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Short Communication

Investigation of volatile organic pollutants in atmospheric air in Tehran and acetylene pollutants in Tehran qanat waters

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ABSTRACT:

The United Nations General Assembly interprets the issue of air pollution and its consequences as a common concern of humanity, and the growing development of an international flow calls for immediate and decisive action against it. Therefore, air pollution is one of the today's problems in the world. Air pollutants are a major contributor to environmental pollution since they do not only affect the ecosystem directly but also indirectly pollute the rains, surface waters, and groundwater's and endanger human life. Therefore, the present study was carried out to investigate the relationship between volatile organic pollutants in the urban atmosphere and acetylene contamination in Tehran qanat waters. The present research is a library type. Air pollutants have been investigated by the organization for controlling the quality of air pollution in Tehran for a five-year period of measurement of atmospheric volatile organic components. Measuring pollutants in groundwater was done through a monthly sampling of stations. SPSS software was used to analyze the statistical data. The results showed that there is a significant relationship between volatile organic pollutants in the urban atmosphere and acetylene contamination in the city of Tehran. The source of acetylene pollutants in Tehran's qanat water is atmospheric and caused by rainfall or precipitation of air pollutants and their entry into the groundwaters.

Keywords:
Acetylene pollution, Organic pollutants, Urban atmosphere, Qanat waters.

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INTRODUCTION

Air pollution in Tehran has always been one of the most important environmental problems of the past three decades (Zahed *et al*., 2010). Despite the statistics on the comparison of Tehran's pollutants with world standards, the claim is not far from real, if we consider the main environmental problem in Tehran as an air pollution issue. Fuel consumption in different sectors result in the production of particles and gases that continuous exposure creates problems and complications for human health and other living organisms, and this is only part of the effects of air pollution (Nazarian *et al*., 2007). Tehran is limited in three directions by the Shemiran, Karaj and Damavand heights, and has only a mild slope in the south. The lack of air mobility, especially in autumn and winter, causes pollution accumulation in the eastern hills of Tehran. Wind, which is one of the most important contributing factors for the outbreak of pollution, acts as an agent for the transmission of pollution from the north to the south and vice versa, with the majority of these winds having a speed of less than 3 m/s.

The more stability of the air, especially in the autumn and winter, causes the genesis of the necessary conditions for the occurrence of the heat inversion phenomenon and the density of pollution at the ground level and the level of people's respiratory and endangers their health. Tehran's weather is much more polluting than the maximum in most of the year (Karimi, 2012). It can be said that the most important pollutants in the atmosphere due to the smoke of factories and power plants and exhaust cars are sulfur oxides, nitrogen oxides and Volatile Organic Components (VOCs). The most important volatile organic components are benzene, ethylbenzene, toluene, butadiene 1 and 3 and xylene (Nazarian *et al*., 2007). On the other hand, one of the most dangerous methods of contamination of ground waters in populated and polluted cities, including Tehran, is as acid rain in the cold seasons and the flow of water from these rainfalls in the underground aquifers. In populated cities, air pollution is a common phenomenon in the fall and winter seasons, and since precipitation in the two seasons reaches its maximum Khaki (2004), hence the incidence of contaminated gases in the atmosphere reaches its highest level and its penetration into underground aquifers causes pollution of these water sources. The chemical pollution of these water resources will have a significant impact on the health of citizens (Boostani A and Ansari, 2011). These effects can directly have carcinogenic, mutagenic and teratogenic properties, which, in other words, can increase the risk of developing various cancers. It can also indirectly affect the ability of reproduction of citizens. Therefore, the overall aim of this study is to determine the amount of air pollution in Tehran to volatile organic components on the quality of groundwater resources. This paper attempts to investigate the contamination of Tehran's qanats as groundwater sources in the city by the BTEX index (including benzene, toluene, ethylene benzene and xylene compounds) in the atmosphere and the statistical relationship between them.

Rashidi and Almasian (2014) reported that the total concentration of volatile organic components in the air of Khorramabad city was 1140.9 $\mu g/m^2$ which is about 7 times than the USEPA maximum, in a study entitled evaluation of volatile organic components in the air of Khorramabad and comparing it with existing standards. Also, the findings showed that BTEX kidney concentration in different parts of Khorramabad city was more than the standard EPA standard for respiratory air. Comparing the mean of volatile organic components concentration in Khorramabad city in warm and cold seasons, the results of statistical tests showed that there was a significant relationship between benzene and toluene concentration and season of the year. (Karimi, 2014) reported the results in the results showed that the greatest concentration and severity of this pollutant occurs during the warm period of the year, *i.e.* in June

and August, the most important patterns of circulation that explain it are low surface and tidal pressure, although the ozone levels were observed in other seasons. Generally, what causes the density of ozone tropospheric in the metropolis of Tehran is superficial stability because of the stability; atmospheric photochemical processes of the atmosphere and subsequent ozone concentration increase the troposphere. The factors contributing to this sustainability are high-pressure patterns such as tidal pressure in the summer as well as high-pressure thermal patterns on the earth's surface, such as high-pressure Siberia in winter. Asadi *et al*. (2013) in a research that aimed to investigate a number of volatile organic components in the air of Tehran, showed that half-day traffic, cooking at noon, and wind speed at noon as low as possible cause the average BTEX concentration reaches its peak at noon. Due to the high ability of p-xylene to become photochemical pollutants, high levels of p-xylene are hazardous. The seasonal comparison of benzene at the Darrous station showed that the amount of this pollutant during the summer months is higher than in the fall months. Also, the annual comparison at both Darrous and Fath stations showed that BTEXs have increased in 2012 compared to 2013. Zahed *et al*. (2010), in their report on acetylene contamination remnants in Tehran, showed that the collected rainwater specimens contained the average of polycyclic aromatics concentration (total 16), the BTEX index (including benzene, toluene, ethylbenzene and xylene compounds) and the gasoline range acetylenes (C_5-C_{11}) and diesel range acetylenes (C_{12}-C_{20}) were in the range of 372-527, 78-188, and 190-195 µg/L, respectively. In a study, the emission factors for suspended particles with a diameter of fewer than 2.5 microns and 10 microns from almond harvesting in California were compared with the two models of ISCST3 and Aermod with monitored values (Faulkner *et al*. 2009). In a study, mercury vapors from four coal-

Table 1. Average volatile organic compounds at different stations by year (in terms of ppb)

S. No	Urban districts	Year (AHS)						
		2012	2013	2014	2015	2016	2017	Mean
1	Aqdasiyeh	1.24	0.63	0.11	1.74	0.85	0	0.761
2	District 2	-	-	-	0	0	0	0
3	Darrous	-	6.63	0.385	2.2	30.73	0.2	8.72
4	District 4	0	0	0	0	0	0	0
5	Golbarg	3.75	5.79	2.25	1.76	0	2.71	2.71
6	Mahallati	-	1.33	1.93	7.8	20.67	15.45	9.43
7	Masoudieh	3.62	3.94	0	6.07	0	2.73	2.72
8	District 16	0	0	0	0	0	0	3.62
9	District 19	0	0	0	0	0	0	0
10	Shahr-e- Ray	5.41	2.35	6.54	3.81	0	3.63	0
11	Punak	4.24	0.58	7.39	3.83	0	3.21	2.96
12	Shadabad	-	0.21	1.71	6.82	3.12	2.97	9.82
13	Rose Park	-	-	24.64	1.09	3.75	9.83	3.2
14	Fath	2.16	0.19	0.05	0.74	3.75	1.38	1.37
15	Sharif University	-	-	24.64	1.09	3.75	9.83	9.82
16	Tarbiat Modarres University	-	-	2.09	29.63	0	2.10	8.45
17	Crisis Staff	-	6.40	2.15	13.7	0	6.41	5.73
18	District 11	0	0	0	0	3.75	0.75	0.75

Table 2. Variance analysis test results to evaluate the concentration of volatile organic compounds at different stations

S. No	Pollutant	Source	Sum of squares	df	Mean of squares	F statistic	Significant level
1	VOCs	Intergroup	1141.92	18	63.44	2.123	0.012
		Intragroup	2450.41	82	29.88		
		Total	3592.34	100			

fired power plants in the city of Alberta, Canada, were modeled in 60x60 squares, along with 169 receptors with the AERMOD model, and compared with the values recorded at the two monitoring stations (Mazur *et al.*, 2009).

MATERIALS AND METHODS

Air pollutants were investigated by the five year data collection of atmospheric volatile organic components from Tehran air pollution quality control organization and zoning and comparison of urban districts in terms of pollutants Table 1. Measurement of pollutants in ground waters was determined through the establishment of stations including the qanats in the city of Tehran, the control station in the non-urban district, monthly sampling of the stations and the measurement of a number of acetylene contaminants. For statistical analysis, first, the normalization (homogeneity) of data was investigated using the Kolmogorov-Smirnov test. In order to compare the air and water pollutants between the stations, ANOVA (in the case of homogeneity of data) and Kruskal-Wallis (in case of non-homogeneity) were used. Also, the statistical relationship between organic pollutants in the air with the same type of compounds in groundwater was investigated by two-tier Pearson correlation (if normal) and linear regression. Data were analyzed using SPSS software version 20 and Excel software was used for drawing figure.

Findings

The status of air pollutants in air quality control stations in Tehran. The volatile organic components (VOCs) at the stations of the Tehran air quality control organization include Aqdasiyeh (district 1), district 2, Darrous (district 3), district 4, Golbarg (district 8), Piruzi (district 13), Mahallati (district 14), Masoudieh (district 15), district 16, district 19, Shahr-e-Ray (district 20), Punak (district 5), Shadabad (district 18), Rose Park (district 22), Fath (district 9), Sharif University (District 2), Tarbiat Modares (District 6), Crisis Staff (District 7), and District 11.

The results showed that Sharif University stations and Rose park with an average of 9.82 ppb are the most polluted districts with volatile organic components. On the other hand, in the districts of 2, 4, 16, and 19 of Tehran during the years 2012 to 2017, no pollution has been recorded for these pollutants. Considering that the level of significance is more than 0.05, therefore, there is no significant difference between the observational and expected frequency of the measured component and the distribution of the population is normal. Therefore, parametric tests can be used for statistical comparisons.

Variance analysis results and comparison of air pollutants averages in different districts of Tehran. Based

Table 3. General results of descriptive statistics of measured parameters

S. No	Variable	Number	Mean± SD	Minimum	Maximum
1	Benzene (ppb)	24	5.21± 6.39	0.20	30.22
2	Xylene (ppb)	24	0.277±0.056	0.06	0.92
3	Toluene (ppb)	24	<0.01	<0.01	<0.01
4	Ethyl benzene (ppb)	24	<0.2	<0.2	<0.2

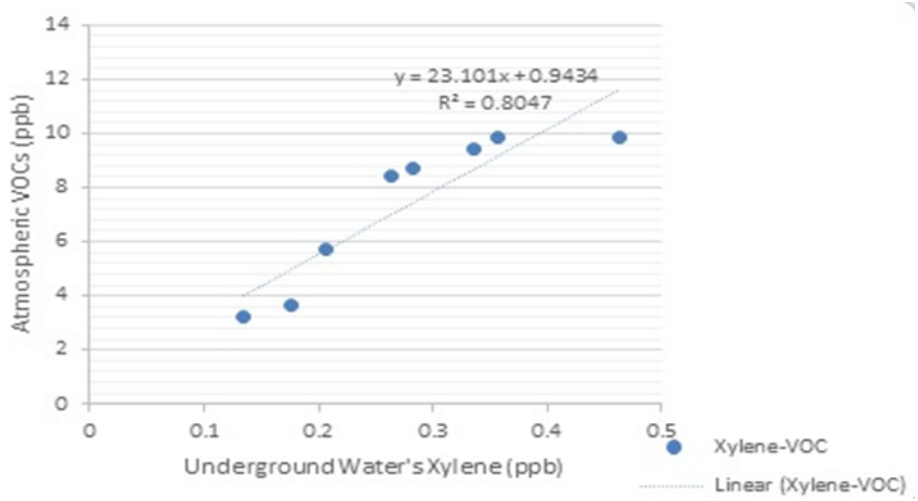

Figure 1. Relationship between atmospheric volatile organic components and xylene in groundwater

on the results in a Table 2, given the fact that the significant level is less than 0.05, the assumption of the equality of the average concentration of volatile organic pollutants in different sampling stations are rejected. Therefore, the effect of concentration factor of these indices on different sampling stations are significant.

The status of organic pollutants in the water of Tehran qanats

Table 3 shows the general results of measurement of light acetylene contaminants including benzene, xylene, toluene, and ethylbenzene in Tehran's qanats with a ppb unit. According to the Table 2, the benzene value was measured over the statistical period with an average of 5.21 (micrograms per liter or ppb). In addition, the amount of toluene and ethylbenzene in all the qanats was <0.01 and <0.2 mg/l, respectively. Due to these statistics are constant in sampling and in all the qanats, performing inferential statistics on these two issues will be meaningless. Considering that the significance level is more than 0.05, therefore, there is no significant difference between the observational and expected frequency of all components, and the distribution of the community is normal. Therefore, parametric tests can be used for statistical comparisons.

According to the results presented in Table 4 and in accordance with the significant level is greater than 0.05, the assumption of the equivalence of the average benzene concentration at the sampling stations is acceptable. Therefore, the effect of concentration of this type of acetylene pollutant in different sampling stations is not statistically significant. In other words, there is no significant difference among the various sampling stations at the concentration level of benzene.

Analysis of xylene variance in water

The results of one-way ANOVA are presented in Table 5 to compare the different sampling stations in the xylene mean. Therefore, the effect of concentration of this type of acetylene contaminants in different sampling stations is not statistically significant. In other words, there is no significant difference among different sampling stations at the concentration of light acetylenes. According to the results presented in Table 5 and in

Table 4. Variance analysis test results to evaluate the concentration of benzene at different stations

S. No	Pollutant	Source	Sum of squares	df	Mean of squares	F statistic	Significant level
1	VOCs	Intergroup	313.403	7	44.772	1.142	0.386
		Intragroup	627.151	16	39.197		

Table 5. Variance analysis test results to evaluate xylene concentration in different stations

S. No	Pollutant	Source	Sum of squares	df	Mean of squares	F statistic	Significant level
1	VOCs	Intergroup	0.242	7	0.035	0.370	0.907
		Intragroup	1.492	16	0.093		
		Total	1.733	23			

accordance with the significant level is greater than 0.05, the assumption of the equivalence of the average xylene concentration at the sampling stations is acceptable. Therefore, the effect of concentration of this type of acetylene pollutants in different stations is not statistically significant. In other words, there is no significant difference among different sampling stations at the concentration of light acetylenes.

Statistical relationship between volatile organic components in qanat waters and urban atmosphere

The amount of benzene in groundwater's and VOC pollutants in the air have a statistically significant relationship (P<0.05). The coefficient of determination indicates that the severity of the relationship is moderate (R^2 = 0.506) and is positive (direct). The volatile organic components and the xylene of qanat waters of Tehran have a statistically significant relationship. Based on Figure 1, the coefficient of determination is robust (R^2 = 0.850) and the statistical relationship is positive and direct.

The findings of the research are summarized as follows:

- There is a significant statistical difference among the stations of the Tehran air pollution quality control organization in a number of volatile organic components in the atmosphere. As a result, stations in the districts 2, 4, 16 and 19 of Tehran municipality have the lowest pollution levels (0 mg/l) with volatile organic components and have significant differences with other stations while the stations at Sharif University and Rose park with the values of 9.82 ppb without statistically different from each other are significantly different from the others and are the most polluted districts. In the districts 2, 4, 16 and 19 of Tehran during the 2012-2017 no pollution was reported to this type of pollutant.
- There is no significant difference among the various sampling stations of Tehran qanat waters in the concentrations of benzene and xylene. The amount of benzene was measured over the statistical period with an average of 5.21 (micrograms per liter or ppb). The concentrations of benzene and xylene are close to each other in all stations and in the range of 1.2 to 13.5 and 0.1 to 0.9 mg/l and there is no statistical difference among them. The amount of toluene and ethylbenzene in all the qanats was recorded as <0.01 and <0.2 mg/l, respectively.
- Benzene and xylene in groundwater with VOC pollutants in the air have a statistically significant relationship (P<0.05). The coefficient of determination indicates that the intensity of the relationship for these acetylenes is moderate (R2 = 0.506) and strong (R2 = 0.850), respectively and is positive (direct).

CONCLUSION

The present study showed that there is a significant (statistical) relation between volatile organic pollutants in the urban atmosphere with the acetylene contamination of Tehran qanat waters. The source of acetylene pollutants in the Tehran qanat waters is atmospheric and caused by the precipitation or subsidence of air pollutants and their entry into ground waters.

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