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Designing wastewater treatment systems and studying the sewage absorption coefficient in temperate regions of Iran

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ABSTRACT

This study is dedicated to determine the parameters of designing wastewater treatment systems and study their sewage absorption coefficient for temperate regions of the country. Two anaerobic and aerobic wastewater treatment systems located in Guilan Province were selected as a pilot in a temperate region. By comparing the results of per capita parameters in two wastewater treatment systems, a significant difference was determined between BOD5, COD and TSS parameters. Using the designing parameters specific for developed countries for designing a wastewater treatment system and absorbing the resulting sewage in cities of Iran is not appropriate. Therefore, it is suggested to use the designing parameters based on different weather conditions and real specifications of wastewaters for increasing the efficiency in the operation of wastewater treatment systems. The application of a unit design as an integrated system can separately reduce the pollution load of each industrial wastewater to the level of environmental standards, and significantly reduces the need for the design and implementation of a collection network and wastewater treatments.

1. Introduction

Provision of health conditions, prevention from contamination of water resources and need for the reuse of municipal wastewaters require that collection networks and wastewater treatments are created for cities of Iran. Given the fact that only few cities have collection and wastewater treatment facilities and considering the future development of these societies and creation of new cities and towns, we can expect that approximately 800 municipal wastewater treatments will be created by 2021 which require a great financial and human investment (Archival, 2000).

In order to design the type of treatment system and for the method of design, it is required to determine the quality of wastewater by measuring some parameters. The most important parameters include BOD5 (5-day biochemical oxygen demand), COD (chemical oxygen demand), VSS (volatile suspended solids) and phosphor. In addition, other parameters which show the operations working conditions but are not controlled include discharge, temperature and PH of the entering wastewater. Knowing the change process and deviations of these variables can provide appropriate information about the better design and navigation, timely prevention of the system's failure and taking preventive measures for reducing the effects (Jazayeri et al., 2008).

Therefore, considering such a great investment and numerous administrative problems such as different weather conditions, underground aquifers' level difference, possibility of expansion of towns, integration of different wastewaters with different pollution load (health-human, infectious-hospital, etc.), this study which aims to use integrated, small and economic units of wastewater treatment systems and investigate output sewage absorption coefficient in temperate regions provides an appropriate strategy to the problems raised.

2. Method of study

In order to insert real factors in this project, we selected Lakan Shahr region in Rasht as a pilot and a region similar to the project's subject using laboratory and experimental measurements and data entry in this region. During the study, the values of these parameters were measured and compared with the output values of wastewater treatment

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systems. Meantime, Results obtained from experiments on the soil permeability coefficient in the project's region were used as an effective parameter in the design of the structure of absorbed trenches in order to absorb the output sewage of systems. Samples were prepared in combination and according to the wastewater discharge as follows:

A – Obtaining a sample from the entering wastewater in a 24-hour period.

B – Reading and recording the wastewater discharge into the system while obtaining the sample.

C – Maintaining obtained samples at temperature below 4 ° C.

D – Preparing a 24-hour compound sample according to the wastewater discharge through mixing samples to the proportion of discharge at moments of sampling.

In this research, in addition to the continuous measurement of the wastewater discharge into the system, entering PH, COD, BOD5 and TSS were measured in 24-hour compound samples. All measurements were done based on the methods stipulated in the book of standard methods for water and wastewater experiment.

The output sewage from wastewater treatment systems is disposed in two ways:

A – In lands with high permeability where the sewage is entered in a 40-60-m depth trench and is disposed under the ground level in the form of distribution.

B –In lands with low permeability where the sewage enters the absorbing wells due to the low permeability of the surface soil.

The absorption capacity or land permeability in relation to the wastewater is not the only capability of the water absorption because the existence of fine particles in the output wastewaters (anaerobic system) and bacteria's reaction led to the creation of gel-shaped materials and significantly reduced the water absorption power and soil permeability capacity. The assessment of this capacity is done through the absorption time. Based on the definition, the time period when the water level in a hole with dimensions of 30 cm and depth of 45 cm (the location of distribution pipes) is reduced 2.5 cm is selected as the land permeability.

By having the absorption time, the amount of sewage entering per square meters of the bottom of trench is estimated. This estimation is done in two ways. The first method uses the following relation where Q is the amount of sewage based on the cubic meter per square meter of the trench's bottom and t_a is the absorption time based on the minute. Therefore, by having the total sewage and using the following tables, the surface, depth and length of trench can be obtained (Khaldani, 1970) (Table 1 and 2).

$$Q = 1.3/ (t_a+7.5)$$

Table 1: The absorption coefficient values of the output sewage from the wastewater treatment system

Absorption time (minute)	The amount of absorbed sewage per square meter in a day (cubic meter)	
	Trench	Absorbing well
1 or less	0.152	0.205
2	0.137	0.184
5	0.103	0.240
10	0.075	0.1
30	0.035	0.047

Table 2: Estimation of the trench's width

Absorption time (minute)	Trench's width (cm)
1-3	45
4-9	60
10-60	90

3. Findings

The average per capita of parameters under research in this study based on milligrams per liter with industrial use for every day of production of BOD5, COD and TSS was equal to 90, 346.5 and 59.8 L, respectively and the average production of wastewater was 16000 L per day (Laak, 1986). By comparing the results of per capita parameters in two wastewater treatment systems, a significant difference was determined between BOD5, COD and TSS parameters.

The minimum and maximum discharge into the system was related to hours at noon (12:00 to 02:00 p.m.) and earlier hours in a day (09:00 to 11:00 a.m.), respectively (Table 3 and Fig. 1).

Conducting experiments for determining the permeability based on what mentioned showed that the soil type of the land of region in the project (Lakan Shahr) has high permeability and results are as follows:

The absorption time based on minute is equal to 0.083 (t_a=0.083 min)

$\twoheadrightarrow Q = 1.3/(7.583) = 0.17\ m^3/m^2 \twoheadrightarrow Q = 0.17$ m

If use Table 1 $\twoheadrightarrow Q = 0.152$ m

If use Table No.2 $\twoheadrightarrow L = 0.45$ m

It is clear that the amount of sewage absorption at the bottom of trench is 0.17 and 0.152 cubic meters per square meter based on the experimental formula and table 1, respectively and considering the obtained absorption time (t_a), the trench's width in the region of project is 45 cm during the experiment (Fig. 2).

4. Discussion

Specifications of the wastewater entering the wastewater treatment systems under study in the period of research and the values of per capita discharge and wastewater pollutants are recorded in Table 1.

Table 3: The values of the per capita discharge and entering wastewater pollutants and output sewage from wastewater treatment systems (Tchobanoglous, 2003)

Type of system	Q(L per day)*	Temperature (water/air)	PH*	COD*	BOD5*	TSS*
Entering raw wastewater	16000	30.25	7.74	346.5	90	59.8
Output sewage from anaerobic system	16000	28.23	7.2	301	47.7	36.5
Output sewage from aerobic system	16000	28.19	3.9	41.5	6.3	3.5
Standard of discharge into surface waters	Mg/Lit	-	6.5-8.5	100	50	40
Standard of discharge into the wastewater treatment's outlet	Mg/Lit	-	6.5-8.5	2000	1000	-
Standard of agricultural and irrigation uses	Mg/Lit	-	6-8.5	200	100	100

Q of wastewater discharge into the system, PH of phosphor, COD, BOD5 and TSS

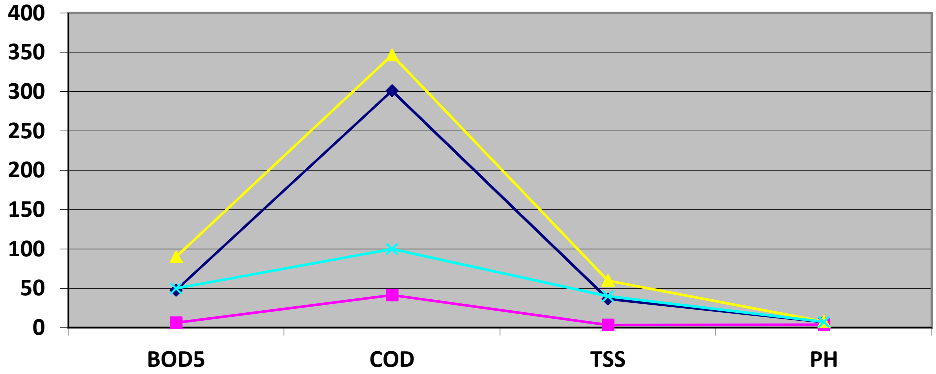

Fig. 1: The values of the per capita discharge and entering wastewater pollutants and output sewage from wastewater treatment systems

Fig. 2: Experiment procedures for the determination of water permeability coefficient

Among wastewater pollutants parameters, the maximum difference in terms of standard of discharge into surface waters was observed in COD which the main resources for its formation are included in the wastewater of chemical wastes (30 to 50%) and industrial uses (20 to 30%). Based on the information of this study, the minimum and maximum per capita pollutions in output sewage from system are related to TSS pollutant of aerobic system equal to 3.5 mg/L and COD pollutant of anaerobic system equal to 301 mg/L, respectively (Crook, 1999).

The comparison of values of per capital wastewater pollutants obtained in this research with similar values mentioned by other researchers shows that the per capita BOD and COD in this study is significantly lower than that obtained in studies of other countries (Lape, 1994). Therefore, the role of time of study and local conditions cannot be ignored in this study. While, two mentioned parameters are the basis of designing wastewater treatment systems and consequently the localization of these factors based on the social and cultural behaviors and economic facilities is necessary. In addition, the values of per capita COD indicate the high proportion of industrial wastewater.

As it is concluded form results, by accepting 5% error and considering the confidence interval, the average pollutant parameters is not in the area of the design per capias' values. Therefore, it can be concluded that in this case, there is the possibility of error and consequently there are errors with unnecessary expenses in the estimation of aeration power, the amount of electricity required and size of systems' structure. By comparing the results of per capita TSS in the selected pilot, it was observed that the most important reason for an increase in the amount of suspended materials is the rain fall and lack of isolation of rainwater percolation collection system from the collection network.

Using designing parameters specific for developed countries (which do not have any common point with Iran) in cities of Iran is incorrect. For example, the per capita wastewater production for developed countries is 410 L per person per day, while this value is measured to be approximately 4 times larger.

Based on the obtained results, it is suggested that for designing wastewater treatment systems in temperate and cold regions of the country and for cities similar to cities in the north of Iran in terms of climate and culture, the per capita wastewater production is used in the confidence interval of the research results. In order to prevent from the rework and waste of resources, Ministry of Power takes measures for determining the design parameters based on the culture and climate of the country (cold, tropical and temperate regions) in a pilot scale and prevents from using the fundamentals of design parameters relating to the developed and or developing countries.

5. Conclusion

When using design parameters according to different weather conditions and real specifications of wastewaters, a higher efficiency can be obtained in the navigation and application of wastewater systems. Therefore, it is suggested that for designing wastewater treatment systems in temperate regions and cities similar to cities in the north of Iran in terms of climate and culture, as well as the per capita wastewater and sewage absorption coefficients and other design parameters, the results of this research are used.

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