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ORIGINAL ARTICLE

The Efficiency of Sugar Factory Wastewater Treatment in terms of COD

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ABSTRACT
The aim of this study was to evaluate the efficiency of Eghlid wastewater treatment plant as well as surveying the wastewater quality of this refinery in terms of COD to be used for agricultural irrigation. In this study, sampling was done in the second 6 months of 2012 to 2014, samples were taken as composite at intervals of 6 hours and after mixing, a sample was provided and then was tested. Comparing the data related to COD annual mean with a standard level showed that this average in three years of sampling is significantly lower than Iran standard rate. So it is suitable for agricultural irrigation. However, this parameter did not meet the EPA standards. The wastewater COD of this refinery was gradually increased during the second 6 months and the refinery efficiency will be decreased in its omission so that from October to December, it is lower than the standard levels and in February and March, it was higher than the standard level. According to the results, the effectiveness of this refinery between 2012 and 2014 did not change significantly.
Keywords*: Quality, wastewater, sugar factories, COD, Agriculture*

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INTRODUCTION

People realized the importance of water resources from the beginning and their residence was built around water sources. In addition to meet vital needs, they could not meet the agricultural and transport needs. Understanding the importance of water quality was done much later. Early, human measure water quality through physical senses such as vision and taste and smell. However, we know that water is one of the most abundant materials that are found in nature and occupied almost three-quarters of Earth's surface, the uneven geographic distribution of water resources has led to ground water shortage in various parts of the world. On the other hand, world population growth increased different consumption of water. This not only reduces the quantity of water available and faced it with more limitations, but it leads to water pollution and degradation of water resources [6].Wastewater is the most important factor of water pollution in the one hand and on the other, it can be one of the alternative sources of water in the case of adequate treatment. The industrial sector plays a major role in reducing the pollution of fresh water reserves and pollutions and also the greatest potential to reduce the consumption of water and wastewater management programs [3].Chemical oxygen demand (COD) of a water sample indicates the amount of oxygen needed for oxidation of all organic matter in the water and its measurement can be a very important indicator to determine water quality. The more the amount of wastewater COD, the more the output materials that cause more pollution [6]. Food industry with more than 24% of the total consumption of water is in the first place of different industrial groups. The sugar industry with more than 18% water consumption and producing 34% of the industry total organic load deserves more attention [9]. Comparing the amount of water in the sugar factories with the same industry in other countries shows that these plants consume more water on average 2 to 10 times. Accordingly, this industry has a very high potential for water and wastewater management programs, especially performing the projects of wastewater treatment and controlling production pollutions of this industry will fix much of the environmental concerns associated with the industry [3].Given that the beet

harvesting season is usually late summer and early fall, so the activity season of these factories is usually during the months of October, November and December each year and the rest of the season will be assigned to make repairs, replacement parts, etc.Thus environmentally, the activity of these units in certain seasons of the year produce severe infection. In Table 1, the most important sources of wastewater and their characteristics are given that specifies the need for systematic treatment more than ever [2].Given that today wastewater treatment systems are capable of producing effluent with any degree of purification, the basic problem in the refining process is deciding on the most appropriate treatment options, based on environmental and economic issues in order to properly guide national investment and avoid wasting resources [3]. Among the various technologies of sugar industry wastewater treatment, anaerobic lagoons were able to remove 85 to 90 percent of COD with hydraulic retention time of 0.8 to 2.5 of day, while the activated sludge is able to remove 90% of COD in the hydraulic retention time in less than 4 hours [4].In Iran, the EPA sets has released standards for sewage effluent discharge on three different media (surface water, agriculture, groundwater) thatshould be used in plans of treatment and reuse of wastewater. EPA standard for the use of wastewater contains BOD <30 mg/l and COD <60 mg/l. However, the Environmental Protection Agency in Iran has announced effluent BOD and COD values in the order of 100 and 200 mg/l for use in irrigation [7].The aim of this study was to evaluate the quality of treated wastewater at Eghlid (Iran) sugar factory in terms of COD amount (which is one of the most important factors determining quality) for use in agricultural irrigation. In this study, the amount of COD was measured in three consecutive years and by comparing these values with standard in Iran and also by comparing these values in different years of performance, this refinery was studied to reduce the amount if COD.

MATERIALS AND METHODS

In this study, sampling was done in the second 6 months of the year and in autumn and winter (as noted above, active seasons of sugar factories). Sampling was conducted on a monthly basis, samples were prepared as compounds at intervals of 6 hours (4 times a day). In each turn, 250 ml were sampled and finally all samples were collected in a sample after being kept in an optimal condition and after mixing, a sample was prepared and was transferred to the laboratory for testing. In all the examples, the amount of COD based on standard methods for testing water and sewage (standard number SM-5211-B) in terms of mg per liter was measured [5]. The data were entered into SPSS software for statistical analysis. For comparison of the average COD in different years and months, the two-sample t-Test test and the standard test for comparison of COD with the one-sample t-Test were used.

RESULTS AND DISCUSSION

Comparison with standard level

Different standards for using wastewater in various fields by international organizations such as WHO, EPA and FAO are provided. In our country, the standard use of wastewater in agriculture and irrigation is provided by the Environmental Protection Agency. The decision about the performance of a wastewater treatment plant as well as the usability of the output of various treatment options based on the results of tests carried out on waste and comparing with the standards is possible. This comparison on the amount of BOD of Eghlid wastewater treatment plant sugar is provided in Table 1.

Table 1: Comparison of Eghlid COD sugar factory wastewater with Standard EPA and EPA standards for reuse in agriculture

		Year		Unit	Iran standard	Standard EPA
	2012	2013	2014			
October	50	58	40	mg/l	200	100
November	85	35	80	mg/l		
December	138	124	135	mg/l		
January	170	165	170	mg/l		
February	263	244	250	mg/l		
March	299	290	284	mg/l		

As can be seen in Table 1, Iran standard is much higher than the EPA standard. In almost all cases, except for measurements that have been done in September and October, the amount of COD from the EPA standard is higher, while this is higher only 2 months in February and March of last year from the Environmental Protection Agency's standard. Therefore, the EPA standard is stricter than Iran standard,

but since the decision-making in Iran is done on the basis of Iran itself, the basis for statistical comparison is COD with standard amount in Iran in this article.

To compare the amount of COD in the years 2012, 2013 and 2014 with standard amount, the mean amount of COD in the second 6 months of these years was compared with the standard amount. Test results can be seen in Table 2 and 3. Table 2 contains the statistical data and Table 3 contains statistical test results and the significance or non-significance of the differences. As can be seen in Table 2, the average COD equals 167.5, COD average in 2013 equals 152.67 and COD average in 2014 equals 159.83 that is less than 200 in all years. But in order that the significance of this difference is proved, the data presented in Table 3 should be referred.

According to Table 4, p-value for2012 equals0.453, 0.303 for 2013 and 0.347 for 2014 which in all cases is 0.05 and this means that the average COD for all years has a significant difference with 200 (Iran standard) and given that mean difference is negative, thus is lower than standard values and is in a desirable level.

Table 2: Statistical data concerning the quantities of COD in years 2012, 2013 and 2014

	N	Mean	Std. Deviation	Std. Error Mean
COD91	6	167.5	97.87901	39.95894
COD92	6	152.67	100.97855	41.22432
COD93	6	159.83	94.86921	38.73019

Despite lower levels of COD in all years than the EPA standard, the annual average of COD parameter in each three years of sampling is higher than the EPA standard.

Table 3: results of statistical test of one sample t-test to compare with the standard amount

Test value = 100	t	Df	Sig. (2-tailed)	Mean Difference	97.5% Confidence	
				`	Lower	Upper
COD91	-.813	5	.453	-32.50000	-158.9054	93.9054
COD92	-1.148	5	.303	-47.33333	-177.7416	83.0749
COD93	-1.037	5	.347	-40.16667	-162.6850	82.3517

Comparisons between different months and years

Comparisons between different months or comparison between different years is very important in examining the effectiveness of a wastewater treatment plant as well as for management programs. Given that sugar plants are active in some seasons, so the wastewater produced and the amount of pollution they produce is different in different months. Therefore, this comparison will be more important on sugar factory wastewater.

Figure 1 shows the difference between different months of the year (in the case of sugar plant, months of October, November, December, January, February and March), and the difference between the 3-year sampling conducted in the study.

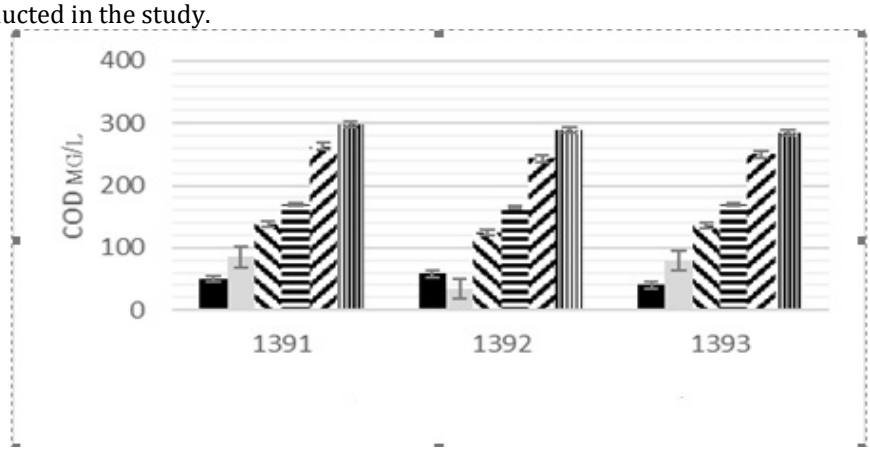

Figure 1: Comparison of COD in different months and different years

As can be seen in Figure 1, in the years 2012-14which the samples of this study was carried out,the pollution load COD has increased from October to March, so that in 2012, it increased from 50 to 299 mg/l, in 2013, from 58 to 290 mg/l and in 2014, from 40 to 284 mg/l.The reason for this increase is likely increasing plant activity and thus increasing pollution load during the fall and winter. However, in the case of COD in November, the year2013is decreased compared to October and is reached from 58 mg/l to 35 mg/l. 3-year average of COD during the fall and winter also shows an increasing trend (Figure 2). This amount in October is 33/49 mg/l and in March 291 mg/l respectively.

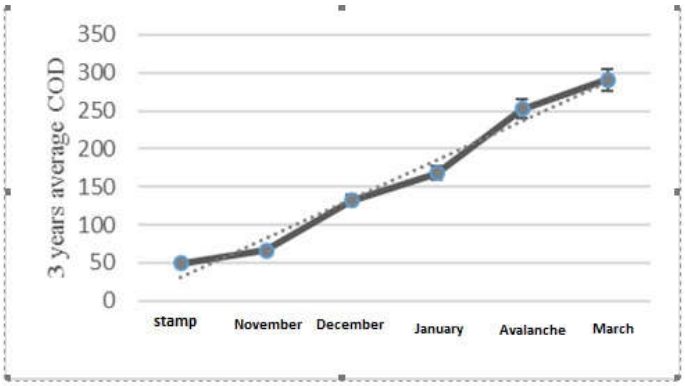

Figure 2: Comparison of 3-year average COD in different months

Figure 3 shows the difference between the amounts of COD in different years. As can be seen, this amount is reduced from 2012 to 2013so that the 167 .5 mg/l in 2012has decreased to 152 .66 mg/l in 2013. But its amount has been increased from 2013 to 2014 from 152.66 mg/l to 159.83 mg/l. However, the amount is less than that of 2012 and this indicates increased efficiency of Eghlid wastewater treatment sugar plant from 2012 until 2014.

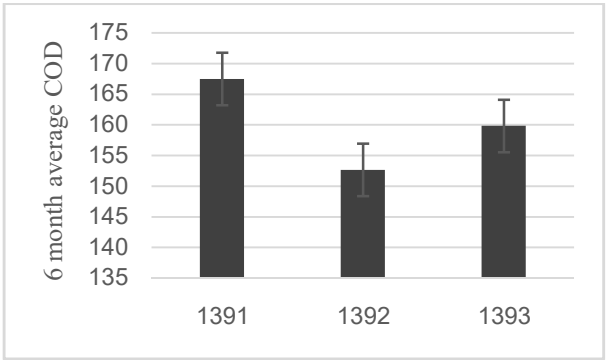

Figure 3: Comparison of BOD for 6 months in 2012 until 2014

To examine whether a statistically significant exist difference between the average COD in different years, two sample t-Test test were used. Statistical test results in Tables 4 and 5 are visible. Table 4 contains the statistical data and Table 5 contains statistical test results and significance or non-significance of differences.

Table 4: Statistical data concerning the quantities of COD in years 2012, 13 and 14

	Mean	N	Std. Deviation	Std. Error Mean
COD91	167.5	6	97.87901	39.95894
COD92	152.67	6	100.97855	41.22432
COD92	152.67	6	100.97855	41.22432
COD93	159.83	6	94.86921	38.73019

As said in the average of COD in different years in the previous section (Figure 3),these values are also visible in Table 4. As can be seen, the average COD in 2013 was reduced compared to 2012 and also

increased in2014 compared to 2013, but to prove the significance of these differences, the data in Table 5 should be referred.
According to Table 4, the average COD in 2012is 167.5 and for 2013 is 152.67 i.e. the value of COD in 2013 has been reduced.
For a closer survey, the mean equality of test results presented in Table 5 should be referred to. Since the p-value is equal to 0.122 and is more than 0.05, assuming equal means is not rejected at a significance level of five percent and therefore the amount of COD in 2013is significantly reduced compared to the year 2012. Also according to Table 4, the average COD in 2014 equals 159.83 and for 2013 is 152.67 and this means that the amount of COD has been a slight increase in 2014. For a closer survey, refers to the results of statistical tests in Table 5. Given that p-value equals 0.446 and is more than 0.05, assuming average equality in a significant level of 5% is not rejected and thus it can be concluded that the amount of COD in 2014 than 2013 did not change significantly. As a result, despite a reduction and increase in the COD between the years 2012 to 2014, there is no significant difference between the COD in these years and so the effectiveness of refinery under study were not changed.

Table 5: Statistical test results of two sample t-test was used to compare COD for different years

	Mean	Std. Deviation		SEM.	95% Confidence	T	df	Sig. (2-tailed)
				Lower	Upper			
COD91 - COD92	14.833	19.52861	7.97252	-5.66069	35.32735	1.861	5	.122
COD92 - COD93	-7.16667	21.25480	8.67724	-29.4722	15.13888	-.826	5	.446

Hashemi *et al* [7] conducted a study on the use of sewage effluent irrigation in Isfahan. In this study, the COD was lower than the EPA standard but did not meet EPA standards.
Safa and colleagues [11] investigated the possibility of using wastewater in agriculture in Kerman and thus concluded that COD amount is in standard level in Iran and the effectiveness of refinery in the omission COD has been 80.37% [11]. Studies on wastewater treatment plant in Kermanshah, Zanjan and also the refinery at the University of Sistan and Baluchestan were conducted which reported the efficiency of these refineries in omitting the COD as 74, 87.29 and 83.83 percent.
In the studies conducted by West, the efficiency of BOD and COD omission in wastewater treatment containing Molasses Sugar Factory have been announced 85 and 65-70, respectively [12-13]. In the study conducted by Ahmadi *et.al* [3] on the sugar industry waste water treatment system, it was found that various amounts of COD removal efficiency from 74 to 97 percent based on the organic loading to the system is obtained, as well as removal of BOD 91% have been reported. Research by Naseri *et al* [10] assess the quality of refinery wastewater in Ardebil for reuse in agriculture, the mean of COD and BOD parameters are obtained 97.87 and 57.25, respectively, that is much less than the measured values and is in Iran standard value [10].

CONCLUSION

Based on the results of this study, it can be concluded that if the quality parameters of wastewater treatment of Eghlid plant effluent sugar such as COD is compared with EPA standards, the value of this parameter is in the standard level to reuse for irrigation in agriculture. But if these values were compared with exacting standards such as comparable standards, COD value is much higher than the standard level and thus not suitable for use in irrigation. The COD wastewater treatment regulations are gradually increased during the second 6 months of the year (other than one exception) and treatment efficiency in its removal becomes less. So that from October to December, it is lower than the standard level in February and March, it was higher than the standard level. According to the results, the amount of COD in 2012 to 2014 was not significantly different and thus the refinery efficiency between mentioned years is not significantly changed.

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