AENSI Journals

Advances in Environmental Biology

ISSN-1995-0756 EISSN-1998-1066

Journal home page: http://www.aensiweb.com/AEB/

Measurement of nitrate, nitrite and chloride concentrations in potable water sources (Case study: Ardabil City, Iran)

[1]Nahid Zeinizadeh Jeddi, [1]Fatemeh Nasehi, [1]Ebrahim Fataei, [2]Morteza Alighadri

[1]Department of Environmental sciences, Ardabil Branch, Islamic Azad University, Ardabil, Iran.
[2]Assistant Prof Of Environmental Health Engineering, Ardabil University Of Medical Science, Ardabil, Iran.

ARTICLE INFO

Article history:
Received 12 October 2014
Received in revised form 26 December 2014
Accepted 1 January 2015
Available online 17 February 2015

Key words:
nitrate, nitrite, chloride, pollution, potable water, Ardabil City

ABSTRACT

Water quality has great importance for humans, because it is directly connected to their well-being. Thus, monitoring water quality parameters are critically important. In this descriptive-cross-sectional study, totally 100 samples (16 from input and output of the treatment plant, 36 from wells inside the city and 48 from those outside) were taken in wet and dry seasons in 2013 and 2014, which were then analyzed by ion chromatography in less than 6 hours after the sampling finished. Average concentration of nitrate, nitrite and chloride in the treatment plant, and wells outside the city, supplying more than 95% of potable water in Ardabil City are: (3.84g/l, 0.033 g/l, and 96.5 g/l) and (8.46 g/l, 0.042 g/l and 7.17 g/l), respectively. Concentrations of these compounds in wells inside the city, supplying lower than 5% of potable water are 30.07g/l, 0.032g/l, and 169 g/l, respectively. No significant difference was observed between nitrate in treatment plant and wells outside the city (p=0.493), while a significance difference was observed between nitrate in treatment plant and wells inside the city (P=0.006). For nitrate and chloride in wells inside and outside the city, there was also a significant difference. But, for nitrite no significant difference was found in wells inside and outside the city as compared to other sources. Nitrate, nitrite and chloride concentrations of all samples within standard limits, andnitrite levels are much lower thanMaximum Contaminant Levels (MCL). Since more than 95% of potable water of Ardabil City is supplied by the water treatment plant and wells outside the city, concentrations of the parameters were desirable, but relatively high levels of nitrate and chloride in the wells inside the city compared to the other sources makes continuous monitoring of water quality of these sources necessary. Of course, the effects of wells inside the city on quality of the potable waterareslight, because water in the wells inside the city enters the reservoirs for dilution before entering to water network.

To Cite This Article: Nahid Zeinizadeh Jeddi, Fatemeh Nasehi, Ebrahim Fataei, Morteza Alighadri, Measurement of nitrate, nitrite and chloride concentrations in potable water sources (Case study: Ardabil City, Iran). ***Adv. Environ. Biol., 9(2),*** *836-841, 2015*

INTRODUCTION

Water quality has great importance for humans, because it is directly connected their well-being (1). Ardabil City is the center of Ardabil Province, northwest of Iran. (2) Balekhloo River, with a discharge rate of 90 million m^3/year runs northward in the middle of the city. Potable water of Ardabil City is supplied by three sources: Yamchi Dam (water source Ardabil water treatment plant), Zaranas water facilities including 10 deep wells outside and 24 deep wells inside the city at the banks of Balekhloo River [3], only three of inside well is being utilized due to relative drop of water quality in wells inside the city as well as use of the treatment plant.

Nitrate is a common pollutant of ground waters of the world. Nitrate and nitrite are mainly water soluble generated naturally through oxidation of nitrous compounds by aquatic microorganisms, soil and in low contents by electric discharges such as thunder [4]. They mostly enter the body through digestion, which the nitrite formed by reduction of nitrate by oral bacteria almost accounts for 80% of total nitrite [5].

Nitrate originates from or occurs naturally groundwater or point sources such as disposal of fertilizers from certain places, absorption wells, effluents, animal husbandries, industrial sewages, and food residues or non-point such as application of agricultural fertilizers in parks, golf courses, grass lands and orchards [6,7,8,9].

In recent years, average levels of nitrate are increasing in groundwater sources owing to agricultural developments and human activities [10, 11].

Corresponding Author: Fatemeh Nasehi, Department of Environmental sciences, Ardabil Branch, Islamic Azad University, Ardabil, Iran.
E-mail: Abfa_ardabil@yahoo.com

Today, increased concentrations of nitrate and nitrite in natural waters, especially groundwater sources have created concerns for supplying the potable water [12].

According to national standards of Institute of Standards and Industrial Research of Iran (ISIR)recommendation of WHO, maximum allowable concentration for nitrate is 50mg/l andnitrate in terms of NO_2 is 3mg/l and US EPA determined 45 mg/l as the maximum concentration for nitrate. If it goes beyond this limit, it could be dangerous for health. Of course, it is noteworthy that because of simultaneous presence of nitrate and nitrite ions in the potable water, total ratios of measured parameters to standard values should be lower than or equal to 1 [13, 14, 15].

If nitrate concentration is higher than the standard level, such water is hazardous to children especially those younger than 6 months old and causes a disease called methemoglobinemia [16, 17].

In addition to children, other groups exposed to excessive amounts of nitrate are pregnant women, old people and individuals suffering from digestion disorders or a deficiency of acidic property of stomach [19-20].

With regard to the importance of nitrate in potable water, similar studies was carried out on quality of potable water in Ardabil City, particularly its amounts in water supplies (Alighadri et al, 2011) [21].

Since chloride can infiltrate water sources through dissolution of soil salts, natural resources, wastewaters, industrial effluents, municipal chlorinated runoffs, defrost of salts and infiltration of salty waters are the sources of chloride, and its concentration increases in water sources exposed to evaporation [22]. High concentration of chloride is sign of pollution. Overexploitation of water sources can also result in salinity of water. Hygienically, chloride is of minor importance, and the favorable limit (250mg/l) and permissible maximum (400mg/l) as a national standard was not set based on pathogenicity and even on taste makings properties, because, in some cases, its sour taste is felt in 500mg/l or even 1000mg/l [14]. Based on WHO standards, no permissible limit was recommended for chloride in drinking water. It was also stated that possibility of feeling sourness increases in chloride concentrations greater than 250mg/l, but some consumers may feel it in lower doses [15].

"Nitrate concentrations in groundwater of Sopore town and its envirions in Kashmir, India"(2007) showed that almost 85% samples collected in summer and 67% of samples collected in winter contained nitrate concentrations above the permissible limit (50mg/l) as a result of using nitrogen-containing fertilizers [23].

Diversity of water supplies in Ardabil City, probable differences of their physical and chemical qualities, and probable pollution of water sources including the dam due to environmental changes and human activities, etc.; wells a result of wastewater penetration and surface waters, …, which is the reason of this study for monitoring water supplies of the city.

The study area

Ardabil Province, as vast as 1795km^2 (an area, 1.1% of Iran), is located in northwest Iran. This province lies between 37 45 to 39 42 northern latitudes and 47 30 to 48 55 eastern longitudes. Based on the census in 2011, 1,249,000 persons are living in the Province, out of which 418,262 persons are living in Ardabil City as the its center [2].

Production and distribution of healthy and hygienic potable water in Ardabil City is undertaken by the Municipal Water and Wastewater Company. Potable water is supplied by three sources: Yamchi Dam (water treatment plant)25km from the city, Zarnas wells 23km from the city and the wells inside it. Figure 1 shows the location of water sources in the study area [3].

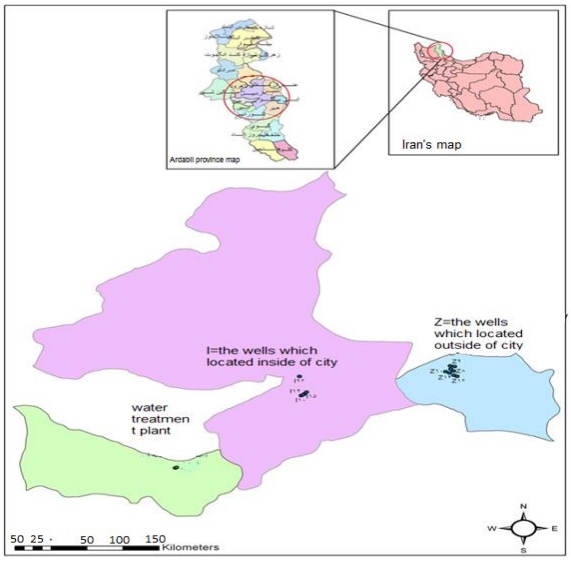

Fig. 1: Location of potable water sources in the study area

MATERIALS AND MATERIALS

In this paper, totally 100 samples were collected from 8 water wells in Zaranas and 6 wells inside the city in wet seasons (spring and autumn) and dry season (summer) as well as input and output of Ardabil water treatment plant in four seasons , 2013 and 2014 (16 samples each season). Geographic coordinates of the study area were collected by a GPS device and were located on the map.

The samples were kept in a one-liter Pyrex container, immediately sent to the laboratory and all of them were analyzed by ion chromatography no later than 6 hours after sampling was done. After nitrate, nitrite and chloride levels were measured, the results were analyzed to prepare a databank and to draw comparative diagrams. Then, the obtained data were compared with standards of WHO, US EPA and ISIR.

Results:

Table 1: Average concentrations of nitrate, nitrite and chloride in the water sources under study in wet and dry seasons

row	source name	avr.w/avr.d	mg/l			row	source name	avr.w/avr.d	mg/l		
			CL^-	NO2-	NO3-				CL^-	NO2-	NO3-
1	z9	avr.w	5.0	0.08	11.1	9	input.t	avr.w	82.5	0.06	9.4
	z9	avr.d	3.3	0.03	8.0		input.t	avr.d	83.5	0.03	5.1
2	z16	avr.w	6.7	0.04	13.3	10	outp.t	avr.w	93.3	0.04	3.3
	z16	avr.d	6.0	0.01	10.0		outp.t	avr.d	99.7	0.03	4.4
3	z8	avr.w	6.8	0.08	14.2	11	I 38	avr.w	177.5	0.02	39.6
	z8	avr.d	15.0	0.01	6.9		I 38	avr.d	148.5	0.03	43.8
4	z13a	avr.w	5.0	0.06	9.8	12	I 26	avr.w	137.0	0.05	44.9
	z13a	avr.d	7.5	0.02	8.0		I 26	avr.d	138.5	0.03	45.6
5	z15	avr.w	4.5	0.06	5.3	13	I 10	avr.w	177.5	0.03	9.9
	z15	avr.d	3.9	0.02	6.5		I 10	avr.d	181.0	0.03	10.7
6	z14	avr.w	13.0	0.05	8.2	14	I11	avr.w	180.8	0.03	31.7
	z14	avr.d	10.5	0.04	8.8		I11	avr.d	161.5	0.03	23.5
7	z10	avr.w	12.5	0.07	9.4	15	I15	avr.w	175.5	0.05	44.0
	z10	avr.d	14.3	0.03	8.3		I15	avr.d	180.0	0.02	35.2
8	z12	avr.w	6.3	0.05	10.0	16	I 12	avr.w	179.5	0.03	16.1
	z12	avr.d	5.0	0.02	8.3		I 12	avr.d	176.5	0.03	10.4

Z= well outside the city
I= well inside the city
Input.t= input of the treatment plant
Output.t =output of the treatment plant
Avr.W= average of the wet season
Ave.D= average of the dry season

Table 2: Maximum and minimum concentrations of the pollutants in the wells outside the city

Source name	max/min	mg/l		
		CL^-	NO2-	NO3-
Z	max	17.0	0.11	19.1
	min	2.0	0.01	1.1

Z= the wells outside the city

Table 3: Maximum and minimum concentrations of the pollutants in in the wells inside the city

Source name	max/min	mg/l		
		CL^-	NO2-	NO3-
I	max	211.0	0.1	50
	min	120.0	0.01	5.9

I= the wells inside the city

Table 4: Maximum and minimum concentrations of the pollutants in outputs of the treatment plant

Source name	max/min	mg/l		
		CL^-	NO2-	NO3-
Output of treatment plant	max	122.0	0.05	8.2
	min	73.6	0.01	1.9

Advances in Environmental Biology, 9(2) January 2015, Pages: 836-841

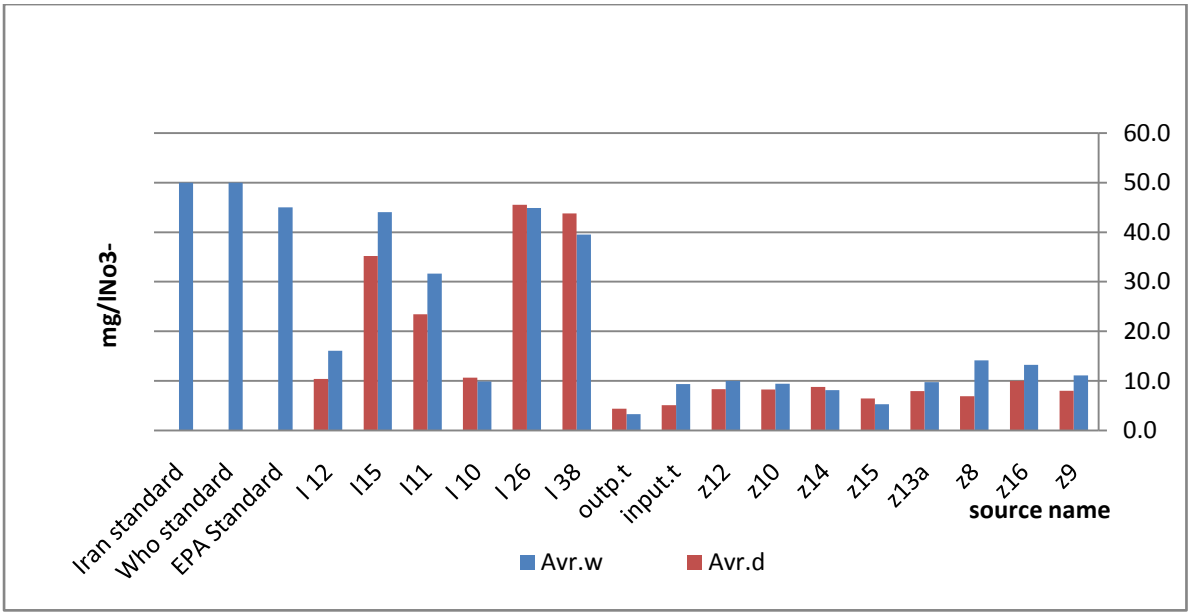

Diagram 1: Comparison of nitrate concentrations in the water sources in wet and dry seasons with national and international standards

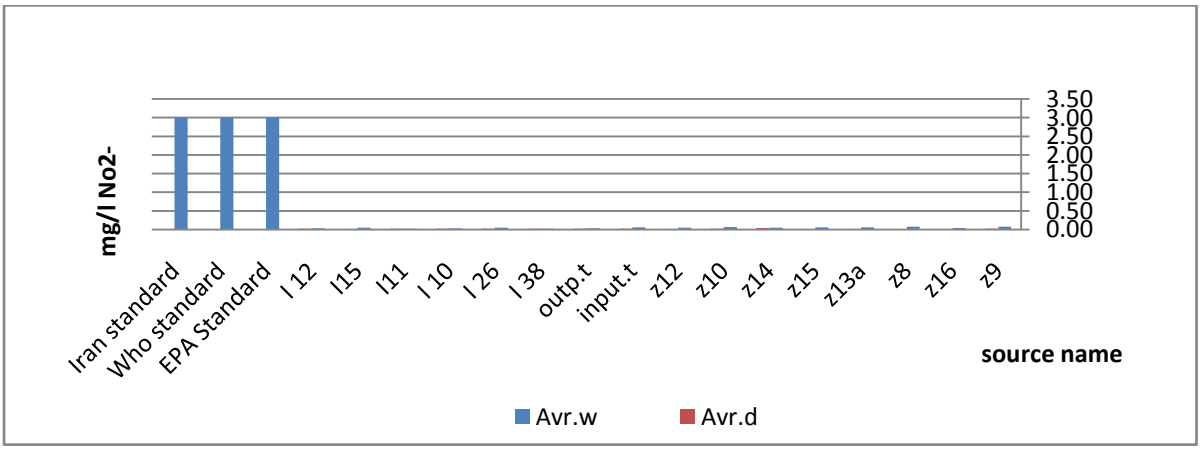

Diagram 2: Comparison of nitrite concentrations in the water sources in wet and dry seasons with national and international standards

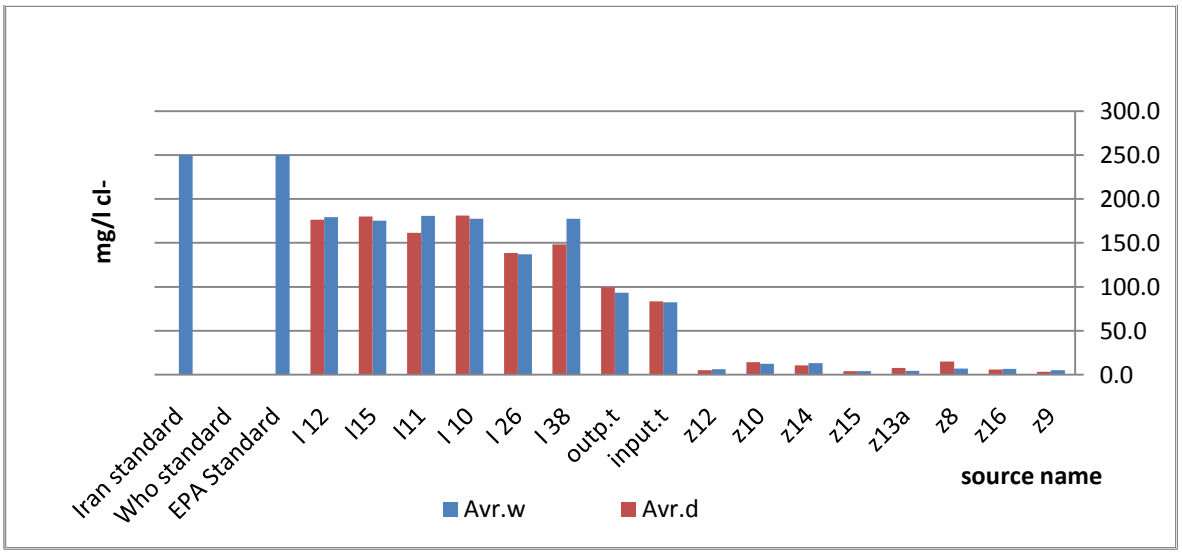

Diagram 3: Comparison of chloride concentrations in the water sources in wet and dry seasons with national and international standards

Advances in Environmental Biology, 9(2) January 2015, Pages: 836-841

Since according to Iranian National standard on nitrate and nitrite, the sum of ratios of each of them to recommended values should not be higher than 1. Thus, the following equation was calculated for all the samples, which for all of them it was desirable, i.e. lower than one. Diagram4 shows a comparison of factor b values among (average) samples water resources in wet and dry session, 2013 and 2014.

$$\frac{\text{c:nitrite}}{\text{cv:nitrite}} + \frac{\text{c:nitrate}}{\text{cv:nitrate}} \leq 1$$

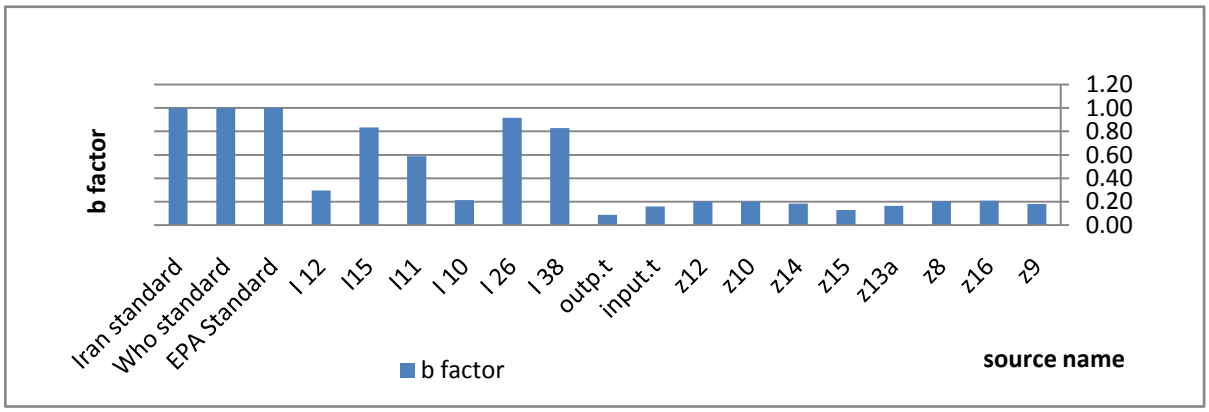

Diagram 4: Comparison of factor b values among samples of water resources

Discussion and conclusions:

Today, as population is growing increasingly in megacities, water pollution is also increasing. Improper disposal of municipal wastewaters through absorption wells; excessive use of detergents and cleaning agents, which infiltrate deep in the earth and pollute groundwater; chemical fertilizers and manures,pesticides, insecticides, … are main reasons of pollution potable water. Poisons such as nitrate threaten the health of our children slowly and continuously. Nitrification cycle is still running in cities where improper disposal of wastewater goes on resulting in continuous generation of nitrate and its diffusion to groundwater.

According to the results, average concentrations of nitrate, nitrite and chloride in all samples taken from the water supplies of Ardabil are desirable and within standard limits, especially concentrations of these compounds both in the treatment plant and the wells outside the city (supplying over 95% of the potable water of Ardabil City) is favorable and mostly much lower than MCL, but nitrate concentration in well no.15 located inside the city in spring 2012 was 50mg/l, and chloride at the same well in spring 2013 was 211mg/l. Nitrite concentrations was much lower than MCL in all samples. This fact in spite of low levels of nitrite indicated that the existing pollution has not happened recently and instantaneously, this happened over a long time and will continue if necessary measures are not taken. Low levels of nitrate and chloride in the wells outside the city and the treatment plants is the distance of these facilities from the city and probable reduction in pollution as a result of human activities, urban sources, absorption wells, and soil texture and treatment processes and coagulants used in water treatment.

With regard to scarcity of water sources and increasing growth of population and possibility of being exposed to pollution through a variety of ways, control of boundaries of water sources, supervision on agricultural fertilizer usage, planning to control municipal, industrial and agricultural, expansion of wastewater collection and treatment networks are practical ways to control nitrate, nitrite and chloride concentrations in water supplies of Ardabil City.

Relatively, high levels of nitrate and chloride in the wells inside the city make continuous monitoring of water quality of these sources necessary.

REFERENCES

[1] Gupta, S., A. Mahato, P. Roy J.K. Datta and R.N. Saha, 2008. Geochemistry of groundwater, Burdwan District, West Bengal, India Environmental Geology, 53(6): 1271-1282.

[2] Grandwater and its susceptibility to degradation ,a global assessment of problem and option for management ,Division of Early Warning and Assessment United Nations Environment Programme(UNEP)

[3] ABRAN Consulting Engineers, 1388. studies of water transfer line from Ymchi dam , purification, storage and distribution of drinking water in Ardabil city.(in Persian)

[4] Well Management 2010. Section Environmental Health Division Minnesota Department of Health(Third Edition (well owner's handbook

[5] Document 2013. for Public Comment Prepared by the Federal-Provincial-Territorial Committee on Drinking Water Consultation period ends.
[6] WELL WATER NITRATE MONITORING PROGRAM, 2011. nova scotia environment 2011 REPORT, Well Water Nitrate Monitoring Program.
[7] Fact sheet Nitrate in Drinking Water (state Oregon,department environmental quality) Last Updated: 03/08/2012 By: Sheree Stewart 11-WQ-012)
[8] Drinking Water Facts….nitrate. By: Barbara Daniels and Nancy MesnerRevised December 2010, utahstate university water quality extension)
[9] miranzadeh ,mohamad bager, heydari, Mohsen, dehgan, samaneh,hasanzadeh ,1389,review of nitrate in drinking water and its health effects , With emphasis on the effects of carcinogens in humans, ournal of Health System / Sixth Year / Special Edition 1389). (in Persian)
[10] Water Quality Fact Sheet: Nitrate .british geological survey
[11] JordanMutewekil M. Obeidat1, Muheeb Awawdeh2,Fahmi Abu Al-Rub3 and Ahmad Al-Ajlouni,An Innovative Nitrate Pollution Index and Multivariate Statistical Investigationof Groundwater ChemicalQuality of Umm Rijam Aquifer (B4), North Yarmouk River Basin, Jordan
[12] Dolatshahi, shidon, Malakotuyan, mohamad,momeni, jamshid, 1389. Evaluation of nitrate and nitrite in drinking water Bardsir city in 1388. Thirteenth National Conference on Environmental Health
[13] Fact sheet Nitrate in Drinking Water state Oregon,department environmental quality)
[14] Fact sheet Nitrate in Drinking Water Division of Environmental and Occupational Health Services Consumer and Environmental Health Services
[15] Well Water Nitrate Monitoring Program, 2011, nova scotia environment, 2011 report
[16] 1053 Fifth revised,Iran national standard ICS: 13.060.020
[17] Guidelines for drinking-water quality - 4th ed.
[18] Potable water - standards. 2.Water - standards. 3.Water quality – standards4.Guidelines. I.World Health Organization. ISBN 978 92 4 154815 1 (NLM classification: WA 675)
[19] Fact sheet :Nitrate in Drinking Water(state Oregon,department environmental quality) Last Updated: 03/08/2012 By: Sheree Stewart 11-WQ-012)
[20] Hammer, M.J., 2005. Water and Wastewater Technologies.5th ed. Pearson Prentice Hall, Singapore, pp: 137-146-147.
[21] Salvato, j.A., 1992. Environmental Engineering and Sanitation. 4th ed. John Wiley and Sons.Inc. NewYork, 5: 462-700
[22] Pasban, ali, emami, jafar, chtar simab, Maryam, 2008. evaluation nitrate concentration in drinking water resource of Bejnod city.
[23] Alighadri, moreteza, et al, 2011. measurements of nitrate concentration in the supply and distribution of drinking water resources of Ardabil, Ardabil health magazine, second round, second edition, 69: 75.