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STUDY ON THE REUSE OF ZAMYAD FACTORY WASTEWATER TREATMENT PLANT EFFLUENT IN IRRIGATION

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ABSTRACT
Considering the population increase in the cities and also the increase of per capita water consumption in these societies, the use of treated effluents for the green area irrigation has been taken into consideration. Human ever–increasing needs to green area in municipal societies and on the other hand the limitations in water supplies cause a new review in wastewater reuse. Also making use of treated effluents in irrigation has some limitations including clogging of the soil porosities, increasing of the chemicals and toxic substances to plants and increasing the probability of groundwater pollution. In this research, considering the indicators using recognition of the effluent's quality, at the first stage compound samples of domestic wastewater treatment effluents of Zamyad Factory were taken. The samples were tested from the viewpoint of quality. Results showed that the indicator of Sodium Adsorption Ratio, Sodium Percentage, amounts of chloride, and electrical conductivity comparing to Food and Agriculture Organization and Department of the Environment of Iran standards were higher than the standard levels. Also parameters such as TDS, TSS, BOD, COD, anions and cations were in standard levels. Results also showed that the increase of some of the undesirable parameters was not related to the operation of wastewater treatment plant. Therefore, in order to make the standard effluent, different methods may be proposed and the most practical and economical one is dilution by using 50% mixing with raw water.

Key words: Domestic wastewater, wastewater treatment, irrigation, green area, wastewater reuse

INTRODUCTION
Water shortage is one of the main obstacles in development of green areas in many countries especially in those which have less amount of water. Considering growth and expansion of communities and cities along with industrial development, green areas development is also necessary. In developed countries together with industrial development, applied studies on reusing treated wastewater have been done. In 1889 for the first time, treated wastewater was used for the irrigation of the green areas in San Francisco (Mathan, 1997). Then with more essential conception of using treated wastewater in agriculture, green areas and gardening, big success was achieved in Panama city in California state in 1929 (Xie, and Kuffner, 1993). In recent decades with impressive progresses made in wastewater treatment, water produced in this way is more wanted. On the average, 60% of wastewaters in United States are reused (Harury, 1997). 432 million cubic meters wastewater is treated in the state of California, 260 million cubic meters of which is used in agricultural activities (Pescod, 1992). The same activities were begun in Japan in 1968, and in 1996 more than 13 million cubic meters treated wastewater were reused in agricultural activities (Taniyama, S. and Adachi, 1999). In the Middle East, considering water crisis, investigations on reusing the wastewater have begun. Pioneer countries are Morocco, Jordan, Pakistan, Oman and Saudi Arabia (Arabi, *et al.*, 1996). In Mediterranean countries due to population increase and periodic drought, municipal and agriculture authorities are considering the reuse of treated wastewaters. In Portugal, comprehensive investigations have been done to

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determine required standards for irrigation by using treated wastewaters. Results show that a proper method of treatment of domestic wastewater is stabilization ponds and the treated wastewater can be used in agricultural irrigation (Krauss, 1997).

Because of shortage of water in different parts of Iran, treated or untreated wastewaters have always been used for agricultural purposes. One example is Firooz–Abad stream located in south of Tehran which contains a big portion of surface pollutions and wastewater of many factories and treatment plants. The stream is a source of water in agricultural purposes in southern part of Tehran (Daie, 1995). In Shiraz, industrial and domestic wastewater of more than 80 units are dumped into Khoshk river and in south–east of Shiraz in different seasons this wastewater is used for agriculture consumptions. This wastewater is finally dumped into Maharlou lake from which a great amount of salt is extracted each year for industrial and edible uses (Massoudinejad, 1994). In Tabriz a major portion of surface and household wastewaters are being disposed into storm–waters and in suburbs, this water is a source for agricultural activities (Alizadeh, Haghnia, Naghibi, 1996). In spite of problems and difficulties in using treated wastewater, this method has many advantages such as:

- From the view point of quantity, it gives a reliable source of water for agriculture.
- It leads to reserve safe water sources and using it for important and economical consumptions.
- It reduces the risks of disposing the untreated wastewater into our environment.
- Nutrients such as nitrogen and phosphorous which exist in wastewater have good impact on plants if they are at standard levels.

On the other hand, direct discharge of untreated effluents may cause environmental problems:

- Contamination of groundwater sources.
- Suspended solids in treated wastewater clog the porosity in the soil in the course of time and prevent breathing of roots.
- Some dissolved compounds in wastewater are toxic for plants.
- Some dissolved compounds can be accumulated in plants and if these plants are used directly or indirectly they will be measured in human's food chain (Asano, and Levine, 1996; Boll, and Dernbach, 1986).

The purpose of this investigation was to study the quality of domestic wastewater plants and to assess possibility of using this wastewater in watering green areas around the Zamyad factory.

MATERIALS AND METHODS

Zamyad automobile factory is located in south-east of Tehran. This factory has been manufacturing different kinds of vans and trucks since 1971. Zamyad factory has one domestic and one industrial wastewater treatment plant. To determine the amount of elements and chemical compounds in the wastewater of the factory, combined sampling was done. In this method a 20–liters tank was used at the entrance of the plant to get 5–liters samples of the wastewater every four hours. Finally after two work shifts (16 hours) in all, 20 liters of sample were collected. After mixing them, the sample was sent to the lab to measure different chemical and physical parameters. Special sterilized containers were used to get microbial samples. These samples were taken gradually according to standard methods (WHO, 1993).

In irrigation by treated wastewater, different aspects such as salinity, infiltration, toxicity and health risks are important. Therefore for each of these aspects a special method was used. For salinity and salts in water, Electrical Conductivity (EC) and Total Dissolved Solids (TDS) were used. To determine soil infiltration we can measure the amount of suspended solids, oil and grease. The water which penetrates through soil porosity can reach the roots of plants. Also to determine soil infiltration we can measure dissolved elements such as Ca^{++}, Mg^{++}, Na^{+}, carbonates and bicarbonates. To determine toxicity, ions in treated wastewater such as boron, chloride and sodium may be measured. To determine health risks, standard microbiological tests and measuring amount of heavy metals in treated wastewater can be done (Research Department of the Environment, 1994). To determine the amount of Sodium Adsorption Ratio (SAR) the following equation was used:

$$SAR = \frac{Na^+}{\sqrt{\frac{Ca^{++} + Mg^{++}}{2}}} \qquad (1)$$

Where the units of the cations are in (meq/L).
The Percentage of Sodium (Na%) is determined by equation (2) :

$$Na\% = \left(\frac{Na^+}{Ca^{++} + Mg^{++} + Na^+ + K^+}\right) \times 100 \qquad (2)$$

Also the Residual Sodium Carbonate (RSC) is determined by:

$$RSC = (CO_3^{--} + HCO_3^-) - (Ca^{++} + Mg^{++}) \quad (3)$$

Results were compared with Food and Agriculture Organization (FAO) and Department of the Environment of Iran Standards(DOE) standards.

RESULTS

According to the results, a decision can be made whether to use treated water for irrigation or not. The test results are shown in Table 1.

Table 1: The characteristics of human wastewater treatment plant effluent of Zamyad factory (Pescod,1992)

Characteristics	Unit	Wastewater treatment plant effluent			IREPO standards	FAO standard	Standard range
		Minimum	Average and Standard Deviation	Maximum			
pH	—	7.4	7.6 ± 0.2	7.8	6.0 – 8.5	6.8 – 8.4	6.0 – 8.5
EC	µs/cm	2300	2325 ± 25	2350	—	2500 – 3000	< 250: High quality , 250 – 750: Good quality 750 – 2000: Acceptable 2000 – 3000: Questionable
TDS	mg/L	1350	1365 ± 15	1380	—	< 2000	< 450: Suitable quality 450 – 2000: Intermediate > 2000: Severe limitation
TSS	mg/L	50	57.5 ± 7.5	65	< 100	—	Maximum acceptable: 100
BOD_5	mg/L	65	69 ± 4	73	< 100	—	Maximum acceptable: 100
COD	mg/L	150	155 ± 5	160	< 200	—	Maximum acceptable: 200
Ca^{++}	mg/L	44	44 ± 0	44	—	< 400	—
Mg^{++}	mg/L	9	9.5 ± 0.5	10	< 100	< 61	Maximum acceptable: 100
Na^+	mg/L	620	645 ± 25	670	—	< 460	Measured with SAR and Na%
K^+	mg/L	30	31.5 ± 1.5	33	—	—	—
Cl^-	mg/L	770	775 ± 5	780	< 600	< 350	Maximum acceptable: 600
SO_4^{--}	mg/L	330	340 ± 10	350	< 500	—	Maximum acceptable: 500
HCO_3^-	mg/L	158	159 ± 1	160	—	< 610	Measured with RSC Index
CO_3^{--}	mg/L	0	0	0	—	—	Measured with RSC Index
SAR	—	21.8	22.8 ± 1	23.8	—	< 9	< 8: Suitable , 8 – 15: Acceptable > 8: Unsuitable
Na%	—	87.6	88 ± 0.45	88.5	—	—	< 20: High quality , 20 – 40 Good quality 40 – 60: Acceptable , 60 – 80 Questionable > 80: Unsuitable
RSC	—	0.41	0.42 ± 0.01	0.43	—	—	< 1.25: Harmless , 1.25 – 25: Suitable > 2.5: Unsuitable
Turbidity	NTU	20	25 ± 5	30	< 75		Maximum acceptable: 75
Total Alkalinity	mg/L $CaCO_3$	140	140 ± 0	140	—	—	—
Detergent	mg/L	0.1	0.15 ± 0.05	0.2	< 0.5	—	Maximum acceptable: 0.5 (ABS)
Oil & Grease	mg/L	2	2.5 ± 0.5	3	< 10	—	Maximum acceptable: 10
Residual Chlorine	mg/L	0	0	0	< 0.2	—	Maximum acceptable: 0.2
Faecal Coliform	MPN/100 mL	—	—	—	< 400	< 100	—
Total Coliform	MPN/100 mL	—	—	—	< 1000	—	—
Helminthes egg	No./100 mL	—	—	—	< 1	—	—

IREPO = Iranian Environmental Protection Organization FAO = Food and Agriculture Organization

DISCUSSION

Analysis of the results presented in Table 1 shows that some indicators are higher than the standard levels such as SAR which is an important parameter in irrigation. If this parameter is higher than 18, it will have an undesirable impact on soil. In this test SAR and Na% are higher than standard levels. The concentration of chloride is more than expected. Also the amount of EC is higher than standard level and is categorized among questionable waters. According to standard levels the rest of the measured parameters, were acceptable for irrigation. Problems in the quality of the treated wastewater and the increase of the SAR, Na%, Cl^-, and EC are not influenced by the efficiency of the wastewater treatment plant. Therefore in order to make the treated wastewater suitable for irrigation of the green area, these options were suggested:

- Adding calcium and magnesium to wastewater effluent can lead to decrease of SAR and Na% and increase of TDS and EC.
- According to researches done by Haruvy in 1997 in connection with using membrane methods such as reverse osmosis, we can eliminate the amount of dissolved solids in wastewater effluent in accordance with the standard levels. But setting up this system is expensive.
- According to studies done by Escontria, the best choice is to dilute the treated wastewater up to 50% by an available source of water, which will not be any problem to irrigate the green areas for a prolonged period.
- Some other qualitative parameters such as turbidity, TSS, BOD, COD, detergents, oil and grease are now at standard levels. According to similar researches done by Jame in 1985, in case any of these parameters reach above the standard levels a pressure sand filter can be used.

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