

Investigating procedures to collect and dispose of municipal wastewater: An emphasis on regional, economic and environmental considerations in Semnan province

Ali Akbar Alimoradi and Ahmad Sayyahi

Power & Water University of Technology (PWUT), Tehran, Iran

ABSTRACT

The present study aims to investigate the procedures to collect and dispose of (treat) municipal wastewater with special emphasis on regional, economic and environmental considerations in Semnan province. The study purports to propose a procedure to collect and treat sewage in Semnan, which bears no adverse environmental effects and matches the regional and economic conditions. The current disposal method is the traditional underground sewage soakage well, 5-10 meters deep, two of which are typically dug in every house. This method seems functional as the soil has good permeability qualities. However, as the sewage disposed of this way sinks down and joins underground aquifers, it contaminates the aquifers. The results showed that the use of stabilization pond is the most viable method to treat wastewater in Semnan considering the operational ease of wastewater treatment plants, insensitivity to qualitative and quantitative changes in wastewater quality, availability of the equipment in Iran, lack of a need for expensive waste sludge treatment equipment, lack of a need for highly-skilled operators for operation and maintenance, cheap lands and good climatic conditions.

Keywords: Wastewater, Regional, Economic and Environmental Considerations

INTRODUCTION

The dramatic increases in population followed by increased water consumption have led to increased wastewater that in turn poses problems to urban communities. Some of these problems include sanitation and environmental issues, disturbed balance of groundwater and contamination of water resources [1].

Sewage is considered as one of the main contaminants of water so that every cubic meter of untreated sewage may seriously contaminate about 40-60 cubic meters of fresh water. Aquifers have limited self-purification qualities; however, when the dissolved oxygen is consumed faster than supplied, it significantly decreases in the bodies of water and endangers the life of aquatic organisms so that they lose their utility and the treatment would not be economical [1-2].

Water constitutes about 99.9 percent of sewage while effluents such as suspended colloidal solids constitute only 0.1 percent of wastewater. Thus, sewage is used as a source of water in several countries, particularly in dry regions. This is particularly important in Iran that is considered as a dry or half-dry country so that wastewater treatment can

significantly contribute to water recycling. In this regard, the first step is to collect wastewater from different communities and transmit it to treatment plants so that it may be treated to a standard degree consistent with the final disposal method [3]. The major objectives for wastewater treatment may include providing adequate sanitation for communities, preventing the outbreak of waterborne epidemics, preservation of the environment and aesthetic effects to provide public welfare, preventing the contamination of water resources, developing treatment and recycling of water in dry regions.

The current disposal method in Semnan city is the traditional underground sewage soakage well, typically 5-10 meters deep, two of which are usually dug in every house. This method seems functional as the soil has good permeability qualities. However, as the sewage disposed of this way sinks down and joins underground aquifers, it contaminates the aquifers [1-4]. Besides, an investigation of groundwater shows that the water level decreases along the regional hydrogeological slope from north to south so that it ranges from 160 meter deep in north Semnan to about 5 meters deep around Delazian (south Semnan) and eventually surfaces and flows in desert areas with a very low quality due to evaporative formations and sewage contamination. Thus, sewage disposal poses problems in south districts due to elevated groundwater so that it must be given due consideration in wastewater disposal projects [5-6].

Semnan is a historic, populated city that still uses the traditional underground sewage well to dispose of municipal wastewater. This method is prevalent in many cities in Iran, which imposes serious economic and environmental adverse effects. Thus, we need to adopt a scientific approach and utilize cutting-edge technologies to deal with this problem. To eliminate wastewater disposal problems in Semnan, we need to adopt a method that not only has less adverse effects but also brings about positive outcomes. Thus, the present study aims to introduce a method with special consideration of regional, economic and environmental factors to collect and dispose of wastewater in Semnan. The study specifically seeks to answer the question: "Is it possible to propose a wastewater collection and disposal method for Semnan, which is suitable in regional, environmental and economic terms? Is separate wastewater collection suitable for Semnan?"

MATERIALS AND METHODS

Nowadays, many a country requires her to implement sewage collection and treatment projects so as to promote health and environmental characteristics in urban and rural communities [7]. Thus, they need to follow a scientific method to adopt a suitable procedure for the collection and treatment of municipal wastewater, which is consistent with economic and ecological conditions of the region.

There are various methods – physical, chemical and biological- for sewage treatment. Besides, there are three main methods to collect the sewage including separate, semi-separate and combined systems. To select a system, a number of factors such as climatic, cultural, economic and geological variables should be taken into consideration.

The present study aims to propose a comprehensive solution to the collection and treatment of wastewater in Semnan. To this end, library studies were first conducted to collect the theoretical data on the collection and treatment of sewage as well as environmental and economic considerations. Then the regional characteristics of Semnan were addressed briefly.

Some basic data is required to help select the suitable wastewater treatment method in Semnan; however, this was not possible as there was no wastewater collection system installed in the city. To remedy this deficiency, the available data on similar cities were used comparatively. Accordingly, a study on Iranian cities with wastewater collection systems revealed that Zabol shared cultural, meteorological and demographic similarities with Semnan so that it was used as a model to obtain the comparative data.

RESULTS

Design parameters are needed to install a wastewater treatment plant in Semnan as the city lacks a sewage collection system (BOD, COD, SS, PH...) [2-5]. In other words, as there is no sewage collection system in the city, we may not select a sample of the municipal wastewater and generalize the results to the whole city. To remedy this problem, the wastewater in similar cities with sewage collection and treatment systems may be used. To this end, the selected city should be similar to the target city in terms of climatic and industrial factors. Studies showed that Zabol city, which has sewage collection and treatment system, corresponds to Semnan in terms of climatic, geological and industrial

factors. Thus, the municipal wastewater data in Zabol was applied to Semnan to help propose a suitable sewage collection and disposal system for the target city (Figure 1-2-3).

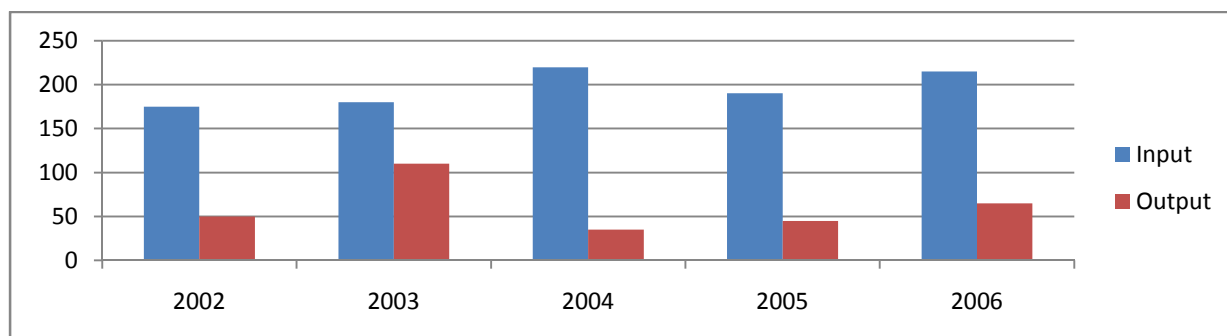


Figure 1: Average input and output of BOD (mg/L) in wastewater treatment plant of similar city

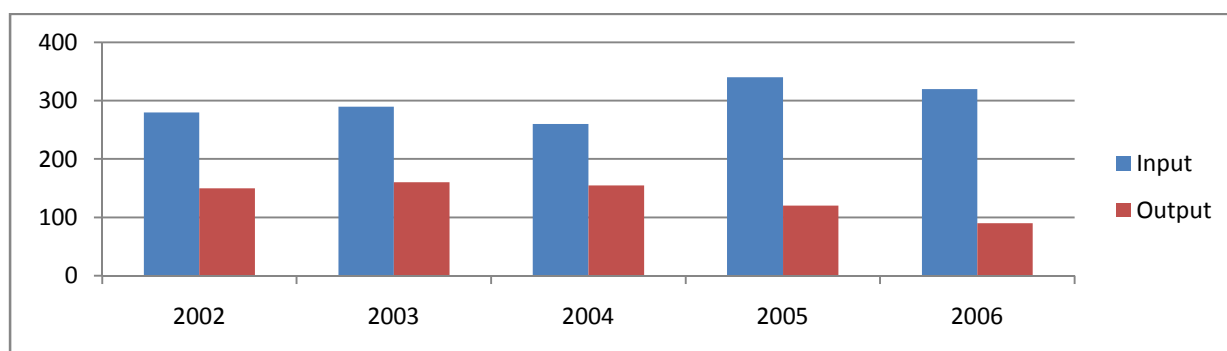


Figure 2: Average input and output of COD (mg/L) in wastewater treatment plant of similar city

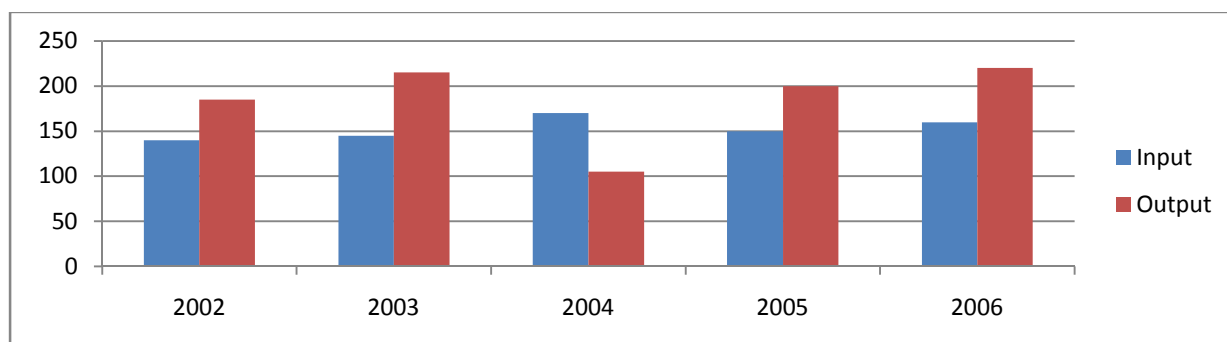


Figure 3: Average input and output of SS (mg/L) in wastewater treatment plant of similar city

Considering the climatic, cultural and economic similarities between these two cities, some design parameters may be borrowed from Zabol sewage collection and treatment system and applied to Semnan to help develop a plan for sewage collection and disposal system in this city. Thus, we also devoted a certain proportion of the study to the investigation of sewage collection and treatment system in Zabol.

CONCLUSION

Semnan city is the provincial capital of Semnan province lying to the 35 degrees, and 33 minutes north latitude and 53 degrees, 23 minutes east longitude along the desert on the gentle southern slopes of Alborz Mountains. The city is about 1100 meters above the sea level and has a general north-south slope. Semnan is located on a wide plain, reaching Tehran from west with 237 Km distance and Damghan from east with 107 Km distance as well as

Mahdishahr and Shahmirzad from north with 25 Km distance. In addition to the said connections, Semnan is also connected to northern cities through Firooz Kooch road. There is also a rail network that connects Semnan to Mashhad from the east and to Tehran from the west.

The city lies on a plain developed by river sediments. Lack of a permanent river gives this plain a uniform natural outlook. Thus, sedimentation and soil renewal, which occurs due to torrential river floods, happens scarcely. Golroudbar is the only permanent river in Semnan that has several branches such as Dehsofian and Shahmirzad and runs through a wide area. These two branches meet near Mahdishahr dam, join other branches, and run past the west of Semnan where they creep into Dasht-e Kavir. Semnan is surrounded by alluvial farm lands from east, west and south. However, lands to the north of the city are barren due to their altitude and steepness. Alborz Mountains are located on the north of the city and function as a gigantic barrier that separates the city from the Northern humid regions so that the wet masses do not reach the city area.

Considering the geographical condition, raining level and temperature variations in Semnan region located a hot and dry environment, the general characteristics of the region lying from the southern slopes of Northern mountains to the inside of Iranian plateau are as follows. Due to its adjacency to central plateau of Iran, it is affected by the hot and dry climate of this plateau with cold winters and hot and dry summers. However, as it has a higher altitude in comparison with the central plateau or local holes, it benefits from the moist weather that passes over it so that it has a rather moderate climate comparing with the main holes. It is typically dry during the year and has a great temperature variance between the daytime and night, which is related to the cloud and moisture in the atmosphere. The reason is that the sunshine warms the ground during the daytime while the heat is sent up to air at night with no significant resistance. Considering the location of Semnan on the southern slopes of Alborz Mountains, the raining increases from south to north and bears a direct relationship with the altitude of the region. Besides, the raining season begins in September/October and continues for almost eight months. It typically intensifies in November but decreases after May/June.

The meteorological characteristics of the region were extracted from Semnan synoptic station between 1990 and 1999. According to this data, the average annual raining was 134.8 mm, the highest amount of raining in a day was 29.6 mm (1996) and the average annual moisture was 41.5 mm in the respective period. The average maximum and minimum temperatures were 28.6 and 7.3⁰ C, respectively.

The results showed that it was a necessity to design and implement sewage collection and treatment system in Semnan city considering the environmental, economic and sanitary urgencies. The sewerage in Semnan should use the separate, gravity and pressure systems. Considering the advantages and disadvantages of different pipes in technical or economic terms and as the Iran PVC company is located in Mahdishahr 15 kilometers from Semnan, it is recommended that the sewerage system in Semnan be made of PVC pipes for up to 400 mm in diameter and cement pipes for 500 mm in diameter and above.

Thus, considering such factors as the operational ease of wastewater treatment plants, insensitivity to qualitative and quantitative changes in wastewater quality, availability of the equipment and spare parts in Iran, lack of a need for expensive waste sludge treatment equipment, lack of a need for highly-skilled operators for operation and maintenance, cheap lands and good climatic conditions, stabilization pond is the most viable method to treat wastewater in Semnan.

Thus, considering the present findings, the following recommendations are made. First, due to variability of the output, the treated wastewater should only be used for agricultural use consistent with environmental issues and recurring experiments. It, however, needs further study to be approved for other usages. It is recommended that in case the output effluent standards are not met, other natural complementary units be added to the stabilization ponds serially. Second, if the aerobic ponds are made anaerobic due to heavy mineral load, it is recommended that manual floating aerating be applied. Third, due to inadequate operation, the ponds may become anaerobic and emit stinks. It is recommended that the ponds be constructed away from the urban areas (at least 500 meters) against the dominant wind directions.

REFERENCES

- [1] L. W. Canter; Environmental Impact Assessment, McGraw Hill Book Company, New York, 1977.

- [2] A. C. Alder, E. Golet, S. Ibric, W. Giger, *The American chemical society*, Sanfrancisco, CA. **2000**, 32, 219
- [3] G. Wiyasu, O. A. Kure, *Adv. Appl. Sci. Res.*, **2012**, 3(3):1691-1701
- [4] S. Jitendra Kumar, R. L. Meshram, D. S. Ramteke, *Euro. J. Exp. Bio.*, **2011**, 1(3):209-215
- [5] X. Anupama, P. Ravindra, *Biotechnology Advances*, **2000**, 18, 459–479.
- [6] M. H. Choi, Y. H. Park, *Bioresource Technology*, **1999**, 70, 231–236.
- [7] Y. A. Maruthi, K. Hossain, D. Hari Priya, B. Tejaswi, *Adv. Appl. Sci. Res.*, **2012**, 3(1):605-610