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The status of wastewater management in Shokuhieh industrial park (A case study of Qom province)

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Abstract

Background: Water resource management is a strategic issue in Qom city. Water scarcity is one of the most critical concerns of industrial estates. This study aimed to evaluate wastewater management in the Shokuhieh industrial park of Qom province in 2013.

Methods: This is a descriptive cross-sectional study done by visiting the industrial units in person, completing questionnaires and analyzing the results. The questionnaire had 25 questions, including general information, the status of water supply, treatment and consumption, wastewater production, reuse or discharge of produced wastewater and the status of wastewater treatment and discharge of effluent. The industrial units evaluated were active with over 50 personnel and numbered 44 in total.

Results: The water suppliers in the industries included network (70.5%), network and reverse osmosis (RO) (22.5%), network and tanker (2.4%) and tanker (4.6%). 63.63% of the industries had water treatment systems. 19.5% reused wastewater and 31.8% performed pretreatment before discharge of wastewater. The discharge sites of water treatment units' effluent included the absorption well (17%), greenbelt (18%) and sewer (65%). Discharge sites of sanitary wastewater in 50% of the industries was sewer and in 50%, it was absorption well. The discharge sites of processed wastewater was reuse (2%), sewer (52%) and absorption well (46%). Discharge sites of exiting effluent from pretreatment units in the industrial park, included sewer (85.5%), transport by tanker (7.1%) and absorption well (7.1%). The type of pretreatment process in 35.7% of the industries was chemical and in 64.3%, it was septic tank.

Conclusion: The results of this study showed that pre-treatment is not done in most industries and wastewater reuse is performed in few industries. The main method of wastewater disposal in industries was by discharge into the sewer and absorbent well.

Keywords: Wastewater management, industrial park, Shokoohieh, Qom.

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Introduction

For more than two decades, industrial cities with the aim of encouraging industrial sectors and reinforcing polices on distributing population equally, in order to make the best use of natural resources and local produce, and prevent unequal centralization of industries, condensation of industries around cities and synchronizing industrial development with environment sustainability, has attracted the attention of the authorities. Moving polluting industries away from cities and condensing them in one place have provided the possibility of better pollution control (1,2). An industrial park is defined as a piece of land which has been prepared and has been divided according to a comprehensive project, into smaller pieces and arrangements have been made for building roads, transit and general facilities and industries; and industries have been built on these lands with joint facilities (3).

Together with industrial development in different countries, the use of water and wastewater production in industrial units has increased. In Iran, after the agriculture

sector, the industrial sector is the most important water consuming sector (4). The amount of wastewater production in polluted industries in 2003 was over 91 million cubic meters and only 31% of it was treated and recycled and the rest was released into the environment (5).

Rapid gathering of wastewater from industries and then treating and discharging it is not only desired, but also necessary in industrial societies and the main aim is: to protect public health, environmental sustainability and prevent pollution of water resources and reuse treated wastewater in agriculture and industry (6). Industrial wastewater is potentially highly polluted and should not be released into the environment without treatment. The most important factors that make industrial wastewater not suitable for release into the environment are high acidity, strong alkalosis, high concentration of dissolved chemicals, fat, grease, heavy metals and toxins, toxic and malodorous gases, radio activity, suspended material, color, odour, high temperature and pathogenic microorganisms (7). Every m^3 of untreated wastewater can pollute about 50 m^3 of water. Therefore, if no attempt is made to control industrial wastewater, the country's water resources will be seriously exposed to the hazards of these pollutants (4).

The quality of wastewater in each industry is different according to the kind of produce, amount of water used, incorporating modern technology and other factors related to by-products. Some industries need pretreatment due to their heavy load of organic material (8). The difference in the quantity and quality of industries, type of industrial activity, high variation of chemical used in the industrial units are among the factors that make industrial wastewater management more complicated and professional than urban wastewater (9).

Lack of water resources and the importance of environment sustainability highlight the reuse of sewage in societies. Currently, in most countries including the United States, Germany, Australia and Turkey, about 60% of industrial wastewater is treated and reused. If industrial wastewater is treated property, it can be used as a certain and valuable source for agriculture (10).

Qavami et al in 2006, in a study on evaluating the situation of industrial wastewater management in industrial towns of Sanandaj, showed that the wastewater produced in industries is discharged without treatment or after inadequate treatment, into the river that runs beside the industrial town (11).

Fahiminia et al in 2007, evaluated the situation of urban waste water management in Iran and their results showed that the current wastewater management system is causing trouble for more than 50% of the population in 42.4% of cities and for more than 50% of the population in 52.4% of the cities (12).

Piadeh et al conducted a study on the current situation of wastewater treatment in industrial units and showed that from 689 industrial units, only about 37% of wastewater was treated by wastewater treatment plants and about 20.25% of the treated wastewater was used for irrigation. Also, wastewater reuse for industrial purposes increased from 0.88% to 7.22% (13).

Industrial cities are responsible for designing a central sewage treating system and obtaining their construction license, and after assigning 50% of the units and operating 30% of them, and producing at least l00 m^3 of wastewater per day, they should build their central sewage treatment system. According to this, before the central wastewater treating units is operational, each unit should establish a wastewater pretreatment and discharge system (14). This study was performed in order to evaluate wastewater management in the Shokoohieh industrial park in Qom province in 2013, in order to suggest management initiatives.

Methods

This was a descriptive cross-sectional study performed in the Shokoohieh industrial park. The Shokoohieh industrial park is located at kilometer 12 of the Qom-Tehran highway. This park is located at 34 to 42° N and 50 to 51° E. The area of this park is 955 ha and it was given to applicants in two phases. This study was done based on local visits to chosen industries, completion of questionnaires and performing data analysis.

In this study, the Iranian Environmental Protection Agency Questionnaire (IEPA) was used. The questionnaire had 25 questions in 4 sections, including general information, the water supply, water treatment and use situation, the situation of resources and reuse or discharge of the produced wastewater and the situation of wastewater treatment and sewage discharge. The general information inquired in this questionnaire was the type of industry, address, number of personnel, potential of production according to type of produce.

In this study, the industries were categorized into 11 groups. These groups included food, drug, plastic and chemicals, metals, nonmetal minerals, wood and cellulose, paper, textile, machinery and equipment, electrical and cosmetics. This grouping was based on the national census of industrial workshops. Due to the fact that industrial units with employees less 50 people are classified as small workshops; in this study, only units with employees more than 50 were evaluated. The number of chosen workshops was 44 in total and included 1 machine making, 9 metal minerals, 9 food, 1 drugs, 8 chemicals, 8 textile, 2 electronics, 2 nonmetal minerals, 1 agriculture, 1 leather and 2 cellulose industries. The industrial units were visited and the relevant questionnaire was completed. Then, the collected data were analyzed.

Results

The source of water in the selected industries is shown in Table 1. In 52% of the industries, the source of drinking water was the network, in 32%, it was the network and the reverse osmosis (RO) system, in 11.5%, it was tanker and in 4.5%, it was network and tanker. The source of water for sanitary purposes in 88.5% of the industries was network

and in 11.5%, it was network and RO. Also, the source of water used in the process in 73% of industries was the network, in 22.6% of the industries, it was network and RO, in 2.2%, it was tanker and in 2.2% of the industries, it was tanker and network.

The situation of industries with pretreatment units for wastewater is shown in Table 2. The industries which mainly own pretreatment unit are the food industry (88.9%). In the chemical industry, from the 8 available industrial units, 3 (37.5%) possess a pretreatment unit.

In the metal industry, from the 9 available industries, only one (11.1%) had a chemical pretreatment unit. From the 8 textile industrial units, one (12.5%) had a pretreatment unit. Also, the only agriculture industry has a pretreatment unit (100%).

The type of pretreatment process in industries was mainly chemical and septic tank. The place of sewage discharge of the pretreatment units in 85.7% of the units was the sewer of the industrial park, in 7.15%, it was transferred by tanker and in 7.15%, it was the absorbent well. In 71.5% of the industries, sludge was transferred by tanker outside the industry and in other industries, the sludge landfill was not specified.

The situation of sanitary, processed wastewater and sewage discharge in the evaluated industries is shown in Table 3. The discharge of sanitary wastewater in 50% of the industries was the sewer and in the other 50%, it was the absorbent well. The final discharge method of the processed wastewater in 70% of the industries (31 industrial units) was the sewer, in 27% of the industries (12 industrial units), it was the absorbent well and in the remaining 3%, it was (one industrial unit) reused.

The sewage discharge site of the water treatment unit in 64.7% (11 industrial units) was the sewer, in 17.6% of the industries (3 industrial units), it was absorbent well and in 16.7%, (3 industrial units), it was greenbelt. In only 18% of the evaluated industries was sewage reused. The main reuse of sewage was in the food industry and it was used for irrigation and washing. The characteristics of the water sources, sewer and units based on the central wastewater treating unit are shown in Table 4.

Discussion

In this study, management of wastewater in 50 selected industries was evaluated by a questionnaire. Seventy percent of these industries had wastewater treatment units. From the evaluated industries, 47% discharged their industrial wastewater into the absorbent wells, 34% into surface water and 19% reused the wastewater for agriculture land (9). In the present study, the methods for wastewater discharge were absorbent wells, sewer and reuse in the greenbelt. Also, in the present study, 31.8% of the evaluated industries pretreated their wastewater before discharge.

The results of this study are not consistent with that of Farzadkia et al (9) who ranked the industries working in the west of Tehran according to quantity and quality of the produced industrial wastewater. In another study by Torabian and Mahjouri the situation of industrial wastewater produced in Tehran province in 1994-1998, the food, textile, metal and nonmetal mineral industries were studied. The results showed that in the food industry, 8%, drug industry 7%, paper making industry 13%, metal industry 17% and nonmetal mineral industry 33%, had a treatment unit with acceptable performance, but none of the paint making or cosmetic industries had a treatment unit. Also, the maximum sewage discharge into surface water in the food and textile industry was 62.5% and 48.8% and in the metal and non-metal mineral industry, in the underground water, it was 86% and 83%. The site of sanitary wastewater discharge in 50% was the sewer and in the other 50%, it was absorbent well. The site of processed wastewater discharge in 6% of the industries was septic tank, in 2%, it was reuse, in 46%, it was sewer and in 46%, it was absorbent well (15).

In the present study, the site of sanitary wastewater discharge in 50% of the evaluated industries was the sewer and in the other 50%, it was absorbent well. Also, the site for final discharge of processed industrial wastewater in 2% was reuse, 52%, sewer and 46%, absorbent well.

Shayegan et al conducted a study in Iran in 2004 on the situation of urban and industrial wastewater in Iran and their results showed that 3.9 billion m^3 per year urban wastewater was produced in Iran, and only 9% of it is treated and 91% is discharged in sinkholes, rivers or agricultural land. The amount of wastewater produced by polluting industrials in Iran in 2003 was 91 million m^3, in which only 31% of it was treated or recycled and the rest was discharged without treatment (5).

Lasut et al by analyzing the constraints and potentials for wastewater treatment in the coastal city of Manado in Indonesia in 2008, they showed that a wastewater management project is necessary for immediate prevention and reduction of pollution in wastewater. The constraints were land location, population increase, low income families, the variety of wastewater producing sources, weak resources and low capacity of wastewater treatment and disposal sites, weak governmental management, lack of local regulations and policies. The potentials were good environmental knowledge in the society, private and governmental organizations and the available guidelines and regulations (16).

The results of this study are in line with that of Torabian and Mahjouri (15). Discharging wastewater is the main reason for underground water contamination. Contaminated or untreated underground water can lead to waterborne diseases (17). Underground water is contaminated by pollutants released from urban landfills, absorbent wells, sewage storage tanks, oil and gas transfer lines and eventually the discharge of toxins, pesticides, chemical fertilizers from agriculture land (18).

In a study conducted by Arjmandi et al in 2007, the environmental effects of the Kaveh industrial park were evaluated. The Kaveh industrial park had a central wastewater treatment unit in which the wastewater of all industries

Table 1. The source of water in the surveyed industries

Water resource		Industry										
		Pharmaceutics	Machinery	Cellulose	Food	Leather	Agriculture	Nonmetal minerals	Electronics	Textile	Chemical	Metal
Drinking water	Network	0	0	(100)2	(22.2)2	(100)1	(100)1	(50)1	(100)2	(62.5)5	(62.5)5	(44.4)4
	Tanker	0	0	0	0	0	0	(50)1	0	(12.5)1	(12.5)1	(22.2)2
	Network and RO	(100)1	0	0	(77.8)7	0	0	0	0	(25)2	(25)2	(22.2)2
	Network and tanker	0	(100)1	0	0	0	0	0	0	0	0	(11.2)1
Sanitary	Network	(100)1	(100)1	(100)2	(100)9	(100)1	(100)1	(100)2	(100)2	(62.5)5	(87.5)7	(88.9)8
	Network and RO	0	0	0	0	0	0	0	0	(37.5)3	(12.5)1	(11.1)1
Processing	Network	0	(100)1	(100)2	(66.6)6	(100)1	0	(100)2	(100)2	(62.5)5	(62.5)5	(88.9)8
	Tanker	0	0	0	0	0	0	0	0	(12.5)1	0	0
	Network and RO	(100)1	0	0	(33.3)3	0	(100)1	0	0	(25)2	(25)2	(11.1)1
	Network and tanker	0	0	0	0	0	0	0	0	0	(12.5)1	0

Table 2. The wastewater pretreatment situation

Existence of a wastewater pretreatment unit	Industry				
	Food	Agriculture	Textile	Chemical	Metal
	(88.9)8	(100)1	(12.5)1	(37.5)3	(11.1)1
Type of process					
Chemical	(22.2)2	0	(12.5)1	(12.5)1	(11.1)1
Septic tank	(66.7)6	(100)1	0	(25)2	0
Sewage land fill					
Transfer with tanker	0	0	0	(12.5)1	0
Sewer	(88.9)8	(100)1	(12.5)1	(12.5)1	(11.1)1
Absorbent well	0	0	0	(12.5)1	0
Sludge discharge					
Transfer with tanker	(66.7)6	0	(12.5)1	(37.5)3	0

Table 3. The situation of processed wastewater and sewage discharge in the water treatment units

Wastewater discharge	Industry										
	Pharmaceutics	Machinery	Cellulose	Food	Leather	Agriculture	Nonmetal minerals	Electronics	Textile	Chemical	Metal
Sanitary											
Absorbent well	0	(100)1	0	(100)9	0	(100)1	(50)1	(50)1	(12.5)1	(50)4	(44.4)4
Sewer	(100)1	0	(100)2	0	(100)1	0	(50)1	(50)1	(87.5)7	(50)4	(55.6)5
Processing											
Absorbent well	0	(100)1	0	0	0	(100)1	(50)1	(50)1	(12.5)1	(37.5)3	(44.4)4
Sewer	(100)1	0	(100)2	(100)9	(100)1	0	(50)1	(50)1	(87.5)7	(50)4	(55.6)5
Reuse	0	0	0	0	0	0	0	0	0	(12.5)1	0
Sewage discharge of The treatment plant											
Absorbent well	0	0	0	0	0	0	(50)1	(50)1	0	0	(11.1)1
Sewer	(100)1	0	0	(77.8)7	0	0	0	0	(37.5)3	0	0
Greenbelt	0	0	0	(22.2)2	0	0	0	(50)1	0	0	0
Reuse of sewage	0	0	0	(33.3)3	0	0	0	(50)1	(12.5)1	(12.5)1	(22.2)2

Table 4. The characteristics of the water source, sewer and the units based on the central wastewater treatment unit

The source of water in the industrial park	A sail well of about 30 L/s and also water transfer to this site by tanker
Sewer	The wastewater treatment unit does not have the potential to accept any kind of sewage and only receives sewage which is in the standard range. Therefore, it is necessary that industries in which their sewage is not in the standard range, should establish pretreatment units. Otherwise, they will not be allowed to discharge their sewage into the sewer. In phase 1, most industries were connected to the wastewater collecting system. In phase 2, the drainage tubing was done, but the industries were not connected to the collecting system and released their wastewater in the streams.
Units based in the central wastewater treatment unit	The basis of the Shokoohieh industrial park's wastewater treatment is MBR. This process has substituted the usual treatment process (conventional activated sludge). After the MBR unit, ozone was used for eliminating biochemical oxygen demand (BOD) from the discharges of the secondary treatment process and also some organic chemicals from the discharge of the treatment unit. Then, in order to remove dyes, remaining organic material and also tiny colloidal material, 3 active carbon devices under pressure, each with 10 cubic meters per hour,were used. Eventually, the RO process was used for separating dissolved minerals from the water or used for irrigating the greenbelt and the other part is used for industrial purposes.

and residential areas, is collected by a wastewater collecting network and is then transferred to the treatment unit. Then, after passing the treatment steps, the effluent sewage from the treatment unit is discharged into a lagoon and from there it is used for irrigating the greenbelt of the industrial park (3).

In another study, Monavari et al in 2008, evaluated the environmental effects of industrial development in the city of Shahriar. Excluding the units available in the food industry, the number of industries equipped with appropriate wastewater treatment units in other industrial groups was limited and industries mainly discharged their wastewater without treatment and by incomplete treatment into the wells (4). In the present study, some of the industries (31.8% of the evaluated industries) discharged their wastewater into the Shokoohieh industrial park wastewater treatment plant after performing pretreatment. Other industries discharge their wastewater into the wastewater treatment plant without pretreatment.

A systematic approach towards the management of water and wastewater, especially in the industrial sector can solve the water shortage problem in Iran. In the Abbasabad and Aliabad industrial park in Tehran, the Khayam of Nayshabour, Aghghela of Golestan and Booali of Hamadan industrial parks, treated sewage was used for irrigating the greenbelts of the park (10). This approach was also considered in Kuwait and the Shuaiba industrial area. This area produced 31 000 m^3 of industrial wastewater and 3000 m^3 of sanitation and was the first industrial area in Kuwait that discharged its wastewater into the Persian Gulf without treatment. After principal management and treating this wastewater, all the produced wastewater in this zone were used for irrigating the greenbelt in this dry and water lacking area (19).

Astani in 2010 studied industrial wastewater management and its hazardous effects on the environment and his results showed that most industrial wastewater contains a high concentration of heavy metals and when these toxic metals are released into dumping sites, they pollute the soil, underground water and eventually the sea, and affect the life of aquatic animals and enter the food chain. As this industrial waste water eventually enters surface water and the rivers, it is necessary to evaluate the concentration of different pollutants in waste water and this has to be done before they get discharged into surface water (20).

Cirelli and Ojeda conducted a study in 2008 in Buenos Aires, Argentina on wastewater management and stated that wastewater treatment facilities in the discharge sites should obey regulations on wastewater discharge in the rivers of Buenos Aires. Also, wastewater treatment facilities should be built in different sites for water treatment (21).

In the present study, part of the treated sewage from the treatment plant of the Shokoohieh industrial park was used for irrigating the greenbelt. Reuse of treated wastewater can solve the water shortage problem and can prevent underground water and environmental pollution. The concentration of pollutants in the wastewater entering the Shokoohieh wastewater treatment plant has to be in a specific range. Therefore, in some industries in which the concentration of some pollutants is high, building pretreatment units is necessary. In our visit to the industries, in some industries, the pretreatment unit was out of place or switched off. Because of the high mineral content of Qom's water resources, a water purifying unit was needed in some industries. The results of this study showed that the rate of sewage reuse in the process and other applications is very low. The water crisis in Qom province highlights the reuse of treated wastewater. The industries in the second phase were not connected to the wastewater network and most industries released their wastewater into the absorbent well or surface water wastewater, which can lead to underground water contamination and environmental pollution.

Conclusion

This study presents an overview of the wastewater management at the Shokuhieh industrial park located in Qom city. The results of this study showed that pretreatment is not done in most industries and wastewater reuse is performed in few industries. The main methods of wastewater disposal in industries were discharge into the sewer and absorbent well. The practice of reusing treated wastewater for landscape irrigation in Qom is useful and successful. It will provide a valuable source of water for reuse in special irrigation. About 32% of total produced wastewater was pretreated. The type of pretreatment process in 35.7% of industries was chemical process and in 64.3%, it was septic tank. Considering these constraints and potentials, industries involvement should be increased through an environmental education program.

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Ethical issues

It is certified that all data collected during the study are presented in this manuscript and no data from the study has been or will be published separately.

Competing interests

The authors declare that they have no competing interests.

Authors' contributions

Mohammad Fahiminia and Mahdi Farzadkia designed the study. Monireh Mirzabeygi Arhany and Naser Yousefi collected the data. Hossein Jafari Mansoorian and Gharib Majidi performed the literature search and wrote the manuscript. Narges Khanjani carried out statistical analysis and significant improvement in English. Every author

participated in the data acquisition, analysis and interpretation and critically reviewed, refined and approved the manuscript.

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