

Environmental Study on Discharged Wastewater of Albourz Industrial City

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Abstract

The treatment facility of Albourz Industrial City was established in 1999 at the southeast of Albourz Mountain with an area of 200,000 square meters. Currently, 40,000 cubic meters of industrial wastes are treated daily utilizing biological method of activated sludge up to the second phase without chlorination in this treatment facility. Then, the discharged wastes are directed toward the lower agricultural lands. The environmental status of the region was investigated by testing the impact of wastewater and agricultural products in four tries. In two tries, the levels of COD and BOD were higher than the environmental standards, but there was no trace of heavy metal contamination in any of the tests. In order to make inquiry about the general health of the residents and domesticated animals, a questionnaire for the farmers and animal of husbandmen was prepared. The residents were dissatisfied with the utilization of wastewater for their domesticated animals. However, farmers were content and satisfy due to their need to compensate the shortage of cultivation water with the freely available discharged wastewater of the industrial city. Because there is no enough water in Iran, they have to buy water from tankers. In the other way wastewater of Albourz industrial city had some metals and mineral materials, so it effected on growth of agricultural product, this shows a little bit of metals and mineral materials is useful for plants. An inquiry about the status of public health and diseases transferred by water was conducted and local physicians were interviewed and statistical data was collected. The number of reported cases of cholera and typhoid was low, but the number of parasitic disease cases due to remains of human waste in water was quite high. Approximately, most of the local residents were suffering from stomach-aches related to parasitic disease and physical weakness. It is recommended that the Department of the Environment conduct educational programs for the employees of Industrial Cities in order to persuade them on the benefits of mandatory chlorination process in the treatment facility for the sake of employees and public health. Meanwhile, related laboratory tests to be followed up and studied by pertinent organizations to ensure proper management and planning of the discharged wastewater resources; the wastewater is a valuable source of irrigation water.

Keywords: *Environmental health, Wastewater management, Iran*

Introduction

According to the policy of industrial states and cities in Iran, all industries can be established only in 120 km far from Tehran, capital of Iran (1). According to this rule, the biggest industrial city of Iran was established in Qazvin near Tehran. Albourz Industrial City (AIC) was established 13 kilometers from the city of Qazvin at its southeastern wing in 1966. The area of the land is 860 hectares. As it is shown in Table 1, currently, there are 359 active semi-heavy

and light industrial units in this place, and all the categorized industries are active (2).

The required water for industrial purposes are provided by the 13 water wells, which three of the wells are utilized after water chlorination for the consumption of the employees and residents of the industrial city. The industrial wastes were discharged into the leaching pits without any kind of treatment or were directly released through open trenches to the lower agricultural lands. Until the year 2000, the treat-

ment facility of the industrial city was not operational.

From the year 2000, at the far end of the industrial city's south wing, the treatment facility was established in a land with an area of 200,000 square meters. The wastewaters were collected through canals or trucks and were directed into the pits connected to the treatment facility's entrance pool and afterwards the wastewaters were treated with biological method of activated sludge up to the second treatment stage without chlorination.

Along side the AIC, there is the Alvand Residential Complex hosting the industrial city's employees. The human wastes produced by this residential complex along with the industrial wastes of the industrial city are treated together. After treatment, the discharged wastewater of AIC is released free into the lower farmlands for the irrigation of agricultural crops. The main crops at the vicinity of the treatment plan were: corn, barely, wheat. Due to the precedence of AIC, it enjoys better electric, gas and telephone facilities in comparison with the other newly established industrial complexes. Also, it doesn't encounter predicaments like lack of proper access roads, gas station and health facilities. A total of 50000 employees work in this industrial city that are mostly from the rural areas and Qazvin province. For information of pollution of treatment wastewater on environment (water, soil, animals and health of people) was studied by testing in laboratories and questionnaires (2).

Table 1: The statistics of industries situated in Albourz industrial city

| # | Type of Industry | Number of Units |
|---|--|-----------------|
| 1 | Food Industries | 11 |
| 2 | Textile, Clothing and Leather Industries | 52 |
| 3 | Cellulose Industries | 30 |
| 4 | Chemical and Plastic Industries | 95 |
| 5 | Non-Metal Mining Industries | 29 |
| 6 | Metal Industries | 80 |
| 7 | Machinery Industries | 7 |

| | | |
|----|---|-----|
| 8 | Automotive Industries | 11 |
| 9 | Electric, Electronic and Household Industries | 33 |
| 10 | Light and Miscellaneous Industries | 8 |
| | Total | 359 |

Materials and Methods

First, the current status of AIC was studied and the number of industrial units, type of pollution based on the process and type of production were categorized. Afterwards, data and information on waste treatment system, type of treatment, means of wastewater transportation and disposal, and the amount of wastewater were collected. After theoretical studies, field studies were conducted in two categories, namely laboratory tests and questionnaires. Laboratory tests included tests on water, soil, plants irrigated with wastewater (stem, leaf and seed), and discharged wastewater as well as sewage prior to treatment. These tests were performed in four seasons.

Also, samples of the entering wastewater into the treatment facility and the wastewater after treatment prior to their discharge into the farmlands were taken for further laboratory tests on the level of wastewater contamination and their correlation with the standards, especially standards related to irrigation of agricultural lands.

Moreover, in order to ensure the health of the residents and the domestic animals, a questionnaire was prepared for the farmers, or they were interviewed on spot and then the questionnaires were filled out according to their responses. Also, the local physicians were interviewed. There are two health houses and a clinic in the region and their registration forms were searched in order to determine the number of diseases related to water pollution. Unfortunately until the year 1998, here was no categorized registration of patients based on their illnesses. All the statistics prior to the year 2000 are scattered, but after that the registered statis-

tics are more complete and more comprehensive.

The questions were modified with the assistance of a sociologist and an environmental expert later on. The objective of the questionnaire was to inquire about the water related diseases and the impact of discharged wastewater on public health as well as the food chain. The rural population of the region is 12,000, which all could potentially drink from the wells. Thus, population was randomly interviewed for the questionnaire and the farmers and animal husbandmen filled out a total of 400 questionnaires at various time intervals. The questionnaires were read at their presence and questions were asked. Due to animal husbandmen's low level of education, some of the questions were explained to them.

Finally, the information was compared with EPA (Environmental Protection Agency), the environmental standards utilizing charts and tables in America (3).

Results

None of the tests indicated any levels of heavy metals exceeding the environmental standard and the numbers were relatively small. However, the incoming wastewater showed numbers exceeding the standards that are indicated in (Table 2).

In autumn and winter, the treated wastewater was contaminated, the levels of BOD and COD was higher than the environmental standards (2). Other pollution indicators like temperature; TOC and EC were below the standard levels.

With the collaboration of Department of the Environment Bureau in Qazvin Province, stations were set up in various locations down to the lowest irrigation areas in order to study the contamination of underground water. Due to the steep slope of agricultural lands at the lower sections namely in Shahrestanak and Shir-Esfahan regions, the levels of EC, COD, TDS and BOD were a bit higher than other stations.

From the underground waters of the lower lands, samples were taken from stations, which are shown in Table 3. In the above-mentioned stations, *Coli form* pollution was detected and three stations showed *Escherichia coli* along with *Enterobacteria* contaminations.

Sampling stations were located at the vicinity of discharged wastewaters and all stations revealed *Coliform* contamination. Some of the stations contained *Hetero Coliforms* pollution (Table 3). In tests conducted on the stem, leaf and seed of corn, wheat and barely, concentration of heavy metals and contamination was not detected (Tables 4, 5).

According to Table 6, soil tests were taken from 10 different regions with the chance of wastewater contamination and the samples taken from the surface level and depths of 200 and 500 meters, showed no traces of contamination.

Totally, there was not any heavy metals in soil and agricultural products of the region, that was irrigated by the wastewater of AIC, but there was *Coli form* pollution from human wastewater of employees work in this industrial city that are mostly resident in complex hosting the industrial city's employees. Because wastewaters were treated daily utilizing biological method of activated sludge up to the second phase without chlorination in this treatment facility.

Most of the statistics are for the parasitic and intestinal diseases. According to statistics that were registered in books of public health, the most population in the region suffers from parasitic diseases and the physical weakness of the residents was evident in the interviews.

After test, in order to make inquiry about the health of regional people and animals, have the questionnaires were completed.

The results of the questionnaires are as follows:

- 1- 80% consumed water from the wells for drinking, hygienic and agricultural purposes.
- 2- 50% had private bath in their homes.
- 3- 90% answered consumed water from the pipeline, tankers and wells simultaneously.

4- 100% of the cultivation was both rain-fed and water-fed. The main crops were: 50% corns, 30% barely, 20% wheat.

5- 40% of the consumed water was purchased by tankers.

6- There were 5 primary schools with 8 classes and 3 junior high schools with 3 classes. Thus, there were a total of 12 classes with 360 pupils in the region. Only 50% of the youth populations were able to attend classes. There were 3 active clinics in the region.

7- A total of 70% of the population suffered from intense stomach pains, they suffered from parasitic diseases, which were the source of intense stomach pains.

8- 100% of the populations were satisfied with the free of charge wastewater. Therefore, the locals were inclined to consume less water brought in tankers.

9- 100% of the consumers were satisfied with the discharged wastewater of the industrial city, because they believed it had improved their crops (Discharged wastewater of AIC had a little mineral materials and metals).

10- 90% of the lands at the upper parts close to the water treatment facility of the treatment plant did not encounter shortage of water. However, the lands on the lower side in addition to discharged wastewater of the industrial city, consumed water from wells and tankers.

11- 40% of the lands on the lower side received water from the industrial city.

12, 13- There were no educational programs offered to them in regard to the water pollution by any of the institutions. They were incised to answer only 'yes' or 'no'.

14- 20% reported to have skin and long cancer.

15, 16, 17, 18- Due to their poor knowledge and low education, all of the questions in regard to the disease were answered incorrectly.

19- Peoples did not answer about water-born diseases.

20- 70% knew what "polluted water" was.

Table 2: Average annual heavy metals in treated wastewater of Albourz city

| Pollutant | Concentration mg/l | Wastewater discharge standard for agricultural and irrigation use mg/L |
|-----------|--------------------|--|
| Cadmium | 0.42 | 0.05 |
| Iron | 0.38 | 2 |
| Lead | 0.39 | 1 |
| Chrome | 0.50 | 1 |
| Nickel | 0.12 | 2 |
| Barium | 0.27 | 1 |
| Cobalt | 0.44 | 0.05 |
| Copper | 0.13 | 0.2 |
| Zinc | 0.77 | 2 |

Table 3: Number of parasitic contaminations in the stations

| Name of Bacteria | No. of Stations | % of <i>Coli form</i> Total in the region | Ratio to the total <i>coliform</i> samples | Ratio to the <i>E.coli</i> samples |
|-------------------------|-----------------|---|--|------------------------------------|
| <i>Coli forms</i> | 6 | 30 | - | - |
| <i>Ecoli</i> | 3 | 15 | 0.5 | 1 |
| <i>Citro Bacteria</i> | 3 | 15 | 0.5 | 1 |
| <i>Enterobacteria</i> | 3 | 15 | 0.5 | 1 |
| Hetero <i>Coli form</i> | 1 | 5 | 0.16 | 0.33 |
| <i>Escherichia</i> | 1 | 5 | 0.16 | 0.33 |
| <i>Porudensia</i> | 3 | 10 | 0.33 | 0.66 |

Table 4: Analysis of corn seeds, the agricultural product of the region that is irrigated by the wastewater of Albourz industrial city, 2002

| Pollutant | Concentrationmg/L | Reproducibility %RSD | Average |
|-----------|-------------------|----------------------|---------|
| Cadmium | - 0.04 | 74.7 | - 0.002 |
| Iron | 0.562 | 6.3 | 0.107 |
| Zinc | 0.5413 | 0.2 | 0.391 |
| Chrome | - 0.29 | 22.2 | - 0.004 |
| Lead | - 0.25 | 8.1 | - 0.020 |
| Nickel | 0.38 | 10.3 | 0.007 |
| Cobalt | 0.04 | >.00 | 0.002 |
| Cupper | - 0.11 | 5.2 | - 0.003 |

Table 5: Analysis of corn leaves, the agricultural product of the region that is irrigated by the wastewater of Albourz industrial city, 2002

| Pollutant | Concentration mg/L | Reproducibility %RSD | Average |
|-----------|-----------------------|-------------------------|----------|
| Cadmium | - 0.005 | 76 | - 0.0003 |
| Iron | 0.672 | 8.2 | 0.0107 |
| Zinc | 0.543 | 0.2 | 0.0392 |
| Chrome | - 0.03 | 23 | - 0.003 |
| Lead | - 0.35 | 9.5 | - 0.0030 |
| Nickel | 0.035 | 10.7 | 0.0006 |
| Cobalt | 0.004 | 0 | 0.0002 |
| Cupper | - 0.08 | 6 | - 0.0002 |

Table 6: Average levels of heavy metals in soil in correlation with permissible standards

| Pollutant | Concentration mg/L | Maximum potential permissible concentration of toxic elements in soil |
|-----------|-----------------------|--|
| Cadmium | 0.30 | 3.5 |
| Iron | 0.385 | - |
| Zinc | 0.36 | 330 |
| Cobalt | 0.162 | - |
| Lead | 0.71 | 300 |
| Nickel | 1.302 | 80 |
| Chrome | 0.841 | 600 |
| Cupper | 192.5 | 130 |

Discussion

After imperfect treatment, the discharged wastewater of AIC is released into the lower farmlands for the irrigation of agricultural crops. But many countries discharge perfect treatment like China, Australia, Canada and so on (3). In the tests conducted on water, soil and irrigated plants (corn, wheat and barely), no indication of environmental pollution was ob-

served (4). Nonetheless, they were not much higher than the environmental standards (2). Meanwhile, in interviews made with the local farmers for the purpose of filling out the questionnaires, they expressed utter satisfaction with the usage of wastewater, since it has resolved their main concern for shortage of irrigation water. Due to the presence of small traces of heavy metals, they crops had better growth (4).

Lands right on the route of the wastewater had higher economic value in comparison to the lands adjacent to the road (the asphalt pavement of the road prohibited the crossing of the wastewater). Although, there are only traces of heavy metals in the water and are beneficial in terms of crop productivity in the short term, their accumulation in the long run could have adverse effects on the environment and plants and even could affect human health by entering into the food chain like America, China, Canada, (8,9). Thus, it is the duty of the Department of the Environment to conduct regular tests and laboratory experiments in the future in order to ensure the integrity of the nature and the environment as well as the proper health and well being of the humans, domesticated animals and plants in the region.

Due to the presence of parasitic diseases and the high statistical data gathered by the local physicians on this issue, and according to guideline of United Nation (13), it is recommended that the Department of the Environment and the pertinent ministries obligate the Industrial Cities to add chlorinating phase to its treatment process. Moreover, the cost of chlorine is relatively inexpensive in comparison to the annual operational and maintenance cost of the treatment system in our country. Therefore, it is the duty of the Department of the Environment and the Ministry of Health to educate the management of the Industrial City and persuade them to implement the chlorinating phase for the sake of public health and well being, or use technical of environmental economic like punishment or subsidies affects for reduction of pollution that is used in some countries like America, Europe Australia and China (14).

This shows that treatment needs third phase, like use of ozone or UV or the other methods for reduction of pollution, in Australia wastewater water, for all purposes treated until third stages. Moreover, the Department of the Environment, Non-Government Organizations, Ministry of Jihad Agriculture and the Ministry of Health ought to train and educate the consumers of the

wastewater on the positive and negative aspects of wastewater consumption and the related water diseases. This task is more essential and worthwhile, when it comes to the education of animal husbandmen who lack adequate reading and writing skills and don't have correct information on the subject of water related diseases. Moreover, proper management of wastewater is quite necessary due to the lack of adequate irrigation water in the country and its environmental and economic value. Thus the freely discharged wastewater into the lower agricultural lands should not deter us from preparing a comprehensive plan to promote efficient utilization of wastewater and prevent its evaporation in the upper hand lands.

Finally, usage of new and advanced methods of irrigation like condense droplet irrigation should be practiced in order to irrigate more agricultural areas.

References

1. Statistical Year Book (1998-99, 2000). Iran Statistical Center, planning & Budget Organization.
2. Asghari S (2003). Management of Discharged Wastewater of Albourz Industrial City from an Environmental Economics Perspective, PhD Thesis, Supervisor Professor: Dr. Mehdi Borghei, Islamic Azad University, Science & Research Campus.
3. Asghari S (1998). Environmental Management of Rasht Industrial City, Master's Thesis, Supervisor Professor: Dr. Mehdi Borghei, Islamic Azad University, Science & Research Campus.
4. Caswell M, Ziberman D (1993). The choices of irrigation technologies in California. *Am J Agric Econom*, p.67.
5. Hamiltoo FE Ian (1981). Spatial analysis of industry and the environmental management. *International Industrial systems*, 86(2): 1-77.
6. Hartman R, Huq M, Wheeler D (1976). Why paper mills clean up: Determinants

- of pollution abatement in four Asian countries. *World Bank policy research report*, 320:171-99.
7. Nelson N (1989). *Industrial Wastewater*. Translated by Asadi, M., Tehran University Press.
 8. Rosegrant MW, Binswanger HP (1994). Markets in tradable water rights: Potential for efficiency gains in developing country water resource allocation. *World Development*, 22: 1-22.
 9. Roselle's XMa, Ortolano L (1993). Industrial wastewater control in Chinese cities: Determinants if success in environmental policy. *Natural resource modeling*, 35:1-19.
 10. Smith JB, Sims WA (1985). The Impact of pollution charges on productivity growth in Canadian Brewing. *Rand Journal of Economics*, 16(3): 234-45
 11. Soltani M (2001). Industrial Wastewater and its impact on the environment. *Scientific Information Res*, 3: 58-82.
 12. United Nation (1978). Guidelines for establishment of industrial estates in developing countries. 63: 12-58.
 13. United Nation, environmental programmed (1995). Guidelines for the identification of environmental impacts of industries in the Arab region. Cairo, 1-74
 14. Wilchens D (1991). Motivating reductions in drain water with block-rate prices for irrigation water. *Water Res*, 27: 585-92.

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