Cu and Zn before the treatment. While their concentrations (ppm) after the treatment were 0.45, 0.41, 0.48, 0.54 and 0.37 for Pb, Cd, Fe, Cu and Zn (Figures 6 and 7).

Different efficiency of heavy metals removal of the treatment units during the study period. In November 2014, no significant removal of heavy metals was recorded except for Iron (LSD= 0.07) and Znic (LSD= 0.10), whereas, their concentrations raised after treatment, these effected the existence of organisms [29]. While in December 2014, lead (Pb) and cadmium (Cd) showed a significant difference (LSD= 0.11 (Pb) and LSD= 0.28 (CD) before and after treatment unit. Cd and Zn showed a significant difference in January 2015 (LSD= 0.04 (Pb) and LSD= 0.104 (Zn)) these result also noticed in Feburary 2015. There were no significant differences in March 2015 to all heavy metals, their concentration haven't reduced after treatment unit. These results might be due to the use of paints and other toxic material in industrial processes which they caused decrease of microorganisms in the treatment unit [30]. Khalaf et al. [31] found that the heavy metals concentration within the permissible concentration after treatment processes in Al- Naimea station.

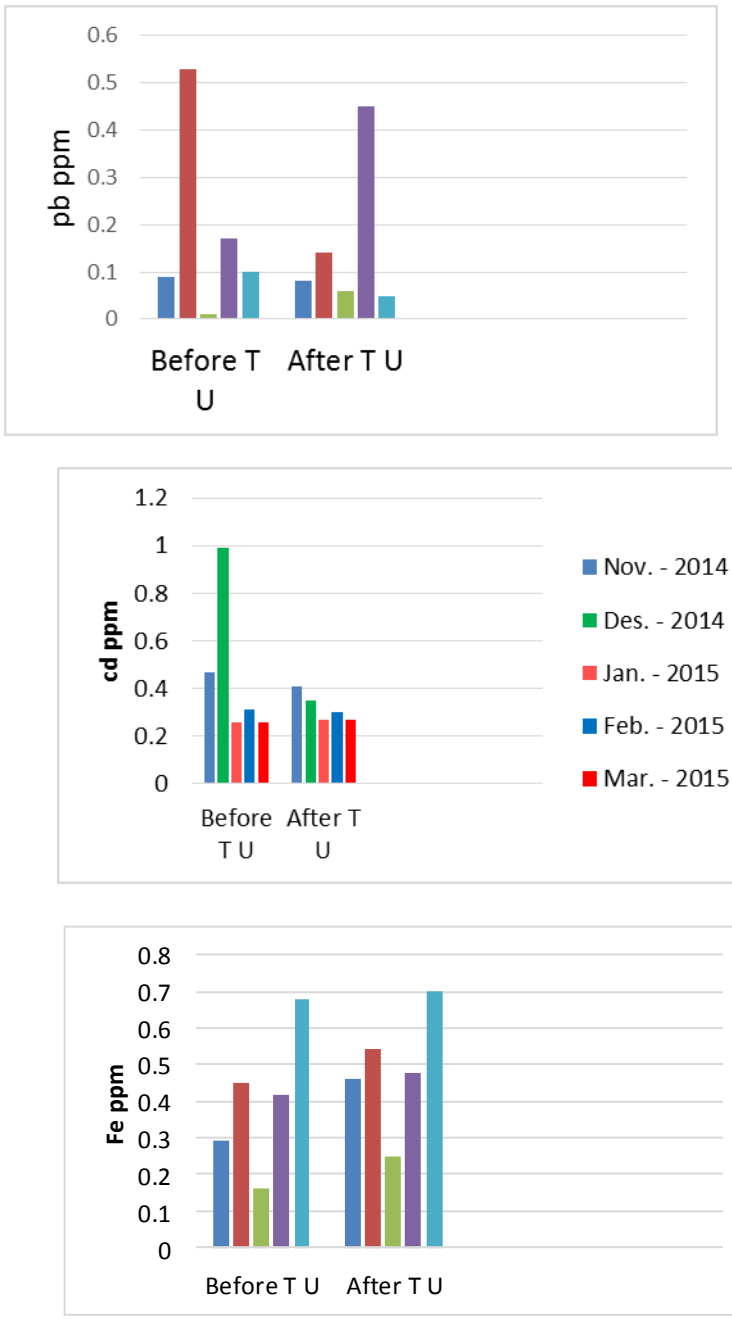

Fig 6: Mean values of Lead (Pb), Cadmium (Cd) and Iron (Fe) before and after treatment Unit (TU) during the study period.

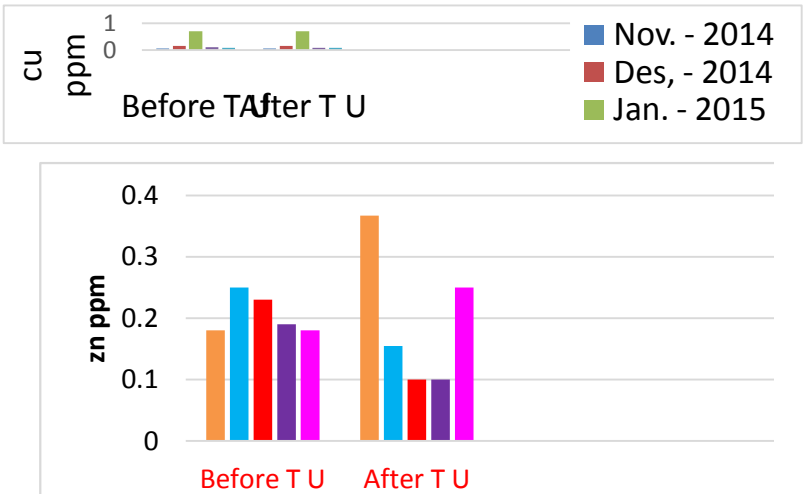

Fig. 7: Mean values of copper(Cu and Zinc (Zn) before and after treatment Unit (TU) during the study period.

Conclusions

There were no previous data about the treatment plant of the Diala state company of Electrical industries, Iraq, therefore, this study drawn attention to do more environmental studies on this company. This study revealed that the treatment plant is not efficient to remove the heavy metals from the industrial and household wastewater of the company and it needs to add the bioremediation to the plant.

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